

# **Identifying barriers to sustainable food production by low resource producers and purchase by low income consumers in Washington and Beaufort Counties, North Carolina**

By

Kimberly Hill

Yiduo Zhang

Dr. Chantal Reid, Advisor

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**Duke University**

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## **Abstract**

Serving the interests of our client, Resourceful Communities of the Conservation Fund, our project investigates ways to better connect low-resource producers and low-income consumers of fresh produce in 31 low-income counties in NE North Carolina. To better characterize barriers rural producers and consumers face to produce and access healthy food, we conducted three separate analyses. A general linear model statistical analysis based on the USDA Food Environment Atlas data was used to identify significant demographic and socioeconomic variables that affect food access at the macro-level. For a qualitative analysis, surveys and interviews were used to define barriers producers and consumers face on the intra-county scale. Using Geographic Information Systems, a spatial analysis was developed to understand spatial patterns of food deserts and access barriers. The qualitative and spatial analyses were focused on two low-income counties: Beaufort County and Washington County, NC. Community stakeholders, local food producers, consumers, and grocery retailers were interviewed. The statistical analysis focused both on 31 target North Carolina counties and on the entire Eastern Coastal plain. Two general linear models revealed that persistent poverty counties and counties experiencing population loss were more likely to experience little or no access to grocery stores. Race was also a factor, particularly within North Carolina where minorities are more vulnerable to food insecurity. Both Washington and Beaufort Counties exhibit a high level of economic and demographic stratification. Two-thirds of consumers from the survey had problems stretching their food budget, and identified a weekly food box at low or no-cost as the best intervention. Retail grocery stores already can and do buy local food. However, retailers buy locally according to the season and price. Major barriers to connecting low-resource producers and low-income consumers were identified as the decrease in the number of small farms, increasing bureaucracy, high cost of entry, and historical divisions between ethnic and socioeconomic groups. Using the geographic and socio-economic barriers, the spatial analysis identified three food deserts, in SE Beaufort County, NE Beaufort County, and SW Washington County and the main drivers for each.

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# 1. Introduction

## 1.1 Definition of a Food Desert

Coined in the United Kingdom in late 1990s, the term “food desert” has gained popularity among researchers, governmental agencies, and the general public (Cummins and Macintyre, 2002; Eckert and Shetty, 2011; Apparicio et al, 2007). This term has been commonly used as a qualitative descriptor of the status of food-stressed communities characterized with “poverty, social exclusion, and... non-existent and/or poor food retail provision” (McEntee and Agyeman, 2010). Despite frequent references, food deserts have “no singularly accepted classification”, and therefore are a conceptual idea rather than a clearly and quantitatively defined concept (McEntee and Agyeman, 2010). Multiple definitions have been proposed by various scholars and agencies in various contexts. Some definitions have a highlighted emphasis on socioeconomic barriers to healthy food, such as price and affordability of the food. For example, many studies of US food deserts (e.g. USDA 2009 and Parsons 2012) have cited the definition in the 2008 Farm Bill–“an area in the United States with limited access to affordable and nutritious food, particularly such an area composed of predominantly lower-income neighborhoods and communities (Title VI, Sec. 7527).” In contrast, other definitions address both the geographical (distance to outlets, density of outlets, etc.) and socioeconomic barriers to food accessibility. For example, McEntee and Agyeman’s 2010 review used the United Kingdom Department of Health (1996) definition of food deserts - “areas of relative exclusion where people experience **physical** and **economic** barriers to accessing healthy food”.

Informed by the United Kingdom’s research, the USDA-Economic Research Service (ERS) developed an interactive mapping tool to “investigate multiple indicators of [nationwide] food access” known as “the Food Desert Locator.” In 2010, the USDA-ERS introduced the “Food Access Research Atlas,” an updated version that reflects new data and more refined quantitative methods (USDA-ERS, 2006 & 2010). Although not the first effort to bring the conceptual idea of “food deserts” into a quantitative context, the Food Access Research Atlas is a successful preliminary framework that enjoys universal recognition, grants public access to its results, and keeps inspiring new quantitative methodology of food access research. However, due to its nationwide scope and lack of comprehensive understanding in this relatively new field by its time of development, the Atlas applies simple criteria based on distance, income level, and vehicle availability in its mapping (USDA-ERS, 2010). The census tract scale output – a small statistical subdivision of a county - and the simplified analytic criteria prohibit the direct derivation of a quantitatively refined definition of food desert. These limitations reduce the reference value of the USDA data in fine-scale research and local decision making. An explicit definition with a comprehensive set of quantified criteria is needed in order to facilitate local-scale food desert studies.

Parsons (2012) challenged the definition of food desert applied by the Atlas (the “USDA definition”) and addressed its drawbacks by expanding the criteria set. Criticizing both the geographic and socioeconomic components of the USDA definition as incomplete and incomprehensive, Parsons (2012) highlighted additional barriers in food accessing in urban communities of Durham, North Carolina using a focus group-supported case study approach. Parsons (2012) recommended a set of 14 criteria to forge a comprehensive definition to support better policy-making. These criteria include fine scale (census block level) household median income, cost of produce, SNAP/EBT acceptance<sup>1</sup> by food retailers, access to fast food, travel distance/time, obesity and diabetes rates, and feasibility of public transportation (Parsons 2012). Some of these criteria may be relevant for food desert studies in a rural context.

### *Characteristics of Food Deserts*

Despite different definitions and aspects of focus, common characteristics of food deserts emerged across studies. Highlighted below are frequently discussed characteristics.

- *Multiple Barriers*: barriers to food access are heterogeneous, for example, varying from location of residence to cooking knowledge (Parsons 2012). Some researchers summarize the multiple aspects of food access into three categories—geographic (or physical) access, economic (or financial) access, and informational access (McEntee & Agyeman, 2010; Eckert and Shetty, 2011);
- *Complexity in Barrier Interaction*: some of the identified barriers to food access can interact with each other. For example, many low-income populations are found to be spatially clustered (Eckert & Shetty, 2011), which exacerbates the limited access issue by providing little incentive for supermarkets to come to these neighborhoods. Inefficient or inconvenient means of transportation tend to be associated with these neighborhoods, especially the lack of public transportation and privately owned vehicles (Eckert & Shetty, 2011);
- *Contextual Specificity*: the main drivers of food deserts in urban, suburban, and rural areas might be different. USDA (2009) identifies racial segregation and income inequality as main characteristics of urban food deserts. However, in rural contexts food access is more likely to be limited by “the lack of transportation infrastructure”. Eckert and Shetty (2011) argue that even within one city, the main stress could vary from area to area due to the heterogeneous nature of the communities;
- *Public Health Implication*: inaccessibility to healthy food has been proved to be associated with diet-related diseases such as obesity, diabetes, and heart disease (Eckert & Shetty, 2011; USDA, 2009; Burns & Inglis, 2007; Larson et al, 2009).

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<sup>1</sup> SNAP/EBT refers to the Supplemental Nutrition Assistance Program (SNAP) / Electronic Benefit Transfer (EBT), which the successor to what was formerly known as the food stamps program. It provides financial assistance to needy individuals and families via an electronic benefits card.

However, little evidence supporting a causal relationship was found. USDA (2009) proposes that limited access of specific healthy food may not be the only or not even a major factor of obesity. “Easy access to *all* food”, argues USDA (2009), is “a more important factor in explaining increases in obesity”, suggesting that obesity is more of a food choice issue than a direct result of limited food accessibility;

- *Vulnerable Populations*: due to frequent co-occurrence of multiple barriers among certain communities, many studies are interested in these “vulnerable populations.” For example, Parsons (2012) and USDA (2009) both quantitatively specify four vulnerable subpopulations in their study areas as focus groups. Vulnerable population characteristics often considered include low income, unemployment, limited vehicle access, minority ethnicity, limited language ability (English in particular), elderly status, and high obesity risk (Parsons 2012; USDA, 2009; Cummins and Macintyre, 2002).

#### **US Food Desert Facts**

- Based on a 1 mile criterion, 2.2 percent of US households experience physical barriers to healthy food and lack access to vehicles;
- 14.3 percent of the low-income community live 10 miles or more from the nearest grocery store;
- On average, lower income people live 0.1 mile closer to the nearest supermarket than higher income people;
- Ethnic/racial minorities and elderly populations are not more distance-stressed than the rest of the total population;
- Spatially clustered low-income populations are less distance-stressed than spatially scattered low-income populations. However, the latter makes up most (53.6%) of the total low-income population;
- Areas characterized as both low-income and low-access are the most stressed —this population spend an average of 19.5 minutes on one trip to the grocery store, 4 minutes more than low-income high-access areas and 4.5 minutes more than the national average.

(Source: USDA, 2009)



## **1.2 Project Summary**

“Food deserts”, regions of limited access to adequate food, still exist in the U.S. This lack of food accessibility is especially severe in rural and low-income communities (USDA, 2009). North Carolina currently ranks as the state with the fourth highest level of food insecurity in the United States, with 1 in every 6 North Carolina households reporting they struggled to provide or could not access affordable and nutritious food within the past year (Coleman-Jensen, Nord, and Singh, 2013). Simultaneously, limited-resource local farmers producing healthy food experience difficulty entering local markets due to inadequate market information and competition from industrialized farms and national chain retailers. The goal of this proposed research is to identify barriers producers face to market entry and barriers consumers face to access high quality and nutritious food in a high-poverty region of northeastern North Carolina. By elucidating these barriers, mechanisms can be created to connect producers and consumers in these regions and ensure a sustainable, long-term food supply.

### **Data Availability**

Existing data on food deserts are not sufficient to evaluate food access in the study area – for example, existing USDA Food Desert data only identifies food deserts on a county-wide basis and incorporates limited data on socioeconomic characteristics, including ethnicity, income, and use of government benefits. This data does not account for informal economic activity such as trading and bartering that are relevant to rural populations (Yousefian et al., 2011).

Additionally, little data exists on barriers to market entry for limited resource producers in the proposed study area. Cloak et al. (2011) identified the main barriers to market entry in southeastern NC as lack of proper food safety certification (for example, GAP – Good Agricultural Practices – certification) due to lack of money or information, lack of a low-cost, government-approved food distribution facility for limited resource producers, and lack of technical assistance for limited resource producers to reach markets within North Carolina. The same barriers to entry might apply to the proposed study area; however, no research material other than anecdotal evidence is available (NC Department of Commerce, 2013).

This project, including interview data, will inform a joint community development initiative in 31 high-poverty counties in eastern North Carolina. Resourceful Communities, a specialized program of the non-profit organization the Conservation Fund, will use the data, the report, and the presentation to further refine its work in eastern North Carolina.

## **Objectives**

Given that the lack of small scale data on market barriers to entry, our research objectives were:

- 1) ASSESS economic and social factors that limit the transfer of sustainable food product between low income farmers and local consumers using a literature review and available datasets from the US Department of Agriculture Economic Research Service (USDA-ERS).
- 2) ASSESS local economic and social factors via interviews with local producers, consumers, government officials, and retail businesses in the study area.
- 3) REDEFINE the meaning of a “food desert” for the counties of interest using GIS analysis and qualitative data.
- 4) DEVELOP a set of recommendations for Resourceful Communities on investment sectors and pilot programs appropriate for the proposed project region to maximize healthy, local food choices for rural communities.

## **Selection of Study Area**

The focus of this project was on two counties out of 31 potential counties in Northeastern North Carolina. We decided to focus on Beaufort County and Washington County based on available data on Tier 1 Counties. Tier 1 counties, defined as the 40 most economically distressed counties by the NC Department of Commerce (2013), are of special interest. We chose Beaufort in part to leverage connections Resourceful Communities and other community organizations have in the county, and because of its applicability to the interests of other economic development organizations (e.g., Carolina Farm Stewardship Association). Though Beaufort county includes some extremes of poverty and wealth – for example, the median household income in the county seat of Washington is \$28,750 compared to the county’s \$40,147- it represents the situation of rural farmers in eastern North Carolina very well (US Census Bureau, 2014). Washington County was chosen as a second research area as it is one of the poorest counties in North Carolina and is primarily African-American, but is somewhat similar to Beaufort County.

Washington County is much smaller than Beaufort County, with a population of 12,736 in 2012 (Census Bureau, 2014) as compared to Beaufort County’s 47,507 (Census Bureau, 2014). Beaufort County is primarily white (71.7%) while Washington County is split between Caucasian and African-American residents (47.9% and 49.7% in 2012, respectively). Beaufort County has a relatively higher median household income (\$40,147 in 2012) versus Washington County (\$33,718 in 2012). The poverty rate was 26.5% in Washington County versus 20.6% in Beaufort County in 2012. Beaufort County and Washington County are similarly educated (80.6% with a high school degree in Beaufort County versus 80.8% for Washington County) (Census Bureau, 2014).

## 2. Identifying Food Deserts and Access Barriers using Geospatial Analysis

### 2.1 GIS Application in Food Access Research

Thanks to the rocketing computing power of modern computers and increased availability of geographic and socioeconomic data, efforts to identify and assess food deserts using GIS analysis have been attempted by many, and various methods have been developed. Both geographic and socio-economic barriers in food access have been studied using GIS approach.

#### Evaluating Different Barriers using GIS

Geographic barriers can be modeled in multiple ways. A simple and straightforward approach is to use a distance indicator. McEntee and Agyeman (2010) explored the identification of food deserts using geographic criteria in rural Vermont. The core process of their method was a network analysis based on a road network. Another typical example of the use of a distance indicator is the Food Access Research Atlas (USDA-ERS, 2010).

Travel time is also a popular indicator of geographic accessibility. Burns and Inglis (2007) developed a set of GIS methods based on travel time using different means of transportation to assess geographic accessibility to “healthy food” in urban Melbourne, Australia. In their study, Burns and Inglis (2007) also applied proxies of “healthy food” and “unhealthy food” to explore the health implication of the food desert phenomenon. Their use of *cost surface analysis* to model travel costs was another innovation in the field.

Modeling the intensity of stressors on an area basis is a third approach to examine geographic barriers. Based on the network approach of McEntee and Agyeman (2010), Eckert and Shetty (2011) applied modified methods of distance measurement to summarize the accessibility conditions on a zonal scale. Specifically, they calculated mean distance to food retailers on a census block group basis and used it as a proxy of “average block group accessibility” to healthy food. This zonal summary of accessibility allows for revelation of spatial patterns as well as detection of correlation between food accessibility and other socioeconomic characteristics per study unit. A similar “zonal statistical” approach is found in the USDA’s 2009 food desert research. The 1-mile buffers around supermarkets were overlaid with low-income grid to allow a *zonal statistics* operation to find out the proportion of the low-income population experiencing geographic barriers to healthy food access and the proportion that was not.

In general, incorporating socioeconomic information in GIS-based barrier analysis is not as instinctive. Therefore, these barriers are not commonly assessed alone. Instead, socioeconomic indicators are usually evaluated in geographic contexts especially when such indicators show spatial distribution pattern. Specific socio-demographic

characteristics are used to refine geographic barriers (USDA 2009). For example, limited availability of vehicles is used as a characteristic to refine the distance-based food access analysis. Eckert and Shetty (2011) also employed qualitative examination of socioeconomic characteristics on distance-based food desert areas. They specified that “block groups that could potentially have or develop accessibility issues” were both geologically constrained to healthy food access and economically stressed.

In some other cases, quantitative analyses of socio-economic indicators and geospatial indicators are conducted separately, but the results are interpreted jointly. For example, a multiple discriminant analysis (MDA) was run alongside with GIS analyses in USDA (2009). The MDA identified influential indicators of community food accessibility among a group of demographic and socioeconomic variables and roadway connectivity. The results of the MDA indicated that both roadway connectivity and socioeconomic disadvantages (captured by an “index of disadvantage”) were strongly influential in differentiating population groups of various food access levels.

### **Limitations**

Despite the powerful computing and visualization abilities of GIS-based analysis, this approach is limited by the model assumptions and quality of input data. Most distance-based analyses include the common assumption that people tend to make shopping trips from home. This assumption is based on the idea that communities far from food retailers have limited access to food as the “food desert” definitions suggest. It is potentially problematic because it tends to underestimate other options of getting food. In fact, over 11% of the *low-income* population living in *geographically limited* areas travel to grocery stores from work or other activities instead of from home (USDA 2009). Thus one can reasonably hypothesize that shopping patterns can vary among socioeconomic and geographic subpopulations. As a remedy, food accessibility should be evaluated using multiple alternative measures rather than one measure based solely on distance. For example, in an investigation of Montréal’s food deserts Apparicio et al (2007) employed a variable set of three spatial measures to capture *distance to stores* (“proximity”), *store abundance* (“diversity”), and *average distance to multiple stores* (“store variety”). By incorporating an assessment of shop options, their method proved “very helpful in identifying food deserts according to several dimensions.” Similarly, Mari Gallagher Research and Consulting Group (2007) used store density instead of simple distance measure as a physical accessibility indicator.

Other limitations of current GIS-based approaches include the issue of consumers’ “potential access vs. realized access” (USDA 2009) and data quality (ERS, 2010; Parsons 2012). First, the consumer preference limitation argues that the physical accessibility does not dictate the way people shop and eat; instead, people may choose to shop farther because of price, cultural preference, or other reasons. This limitation can be mitigated by

integrating the socioeconomic and demographic landscapes into the geographic context as patterns in preference tend to be associated with these factors. Additionally, a survey is a reliable approach to address consumer preference. Second, the often limited quality of available datasets are frequent obstacles in many GIS analyses, especially because data are incomplete and/or of low resolution. More sophisticated techniques, such as spatial interpolation, are often used as substitutes although better quality data is always desirable. Because of these limitations, the results of GIS-based analysis should be interpreted accordingly.

## **2.2 GIS Analysis in Our Research**

In our research, the spatial analysis program ArcGIS 10.2 for Desktop was used to analyze geospatial data and identify food deserts and food access barriers in the study area based on a set of criteria developed from USDA's (2011) and Parsons' (2012) food desert definitions. Harry Zhang mapped the location of different producers and food hubs, including traditional grocery stores, farmer's markets, and produce stands, purposefully excluding convenience stores. Additionally, Microsoft Excel and Access 2010 were used for data management, graphing, and some summary statistical tasks.

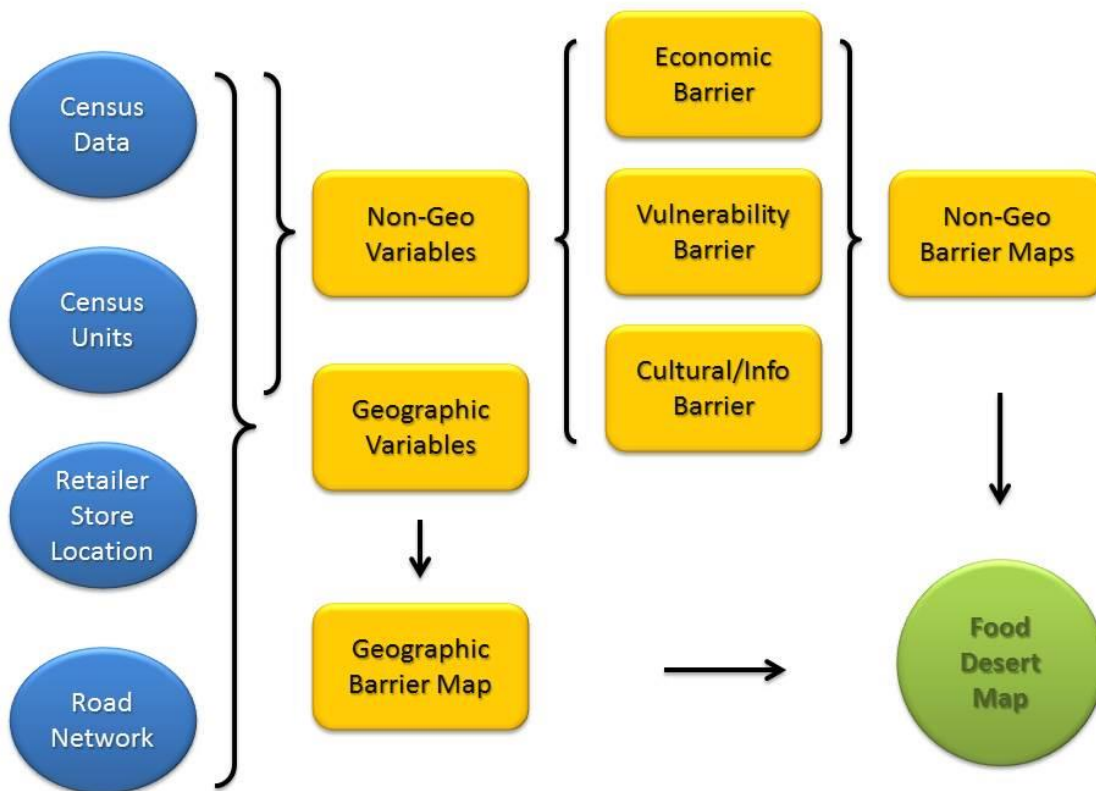
The GIS component of this study accomplished two tasks that serve different purposes. First, the "Food Desert Analysis"—the main body of the GIS analysis—was an integrative analysis using advanced quantitative techniques to furnish a multi-dimensional understanding of the food accessibility issue in the study counties. Due to its emphasis on a comprehensive assessment, the Food Desert Analysis was supported by large quantities of data, more sophisticated analytic techniques, and operator supervision throughout the process. Most of this section presents results and findings from this method. Second, the qualitative mapping tool "Food Desert Locator" is an ArcGIS geo-processing model that enables the user to perform quick and less complex examination of the food access landscape in the study area. It is designed as a user-friendly substitute to furnish resource-limited or efficiency-driven endeavors. As a subset of the Food Desert Analysis, the Food Desert Locator tool is not specifically elaborated here. The tool was submitted as a separate package with other deliverables to the client.

## **Methods**

Three types of non-geographic barriers—*Economic, Vulnerability, and Cultural/Informational* barriers—along with geographic barriers were utilized to evaluate food accessibility. In particular, following the work of Parsons (2012), 8 variables of socioeconomic characteristics were identified (Table 1). Quality and resolution of the input data varied depending on the US Census Bureau. To unify input format and resolution, non-

geographic variables were converted to raster layers using ArcGIS's *Geostatistical Analyst* extension. Geographic barriers were captured by two variables—travel distance to the nearest food retailer, and household availability of vehicles.

The final products of the Food Desert Analysis consist of graphs and maps presenting the statistics and distribution of each barrier type. An ultimate food desert map was also created to integrate all individual barriers. This general workflow is illustrated in Figure 1. A detailed description of the GIS analysis method can be found in Appendices 6 and 7.



**Figure 1 General Workflow of Food Desert Analysis.** Non-geographic barriers are summarized by individual barrier maps as well as an integrated “final score” map. Geographic barriers are summarized in a “distance-based food desert” map. Non-geographic and geographic barriers are combined to generate an “ultimate food desert” map.

**Table 1: Variables and Input Datasets of Non-Geographic and Geographic Barrier Analyses.** Variables were selected to evaluate barriers from different sources. Each variable has one or two input datasets. Whenever possible, auxiliary data was used in spatial interpolation to provide complementary information to the evaluation of a variable. For details about usage of auxiliary-aided interpolation, please refer to program documentation of ArcGIS 10.2 for Desktop (ESRI 2013). Census data was summarized by census units such as census block group or census tracts.

Barrier Group	Variable Name	Primary Input			Auxiliary Input		
		Input Data	Year	Summary Level	Input Data	Year	Summary Level
Economic	Median Household Income	Median Household Income	1999	Block Group	Median Household Income	2012	Tract
	Poverty Rate	% Pop. below poverty	1999	Block Group	% Household Below Poverty	2012	Tract
	Food Stamp Status	% Household on food stamp	2012	Tract	% Household with Non-White Residents	2012	Tract
Vulnerability	Elderly Population	% Pop. 65 and over	2010	Tract	% Pop. 65 and over	1999	Block Group
	Percent Children	% Pop. under 18	2010	Block Group	N/A		
	Disability Population	% Pop. with disability	2012	Tract	% Pop. with disability	2000	Block Group
Cultural/Info	Minority Group	% Non-White Householder	2010	Block Group	% Household with Non-White Residents	2012	Tract
	Education Attainment	% Pop. less than high school	2012	Tract	N/A		
Geographic	Limited Vehicle Access	% Household No Vehicle	1999	Tract	% Worker Driving to Work	2012	Tract
	Travel Distance	Geographic coordinates of supermarkets, big grocery stores, and fresh produce markets/stands	2014	Inside and within 7 miles of Beaufort and Washington Co.	N/A		
		TIGER 2010 Streets	2010				

## Results and Discussion

### *Non-Geographic Barrier Scores*

The resulting *Economic*, *Vulnerability*, and *Cultural/Informational Barrier Scores*, along with the *Final Barrier Score*, are statistically summarized in Table 2. The frequency distributions are presented in Figure 2.

Economic and Cultural/Info scores have realized ranges at 2-100 and 1-99, respectively. The vulnerability score range was only 4-65. This suggests that the vulnerability barrier is not a significant stressor. The final score has a realized range of 11-87. Its moderate lower end suggested that the lowest of the three barriers scores did not coincide spatially. In other words, one place was somewhat stressed by at least one type of barrier. On the other hand, the realized higher score suggests that the severely stressed areas have all barrier types. Notably, the mean values of barrier scores and the final score fall on the lower half of their ranges, indicating larger areas of relatively low scores than of high scores. This observation is consistent with the positively skewed final score distribution observed in Figure 2.

The distributions of vulnerability and cultural/informational barrier scores were characterized with low-score peaks and high-score tails. Such shapes indicate more areas experiencing moderate stresses from these barriers on average. They also indicate that few places suffer severe barriers in terms of dense vulnerable population (children, elderly, people with disability), under-represented population (minority groups), and population with limited nutrition knowledge/information (low education attainment level). In contrast, the symmetric Economic score distribution implies the majority of the study area population experiences medium stresses from limited economic resources.

<i>Barrier Type</i>	<i>Mean</i>	<i>Standard Deviation</i>
Economic	46.83	19.08
Vulnerability	31.92	8.77
Cultural/Informational	38.52	22.42
Final Score	38.76	12.92



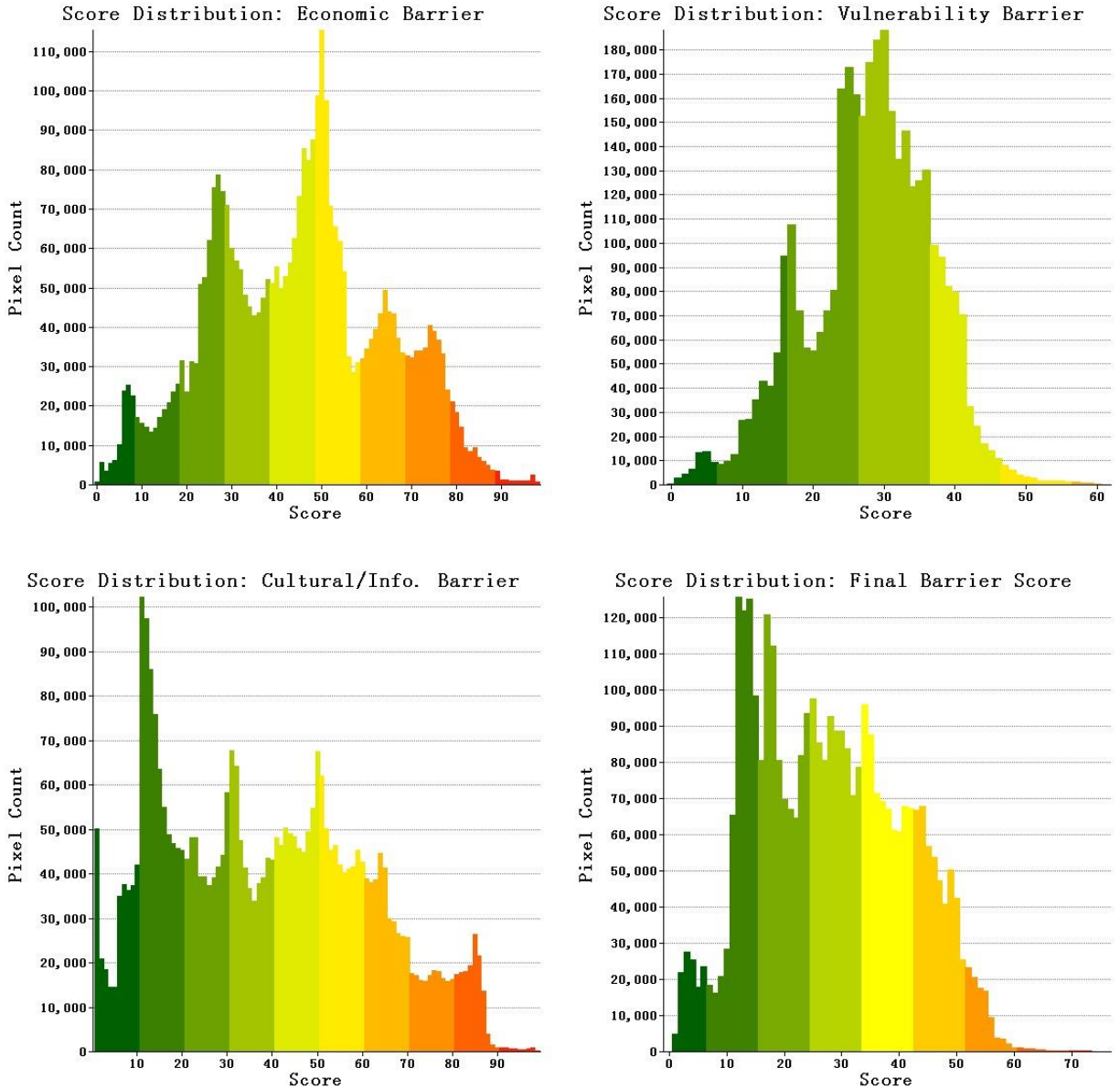
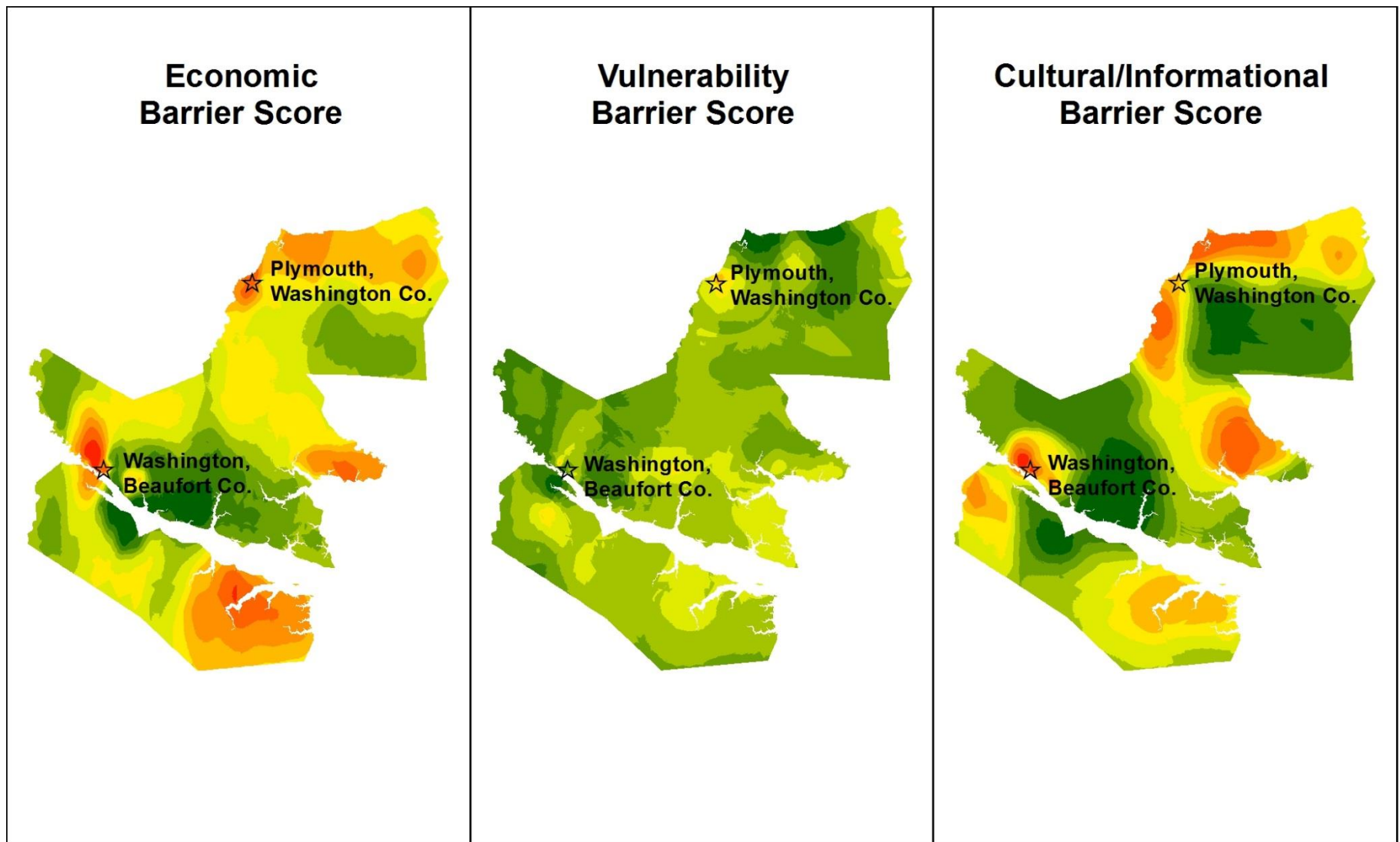


Figure 2: Frequency distribution of barrier scores and final barrier score. Note that Economic scores are roughly symmetric while the others are positively skewed.

Spatially, the greatest non-geographic barriers are found in urban areas near Plymouth, Washington County in the north, and Washington, Beaufort County in the southeast (Figure 3). Significant barriers were also observed in northeastern Beaufort County along the Beaufort-Hyde border, as well as in lower Beaufort County south of the Pamlico River, especially the southeastern region centered roughly at town of Aurora (Figure 3). Also worth noting is north Washington County has stressful Economic and Cultural/Informational conditions, but moderate Vulnerability stresses. In general,

Vulnerability barriers do not show the same spatial distribution patterns exhibited by Economic and Cultural/Info barriers.

The final score map (Figure 4) is a spatial aggregation of the three barrier score maps. Areas significantly stressed by Economic and Cultural/Info barriers are also highlighted by high final scores with bright colors (Figure 4). Vulnerability barrier contributes little to these highly stressful conditions. The majority of study areas fall into low stress (dark green—light green) and medium stress (light green—yellow—light orange) categories. High overall non-geographic stress (orange—red) is not dominant.



**Barrier Scores**

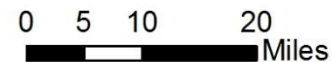
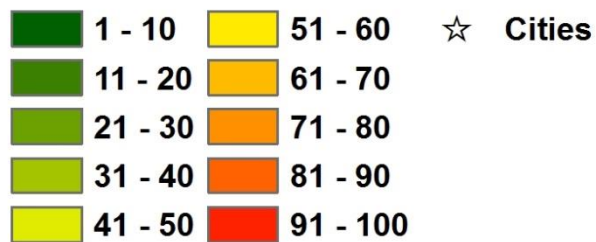


Figure 3: Maps showing distributions of *Barrier Scores* as a result of the Food Desert Analysis. *Barrier Scores* are components of the *Final Score* mapped separately. [Data sources: USDA, US Census Bureau.](#)

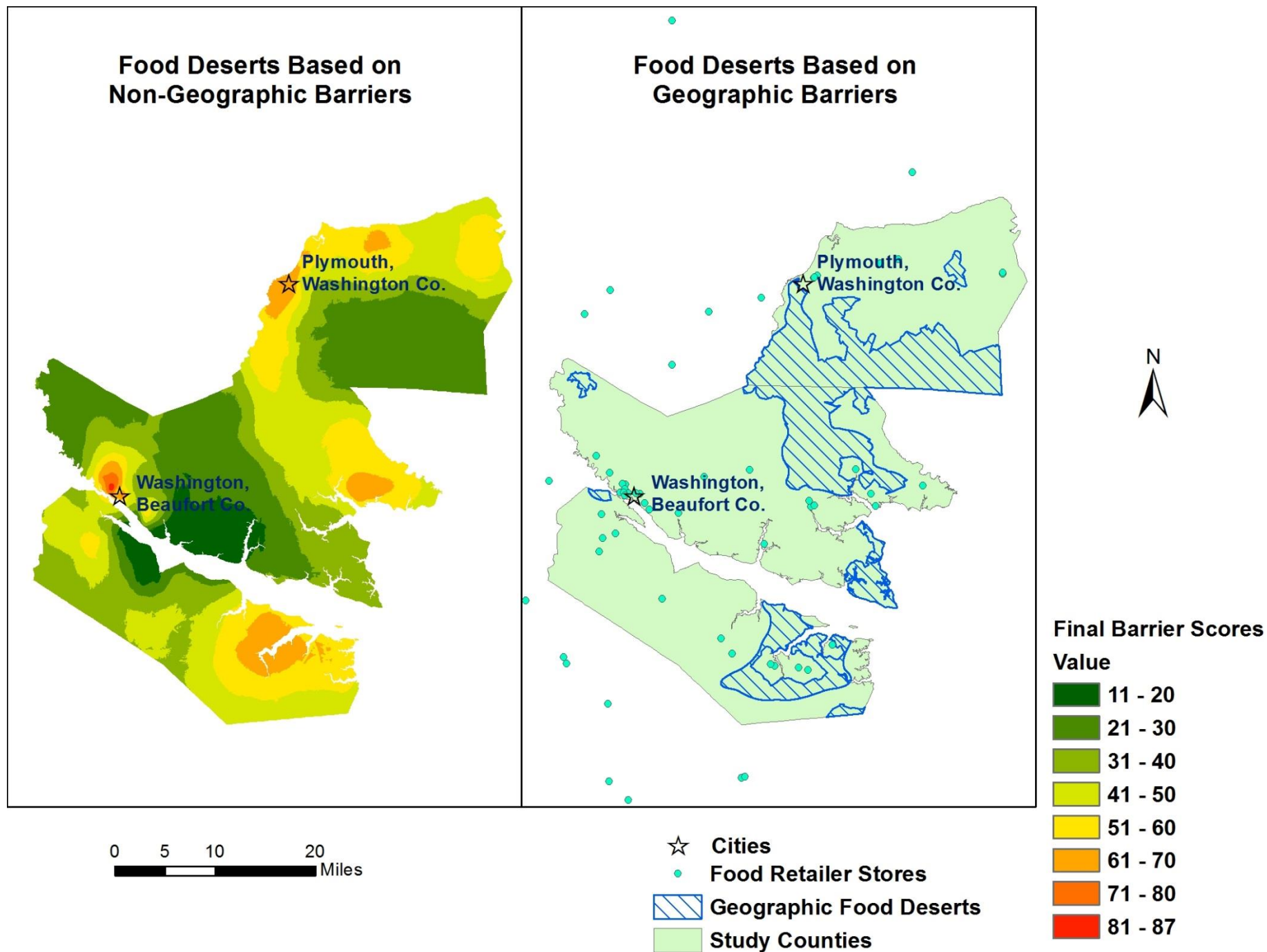
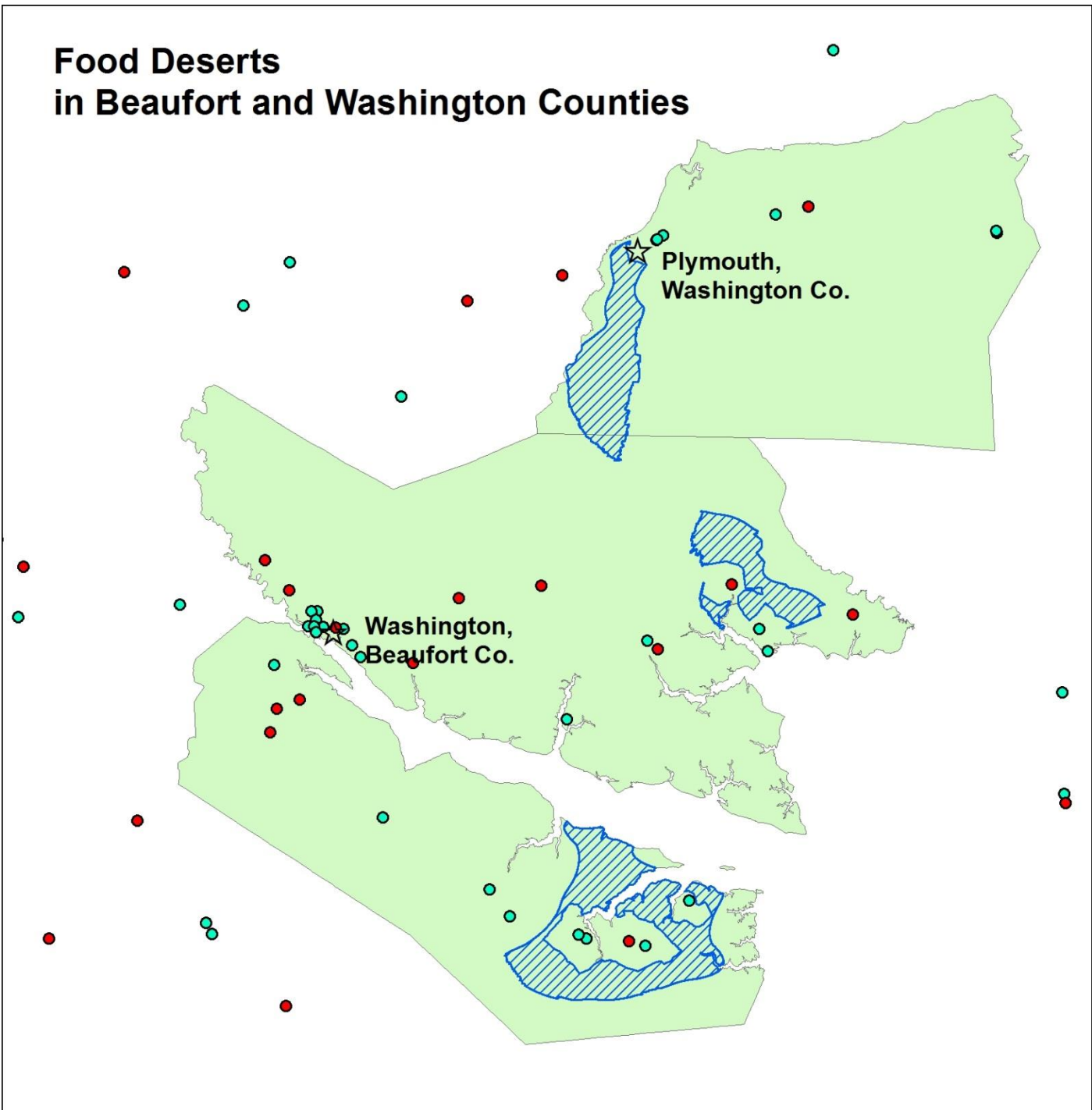


Figure 4 Maps showing results of barrier analyses. Distribution map of *final score* results from non-geographic barriers. *Distance-based food desert* map results from geographic barriers. [Data sources: USDA, US Census Bureau, Google, J. Cates, original data.](#)

# Food Deserts in Beaufort and Washington Counties



- ☆ Cities
- Stores and Markets
- Producers
- ▨ All Criteria Food Deserts
- Study Counties

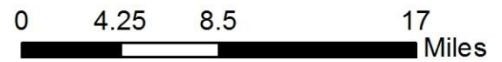


Figure 5 All-Criteria Food Desert map showing areas experiencing both significant non-geographic and geographic barriers to healthy food. [Data Source: USDA, US Census Bureau, Google, J. Cates, original data.](#)

### *Geographic Barriers*

The geographic barriers were integrated into distance-based food deserts (Figure 4). As expected, clusters of food retailer locations tended to occur around urban centers and populous areas. However, some parts of Beaufort County still suffer geographic barriers despite the presence of a number of grocery stores, e.g., northeastern Beaufort County and southeastern Beaufort County near the town of Aurora. Limited access to vehicles is the primary factor in these high-stressed areas although insufficient road connections are also important. The limited food access area immediately north of Pamlico River is well connected by roads and has adequate vehicle access. However, the region lacks food retailer stores. Additionally, the vast areas across the Beaufort-Washington boundary categorized as distance-stressed are results of few retailer stores, sparse road connections, and, to some degree, low vehicle availability. Other distance-based food desert areas are too small to be robust given the possible noise in the input data.

### *Integrated Barriers and Food Deserts*

The final “all-criteria” food deserts were determined by both high non-geographic barrier score and prominent geographical barriers. The intersection of these two criteria located three patches of food deserts (Figure 5). Respectively, the food deserts were located south of Plymouth in Washington County, northeast Beaufort County near Hyde County, and southeast Beaufort County by the mouth of Pamlico River. Totalling approx. 58,415 acres or 91.3 square miles, these food deserts are recognized as places in the study counties where people’s access to food is most seriously limited by their socio-economic conditions and distance to outlets of healthy food. Worth noting is the city of Washington in Beaufort County, which experiences significant non-geographic barriers but is excluded in the final food deserts analysis due to dense clusters of grocery stores in the city’s vicinity.

In Beaufort County economic and cultural/informational barriers are the primary non-geographic drivers of the food desert phenomenon. This is supported by highly overlapping food desert areas and high barrier scores. Geographic drivers of Beaufort County food deserts are vehicle availability and road connections. In addition, vehicle availability is often correlated with economic characteristics. For example, in the study area percent commuters driving cars had a 0.51 correlation coefficient with median household income. As a reference, the correlation coefficient of median household income and poverty rate was -0.74. In Washington County’s food desert, the biggest non-geographic contributor was the Cultural/Info barrier. The primary geographic barrier was low vehicle availability.

In general, for all identified food deserts Economic and Cultural/Informational barriers are responsible for most of the non-geographic stresses whereas Vulnerability accounts for little (Figure 6). Southeast Beaufort County is most limited by local economic conditions, and Northeast Beaufort and Southwest Washington Counties encounter more

Cultural/Informational barriers. Vehicle availability partly explains geographic access to healthy food retailers, but in reality travel distance is more of a concern.

**Stress Levels of Barriers in Entire Study Area and Identified Food Deserts**

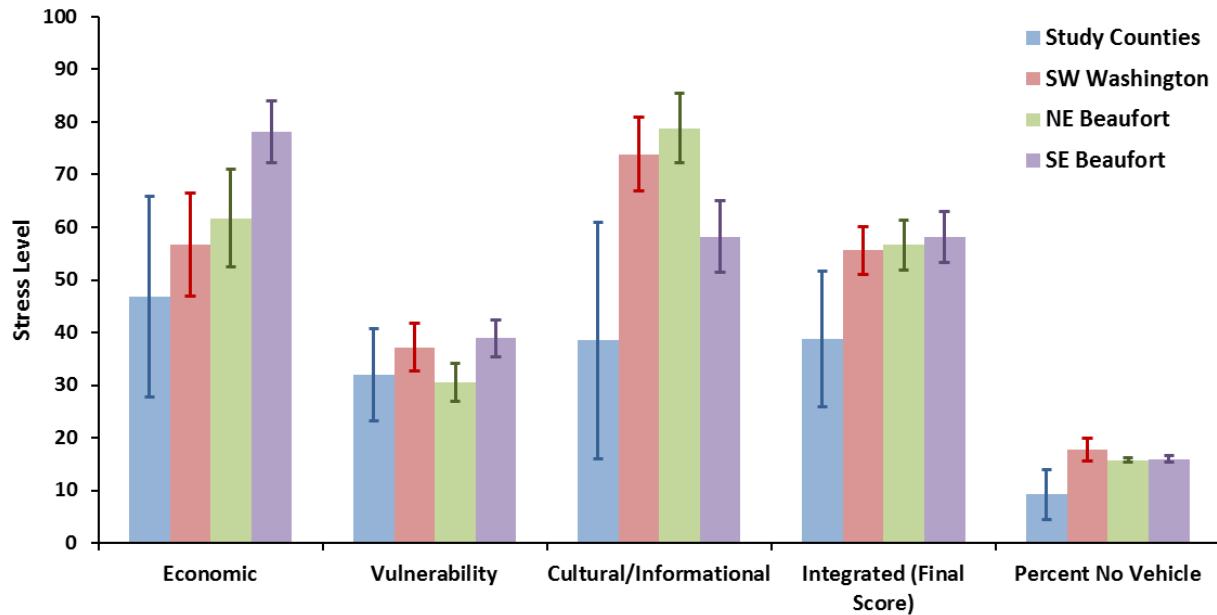


Figure 6 Stress levels of different barriers are compared across food deserts. Presented values are zonal means. Error bars show zonal standard deviations. Difference in stress levels between a food desert and the study area average indicates the magnitude of one barrier’s contribution to the local food desert condition. Note that stress levels of non-geographic barriers are measured by barrier score, while geographic barrier (i.e. vehicle availability) is measured by percent family having no vehicles.

## Recommendations

The Food Desert Analysis implies site-specific focuses in different food desert areas based on their specific major drivers.

Southwest Washington and Northeast Beaufort Counties experience prominent cultural and informational barriers resulting from high minority populations and limited education attainment. Certain cultural and educational backgrounds affect people’s food choice through culture-related preferences, limited knowledge and information about dietary health, or a combination of both. Work in Southwest Washington and Northeast Beaufort communities should thus focus on nutrition assistance programs that promote public awareness of dietary health and increase access to nutritious food. The limited food access situation of Southeast Beaufort County is economy-driven. For these communities, alternative affordable grocery options such as CSA (community supported agriculture) boxes and farmers’ markets should prove effective.

Furthermore, communities having limited access to vehicles and sparse retailer stores in proximity, such as Southwest Washington, could benefit vastly from free/low-cost transportation services and occasional market events in these neighborhoods.

Finally, the city of Washington also faces limitations due to economic and cultural/informational barriers. However, its situation is fortunately mitigated thanks to the considerable number of grocery stores in the urban area. Even though the city of Washington is not categorized as a food desert, efforts can also be considered to address its non-geographic barriers when resources allow.



### 3. Identifying Demographic Variables that Affect Local Food Access

The initial research question was “which socioeconomic variables affect the existence of food deserts in the counties in question?” To address this question, we mined the database from the Food Environment Atlas, developed by the USDA-ERS in 2012.<sup>2</sup> The Food Environment Atlas was developed from 2012 onward using data from the US Census Bureau, the Agricultural Census, the Center for Disease Control and Prevention, the National Cancer Institute, the University of Illinois-Chicago, and the National Farm-to-School Program. We elected to use the entire 31-county study area due to the greater amount of data available on the county level, and also to better characterize demographic and socioeconomic variable which affect food access.

Thus far only about a dozen published studies have been conducted using Food Environment Atlas data.

Ahern and Sterns (2013) evaluated the success of southeastern farms involved in direct sales to consumers. They argued that “Because the Southeast has the highest share and number of small farms of the major US regions, the increased consumer demand for direct-to-consumer marketing of farm products [offers] an exceptional opportunity for the farmers and food system of the region.” They concluded that low grocery store access coincided with the likelihood of farm success. Notably, the percentage of the population that was white and the percentage of the population below poverty level were negatively related to farm performance (Ahern and Sterns, 2013). Ahern, Brown, and Dukas (2011) concluded that availability of grocery stores and supermarkets coincided with better health outcomes and higher levels of direct farm sales are associated with lower levels of mortality and obesity in rural areas. Jilcott et al. (2011) came to a similar conclusion, but noted that the presence of other food sources attenuated the influence of farmer’s markets and direct sales. Bennett, Probst, and Pumkam (2011) used the Food Environment Atlas to compare health outcomes in rural areas experiencing persistent poverty. They noted a new definition of a rural food desert is needed. Schmit and Gomez (2011) used the Food Environment Atlas and surveys of local farmers’ markets to evaluate vendor performance.

However, to date, no one has used the Food Environment Atlas to characterize regional demographic variables that affect the percentage of people experiencing low access to food. This study is an attempt to determine which demographic variables affect people experiencing low access to grocery stores, which serves as a proxy for a “food desert.” Unfortunately, most of the study area (including the entirety of North Carolina) was missing data for direct sales from farms. Thus we did not include local food variables in the regression due to a lack of data.

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<sup>2</sup> The Food Environment Atlas is available online at <http://www.ers.usda.gov/data-products/food-environment-atlas/about-the-atlas.aspx#.UpzLN5Ssim4>.

### 3.1 Data Selection and Statistical Analysis

As an initial model, we used multiple Ordinary Least Square (OLS) regression to interpret the 31 counties of interest in Northeastern North Carolina. We selected the total percent of the population with low access to a major grocery store on the county level as the response variable. To ensure a more accurate regression, we extended the statistical analysis outside of the original 31-county study area in North Carolina, and included regional coastal plains counties in Virginia, South Carolina, and Georgia as defined by the Environmental Protection Agency's definition of an ecoregion. We then applied the original model (Model 1) to a larger sample size of coastal plain counties and independent cities across Virginia, North Carolina, South Carolina, and Georgia. The list of the original 31 counties and the additional observational counties for model 2 is available in **Appendix 1**.

The Eastern coastal plain runs along the East Coast from Maine to Georgia defined by lowlands dominated by woodland, urban land, or marshland with less than 20% used as pasture land or crop land (EPA, 2000). Two subsets of Ecoregion VIII, the Level III Middle Atlantic Coastal Plain (number 63) and the Southern Coastal Plain (number 75), was used to define counties included in this study from Virginia to Georgia with similar climates and land use histories to the North Carolina counties of interest (EPA, 2013). Every county fit in or near the ranges defined by the original 31 county study area in terms of the percentage of the population experiencing low access to healthy food (2.8-24.6%), median household income (\$30,586-\$59,522), and poverty rate (9-27%). Notably the data from the North Carolina counties of interest is extremely variable, reflecting historical poverty in the area and tourism development that has decreased poverty and increased income in counties such as Camden and Dare.

### 3.2 OLS Analysis of Demographic Variables

#### *Introduction*

As a primary step, we removed county #13, (Greene County) due to its having a zero value for the response variable. For **Model 1** (North Carolina Analysis), there were only 30 observations overall. For **Model 2** (Regional Analysis), we also removed county #46 (Mathews County, VA). Five additional counties or independent cities in Virginia were removed due to unusually high median household incomes (greater than \$70,000), low poverty rates (less than 9%), and urban characteristics that would skew the data. These counties or independent cities were Isle of Wight, King George, and York counties in Virginia, and Poquoson and Chesapeake independent cities. For **Model 2**, there are 85 observations overall.

The response variable for **Model 1** - the percent of the population without access to quality, affordable food - had two significant outliers, Hyde and Dare counties. The response variable was positively skewed with a Shapiro-Wilk (SWILK) test p-value less than 0.001 (Table 4a). The same response variable for Model 2 had one significant outlier, Hyde County.

Below is a complete list of variables, *excluding* interaction terms and transformations.

**Table 3: Identification of Variables Used in the Regression**

<b>Category Name</b>	<b>Variable Name</b>	<b>Units</b>
Access and Proximity to Grocery Store	Population, low access to store (%), 2010	Percent
<b><i>Explanatory Variables of Interest</i></b>		
Demographic Characteristics	% White, 2010	Percent
Demographic Characteristics	% Black, 2010	Percent
Demographic Characteristics	% Hispanic, 2010	Percent
Demographic Characteristics	% Asian, 2010	Percent
Demographic Characteristics	% American Indian or Alaska Native, 2010	Percent
Demographic Characteristics	% Hawaiian or Pacific Islander, 2010	Percent
Demographic Characteristics	% Total Non-White Population (created by adding all other % populations together)	Percent
Demographic Characteristics	Percent of county pop under the age of 18	Percent
Demographic Characteristics	Percent of county pop 65 years old or older	Percent
Socioeconomic Characteristics	Median household income, 2010	Dollars
Socioeconomic Characteristics	Poverty rate, 2010	Percent
<b><i>Control Variables</i></b>		
Socioeconomic Characteristics	Persistent poverty counties=1, 2000	Legend
Socioeconomic Characteristics	Metro counties =1/nonmetro counties =0 as of the year 2000	Legend
Socioeconomic Characteristics	Population loss counties=1, 2000	Legend
Store Availability	Grocery stores/1,000 population (% change), 2007-09	% change
Store Availability	Grocery stores/1,000 population, 2009	# per thousand

\*\* indicates that two variables (%\_NONWHITE and MAJNOWHITE) were created by the researchers.

For **Models 1 and 2**, we chose not to transform the percent of county populations that were white, as this data was found to be normal SWILK p-values of 0.2 (Table 4). The percentage of black population by county was normally distributed according to the Shapiro-Wilk test (Table 4). Poverty rate (POVRATE2010) was also normally distributed along with % of nonwhite population<sup>3</sup>, percentage of grocery store loss, percentage of the population older than 65 (%\_65older) and younger than 18 (%\_18younger) (Table 4).

Additionally, the percentages of Hispanic populations by county were not normally distributed, but made up a relatively small proportion of the population in every county save for Johnston. The same trend held true for Asian, Native American, and Pacific Islander percentages by county. Median household income was positively skewed, indicating a potential need for transformation (Table 4).

For **Model 2**, percentage of the population 65 and older and grocery stores per 1,000 residents (GROC\_2009) were somewhat normally distributed according to the histograms, but had several significant outliers influencing the Shapiro-Wilk value.

**Table 4: Descriptive Statistics for General Linearized Models  
a: Model 1 – North Carolina Analysis n=30**

Variable	Unit	Mean	Std. dev.	Min	Max	SWILK
%_LOW_ACCESS	%	13.630	12.146	0.0031	59.20	p<0.001
%_WHITE	%	58.207	15.893	34.37	88.66	0.20331
%_BLACK10	%	34.252	16.515	2.39	62.27	0.50838
%_HISPANIC	%	4.879	2.847	1.25	12.92	0.02035
%_ASIAN	%	0.606	0.442	0.139	1.99	p<0.001
%_NATIVE	%	0.637	1.018	0.16	4.89	p<0.001
%_PACIFIC	%	0.029	0.025	0	0.10	p<0.001
%_NONWHITE**	%	40.403	16.071	9.79	64.42	0.19554
%_18YOUNGER	%	22.573	2.251	17.91	27.81	0.96820
%_65OLDER	%	15.727	3.028	9.88	21.74	0.75955
INCOME_2010	\$	39632	6919	30586	59522	0.04052
POVERTYRATE2010	%	19.76	4.81	9.7	27.1	0.28917
%_GROCERY_0709	%	-10.90	21.97	-66.8	38.8	0.44603

**b: Model 2 - Regional Analysis n=85**

Variable	Unit	Mean	Std. dev.	Min	Max	SWILK
%_LOW_ACCESS	%	15.42	10.88	0.003	59.20	p<0.001
%_WHITE	%	60.61	14.54	31.16	93.41	0.3528
%_BLACK	%	30.66	14.83	2.39	65.44	0.3986
%_HISPANIC	%	5.65	4.34	1.04	29.32	P<0.001
%_ASIAN	%	0.89	0.86	0.14	6.01	p<0.001
%_NATIVE	%	0.51	0.72	0.07	4.89	p<0.001
%_PACIFIC	%	0.06	0.08	0	0.57	p<0.001
%_NONWHITE**	%	37.76	14.57	5.26	68.14	0.4969
%_18YOUNGER	%	23.19	3.02	16.07	30.55	0.7271
%_65OLDER	%	14.81	4.44	6.26	31.20	p<0.001
INCOME_2010	\$	40781	8430	27917	65478	p<0.001
POVERTYRATE2010	%	19.62	5.47	8	34.3	0.7512
GROCERY_2009	%	0.22	0.09	0	0.53	P<0.001

<sup>3</sup> Sum of Black, Hispanic, Asian, Native American, and Pacific Islander percentages by county

## **Methods**

### **Ethnic Group**

In order to better clarify the correlation between ethnicity and food access for **Model 1 (North Carolina Analysis)**, we determined there were three potential ways to incorporate race into the final model—by using % white values, using % black values, or using % nonwhite values. Overall, populations of other ethnic groups were very small in the 30 counties of interest; African-Americans were on average 91% of the non-white population. We chose to use % nonwhite to represent minority populations, given that one of our major interests was the impact of ethnicity on the existence of food deserts. Nonwhite populations have negative correlations with variables highly correlated to the existence of food deserts, including median household income (log of income) and percent change in grocery stores.

For **Model 2 (Regional analysis)** – we ran preliminary regressions by individualized ethnicity variables-- %Hispanic, %Native American, % Pacific Islander, and %Asian (as opposed to %white or %black groupings). Preliminary analysis revealed that the only significant variables in this model were percentage of the population 65 and older and counties identified as persistent poverty counties in 2000. Thus, for **Model 2**, we determined there were three potential means available to incorporate ethnicity into the final model—either by using % white and % black values; using % white and % nonwhite values; or using all ethnicity variables. The % African-American residents of the 85 observed counties and independent cities was on average 81.12% of the nonwhite population, meaning that % black could serve as a proxy for other underserved minorities. (Please see the interaction terms section below for more information for the pairwise correlations between variables).

### **Transformations**

For **Model 1**, poverty rate was not used, and we chose household income as a proxy. Ultimately, only median household income (log of income) was log transformed.

For **Model 2**, we did not perform any transformations.

### **Interaction Terms**

For both models, there were high correlations between: % black and % white; median household income and % white; median household income and % black; poverty rate and % white and black; and poverty rate and income (Tables 5a and 5b).

For **Model 1**, there was a very strong positive correlation between log of income and % white and a very strong negative correlation between % black and log of income. The same white/black disparity was true for the poverty rate variable. In order to account for the high levels of correlation between income and poverty rate, we decided to remove the poverty rate and replace it completely with income and the transformed variable log of income. We created interaction terms for log of income\*% white, log of income\*% of

black, and log of income\*% nonwhite to compare different models using % white values, % black values, and % nonwhite values.

For **Model 2**, there were high correlations (greater than 0.6 or less than -0.6) between: % black and % white, and % 65 and older and % 18 and younger. Poverty rate was significantly correlated with both % white and % black with values of about 0.5 and -0.5 respectively, which may warrant a transformation (Table 5b). In addition, there was a very strong positive correlation between median household income and % white and a very strong negative correlation between % black and median household income. The same white/black disparity was true for the poverty rate variable. Ultimately based on the correlation coefficient, we created interaction terms for % black and % white and for %65 and older and %18 and younger. We then compared different models using different ethnicity values.

**Table 5: Pairwise Correlations for Selected Variables**

**a: Model 1– North Carolina Analysis**

<i>Correlation (Obs.=30)</i>	%WHITE10	%BLACK10	LOG_INCOME	POVRATE2010	LOG_BACHELOR
%WHITE10	1.000				
%BLACK10	-0.9830	1.000			
LOG_INCOME_10	0.8646	-0.8781	1.000		
POVRATE2010	-0.9030	0.8893	-0.9441	1.000	
LOG_BACHELOR	0.6551	-0.7025	0.6226	-0.5595	1.000

**b: Model 2 – Regional Analysis**

<i>Correlation (Obs.=85)</i>	%White	%Black	Poverty rate	%65 and older	%18 and younger	%Groceries
%_NHWHITE10	1.000					
%_NHBLACK10	-0.9463	1.000				
POVERTYRATE	-0.5072	0.4899	1.000			
%65OLDER10	0.0840	0.0676	-0.0695	1.000		
%18YOUNGER10	-0.0568	-0.0896	0.0445	-0.7701	1.000	
%GROC2009	-0.0673	0.1906	0.1432	0.5072	-0.4630	1.000

**Results of Statistical Analysis**

For **Model 1**, higher percentages of the population younger than 18 or older than 65 were negatively associated with low access to grocery stores. These two populations are at greater risk of food insecurity. The response variable which uses spatial clustering may also be affected by programs to increase access for senior and minors, though we have no indication of this based on Food Environment Atlas documentation.

In **Model 1**, median household income acted as a proxy for education in my final model. As seen below, there remains some clustering in the residuals plot, but the overall distribution of fitted values is relatively normal but heteroskedastic (Figure 3 and Model 1). We used non-white variables in my final model. We found that the model is statistically significant at the 5% level with an F-statistic p-value of 0.043 and an R-squared value of 0.5272. The final model equation is:

$$y = -87.1 \cdot \text{Log } a + 3.9b - 3.5c - 2.4d - 0.5e - 0.002f - 2.1g + 10.2h - 11.5i + 1081.4$$

where y is: % of the population with low access to store

a: Median Household income

b: % nonwhite population

c: % 65older10

d: % 18younger10

e: % Nonwhite\*log of income

f: grocery store change \* % nonwhite

g: (Metro00)

h: (Poploss00)

i: (Perpov00)

**Table 6: Model 1 - Final Results of NC Statistical Analysis, R2=0.5272, p<0.05**

Variable	Coefficient	Standard Error	p-value	95% Confidence Interval
LogMHH (\$)	-87.147	39.049	0.037	-168.602 to -----
%_nonwhite (%)	3.881	7.639	0.617	-12.053 to 19.816
%_65older10 (%)	-3.511	1.087	0.004	-5.778 to -1.244
%_18younger10 (%)	-2.371	1.251	0.073	-4.980 to .2380
<b>Interaction Terms</b>				
Nonwhitemhh (%*\$)	-.454	.727	.539	-1.970 to 1.062
grocery_%nonwhite(%*%)	-.00151	.00206	0.473	-.00580 to .002780
<b>Categorical Variables</b>				
Metro00 (0,1)	-2.055	5.695	0.722	-13.935 to 9.826
Poploss00 (0,1)	10.205	9.321	0.284	-9.238 to 29.649
Perpov00 (0,1)	-11.535	6.112	0.074	-24.283 to 1.214
Constant	1081.421	425.834	0.020	193.146 to 1969.696

**For Model 2**, the poverty rate acted as a proxy for education in our final model. As seen below, there remains some clustering in the residuals plot, but the overall distribution of fitted values is relatively normal and not heteroskedastic (Figure 8 and Table 7). We used non-white variables and robust standard errors to account for multi-collinearity in the final model. We found that the model is statistically significant at the 1% level with an F-statistic of 4.44. The R-squared indicates that the variables explain 0.2746 or about 27% of the variation within the response variable, percentage of people in a county experiencing low access to grocery stores. The final model equation is:

$$y = -5.368a - 5.540b - 45.340 \cdot \text{Log } c - 4.205d + 0.252e + 22.308f + 0.00265f + 1.287g - 3.938h + 11.076i - 7.674j + 677.242$$

where y is: % population, low access to store

a: % white population

b: % nonwhite population

c: % 65older10

d: % 18younger10

e: Poverty rate in 2010

f: % white \* % nonwhite

g: Log of % 65older10 \* % 18younger10

h: (Metro00)

i: (Poploss00)

j: (Perpov00)

**Table 7: Model 2 - Final Results of Statistical Analysis R2 value = 0.2746, p<0.01**

Variable	Coefficient	Standard Error	p-value	95% Confidence Interval
%_White (%)	-5.368	2.133	0.014	-9.621 to -1.115
%_nonwhite (%)	-5.540	2.154	0.012	-9.832 to -1.248
Log_65older10 (%)	-45.320	22.463	0.047	-90.087 to -0.552
%_18younger10 (%)	-4.205	2.648	0.117	-9.482 to 1.072
Poverty Rate (%)	0.252	0.243	0.303	-0.232 to 0.736
Grocery09 (per thousand)	22.308	12.812	0.086	-3.227 to 47.842
<b>Interaction Terms</b>				
White_Nonwhite (%*%)	0.00265	0.00349	0.449	-0.00430 to 0.00961
Logold_young (log%*%)	1.287	0.991	0.198	-0.687 to 3.262
<b>Categorical Variables</b>				
Metro00 (0,1)	-3.938	3.079	0.205	-10.074 to 2.198
Poploss00 (0,1)	11.076	3.598	0.085	-1.551 to 23.703
Perpov00 (0,1)	-7.674	3.598	0.036	-14.846 to -0.5024
Constant	677.242	202.333	0.001	273.992 to 1080.491

## Discussion

Both **Model 1** and **Model 2** were very similar for the dummy variables (metro counties, population loss counties, and persistent poverty counties) but very different for the socioeconomic variables. For example, there was a positive correlation between % nonwhite and the response variable in the previous study, but this study indicated a negative correlation between these two variables. This may be due to omitted variables that differ from state to state and county-to-county. It may also be due to differences in ethnic makeup from county to county that are not accounted for in this model.

Notably, **Model 1** (North Carolina Analysis) indicates more stratification by ethnicity via the correlations between the black white, and dependent variables.

Age is an important factor in food access. This is most likely because seniors, who may live in isolated areas without access to transportation, and children, who are dependent upon



their parents or guardians, are over- or under-represented in the response variable (% of population facing low access to grocery stores) due to their extreme dependence on those around them and geographic location.

*Applicability to North Carolina*

It is unsurprising that a number of variables such as household income, ethnicity, and education are highly correlated with one another, just as there is, in fact, very little revelation in the fact that those who are poor or non-white have less access to quality, affordable food than other communities within North Carolina, given its long history of segregation.

## **4. Determining Barriers using Interview and Survey Data**

To augment the statistical analysis and provide some fine scale resolution on what consumers, retailers, and producers identify as barriers, Kimberly Hill conducted surveys and interviews of local retailers, producers, and community stakeholders in both Washington and Beaufort Counties collected over three weekends and weekdays in February and March 2014. The text of the surveys for retailers, producers, and consumers are available in Appendix 3, along with some sample questions for community stakeholders.

Notably, Washington County is much smaller than Beaufort County, with a population of 12,736 in 2012 (Census Bureau, 2014) as compared to Beaufort County's 47,507 (Census Bureau, 2014). Beaufort County is primarily white (71.7%) while Washington County is split between Caucasian and African-American residents (47.9% and 49.7% in 2012, respectively). Beaufort County also has a relatively higher median household income (\$40,147 in 2012) versus Washington County (\$33,718 in 2012). The poverty rate is 26.5% in Washington County versus 20.6% in Beaufort County in 2012. Beaufort County and Washington County are similarly educated (80.6% with a high school degree in Beaufort County versus 80.8% for Washington County) (Census Bureau, 2014).

#### 4.1 Barriers to Consumers

Unfortunately, we were unable to find a suitable community partner in Washington County to disseminate the consumer surveys. Thus we only have data for Beaufort County, courtesy of Jared Cates, Community Mobilizer, Carolina Farm Stewardship Association, who completed a similar study for Beaufort County. However, Beaufort County contains the town of Little Washington (population about 10,000) which serves as a regional center for shopping, doctor's appointments, and other community needs. Some of the respondents (approximately 8 percent) lived in counties other than Beaufort according to their zip codes. Based on some demographic similarities, we can assume some of the barriers and community needs identified are applicable to Washington County as well.

Jared Cates collected data from July to December 2013 with several community partners in Beaufort County - Eagle Wings Food Pantry, Beaufort County Department of Social Services, Beaufort County Health Department, Vidant Family Medicine Aurora, and others.

We conducted additional analyses of the survey results to determine correlations between different variables using STATA, statistical analysis software. The full list of survey questions is available in **Appendix 3**.

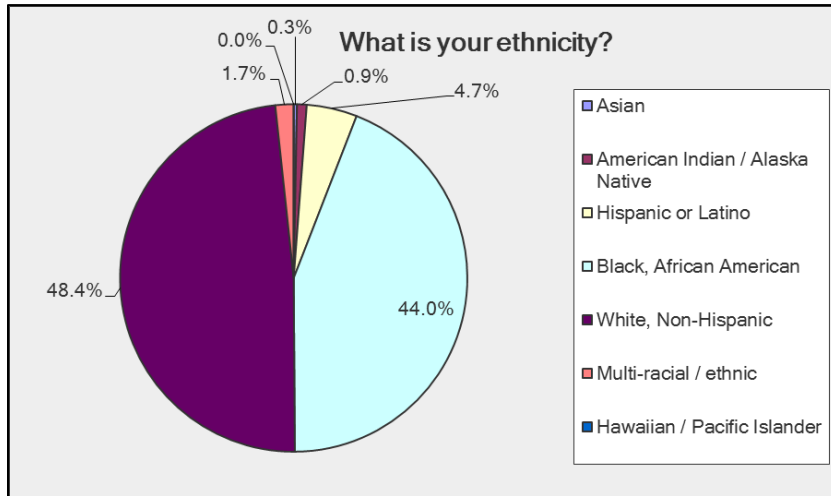
**Table 8: Summary of Survey Results. The text of questions is available in Appendix 3.**

Total N = 687 observations	Number Answered	Number Skipped
Question 1	680	7
Question 2	686	1
Question 3	684	3
Question 4	678	9
Question 5	650	37
Question 6	655	32
Question 7	679	8
Question 8	663	24

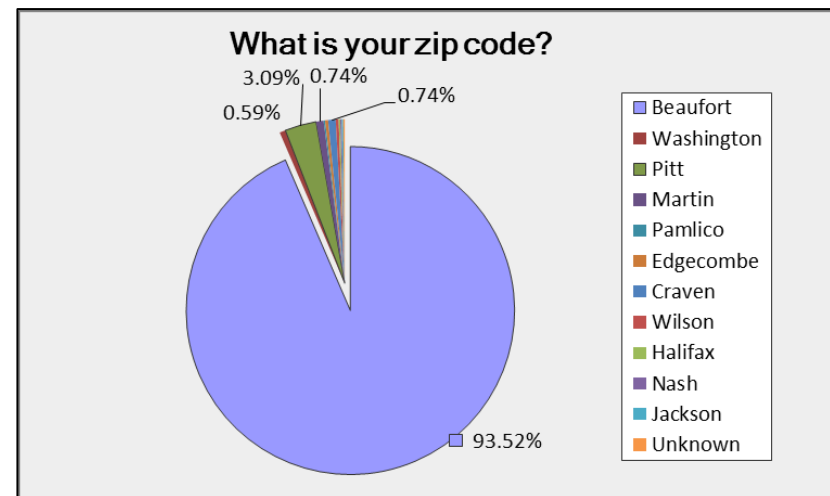
## Survey Results

### Figure 7a-d: Demographic Variables of Interest

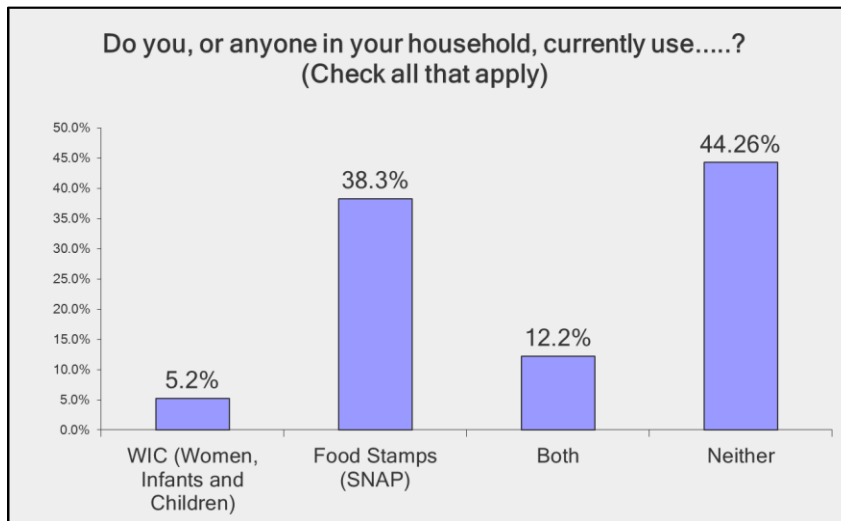
#### a. Self-Identification of Ethnicity



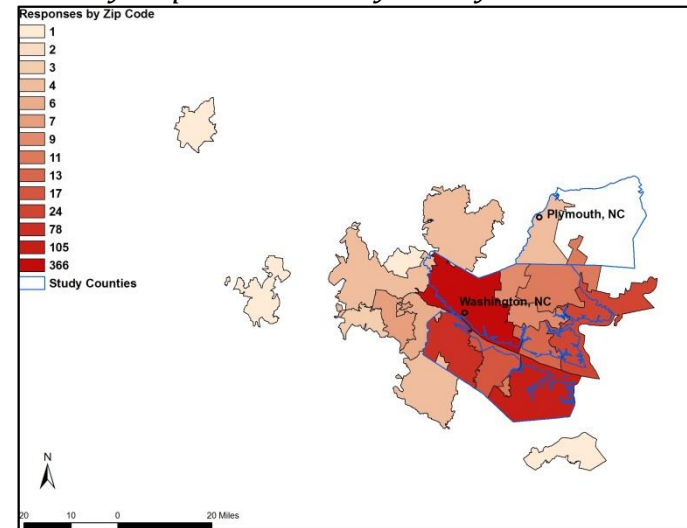
#### b. Self-Identification of Location by County



#### c. Use of Government-Provided Benefits

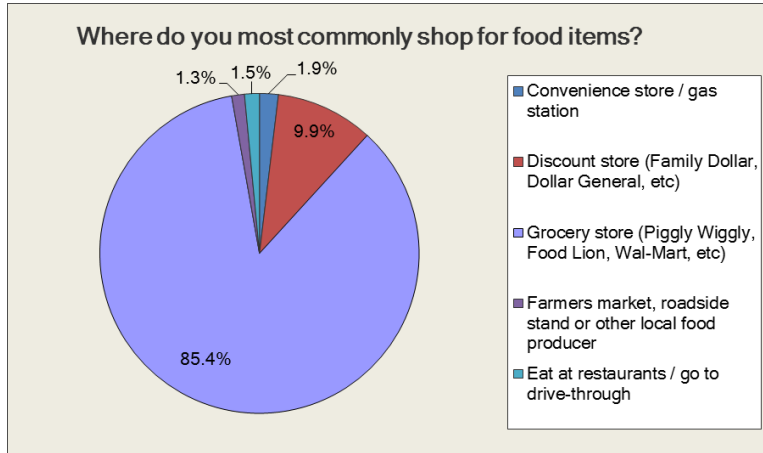


#### d. Survey responses sorted by County

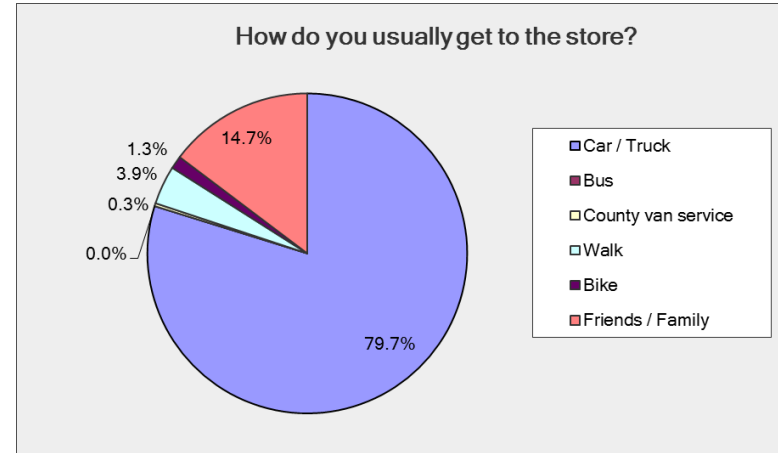


**Figure 8a-b: Food Retailer Use and Transportation Use**

*a: Primary Source of Food*

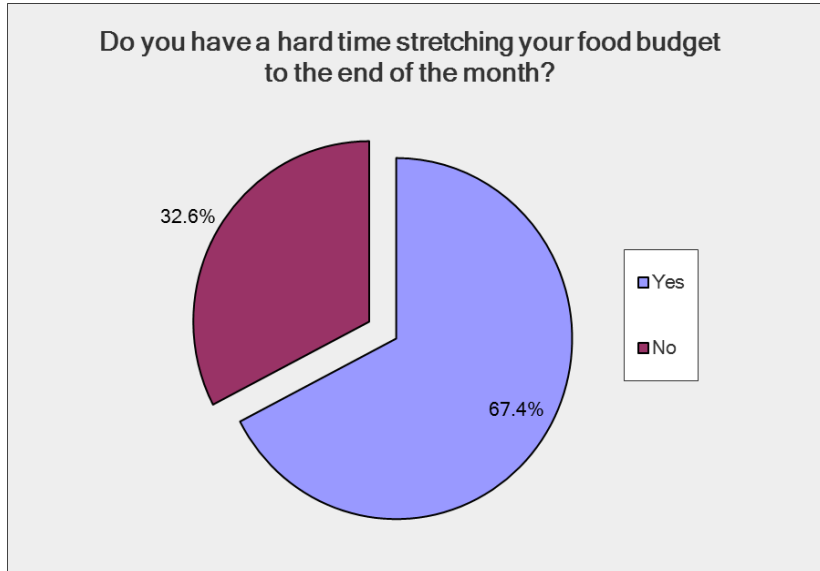


*b. Primary Source of Transportation to Food Retailer*

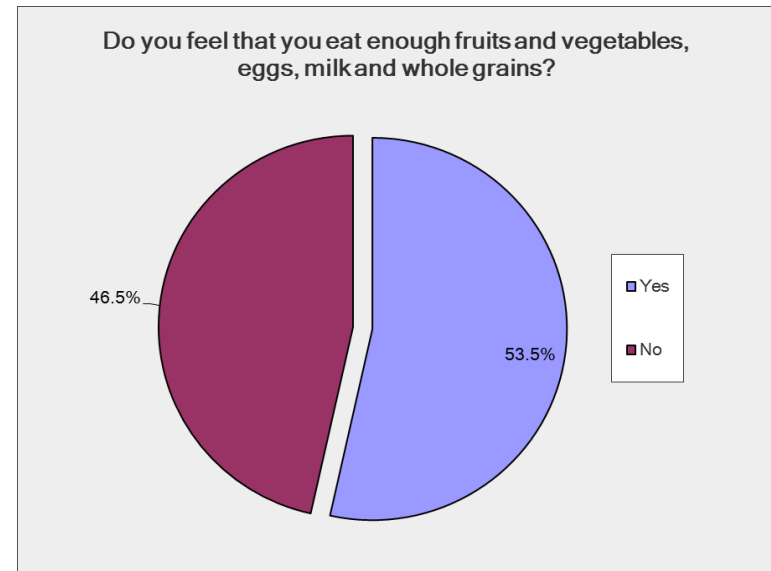


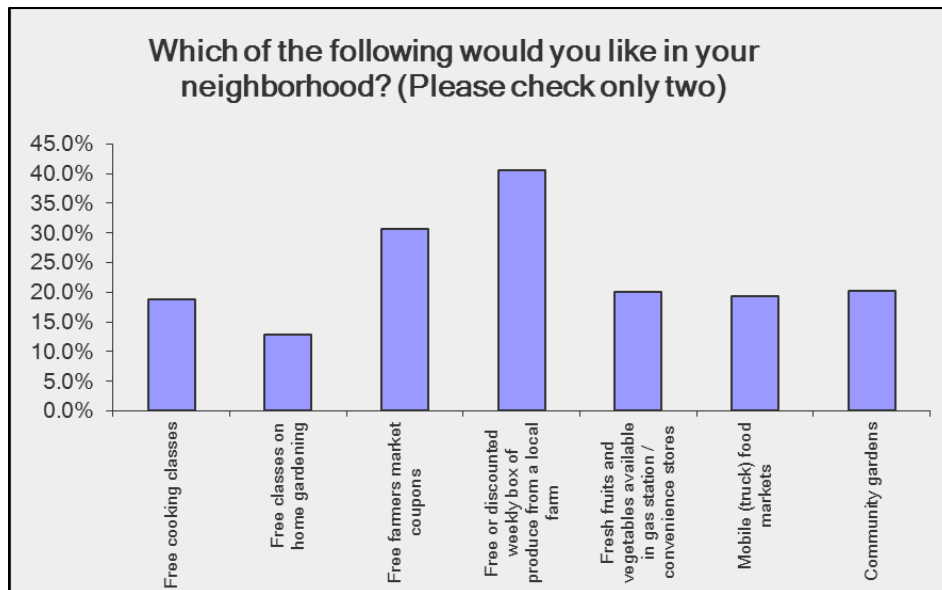
**Figure 9a-b: Food Accessibility and Nutrition Questions**

*a: Measure of Reliable Access to Food*



*b: Measure of Adequate Nutrition*





**Figure 10: Preferred Interventions**

**Discussion**

The results of the survey indicate that it was not a representative sample of Beaufort County, as the identified ethnicity of the sample (44.0% African-American and 48.4% Caucasian) did not match US Census values (25.6% African-American and 71.7% Caucasian as of 2012). Additionally, 67.4% of respondents identified themselves as food insecure, compared with average food insecurity of 17.1% according to the Food Environment Atlas (2012). Despite the lack of state-driven county-level data for comparison, it is well known that Eastern North Carolina faces more poverty and food insecurity than any other region of the state (North Carolina Department of Commerce 2013). Thus, while it is not a representative population of the entire county, the sample can be considered a representative population of people lacking access to quality food.

The data was further analyzed in STATA (a statistical analysis program) to determine connections between any two of the seven variables using the “tabulate” command. The results are below:

**Everyone faces food insecurity.** All ethnicities with a statistically significant sample size (more than 40 observations) were equally likely to say they had a hard time stretching their budget to the end of the month with a consistent 2:1 ratio. They were also equally likely to note they were able to have enough fruits and vegetables from month to month at a ratio of about 1:1.

**But people differ in where they shop, how they get there, and if they use government-provided benefits (SNAP and WIC).** People who identified as African-American were slightly more likely to use convenience stores as primary sources of food (39% versus 31% for Caucasian-Americans). However, Caucasian-Americans were more likely to use discount stores as primary sources of food (57% compared to 39% for African-Americans). Both groups were equally likely to use retail grocery stores as primary food sources. A small, but similar sub-sample of each group, were most likely to shop at farmer's markets or eat at restaurants. Notably, both groups were most likely to use cars or trucks to reach a food source. However, African-Americans were more likely to walk to the grocery store, though only 19 respondents identified walking as their primary means. Notably, 18% of African-American respondents noted they were likely to travel with friends or family to the grocery store as compared to 11% of Caucasian-Americans, perhaps signifying cultural differences, ongoing poverty in the African-American community, or a combination of the two. African-Americans were somewhat more likely to be on SNAP benefits (Supplemental Nutrition Assistance Program, commonly called "food stamps") with 45% of African-Americans as opposed to 35% of Caucasian Americans. Approximately 52% of Caucasian Americans versus 38% of African-Americans do not use any supplemental benefits.

**SNAP and WIC benefits decrease food insecurity and improve nutrition.** However, SNAP benefits and WIC (Women, Infants, and Children) benefits for mothers with young children do decrease food insecurity and improve nutrition. People receiving some form of food assistance were somewhat more likely to indicate they received adequate nutrition. WIC participants in particular responded they had an adequate budget and received adequate nutrition. SNAP and WIC/SNAP participants were more likely to say they had problems stretching their food budget, but did receive adequate nutrition. Those receiving no benefits were more likely to identify themselves as food insecure (59% said they had problems stretching their budgets to the end of the month), but only half of those receiving no benefits said they received adequate nutrition.

**Transportation influences food choices.** Consistent with previous research on the topic, people who shop at grocery stores for their food were less likely to identify themselves as food insecure than people who shop primarily at discount stores or convenience stores. No matter the store type, all groups were evenly split on whether they receive adequate nutrition. Additionally, people who drove a car or truck were more likely to use grocery stores. People who walk were most likely to use a convenience store/gas station as their primary source of food.

**People go without, use food pantries, or ask for help when they cannot afford to eat.** A short answer question for number 3 asked "If you have a hard time stretching your food budget, what do you do in those months?" Nearly every respondent identified three different methods of dealing with food insecurity. Some people said they went without,

bought less food, or used what was in the freezer in times of need. Some respondents noted they used local food pantries or church food drives to get enough to eat. Still others noted they would ask friends or family for money or would eat at their friends' or family's homes when they could not afford to buy their own food.

### ***Limitations of the Survey***

The survey is subject to some response bias and likely some acquiescence bias. Because people knew it is a survey to better understand the food environment of Beaufort County, they were more likely to identify themselves as occasionally facing food insecurity, via being unable to stretch their budget to the end of the month. Most of the questions were simple descriptive questions, including self-identified ethnicity, primary source of food, and mode of transportation, helping to reduce bias. However, the survey was developed from the work of several community meetings and one longer survey developed by Carolina Farm Stewardship Association Community Mobilizer Jared Cates and should be viewed as such.

While not the fault of the survey results, it is difficult to compare them to statistics collected by the state and national government due to missing data on the counties of Eastern North Carolina.



## 4.2 Barriers to Retailers

Harry Zhang identified possible grocery stores, roadside stands, and specialty markets that would meet the definition of “a grocery store or supermarket” using Google maps.

ReferenceUSA data using the NAICS (North American Industry Classification System) code 541105 for both Washington and Beaufort Counties was also used to identify retail grocery stores and to determine the accuracy of both Google maps and ReferenceUSA.

Kimberly Hill drove to the sites over two weekends in February 2014 using the addresses provided by Harry Zhang and cross-referencing them with ReferenceUSA. If a site was primarily a gas station, restaurant, or convenience store/corner market, we marked it as such and took it off the list of surveyed grocery stores. If a site could not be found or had changed owners or store type, we marked it as such. If a site had the wrong address or geocoordinates, we marked it as such and corrected the information. Nineteen survey sites were identified – three sights were not surveyed due to time constraints, one site had an absent manager, two sites were based on original data from Jared Cates of Carolina Farm Stewardship Association, and twelve sights were successfully surveyed. Of the thirteen sites approached, only one store refused to be surveyed. The full list of questions is available in **Appendix 3**.

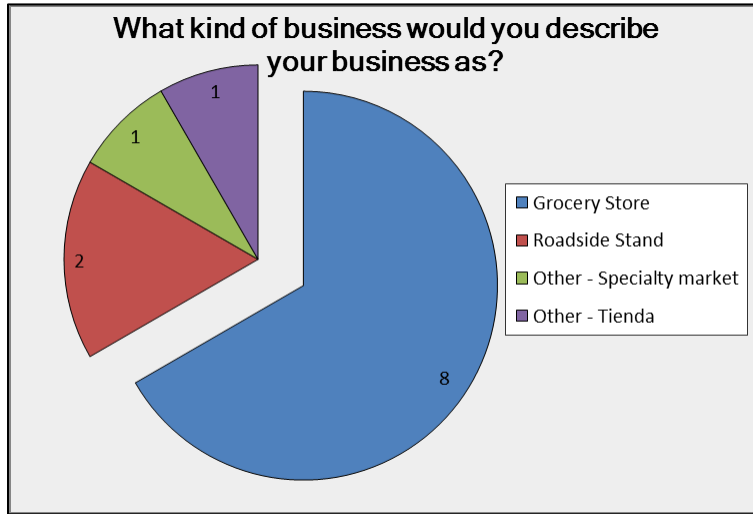
**Table 9: Summary of Ground-Truthing for Retail Grocery Stores**

Total N=19 grocery stores	Google	ReferenceUSA
Total	28	26
Correctly Located	13	12
Wrong address	3	0
Not a retail grocery store	5	6
Not found	4	2
Not on original list, but found via ground-truthing	3	5
Duplicate Address	0	4

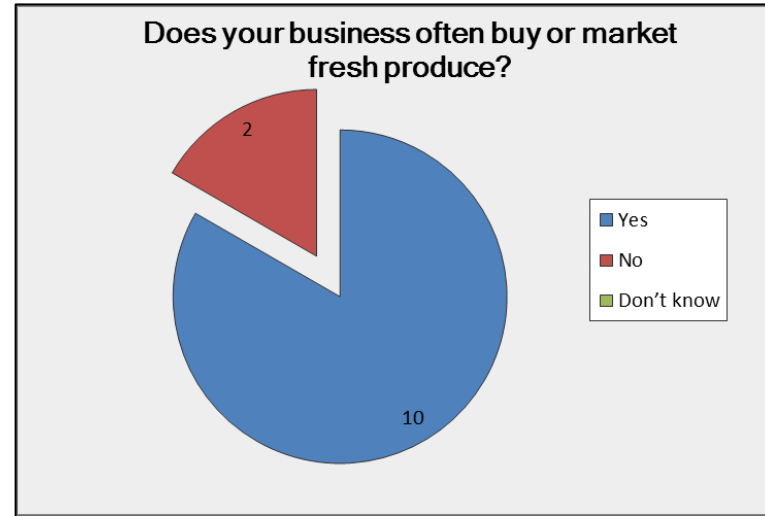
**Survey Results**

**Figure 11a-d: Self Identification of Businesses**

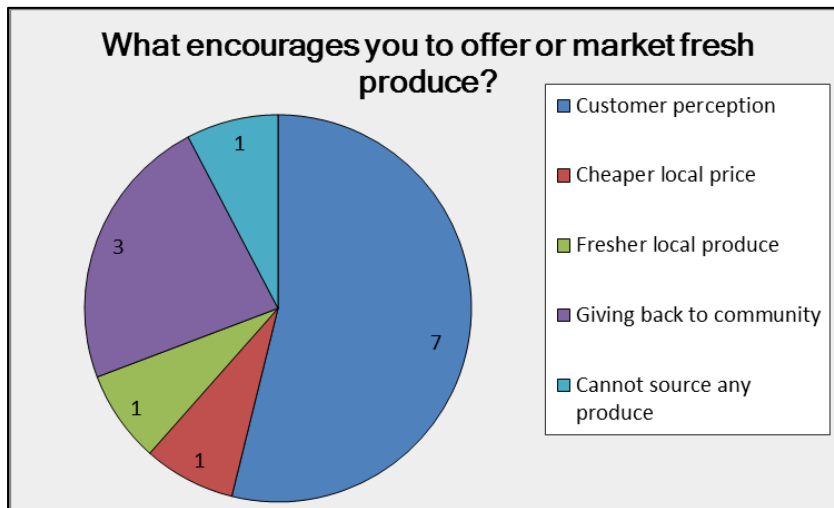
*a: Self-Identification of Food Retailer Type*



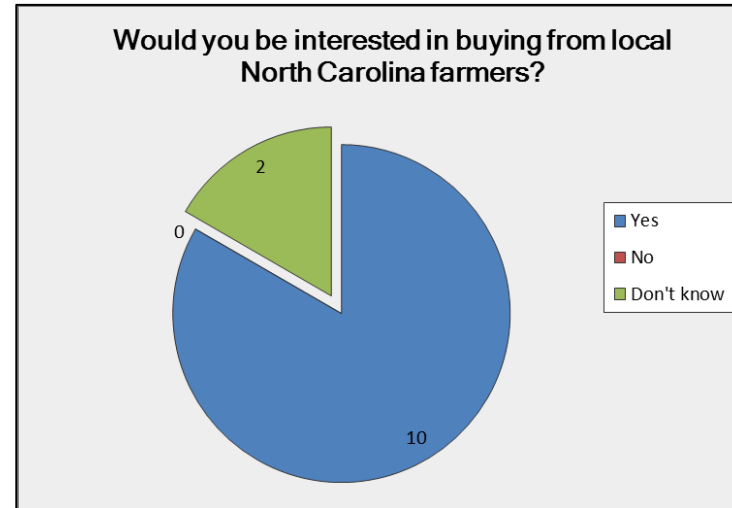
*b: Availability of Fresh Produce*



*c: Reasons for offering fresh food (open-ended question)*

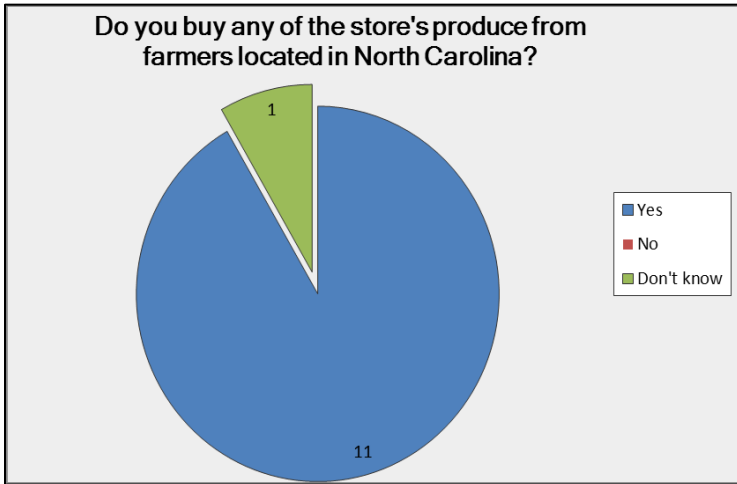


*d. Interest in buying local*

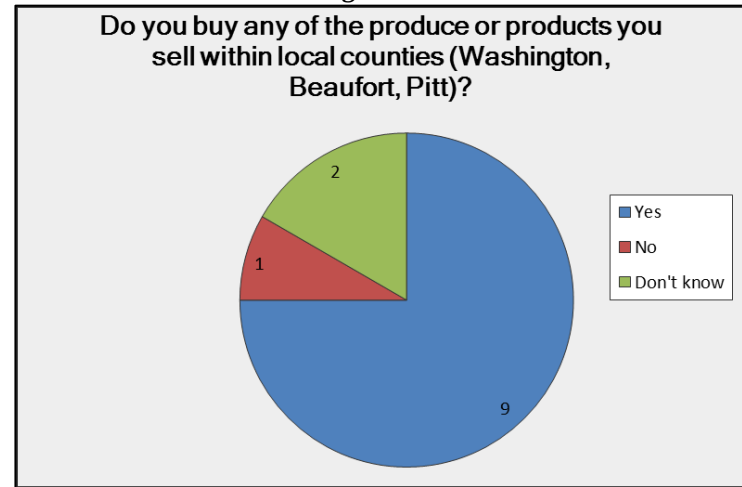


**Figure 12a-d: Local Sourcing Questions**

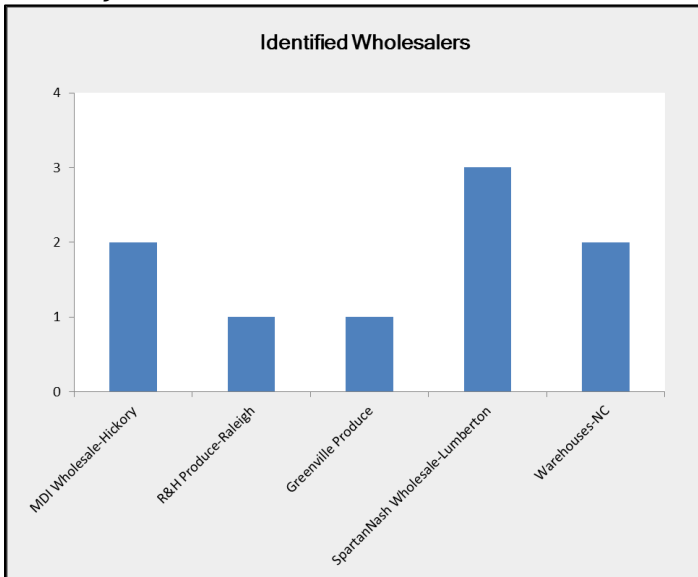
*a: North Carolina Sourcing*



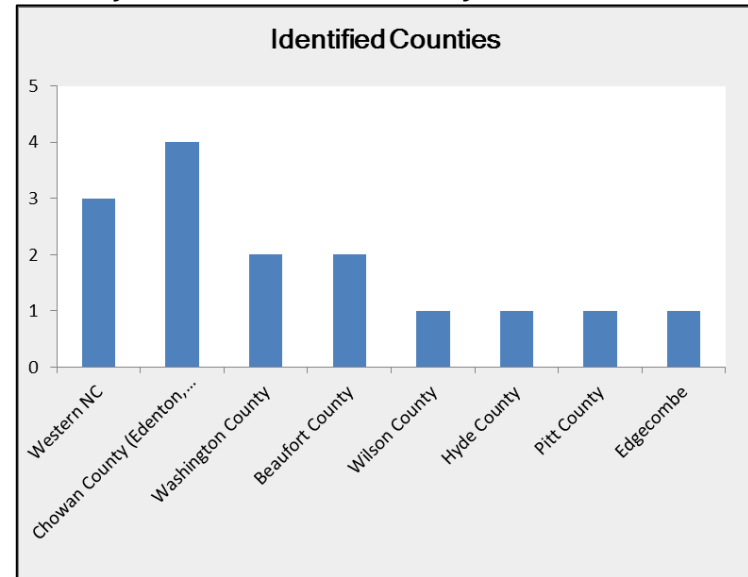
*b: Local Counties Sourcing*

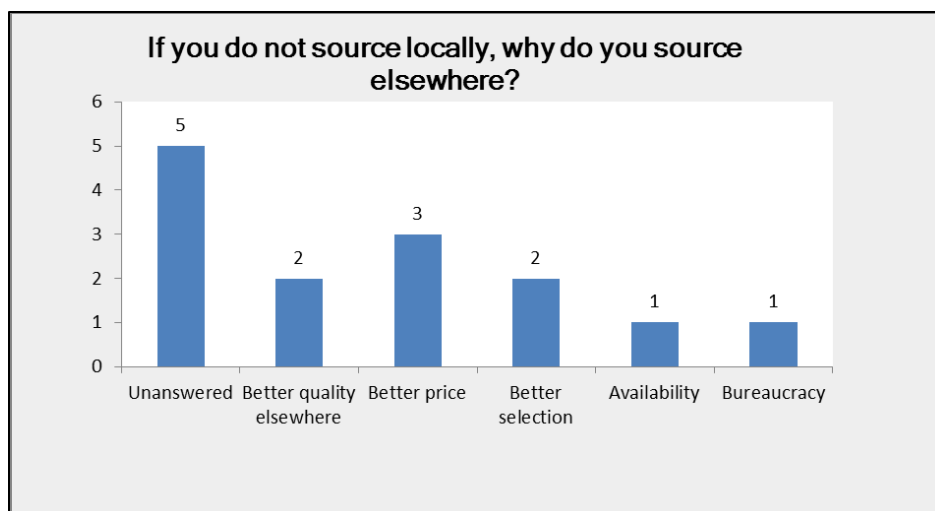


*c. Identified Produce Wholesalers in NC*



*d. Identified NC Counties Stores Buy From*





**Figure 13. Reasons for Sourcing Elsewhere**

### ***Discussion***

**Retailers are interested, but most already buy locally.** Most retailers expressed interest in sourcing produce locally (10/12 surveyed or about 83%). 11 out of 12 retailers surveyed sourced from North Carolina, though only 9 retailers sourced from local counties. One retail grocery store chain, Food Lion, is centrally owned rather than franchised and sources all its produce from a regional distribution center in Salisbury, North Carolina (Food Lion, 2014). Therefore, the Food Lions surveyed were more likely to point to the “Got to Be NC” signage to identify local produce rather than buying directly from farmers. MDI (Merchants Distributors Incorporated) is a major distribution center for Piggly Wiggly stores throughout the state. However, each Piggly Wiggly surveyed noted that they are independently owned, thus they choose their own mix of local and non-local produce.

**Nearby counties besides Beaufort and Washington are major production centers.** Chowan County was cited four times by four different retailers. Both Edenton and Rocky Hock are located in Chowan County, and according to retailers are a common source of fruits like watermelons and cantaloupe. Various other counties and in some cases specific producers were mentioned. Two of the stores surveyed, Petals and Produce, who identified themselves as “roadside stands” or “produce specialty markets” have their own farm in Yatesville, North Carolina near Pinetown, North Carolina. They try to source everything as locally as possible, but noted that better produce and processed products (for example, pickled vegetables) were available as far away as Pennsylvania. Western North Carolina, where three of the five mentioned wholesalers are located, was cited as well.

**Retailers want good quality produce and a variety of produce.** One small grocer noted she had problems sourcing food in general, and thus decided not to carry produce. She said

“people did not buy it,” and “it usually went bad.” One store that identified itself as a tienda occasionally sourced tomatoes and peppers locally, but usually purchased from a warehouse in Raleigh because they have “Mexican vegetables” appropriate for their consumers. Most respondents (9 out of 12) noted they sourced locally when possible, but sourced elsewhere when they could not get the number or kinds of produce they wanted.

**Customers want fresh local produce, encouraging retailers to buy local.** Seven retailers cited “customer perception” of fresh, local produce not from a warehouse as their main reason for carrying produce in general and for sourcing it locally. Lower local price was also a factor.

**Bureaucracy may be a problem.** Only one store noted that state-level bureaucracy was a factor. The surveyed store manager noted “NCDA could come in and take our produce and cite us if it is not up to code.” This may be a bigger issue for all the surveyed retailers. However, it was not explicitly included in the survey and may limit the survey’s effectiveness.

### ***Limitations of the Survey***

The survey is subject to some response bias and likely some acquiescence bias. Because Kimberly Hill conducted the surveys orally and in person, all respondents were more likely to respond in a way to please the surveyor. “Local food” has a positive connotation almost everywhere, and is largely driven by consumer demand and to a lesser extent price. A follow-up survey should include some questions to reduce this bias as well as one yes/no question on whether the retailer accepts SNAP/EBT or WIC benefits. In discussion with store owners or managers, the surveyor noted that small grocery stores and roadside stands do not accept SNAP/EBT and WIC and thus are less accessible to low-income consumers. Additionally, though not discussed with store owners, a question regarding certification requirements for produce should be asked.

### 4.3 Barriers to Producers

Barriers producers face were determined via structured interviews with local producers in Washington and Beaufort Counties, primary data from Jared Cates' interactions with local producers, and via interviews with community stakeholders including representatives of the North Carolina Public Health Foundation, the Washington, Beaufort, and Martin County Extension Offices, Center for Disease Control (CDC) Community Transformation Grant representatives, North Carolina Department of Health and Human Services, North Carolina Department of Agriculture, and others. Interviews were recorded using an Olympus voice recorder, partially transcribed using InqScribe software, and analyzed using NVivo software to identify common themes and barriers.

Nearly all people identified as possible interview subjects were interviewed, save the Center for Disease Control Community Transformation Grant Healthy Eating Lead from Region 9. Farmers were identified via a contact of Resourceful Communities, Jared Cates. Of 14 local producers, three were contacted and two responded. Notably, eleven of these producers are only part-time or seasonal producers for one crop such as "u-pick" strawberries. While there are a dozen local fruit and vegetable producers in Beaufort County not including producers of processed products such as honey, there are only two identified producers in Washington County. Primary data from Jared Cates, including survey data and notes from community meetings, was used to supplement the interviews.

As of 2012, Beaufort County has 369 farms to Washington County's 187. The four major crops of both counties are corn for grain, cotton, soybeans, and wheat. Interestingly, while Washington County reported approximately 15 million dollars in sales of vegetables, fruits, nuts, and berries in 2012 ranking it number 12 in the state, Beaufort County only produced 1.6 million dollars in sales, ranking it number 60 in the state. This is likely because Washington County is home to one of the largest vegetable farms east of Raleigh (NCDA 2013).

Based on the structured interviews, several themes were identified that were barriers for producers and the local food system in general:

**Geography matters.** Two interviewees in Beaufort County and one interviewee in Durham noted the division between the "Northside" and "Southside" of the Tar-Pamlico River in Beaufort County. People have historically divided themselves geographically along the river. One interviewee in Washington County noted it was not divided geographically, though residents of towns in the eastern part of the county such as Creswell shop in Tyrell County due to its closer proximity. He noted that it was the I-95 that divided the Piedmont "from the rest of the state," arguing that the counties were generally poorer east of Interstate 95.

**History matters.** One interviewee in Washington County and one interviewee in Beaufort County noted the impact of the so-called tobacco buyout in 2004. Many small farms closed or leased their land to large farms when the US government stopped subsidizing tobacco crops in 2004. If they remained, they shifted from tobacco to soybeans or corn. North Carolina lost 26,300 farms between 1990 and 2006 (Department of City and Regional Planning-UNC, 2008). While the Southeast still has the largest number of small farms of any region in the United States, the number and diversity of farms has dwindled over the last 20 years. One interviewee noted that Washington County once had a thriving farmer's market that was shut down in 2009. Since then, the last two producers in Washington county have passed away.

**Culture matters.** While reluctant, four interviewees noted racial divisions still exist in Eastern North Carolina and discourage cooperation and development of the local food economy. One producer noted the number of African-American farmers has dwindled. He hopes to increase that number via an educational agribusiness farm.

**People do not trust the government.** Three respondents in Beaufort County and one respondent in Durham noted that the history of disenfranchisement and distrust of government in Eastern North Carolina has hampered development of the local food economy.

**Local food producers have more resources and money than the average farmer.** Five interviewees in both Washington and Beaufort County noted that farmers who produce food usually also grow row crops. They are usually well-established with resources and money to take the risks associated with food crops.

**However, some producers are extremely isolated due to location and lack of connection with other producers and community resources.** Two interviewees noted an owner of a roadside stand in Beaufort County who was only connected to local resources when a Carolina Farm Stewardship Association employee stopped by his roadside stand.

**Regulations have a mixed record of encouraging local food.** While one producer and some interviewees stressed the importance of local, state, and federal government in providing funding and resources for local food, others noted food safety concerns and regulations have discouraged the growth of the local food economy.

**The market is a huge challenge, but also a big opportunity.** One interviewee noted the seasonality of tourism in Beaufort County and the Outer Banks in general made it difficult to effectively market local food to restaurants and stores only open five to six months out of the year. However, one interviewee in Washington County was very hopeful about the

possibilities for agro-tourism and local food purchasing agreements the tourism industry could provide.

**Labor is a big issue all over eastern North Carolina.** All interviewees involved on the production side of food in both Washington and Beaufort Counties (n=8) noted farm labor was a huge issue for local producers. One interviewee noted labor shortages prevented some vendors from participating in Beaufort County's two farmer's markets. She also identified a past program that paid Beaufort County residents to work on local farms. She said that "almost all of them quit after two weeks" due to the low pay and hard physical labor required for farm work.

**Farmers want to mitigate risk. Food is a risk.** One interviewee in Washington County noted that most farmers choose to either lease land or grow row crops because it is less labor intensive and has a guaranteed return on investment. She said "That [food] is not our specialty. That's just not what we do here."

**However, people involved in the movement are cautiously optimistic.** Interviewees in Beaufort County were generally involved in the ongoing development of a local Food Policy Council. While the representative of the Center for Disease Control and Prevention Community Transformation Grant Program for region 10 noted the program will shut down in September due to the new Farm Bill, more money has been invested by the Kate B. Reynolds Charitable Trust to set up Community Catalyst Coordinators in various Eastern North Carolina counties. These coordinators organize local community coalitions to encourage healthy eating and active living.

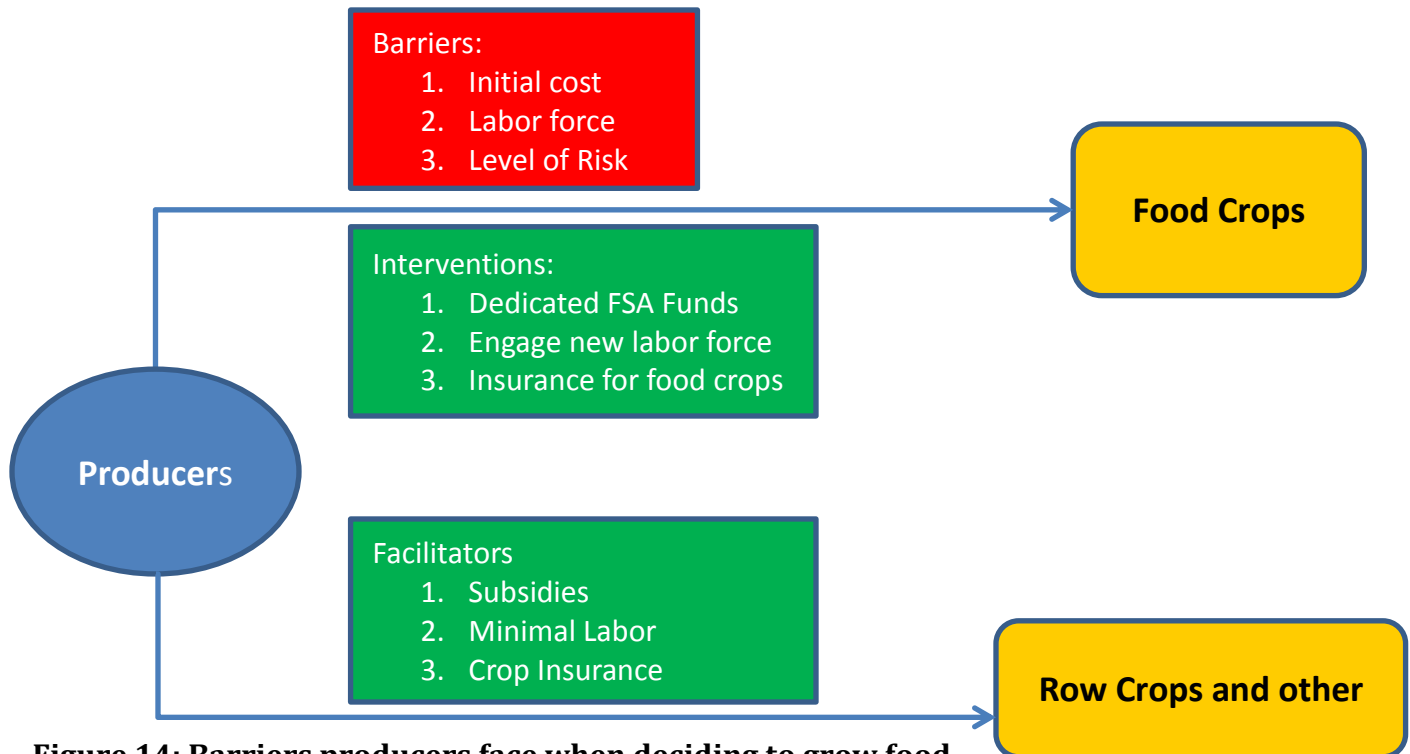
**Washington County has less energy.** Only one interviewee was optimistic about the local food scene in Washington County. However, Washington County is smaller and poorer than Beaufort County. It also has fewer resources and very little statewide or regional attention focused on it. For instance, while the interviewees in Beaufort County have been contacted multiple times regarding local food systems, no one was contacted in Washington County prior to our work.

#### *Comparison with other studies*

The identified barriers are consistent with work conducted by Cates (2013) and UNC (2008). What was not expected were the cultural barriers discussed by multiple interviewees. While some were very upfront about the racial history of Eastern North Carolina, others only inferred it. Though not directly addressed in the results section (below), culture, race, and demographic variables should be taken into account when trying to build a cohesive system that acknowledges and incorporates every participant of that system.



#### 4.4 Identification and Discussion of all Barriers



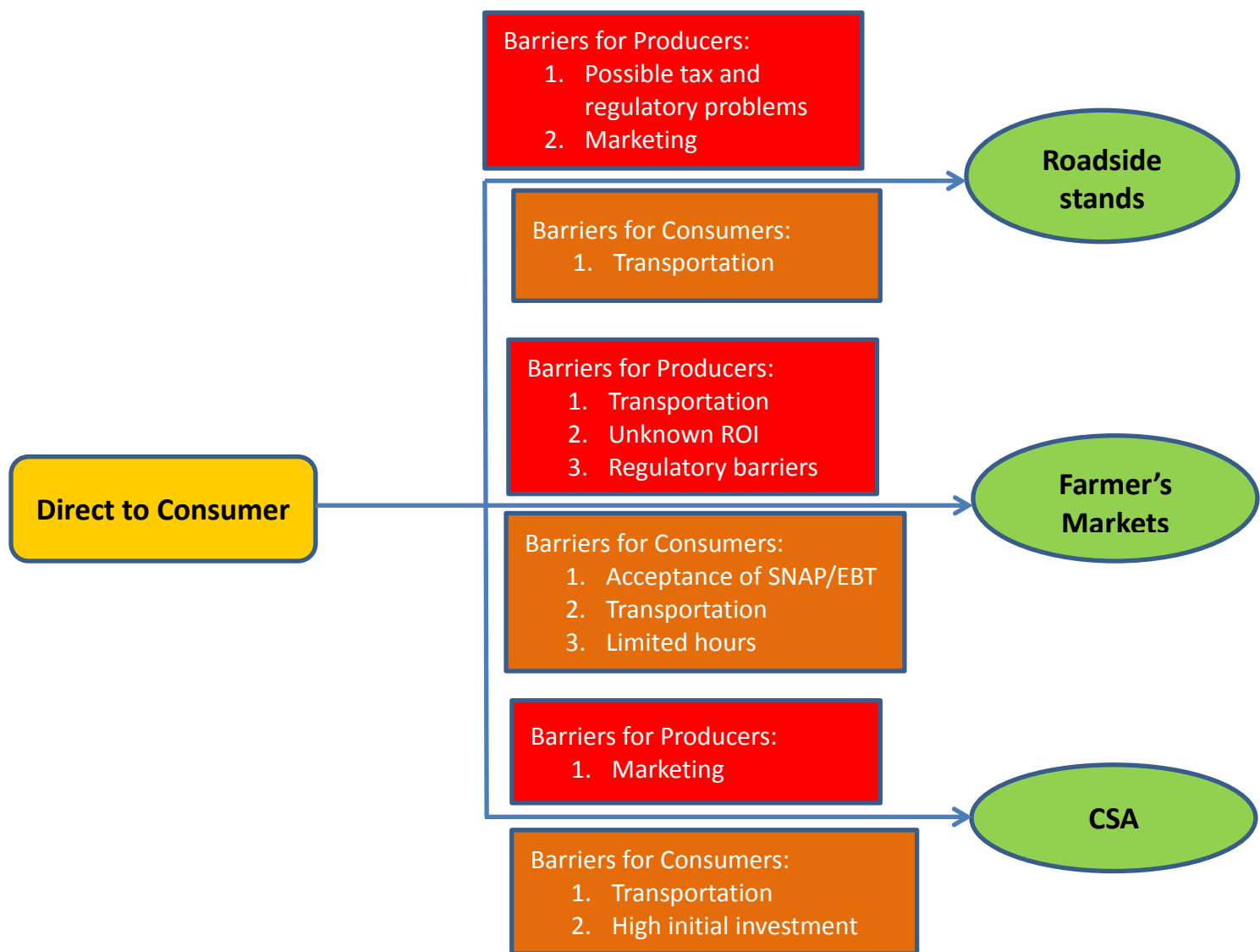
**Figure 14: Barriers producers face when deciding to grow food**

Producers must consider several factors when they decide to grow food.

**How much risk are they willing to take on?** The initial cost to sow, maintain, harvest, and sell food crops is very high, and there are no guaranteed buyers. Pests can destroy crops, and consumers and wholesalers can refuse crops based on quality. On the other hand, row crops are generally covered by US government-backed insurance programs and subsidies. Some farmers work under contract – for instance growing tobacco – and have a guaranteed price for their crop, regardless of its appearance (conversation with Washington County-based interviewee).

**Labor in Eastern North Carolina is limited.** Interviewees in both Washington and Beaufort counties identified labor shortages as a major issue stopping farmers from growing food crops. One interviewee in Beaufort County noted a past program paid local people to work on farms, but most participants quit after a week or two due to the low pay and physically difficult nature of the work.

**Interventions take time and dedicated effort.** Insurance for food crops is available, but is often not worth the cost and is not covered under the Federal Crop Insurance Corporation (FCIC). State and national Congressmembers can advocate for dedicated funds to local Farm Service Agencies (FSA) to encourage growth of the local food movement. However, an advocacy movement is required. Developing a viable workforce requires a well-networked community. For instance, the Beaufort County Developmental Center is training developmentally disabled individuals to grow and harvest food. They may someday work for local producers (BCDC 2014).



**Figure 15: Flowchart of direct-to-consumer barriers**

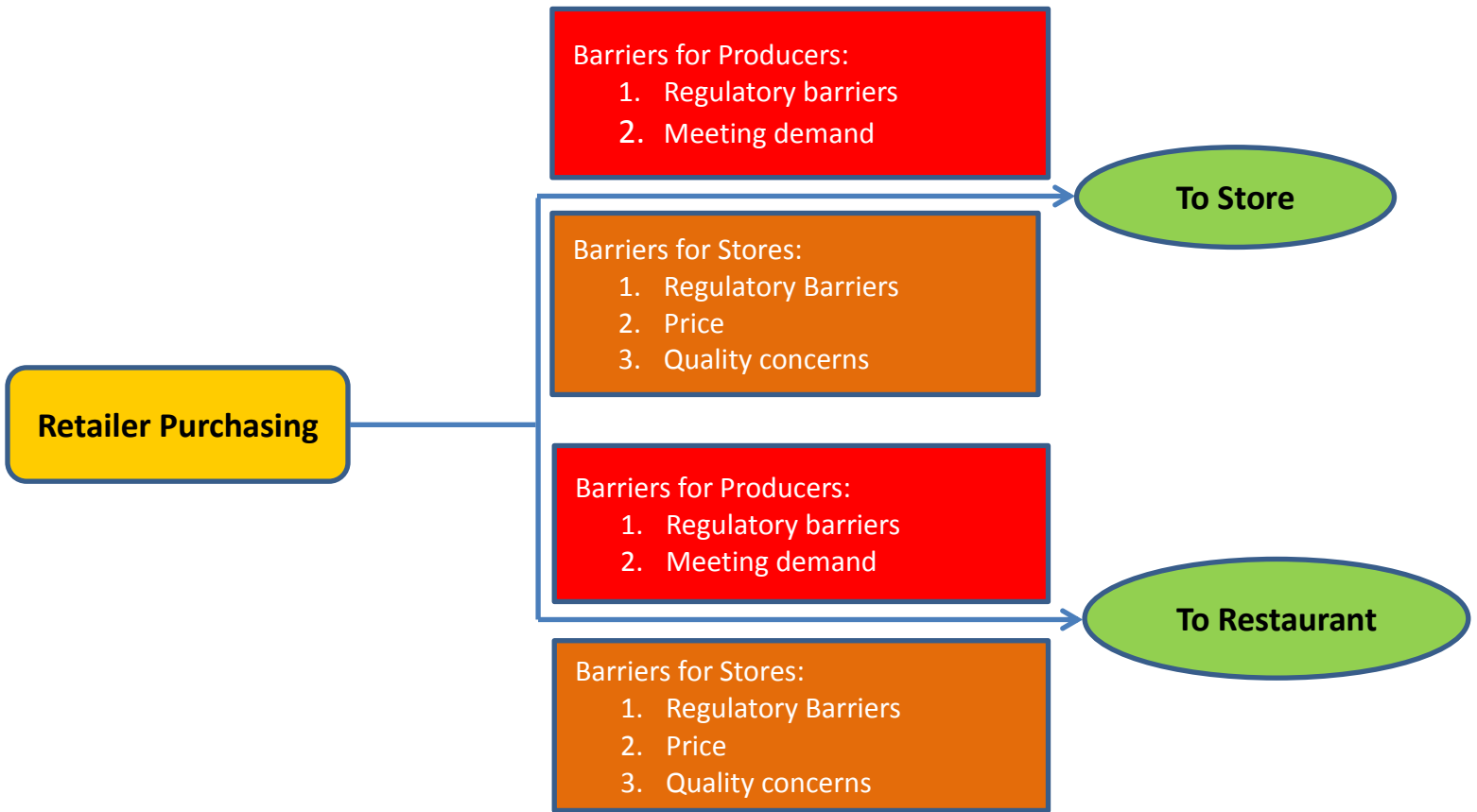
Direct-to-consumer sales methods offer producers low-cost ways to access markets. However, low-income consumers may not be able to access these markets.

**Roadside stands are the lowest cost options for producers.** They do not require a vendor fee, they do not require the producer to travel, and they require minimal labor. However, in most states including North Carolina, these stands are required to have a business license, collect sales tax, and have appropriate liability insurance (Marks 2014). Due to their remote locations, consumers may not be able to access these stands. Due to the costs associating with WIC and SNAP/EBT, small vendors usually do not accept benefit cards, meaning low-income consumers cannot use their benefits.

**Well-organized farmer's markets are the best option for low-income consumers.** Notably, low-income women in Greenville, NC were willing to travel farther to access the farmer's market (Jillcott-Pitts et al. 2013). However, that market accepts SNAP/EBT. Neither of the two farmer's markets in the study area accepts SNAP/EBT. Washington County has not had a functional farmer's market since 2009. Limited hours and limited access to transportation affect the ability of consumers to shop at farmer's markets.

Producers may have to pay a vendor's fee and must meet food safety standards. Additionally, while one interviewee noted farmer's markets are a great venue for beginning farmers, the return on investment (ROI) for producers is not guaranteed. One community stakeholder involved in managing a farmer's market noted that some vendors could not afford the transportation costs based on the money they made at the market. However, incentives similar to Michigan's Double UP Food Bucks program (doubling the value of EBT funds used at farmer's markets) provide systemic incentives for low-income consumers to buy directly from low-resource producers (Baker 2012). Similar programs have been enacted in 25 states around the country (Severson 2013). To address cost differences, some farmer's markets have developed a 50% coupon incentive program. Customers who buy \$20 in SNAP/EBT tokens at certain Western North Carolina farmer's markets receive an extra \$10 matched by FirstHealth, a non-profit healthcare network (Bawden 2013).

**CSAs (Community Supported Agriculture) programs provide the best mix**, allowing producers to have investors to manage risks and consumers to have a guaranteed source of fresh produce for the growing season. While producers must have a business license and practice basic food safety protocols (all information which can be gained from the local extension office), the cost of a CSA is manageable. However, few if any farms in North Carolina accept WIC and SNAP/EBT benefits, and consumers must arrange to pick up their CSA share once a week or every other week during the growing season. Notably, some farms with CSA programs subsidize the CSA cost for low-income residents by having a larger number of full-cost shares (University of Minnesota 2012). Other programs, such as the Chapel Hill-based Farmer Foodshare, encourage donations from both producers and consumers at local farmer's markets. They then distribute to food pantries and low-income people.



**Figure 16: Flowchart of retailer purchasing barriers**

Farmers can and already do sell to local retailers in both Washington and Beaufort County. Local farmers also sell to restaurants in Beaufort County.

**The biggest issue is meeting demand.** According to survey data, retailers like to buy local, but appear to do so seasonally and haphazardly. As one interviewee noted, “the market is a huge challenge.” If local producers cannot meet the quality and price standards expected by the retailer, they cannot sell their crops. Though only one retailer noted that the North Carolina Department of Agriculture could test their fruit and vegetables at any time due to public health concerns, retailers do not appear to impose many, if any, regulatory requirements on producers.

**It is an indirect method of reaching low-income consumers, but it may be more effective.** Grocery stores are more centrally located, have longer hours of operation, and usually accept WIC and SNAP/EBT. Purchasing agreements with restaurants may allow producers to supplement their income from farmer’s markets, CSAs, and the like.

**Producers may be able to expand to the “corner store” market.** One interviewee noted the effectiveness of the “Healthy Corner Store Initiative” in Pitt County; the initiative encourages discount stores, convenience stores, and gas stations to carry limited fresh produce (Pitt County 2012).

## 5. Breaking Down the Barriers

The barriers residents in Beaufort and Washington Counties face in accessing or marketing local produce are similar to barriers faced in other rural areas of the country. However, Eastern North Carolina has an agricultural tradition and climate and soil conditions favorable to fruit and vegetable production, given the correct incentives. According to the statistical analysis, the entire Southeastern Coastal Plain is affected by decreases in the number of grocery stores per 1,000 people, the ethnic composition of the region, persistent poverty, and population loss. According to the Center for Rural Affairs, nearly one in five rural grocery stores has gone out of business since 2006 in the Midwest, and fewer people are employed in the grocery sector (Bailey 2010). The situation is undoubtedly very similar for North Carolina, though no academic data has been collected. Rural consumers are more likely to travel further to reach farmer's markets, according to a study conducted by Eastern North Carolina University in Greenville (Jillcott-Pitts et al. 2013). However, only two farmer's markets are present in the study area – both are struggling, both are located in Beaufort County, and neither of them has the resources to accept SNAP/EBT. Out of 687 respondents for the consumer survey, only nine noted they shopped primarily at a farmer's market. Retailers already do buy and market local produce. Some buy directly from farmers, while others buy local produce through wholesalers such as Greenville Produce. While the retailer survey was subject to bias, it does indicate openness on the part of most grocery stores to work with local producers. Producers and community stakeholders note that food does not make a profit for the small-scale producer. In fact, since the Tobacco buyout of 2004 (Department of City and Regional Planning – UNC 2008), Eastern North Carolina lost several thousand farms. Few new farmers have started in the area and very few of these are willing or able to grow food. As noted by the Washington County Extension Office, the Washington County Farmer's Market fell apart after 2009 when the few remaining producers passed away. Thus, farm succession and incorporating more people with fewer resources into farming in Eastern North Carolina is a huge issue.

Following is a flowchart (Figure 19) describing the barriers identified via survey and structured interviews for producers, consumers, and retailers. Facilitators encouraging local food production and consumption are also identified when appropriate. Both the statistical analysis and spatial analysis helped to better define individual and structural barriers consumers face.

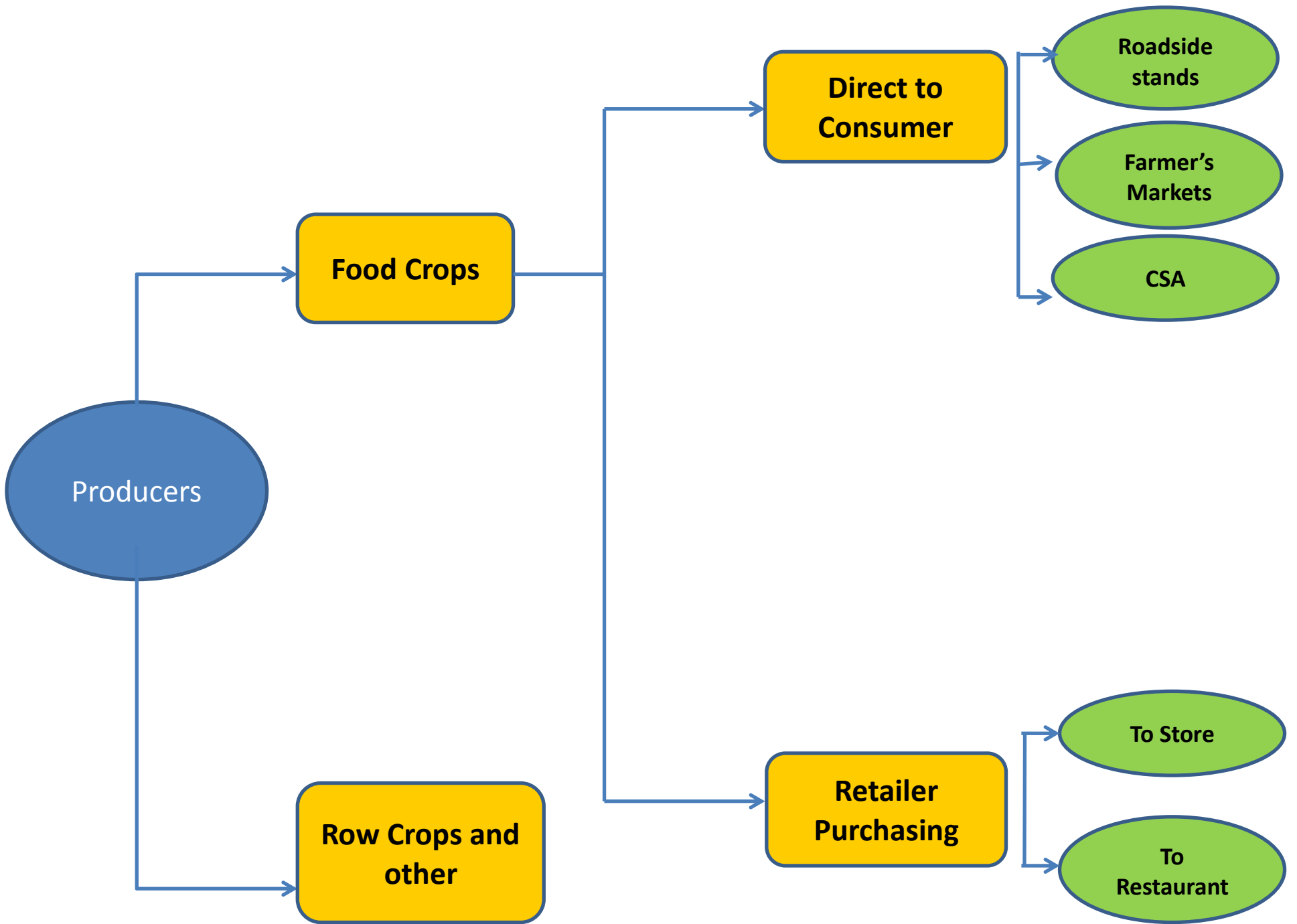


Figure 17: Flowchart of the local food production system

## 5.1 Recommendations

Based on the barriers identified via qualitative, statistical, and geospatial methods, we have several strategic recommendations for Resourceful Communities as both a funder and a capacity builder.

1. **Support organizations that address consumer transportation issues.** The consumer survey indicates that people without a car are more likely to shop at places that are not grocery stores. They are more likely to suffer poor nutrition and food insecurity. Simple volunteer programs such as Produce Ped'lers in Goldsboro deliver fresh produce from the farmer's market straight to people's doors via bicycle delivery. A similar program to address food insecurity in the town of Washington, North Carolina could be easily applied. Geographically, food deserts identified in Southeast Beaufort County are primarily limited by transportation access and could benefit from similar programs that use cars instead of bicycles. Programs that encourage ride sharing from rural areas and/or expanded use of county van services should be encouraged.
2. **Support subsidized or low-cost CSA programs.** Approximately 40% of respondents to the consumer survey indicated they would be interested in a low-cost or free box of produce from a local farm. At least two farms in Washington County have CSA programs already. Focus could be given to food desert regions of Southwest Washington County and Southeast Beaufort County where large population experience economic stressors.
3. **Support organizations that address SNAP/EBT purchases** at farmer's markets and roadside stands. Given that over half the respondents on the consumer survey indicated they were on a food assistance program, doubling their dollars at farmer's markets or allowing them to apply food assistance money toward a CSA encourages healthier eating and better connections with local farmers. This approach will be especially meaningful in the city of Washington, the city of Plymouth, and food desert areas in Southeast Beaufort County given high local poverty rates and rates of people dependent on SNAP benefits.
4. **Support farm labor force development.** For example, Resourceful Communities already works with the Beaufort County Developmental Center to train developmentally disabled people to grow and harvest food. High unemployment rates are found in southern Washington County and southern Beaufort County, which potentially (but not necessarily) implies an available labor force. Additionally, low employment rate in southeastern Beaufort County largely overlaps with a high disability rate.

5. **Encourage producers to be “retail ready”** and provide technical support and training. Gary Bullen of the North Carolina State University Cooperative Extension in Raleigh developed the report *Retail Ready for Local Farm Products* in 2013.<sup>4</sup> Trainings from the NCSU extension offices are ongoing throughout the state.
6. **Connect producers, farmer’s groups, and business alliances** with information about Pitt County’s “Healthy Corner Store Initiative” (Pitt County 2012).
7. **Encourage and support small scale programs and events that connect producers and consumers, even if there is not a long-term benefit.** For example, Resourceful Communities could support an organization that arranges for a local food dinner at a food pantry or an organization that arranges for schoolchildren to visit local farms. While these small gestures do not have immediate effects, they open the door to further connection and collaboration between producers and consumers.
8. **Statistically**, age matters more than race when low access to grocery store is taken into account. Resourceful Communities may take into account programs that benefit seniors and children if they want to increase healthy food access in Eastern North Carolina.
9. **Geographically**, three major food desert areas have been identified in Washington and Beaufort Counties (please see Figure 5). Notably, Resourceful Communities is already supporting one of these food desert areas in the town of Aurora, located in Southeast Beaufort County. To maximize benefit, Resourceful Communities may put special emphasis on programming and training in these regions.

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<sup>4</sup> The report can be found online at [http://ag-econ.ncsu.edu/sites/ag-econ.ncsu.edu/files/faculty/bullen/RETAIL\\_READY\\_COMPLETE\\_2-27-2013\\_6pm.pdf](http://ag-econ.ncsu.edu/sites/ag-econ.ncsu.edu/files/faculty/bullen/RETAIL_READY_COMPLETE_2-27-2013_6pm.pdf).



## 6. References

**Note: All websites were accessed from December 2013 to April 2014.**

- Ahearn, M., & Sterns, J. (2013). Direct-to-Consumer Sales of Farm Products: Producers and Supply Chains in the Southeast. *Journal of Agricultural and Applied Economics*, 45(03).
- Ahern, M., Brown, C., & Dukas, S. (2011). A National Study of the Association Between Food Environments and County-Level Health Outcomes. *The Journal of Rural Health*, 27(4), 367-379.
- Apparicio, P., M.S. Cloutier, and R. Shearmur (2007). The Case of Montréal's Missing Food Deserts: Evaluation of Accessibility to Food Supermarkets, *International Journal of Health Geographics* 6(4).
- Bailey, J. M. (2010). Rural grocery stores: importance and challenges. Center for Rural Affairs Rural Research and Analysis Program. Published October.
- Baker, J. (2012). Double Up Food Bucks: Program benefits farmers and low-income consumers seeking fresh produce. The Ann Arbor News, 3 Mar. 2012. Retrieved from <http://www.annarbor.com/news/double-up-food-bucks-improving-low-income-consumers-access-to-fresh-produce-fair-food-network-says/>
- Bawden, K. (2013). A Guide to SNAP/EBT at Farmer's Markets in North Carolina. Retrieved from [http://www.eatsmartmovemorenc.com/NCFarmersMarketsGuideSNAP\\_EBT/Texts/Guide%20to%20SNAP%20EBT%20at%20Farmers'%20Markets%20in%20North%20Carolina%20%20Steps,%20Best%20Practices%20and%20ResourcesKat%20Bawden\\_January%202013.pdf](http://www.eatsmartmovemorenc.com/NCFarmersMarketsGuideSNAP_EBT/Texts/Guide%20to%20SNAP%20EBT%20at%20Farmers'%20Markets%20in%20North%20Carolina%20%20Steps,%20Best%20Practices%20and%20ResourcesKat%20Bawden_January%202013.pdf)
- Beaufort County Developmental Center (BCDC). (2014). Mission. Retrieved from <http://www.bcdcsolutions.org/>
- Bennett, K. J., Probst, J. C., & Pumkam, C. (2011). Obesity among working age adults: The role of county-level persistent poverty in rural disparities. *Health & place*, 17(5), 1174-1181.
- Bing Maps. (2014). Microsoft. Retrieved from <http://www.bing.com/maps/>
- Burns, C.M., and Inglis, A.D. (2007). Measuring food access in Melbourne: Access to healthy and fast foods by car, bus and foot in an urban municipality in Melbourne. *Health & Place*, 13 (2007) 877-885.
- Cloak, L., Ledford., D., Tocco, N. (2011). Local Farmers and Food Production in North Carolina: A Three-Pronged Approach in Support of the Southeastern North Carolina Local Food Systems (SENCFS) Program. Master's Thesis, Nicholas School of the Environment, Duke University.

- Census Bureau. (2014). State and County QuickFacts: Various North Carolina Counties. Retrieved from <http://quickfacts.census.gov/qfd/index.html#> Note: Data derived from Population Estimates, American Community Survey, Census of Population and Housing, State and County Housing Unit Estimates, County Business Patterns, Non-employer Statistics, Economic Census, Survey of Business Owners, Building Permits
- Coleman-Jensen, A., Nord, M., and Singh, A. (2013). Household Food Security in the United States in 2012 Statistical Supplement. Economic Research Report No. (ERR-155) 41 pp, September 2013.
- Cummins, S., & Macintyre, S. (2002). A systematic study of an urban foodscape: the price and availability of food in greater Glasgow. *Urban Studies*, 39, 2115–2130, 16.
- Department of City and Regional Planning – University of North Carolina. (2008). Sowing the Seeds: The Promise of Local Food Systems in Southeast Central North Carolina – Report prepared for the Center for Community Action and the Center for Integrating Research and Action. Retrieved from <http://www.feastdowneast.org/Research/Sowing%20the%20Seeds%20The%20Promise%20of%20Local%20Food%20Systems%20in%20Southeastern%20North%20Carolina.pdf>
- Department of Health. (1996). Low income, food, nutrition and health: Strategies for improvement. A Report from the Low Income Project Team to the Nutrition Task Force. London: Department of Health.
- Eckert, J., & Shetty, S. (2011). Food systems, planning and quantifying access: Using GIS to plan for food retail. *Applied Geography*, 31(4), 1216-12.
- Environmental Protection Agency. (2013). Level III and IV Ecoregions of the Continental United States. Retrieved from [http://www.epa.gov/wed/pages/ecoregions/level\\_iii\\_iv.htm](http://www.epa.gov/wed/pages/ecoregions/level_iii_iv.htm)
- Environmental Protection Agency. (2000). Ambient Water Quality Criteria Recommendations: Rivers and Streams in Nutrient Ecoregion XIV. Retrieved from [http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/upload/2007\\_09\\_27\\_criteria\\_nutrient\\_ecoregions\\_rivers\\_rivers\\_14.pdf](http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/upload/2007_09_27_criteria_nutrient_ecoregions_rivers_rivers_14.pdf)
- ESRI. (2013). ArcGIS Desktop: Release 10.2 Redlands, CA: Environmental Systems Research Institute.
- ESRI. (2013). ArcGIS 10.2 for Desktop Help. CA: Environmental Systems Research Institute.
- Food Lion. (2014). Distribution Centers. Retrieved from <http://www.foodlion.com/careers/distributioncenters>

- Gallagher, M. (2007). Examining the Impact of Food Deserts on Public Health in Detroit, Mari Gallagher Research & Consulting Group.
- Google Maps. (2014). Google. <https://www.google.com/maps>
- Hassini, E., Surti, C., & Searcy, C. (2012). A literature review and a case study of sustainable supply chains with a focus on metrics. *International Journal of Production Economics*, 140(1), 69-82.
- Herrera, N. M. (2011). "Access to affordable and nutritious food: measuring and understanding food deserts and their consequences." *Eating right: the consumption of fruits and vegetables* (2011): 1-137.
- Jilcott-Pitts, S. B., Wu, Q., McGuirt, J. T., Crawford, T. W., Keyserling, T. C., & Ammerman, A. S. (2013). Associations between access to farmers' markets and supermarkets, shopping patterns, fruit and vegetable consumption and health indicators among women of reproductive age in eastern North Carolina, USA. *Public health nutrition*, 16(11), 1944-1952.
- Jilcott, S. B., Keyserling, T., Crawford, T., McGuirt, J. T., & Ammerman, A. S. (2011). Examining associations among obesity and per capita farmers' markets, grocery stores/supermarkets, and supercenters in US counties. *Journal of the American Dietetic Association*, 111(4), 567-572.
- Larson, N., Story, M., & Nelson, M. (2009). Neighborhood Environments: Disparities in Access to Healthy Foods in the U.S. *American Journal of Preventive Medicine*. 2009: 36(1)
- Liu, X., Kyriakidis, P., & Goodchild, M. (2008). Population-density estimation using regression and area-to-point residual Kriging. *International Journal of Geographical Information Science*. 2008 (22) 4-5: 431-447
- Marks, P. (2014). The Regulatory Environment for Farms in Western North Carolina. Appalachian Sustainable Agriculture Project. (2014). Retrieved from <http://asapconnections.org/downloads/the-regulatory-environment-for-farms-in-western-north-carolina.pdf>
- Marsden, T., Banks, J., & Bristow, G. (2000). Food supply chain approaches: exploring their role in rural development. *Sociologia ruralis*, 40(4), 424-438.
- McEntee, J., & Agyeman, J. (2010). Towards the development of a GIS method for identifying rural food deserts: Geographic access in Vermont, USA. *Applied Geography*, 30(1), 165-176.
- North Carolina Department of Agriculture. (2013). Agricultural Statistics: Summary of Commodities by County. Retrieved from <http://www.ncagr.gov/stats/codata/index.htm>

- North Carolina Department of Commerce. (2013). 2011 County Tier Designations. Retrieved from <https://www.nccommerce.com/research-publications/incentive-reports/2011-county-tier-designations>
- Parsons, S. (2012). An Evaluation of the Food Desert Definition in Durham, North Carolina. Master's Thesis, Nicholas School of the Environment, Duke University.
- Pitt County. (2012). State of the County Health Report. Retrieved from <http://www.pittcountync.gov/depts/health/stats/documents/pitt-county-sotch-2012.pdf>
- Schmit, T. M., & Gomez, M. I. (2011). Developing viable farmers markets in rural communities: An investigation of vendor performance using objective and subjective valuations. *Food policy*, 36(2), 119-127.
- Seuring, S. (2012). A review of modeling approaches for sustainable supply chain management. *Decision Support Systems*.
- Seuring, S., & Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of cleaner production*, 16(15), 1699-1710.
- Severson, G. (2013). New program connects low-income families with farmer's markets. Retrieved from <http://www.wkow.com/story/22896430/2013/07/21/new-program-connects-low-income-families-with-farmers-markets>
- University of Minnesota. (2012). Models for farmer-low income consumer connections. Retrieved from <http://www.misa.umn.edu/FarmFoodResources/LocalFood/AccessToLocalFood/SupplementalInformation/ModelsforFarmers/index.htm>
- US Census Bureau. (1999-2000, 2010, 2012). American Community Survey. Retrieved from <http://factfind2.census.gov>
- US Census Bureau, Geography Division. (1999, 2010, 2012). Topologically Integrated Geographic Encoding and Referencing. *Geographic Data*. Retrieved from <http://datagateway.nrcs.usda.gov/>
- USDA. (2009). Access to Affordable and Nutritious Food—Measuring and Understanding Food Deserts and Their Consequences: Report to Congress. Administrative Publication No. (AP-036) 160 pp, June 2009.
- USDA, ERS. (2006, 2010). Food Access Research Atlas. Retrieved from <http://www.ers.usda.gov/data-products/food-access-research-atlas.aspx>
- USDA, ERS. (2008). 2008 Farm Bill Overview. 2008 Farm Bill Side-By-Side: 20 Aug. 2008.

USDA, NRCS, National Geospatial Center of Excellence. (2002). Processed TIGER 2002 Counties plus NRCS additions.

Yousefian, A., Leighton, A., Fox, K., & Hartley, D. (2011). Understanding the rural food environment--perspectives of low-income parents. *Rural & Remote Health*, 11(2).

Zhou, G., Wu, Y., Xie, X., Xing, D., Fan, F., & Yu, R. (2013). Research on characteristics in the spatial distribution of the whole county population of Sichuan province, China via ARCGIS analysis. 2013 International Conference on Advances in Social Science, Humanities, and Management. Atlantis Press. 2013.

## 7. Appendices

### Appendix 1 – Counties and Independent Cities included in statistical analysis

#### *Coastal Plain Counties in North Carolina and Original Study Area (31)*

Beaufort  
Bertie  
Camden  
Carteret  
Chowan  
Craven  
Currituck  
Dare  
Edgecombe  
Franklin  
Gates  
Granville  
Greene – missing data for dependent variable  
Halifax  
Hertford  
Hyde  
Johnston  
Jones  
Lenoir  
Martin  
Nash  
Northhampton  
Pamlico  
Pasquotank  
Perquimans  
Pitt  
Vance  
Warren  
Washington  
Wayne  
Wilson

*Coastal Plain Counties and Independent Cities in Virginia (21)*

Accomack  
Essex  
Franklin  
Gloucester  
Hampton  
Lancaster  
Mathews – missing data for dependent variable  
Middlesex  
Newport News  
Norfolk  
Northhampton  
Northumberland  
Portsmouth  
Suffolk County  
Virginia Beach  
Westmoreland

*Additional Coastal Plain counties in North Carolina (8)*

Bladen  
Columbus  
Cumberland  
Duplin  
New Hanover  
Onslow  
Pender  
Tyrell

*Coastal Plain Counties in South Carolina (12)*

Beaufort  
Berkeley  
Charleston  
Colleton  
Dorchester  
Florence  
Georgetown  
Hampton  
Horry  
Jasper  
Marion  
Williamsburg

*Coastal Plain Counties in Georgia (19)*

Appling

Bacon

Brantley

Bryan

Bulloch

Camden

Charlton

Chatham

Clinch

Echols

Effingham

Evans

Glenn

Liberty

Long

McIntosh

Pierce

Ware

Wayne



## Appendix 2 – IRB Approval Documentation

[IRB]Exemption Approval

IRB ADMINISTRATOR <ors-info@duke.edu>

Mon 11/18/2013 4:34 PM

To:

Hill, Kimberly <kmh74@duke.edu>;

Reid, Chantal <chantal.reid@duke.edu>;

Cc:

Lorna Hicks;

Protocol : [C0050] Identifying Barriers to Sustainable Food Production by Low Resource Producers and Purchase by Low Income Consumers in Washington and Beaufort Counties

Researcher(s) :

Kimberly Hill(Graduate Student Researcher)

Chantal Reid(Advisor)

Anniversary Date : 11/17/2014

Your *Request for a Screening for Exemption* has been approved.

Exempt research does not require continuing review; however, you will be contacted at one-year intervals to ask if the research is still active. We encourage you to let us know when the research has been completed. Write to us at [ors-info@duke.edu](mailto:ors-info@duke.edu).

When conducting research approved as exempt, it is essential that researchers:

- Submit proposed changes to the IRB for review. The form, Request to Amend an Exemption, may be submitted via email. No signatures are required. The form can be found at <<http://www.ors.duke.edu/Research-with-Human-Subjects/forms>>.

There are two possible outcomes of the review of the request:

1. The proposed changes are such that the research no longer qualifies for exemption. You will be asked to submit a *Request for protocol Approval: Expedited Review or Full Review*.

2. The proposed changes do not change the status of the research as exempt. If this is the case, you will receive an Exemption Amendment Approval notice when the amendment is approved.

- Notify the IRB immediately at [lorna.hicks@duke.edu](mailto:lorna.hicks@duke.edu) if there are any unanticipated risks to subjects or deviations from the research procedures described in the protocol.

## Appendix 3 – Sample Surveys and Interview Questions



20 February 2014

Thank you for helping to survey the Washington and Beaufort County Communities!

This survey is part of a larger assessment going on throughout Beaufort and Washington counties, being performed by the Nicholas School of the Environment at Duke University in cooperation with the Conservation Fund's Resourceful Communities program. The goal of the assessment is to better understand low-income access issues to local, fresh, healthy food and market entry issues for producers of local, fresh, healthy food by surveying local farmers, retailers, and consumers.

Your participation is completely voluntary. We will not collect any personal information, and you are free to refuse to answer any question or to provide more information if you think it is appropriate. We will try to ensure confidentiality, but we cannot guarantee it because we are only looking at two rural counties.

The contact information for the survey lead is below. We look forward to hearing back from you.

For more information or if you have any questions, please email Kimberly Hill at Duke University – [Kimberly.m.hill@duke.edu](mailto:Kimberly.m.hill@duke.edu), [kmh74@duke.edu](mailto:kmh74@duke.edu) or call her at 480-323-9807. I have attached my contact information and the contact information for my adviser, Dr. Chantal Reid, below.

Thanks again for your help!

Kimberly Hill  
Master of Environmental Management Candidate 2014  
Duke University Nicholas School of the Environment

### **Contact information**

Kimberly Hill  
Duke University  
Cell: 480-323-9807  
E-mail: [kmh74@duke.edu](mailto:kmh74@duke.edu)

Dr. Chantal Reid  
Duke University  
Phone: 919- 660-7293  
E-mail: [Chantal@duke.edu](mailto:Chantal@duke.edu)

***Community Food Assessment Survey - For Consumers***

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**The purpose of this survey is to learn how and where people get food for themselves and their families Beaufort and Washington Counties. Your participation will help us to create a community food assessment to increase access to fresh, local and healthy foods in your community. We will keep all your responses confidential, but we cannot guarantee confidentiality because Beaufort and Washington Counties are very small.**

**Please DO NOT put your name on this survey. Please check the box or circle the best answer.**

1. Where do you buy most of your food? Please only check one.
  - Convenience Store/Gas Station
  - Discount Store (Family Dollar, Dollar General, etc)
  - Eat at restaurants most often/go to drive-through
  - Farmers Market or Roadside Stand or other local producer
  - Grocery Store (Piggly Wiggly, Food Lion, Wal-Mart)
  
2. Where else do you buy food at least once a week? Please check all that apply.
  - Convenience Store/Gas Station
  - Discount Store (Family Dollar, Dollar General, etc)
  - Eat at restaurants most often/go to drive-through
  - Farmers Market or Roadside Stand or other local producer
  - Grocery Store (Piggly Wiggly, Food Lion, Wal-Mart)
  
3. How do you usually get to the store? (Please check one)
  - Bike
  - Bus
  - Car/Truck
  - County Van Service
  - Walk
  - I ride in the car with friends or family.
  
4. How else do you usually get to the store? (Please check all that apply)
  - Bike
  - Bus
  - Car/Truck
  - County Van Service
  - Walk
  - I ride in the car with friends or family.

5. On average, how long does it take you to get from your house to where you usually shop for food?

- 0-10 minutes
- 10-30 minutes
- 30-60 minutes
- Over 1 hour

6. Does lack of transportation make it difficult for you to get your groceries?

- Yes
- No
- Don't know

7. Do you have a hard time stretching your food budget to the end of the month?

- Yes
- No

If yes, what do you do in those months?

8. Do you feel that you eat enough fruits and vegetables, eggs, milk and whole grains?

- Yes
- No

9. If no, what is the reason you do not eat enough of these foods? Please check as many as apply or add your own reasons.

- I don't like their taste.
- Fruits and vegetables that I like are not available.
- I don't have enough time to cook them.
- I don't know how to cook them.
- Other \_\_\_\_\_

10. Which of the following would you like in your neighborhood? (Please check ONLY two)

- Free cooking classes
- Free classes on home gardening
- Free farmers market coupons
- Free or discounted weekly box of produce from a local farm
- Fresh fruits and vegetables available in gas stations / convenience stores
- Mobile (trucks) food markets
- Community gardens

11. Do you, or anyone in your household, currently use...? (Please check all that apply)

- WIC (Women, Infants and Children)
- Food Stamps (SNAP)

12. What is your zip code? \_\_\_\_\_

13. How would you describe your race/ethnicity?

- a) Asian
- b) American Indian/Alaska Native
- c) Hispanic or Latino
- d) Black, African American
- e) White, Non-Hispanic
- f) Multi-racial/ethnic
- g) Hawaiian/Pacific Islander
- h) Other \_\_\_\_\_
- i) Prefer not to answer



*Community Food Assessment Survey - For Stores*

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**The purpose of this survey is to learn how and where people get food for themselves and their families Beaufort and Washington Counties. Your participation will help us to create a community food assessment to increase access to fresh, local and healthy foods in your community. We will keep all your responses confidential, but we cannot guarantee confidentiality because Beaufort and Washington Counties are very small. Please DO NOT put your name or the name of your company on this survey. Please check the box or circle the best answer.**

1. What kind of business would you describe your business as?

- Convenience Store/Gas Station
- Discount Store (Family Dollar, Dollar General, etc)
- Grocery Store (Piggly Wiggly, Food Lion, Wal-Mart)
- Roadside stand
- Other. Please describe \_\_\_\_\_

2. Does your business often buy or market fresh produce?

- Yes
- No
- Don't know

3. Why or why not? What encourages you to offer or market fresh produce?

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4. Do you buy any of the store's produce from farmers located in North Carolina?

- Yes
- No
- Don't know

5. Do you buy any of the produce or products you sell within local counties (Washington, Beaufort, Pitt)?

- Yes
- No
- Don't know

6. If so, which products do you source locally and from which counties?

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7. If you do not source locally, why do you source elsewhere? Select all that apply.

- My business cannot afford it.
- My customers won't buy it.
- I don't know anyone selling produce that my customers would want.
- Other \_\_\_\_\_

8. Would you be interested in buying from local North Carolina farmers?

- Yes
- No
- Don't know

***Community Food Assessment Survey - For Farmers***

---

**The purpose of this survey is to learn how and where people get food for themselves and their families Beaufort and Washington Counties. Your participation will help us to create a community food assessment to increase access to fresh, local and healthy foods in your community. We will keep all your responses confidential, but we cannot guarantee confidentiality because Beaufort and Washington Counties are very small.**

**Please DO NOT put your name on this survey. Please check the box or circle the best answer.**

1. Do you sell food directly to consumers (to people in the county, to restaurants, to others)?

- Yes
- No
- Don't know

2. If so, how do you sell food? Check all that apply.

- I sell at the farmer's market. Which one? \_\_\_\_\_
  - I sell to people,
  - I sell to restaurants.
  - I sell directly to grocery or convenience stores.
  - I sell through a CSA (community-supported agriculture) program.
  - I sell to a big food distributor.
  - Other. Please tell us a little bit more. \_\_\_\_\_
- 

3. If you sell directly to consumers, do you find it profitable?

- Yes
- No
- Don't know

4. Do you use any of your produce to make processed products, like jams, jellies, or cakes?

- Yes
- No
- Don't know

5. Do you find these processed products to more profitable than raw goods?

- Yes
- No
- Don't know

6. Do you sell to a food distributor or a dedicated vendor?

- Yes
- No
- Don't know



7. If so, how large is the food distribution service or vendor?

- 0-10 employees
- 10-50 employees
- More than 50 employees

8. Does the food distribution service sell:

- Locally (within this county and neighboring counties)
- Statewide (within North Carolina)
- Regionally (along the East Coast or South)
- Nationwide

9. Do you find selling to the distribution service profitable?

- Yes
- No
- Don't know

10. Do you have any contracts with local school districts?

- Yes
- No
- Don't know

11. If so, could you tell us which school districts you work with? \_\_\_\_\_

\_\_\_\_\_

12. Do you have any contracts with local restaurants?

- Yes
- No
- Don't know

13. Do you have any contracts with local grocery stores?

- Yes
- No
- Don't know

14. Do you have any contracts with local convenience stores?

- Yes
- No
- Don't know

15. Do you use your own fruits and vegetables for you or your family's consumption?

- Yes
- No
- Don't know

16. How far do you travel – distance and time - to sell or market your produce? Check all that apply.

- 0-10 minutes
- 10-30 minutes
- 30-60 minutes
- Over 1 hour
- 1-5 miles
- 5-10 miles
- 10-30 miles
- More than 30 miles

17. How many times a week or a month do you travel to sell your produce? Check all that apply.

- Once a week
- 2-3 times per week
- 4 or more times per week
- Once a month
- Twice a month
- Less than once a month
- I do not travel at all.

18. If a local farmer's market started or a local distribution center was set up less than 30 miles from your farm, would you use it?

- Yes
- No
- Don't know

19. If a local farmer's market started or a local distribution center was set up 15 miles or less from your farm, would you use it?

- Yes
- No
- Don't know

20. Do you think travel time affects how far you can go to sell or market your fruits and vegetables?

- Yes
- No
- Don't know

21. Does spoilage risk of fruits and vegetables have a big impact on your business?

- Yes
- No
- Don't know

22. Has that changed what you grow or decide to produce?

- Yes
- No
- Don't know

23. Could you tell us a little bit more about how you decide what to produce?

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## ***Community Food Assessment – Questions for Stakeholders and Government Officials***

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The purpose of this interview is to learn how and where people get food for themselves and their families Beaufort and Washington Counties. Your participation will help us to create a community food assessment to increase access to fresh, local and healthy foods in your community. We will keep all your responses confidential, but we cannot guarantee confidentiality because Beaufort and Washington Counties are very small.

**Please DO NOT put your name or the name of your organization on this paper.**

What do you think are the biggest problems affecting the agricultural sector in your county? Are you aware of any programs in place to help local producers?

If so, which programs and what kind of financial resources do they have at their disposal?

Are you aware of any programs to encourage consumption of local fresh fruits and vegetables by low-income people?

If so, which programs and what kind of financial resources do they have at their disposal?

## **Appendix 4 – List of retailers and interviewees**

Grocery Stores and produce stores in Washington and Beaufort Counties

### *Beaufort County*

Piggly Wiggly, Aurora, NC  
Della and Darnell's Grocery, Edward, NC  
Veri-Kwik, Edward, NC  
Smith Food Pride, Chocowinity, NC  
Food Lion, Chocowinity, NC  
Piggly Wiggly, Washington Square, Washington, NC  
Piggly Wiggly, River Road, Washington, NC  
Walmart, Washington, NC  
Petals and Produce, Washington, NC  
Food Lion, Washington, NC  
El Lago, Washington, NC  
Acre Station Meat Farm, Pinetown, NC  
Petals and Produce, Pinetown, NC  
Food Lion, Belhaven, NC

### *Washington County*

Oliver's Market, Roper, NC  
Food Lion, Plymouth, NC  
Piggly Wiggly, Plymouth, NC  
Mark's Supermarket, Creswell, NC  
Tienda Mexicana Peniel, Creswell, NC

### *Interviewees*

Rebecca Liverman, County Extension Director, Washington County  
C.L. Sumner, Agricultural Technician, Martin and Washington Counties  
Jacob Searcy, Extension Agent Agriculture-Horticulture  
Cliff Sutton, Agricultural Marketing Specialist, NCDA  
Diana Vetter Craft, Access to Healthy Foods Coordinator, Pitt County Government  
Pastor Eddie McNair, New Life CDC  
LaTasha McNair, New Life CDC  
Renee Harvey, Community Transformation Catalyst Coordinator, Beaufort County  
Jared Cates, Community Mobilizer, Carolina Farm Stewardship Association

### *Communications*

Karen Stanley, RDN, LDN Healthy Eating Coordinator, NC Community Transformation Grant Project, DHHS  
Diane Beth, Nutrition Manager NC Fruits & Vegetable Nutrition Coordinator, DHHS  
GW Stanley, Program Manager of Goodness Grows, NCDA  
Dr. Jane Steigerwald, RD, LDN, Director, Feast Down East/SNCFS Program  
Melissa Rogan, Americorps VISTA, Feast Down East/Southeastern North Carolina Food Systems Program

## Appendix 5 – Spatial Interpolation using Auxiliary-aided Areal Kriging Approach: Spatial Models and Parameters

Variable Name	Best Model	Lag Size/ Lag No. (m)	Anisotropy	Primary Input				Auxiliary Input			
				Dataset	Year	Summary Level	Search Nbhhood. Max/Min	Dataset	Year	Summary Level	Search Nbhhood. Max/Min
Median Household Income	Exponential	1000/10	Y	Median Household Income	1999	Block Group	12/3	Median Household Income	2012	Tract	6/2
Poverty Rate	Exponential	1800/10	N	% Pop. below poverty	1999	Block Group	12/3	% Household Below Poverty	2012	Tract	6/2
Food Stamp Status	Gaussian	900/20	Y	% Household on food stamp	2012	Tract	6/2	% Household with Non-White Residents	2012	Tract	6/2
Elderly Population	Circular	500/20	N	% Pop. 65 and over	2010	Tract	6/2	% Pop. 65 and over	1999	Block Group	12/3
Percent Children	Exponential	500/15	Y	% Pop. under 18	2010	Block Group	12/3	N/A			
Disability Population	Exponential	500/14	Y	% Pop. with disability	2012	Tract	6/2	% Pop. with disability	2000	Block Group	12/3
Minority Group	Exponential	1000/14	Y	% Non-White Householder	2010	Block Group	12/3	% Household with Non-White Residents	2012	Tract	6/2
Education Attainment	Gaussian	1000/18	N	% Pop. less than high school	2012	Tract	6/2	N/A			
Limited Vehicle Access	Circular	1200/12	Y	% Household No Vehicle	1999	Tract	6/4	% Worker Driving to Work	2012	Tract	6/4

# Appendix 6 – Geo-Processing Models

## Data Preparation

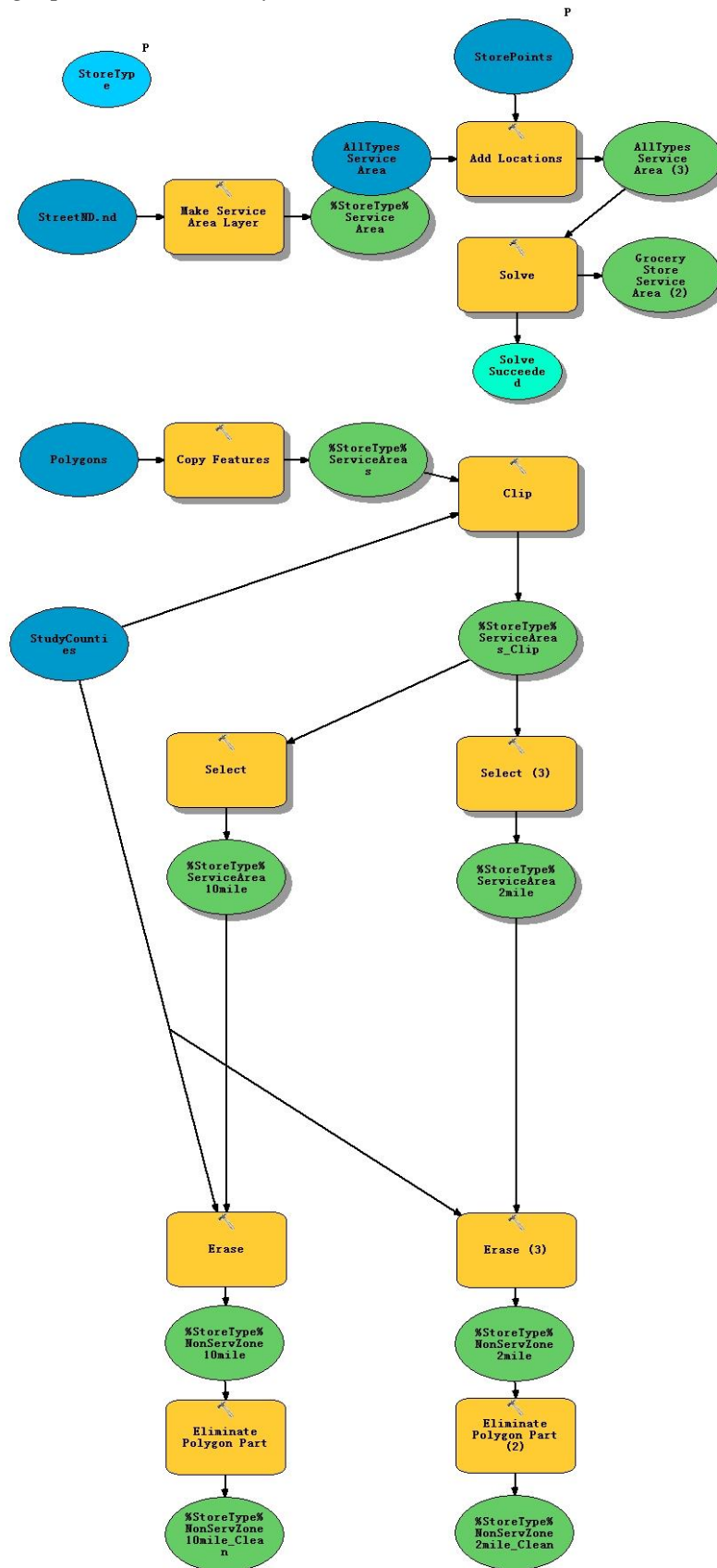


Barrier Score Development-Non-Geographic Barrier Analysis

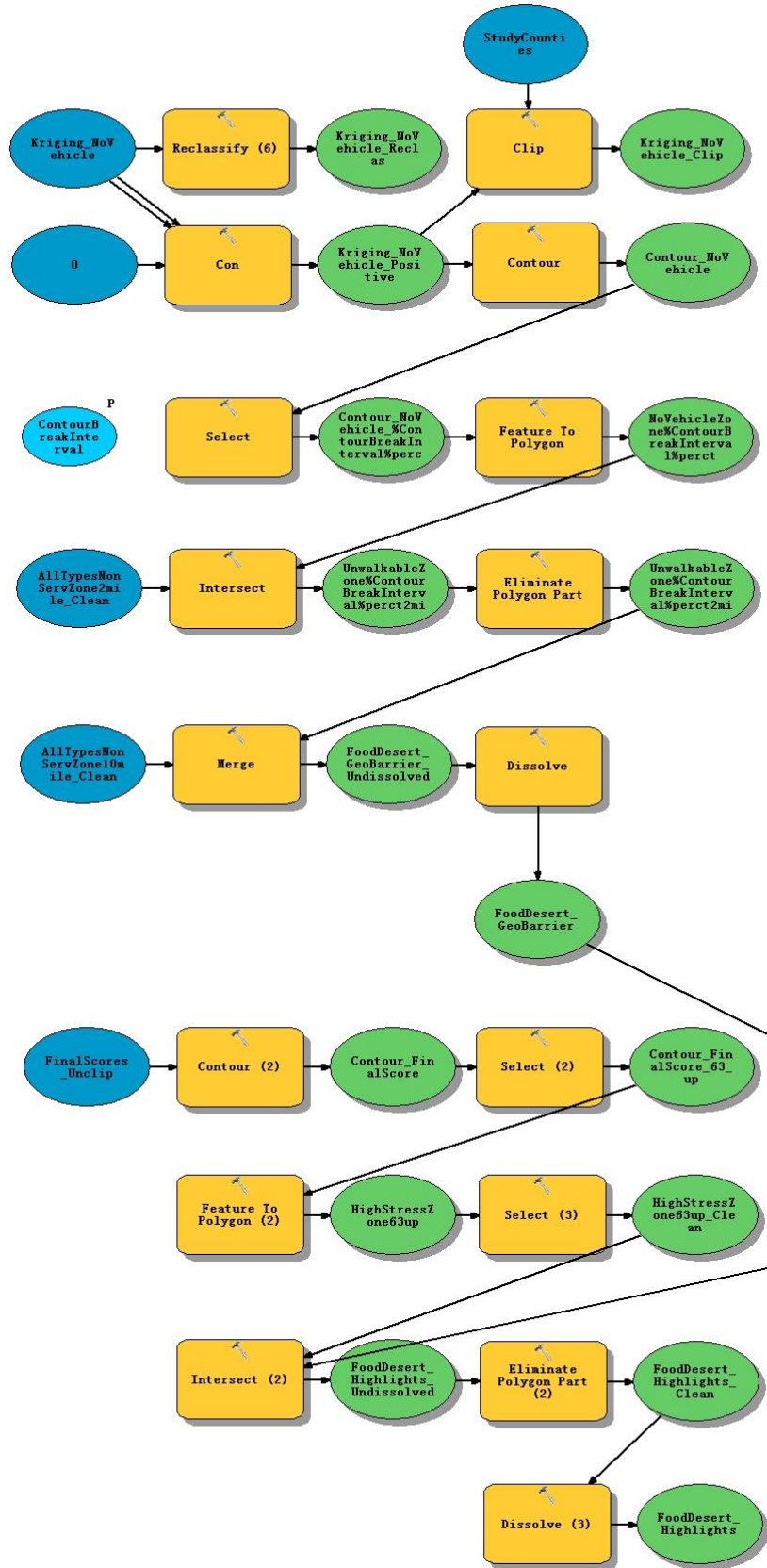




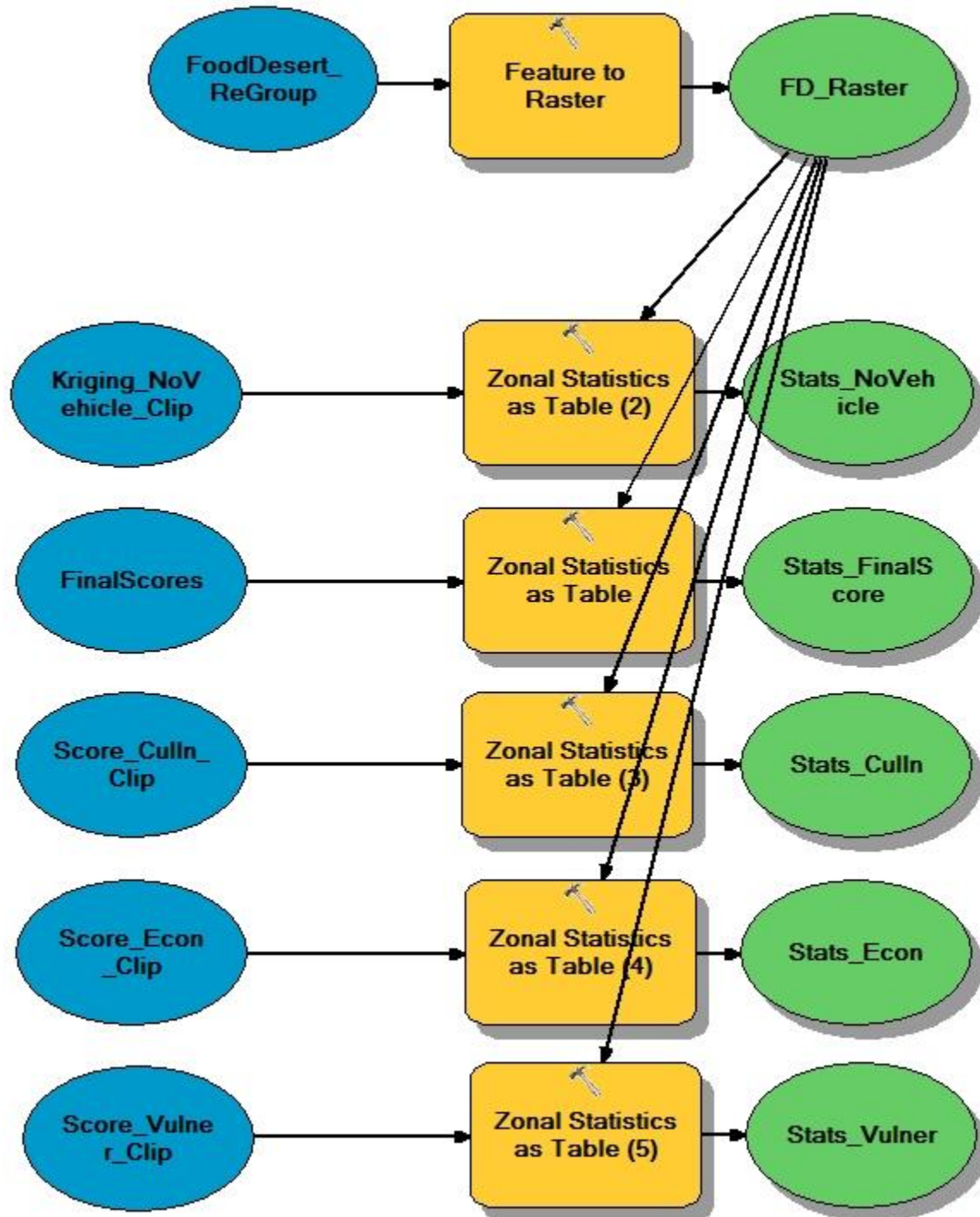
# Network Analysis-Geographic Barrier Analysis



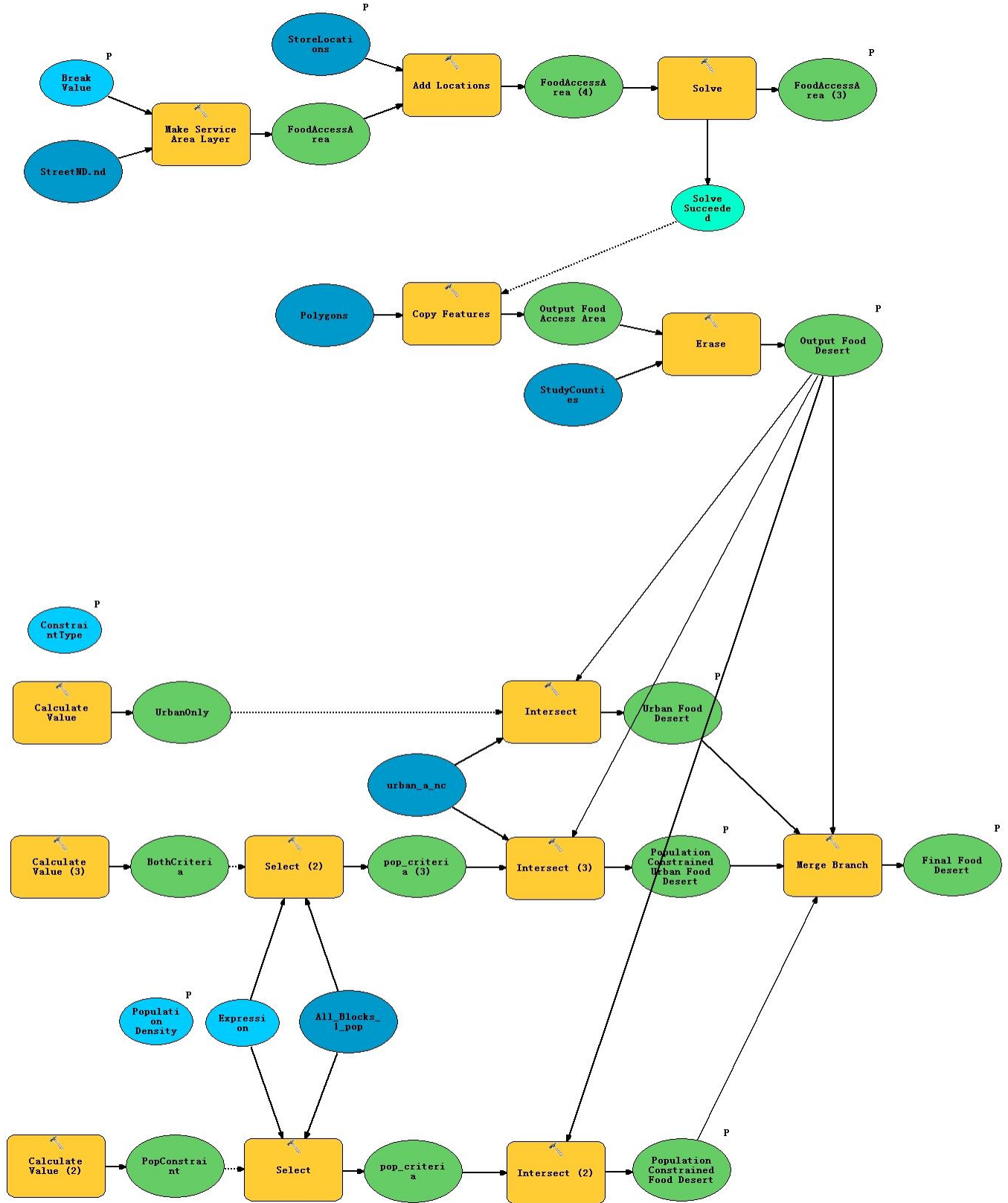
Development of All-Criteria Food Desert Map



*Zonal Statistics-Analysis of Results*



# Food Desert Locator Tool Development



## Appendix 7– GIS Method Details of Food Desert Analysis

The Food Desert Analysis requires ESRI's ArcGIS 10.2 for Desktop software with Advanced License, Geostatistical Analyst extension, Network Analyst extension, and Spatial Analyst extension. The Food Desert Locator requires the same software and licensing with only Network Analyst extension.

### *Data Preparation*

Data of all the *non-geographic* variables and vehicle availability are independent of geographic measures (physical distance between places, etc.) and thus were processed in similar ways. Raw inputs of these variables consisted of two components—census data summarized on a census unit basis and the corresponding census unit polygons (Figure 7.1). Unless otherwise specified, all input census data were downloaded from US Census Bureau's Fact-Finder website in spreadsheets (.csv files). The census unit polygons were requested through the USDA-NRCS (Natural Resource Conservation Service) Geospatial Data Gateway in ESRI shapefile (.shp file) format. The census data were screened to contain only desired variable columns, and then joined to census polygons using *Join Field* tool (ArcGIS 10.2 for Desktop) based on census unit IDs. The finished products of this preparation step were census polygons (ESRI geodatabase feature classes) with desired variables in the feature attributes.

Direct travel distance data was not readily available because it required a distance measure in ArcGIS. The raw inputs for the distance measure were locations of food retailers, street polylines, and study county boundaries. The latter two were easily available from USDA-NRCS Geospatial Data Gateway in standard formats. The acquisition of the food retailer coordinates took several steps. First, a list of food retailers selling fresh healthy food within 7 miles of study area was obtained through various sources (***Google, Cates (2012), and original data***). Retailers included supermarkets, fresh produce vendors, and farmers markets. Intentionally excluded were convenient stores, discount stores, and fast food restaurants. The eligible stores were then located on GoogleMaps and/or BingMaps, and their geographic coordinates were mapped and saved in ArcGIS as point features. Next, road network (.nd file) was created out of the street features. The store locations and road network were two direct inputs for distance calculation in next steps. Study county boundaries served as a spatial reference.

### *Spatial Interpolation*

Vector datasets of non-geographic variables were interpolated into raster layers. The spatial interpolation technique has proved advantageous in improving quality of census data (Zhou et al 2013, Liu et al 2007). Our analysis can benefit on several aspects. First, inconsistent data resolution prohibits comparing and synthesizing results across variables. Second, converting all data into the same resolution also allows for cross-variable operations in later steps. Further, data for certain variables are available only on the census tract level, which is too coarse for effective analysis given the scope of this study. Interpolation using the *Areal Kriging* (ArcGIS 10.2) method

addresses this issue by making a prediction of values in all raster pixels based on sample observations. Presumably, a resulting continuous surface better reflects reality on the ground than rigid blocks representing single values. Finally, the advanced *Geostatistics* tools in ArcGIS make it possible to use auxiliary datasets to assist interpolation of a target variable. For example, when spatially interpolating a household income dataset, using an additional auxiliary poverty dataset can improve the quality of the results. This is because poverty and income are strongly correlated, and poverty can hence add relevant information to our spatial prediction of income.

A pairwise correlation analysis was first run in Microsoft Excel on all census variables to identify potential auxiliary variables based on high correlations. Spatial interpolation was then performed in ArcGIS using its *Geostatistics Analyst* extension. All interpolations applied the *Areal Kriging* approach. For each variable, 6 spatial models were fitted to the data and the best one was selected (For criteria of model performance, please refer to ArcGIS 10.2 for Desktop Help, ESRI 2013). Detailed model parameters from the model fitting process are presented in Appendix 5. The output raster layers have a pixel size set to 30X30 meters and are clipped to the study county boundaries.

#### *Development of Non-Geographic Score Layers*

Based on the interpolated raster datasets, *Barrier Scores* were developed as quantified indicators of the *non-geographic* variables. For each variable, raster pixel values were first normalized based on percentage at a 1-100 scale. Higher scores indicated more stressful conditions. For example, the lowest employment rate had a barrier score of 100 on the normalized employment rate raster surface, while the lowest percentage rate of elderly population was given a barrier score of 1. After normalization, inter-variable operation becomes conceptually valid. Normalization was done in Raster Calculator of ArcGIS's Spatial Analyst extension. Output results were three raster surfaces indicating the three types of Barrier Scores on a possible range of 1-100.

Similarly, the Final Score was also calculated using Raster Calculator as the arithmetic average of the three Barrier Scores in each pixel. The resulting Final Score layer was designed to integrate the information carried in all Barrier Score layers.

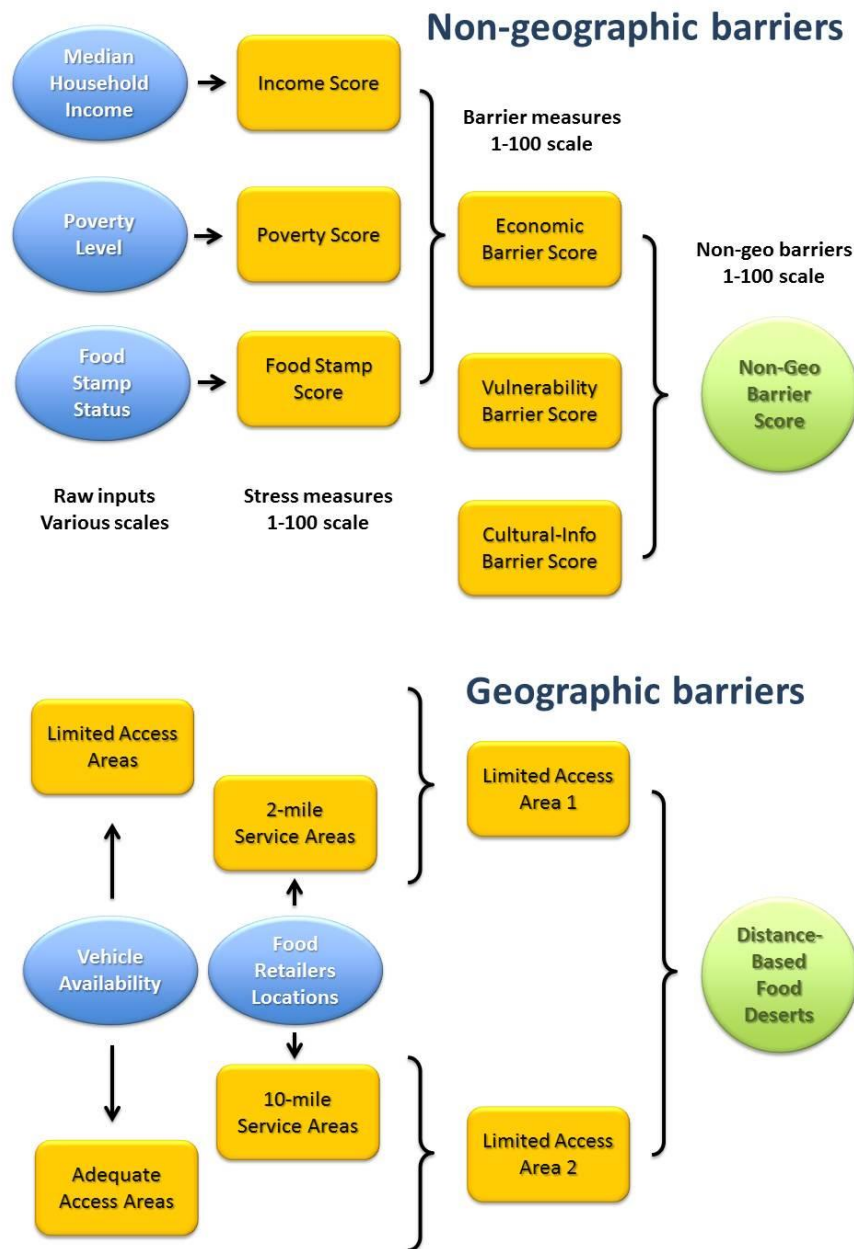


Figure 7.1 General workflow of spatial analysis of non-geographic and geographic barriers.

The data of Household Vehicle Availability was obtained from US Census Bureau. The data was prepared and interpolated using the same methods described above. The output raster layer indicated that the rate of households *without* access to a vehicle ranges from 0% to 22% in the study area, with a mean of 9% and standard deviation of approx. 3.5%. Accordingly, “vehicle inaccessible zones” were set at the threshold of 15% (approx. 2X standard deviation of mean). Contours were drawn at 15%, and the areas at or exceeding 15% were converted to vector polygons.

Using Make Service Area Layer tool, the service areas of food retailers were calculated at street distances of 2 and 10 miles, respectively, based on store locations and road network. These service areas were then subtracted from the study counties using Erase tool to find the 2-mile- and 10-mile “non-service zones”. Here, we assumed that people’s maximum willing-to-travel distance for grocery was 2 miles without a car and 10 miles with a car. We intersected “vehicle inaccessible zones” with the 2-mile “non-service zones” to find the areas in which people have no vehicles but have to travel at least 2 miles to buy groceries. The resulting layer is then merged to the 10-mile “non-service zones”, yielding the final Geographic Barrier map.

#### *Development of the All Criteria Food Desert Layer*

Geographic and non-geographic barriers were synthesized into one map, the “All Criteria Food Desert” map. Contours were drawn for Final Score raster layer at a threshold score of 63 (approx. mean + 2X standard deviation). In other words, areas suffering from non-geographic barriers at score 63 and higher were considered “highly stressed”. The areas enclosed by the contour were converted to vector polygons, and then intersected with the distance-based food desert map. The resulting polygons are “All Criteria Food Deserts”, areas stressed by both socio-economic factors and geographic distance.