

Intentional Technical Assistance: Using Network Model Analysis and Community  
Engagement Tools to Assess Fresh Food Availability and Accessibility in  
Knightdale, North Carolina  
Prepared for the Triangle Land Conservancy

by  
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## Executive Summary

**Background:** In North Carolina, agricultural expansion via deforestation and land conversion contributes to land loss and accelerates climate change. According to Environment America, North Carolina has lost 2.37 million acres of cropland and forest land in 20 years at 325 acres/day [42]. Knightdale, NC, is an agriculture community that faces the threat of hyper development which we believe to be a driving factor of food insecurity as local grocery markets struggle to keep up with the growing population. We aim to establish the need to extend these converted lands back to the community and help rebuild resilience with access to nutritious foods, educational workshop events and volunteer opportunities.

**Objective:** This research aims to investigate and recommend whether the anticipated integration of an Agriculture Pavilion at the Williamson Nature Preserve (WNP), to be used as a food hub location and outdoor learning space, would be beneficial to the community of Knightdale. Our aim is to highlight the growing importance of community-specific comprehensive technical assistance within the environmental justice framework by facilitating the development of two survey service tools and gathering fresh produce accessibility data via network model analysis of the study area.

**Methodology:** A comprehensive and well-rounded understanding of food security in the Knightdale community is made possible by the interdisciplinary approach used in this paper, which combines network model analysis to create an initial comprehensive literature review of case studies by accomplished academic professionals within the environmental justice and environmental science network, and survey service tools that identify key stakeholders using geospatial analysis.

**Key Findings:** The network model analysis and spatial clustering showed that the average drive to the nearest available food source is 2 miles within a Knightdale resident's 5-mile food environment (*Appendix*). In using the percentage of families receiving Supplemental Nutrition Assistance Program (SNAP) benefits to measure fresh produce accessibility, we found over 1,000 Knightdale families are recipients and 45% of their available food environment are limited-service restaurants thus inaccessible to them as fast-food restaurants do not accept SNAP (*appendix figure*). Although the initial geospatial analysis has shown a need for increased fresh produce availability and accessibility, the designed community engagement service tools should be used to ground-truth findings with Knightdale residents lived experience. The custom survey tools use affirmative responses to determine the hidden nuances of the geospatial data findings such as participants grocery store shopping habits and interest in having a food hub location.

**Recommendations:** Fresh produce options are scarce in Wake County, but Knightdale is especially lacking availability and accessibility with only 3% of their local food network

containing fresh produce retailers (*appendix figure*). We recommend that the Triangle Land Conservancy utilize the survey tools with Knightdale community partners and local farmers to consider transforming the Agriculture Pavilion at the Bailey and Sarah P. Williamson Nature in Wake County.

**Conclusion:** Given the impacts of climate change and land use pressures on local agricultural production, it is critical that the current generation of social and environmental researchers foster multidisciplinary approaches to make resources available to those who currently lack access, in accordance with the environmental justice framework.

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## **Introduction - *Historical and Present-Day Context***

In the eastern United States, increased land development of uninhabited and rural areas continues to perpetuate the decline of productive agricultural lands [1] and in turn fragment local food systems. In North Carolina specifically, systemic land fragmentation and agricultural land loss in minority communities has been associated with discriminatory government programs, financial challenges, land inheritance and other socioeconomic factors [2]. For example, African American landowners were displaced from their homes while faced with an unfair housing market due to redlining, heirs property laws and more recently, gentrification [3]. These systemic barriers and land use pressures led to the eventual disconnection of African American families from local food retailers that stocked fresh, nutritious produce [4].

As defined at the 1996 World Food Summit, projects facilitating food security should strive for “all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” [5]. Two key dimensions of food security are availability and access. Although complex, availability has been most defined as the distance to the nearest food location. On the other hand, access is more complex and has been defined in literature as the barriers a person faces to produce and consume nutritious food [5,6]. Researchers have used a multitude of socioeconomic characteristics as proxy measures such as vehicle access, education levels, race, and income [7].

Quantitative and empirical food security studies labeled communities lacking access to nutrient-dense food as food deserts and food swamps. There is dissent on the use of the terms as they imply that the current state of the food environment is a naturally occurring phenomenon and detracts from the root societal causes of food insecurity [8]. However, food justice advocate and farmer Karen Washington coined the term food apartheid to more accurately reflect the historical and systematic disenfranchisement of community food landscapes due to race, class or other forms of discrimination [9]. The importance of food security has been increasingly associated with the environmental justice movement as communities are disproportionately impacted by climate change stressors, environmental hazards, and face inequitable access to financial resources. Thus, compounding health issues within those communities [10]. Despite the challenges, there are many local initiatives dedicated to establishing resilience in their communities that address food insecurity, promote urban agroforestry: the combination of agriculture and forestry techniques that create productive and sustainable polycultures [11]. Now more than before, scientific evidence and alignment with environmental justice principles are more emphasized when dispersing available funds in support of food security initiatives and making long-term environmental policy goals [12,13]. Thus, there is a heightened ethical duty placed on researchers and government officials to complete comprehensive and ethical studies that drive meaningful change for the communities that need it most.

Our client, the Triangle Land Conservancy at the Bailey and Sarah P. Williamson Nature Preserve situated in Wake County, has expressed interest in elevating nearby communities within their service area. According to current trends, communities surrounding the preserve are

developing quickly and residents are suffering displacement. Food apartheid is pervasive because of this increased development and displacement. Our client's status as a land trust sets them apart and gives them the ability to participate in environmental equity. Our client owns land as a conservancy and wants to grant people access to this land in return. As an agricultural land trust, their desire is to establish themselves as a local food hub aggregator in which they can provide the surrounding communities with fresh nutritious produce. The fact that our client is already well-known in these neighboring communities adds to their distinctiveness. TLC is closely associated with the town of Knightdale, NC. To be more precise, TLC is directly affiliated with Knightdale High School, a Wake County public high school in the area. The Pathways into Natural Environments and Science Program (PINES) at TLC is administered by the Department of Education and Outreach. With the help of this program, high school students can easily make the transition to a career in natural sciences and conservation. Moreover, the creation of an environmental learning area at the preserve is underway thanks to collaborations with numerous other groups. Therefore, our client has tasked us with assessing the need for this learning space which we've coined as the Agricultural Pavilion. The intention of this space is to provide a makeshift farmers market for the community, workshop events that increase environmental and sustainability awareness and to get people reconnected with the land. Prior to the fulfillment of such food aggregation projects, we need to ensure that it is a feasible one: the surrounding communities will benefit because there is an established need and desire for one.

## **Study Area and Literature Review - *Wake County***

North Carolina is one of the top 10 hungriest states in the nation. Approximately, 10.9% of the population is food insecure; to be food insecure is to lack having steady access to an adequate supply of reasonably priced, nourishing food. 394,000 of these individuals are children with 1 in 6 of them experiencing hunger [14]. As black and brown children are raised in this environment, they are living at a higher risk of experiencing poor health. Two Wake County census tracts hold the largest combined percentage of persons under the age of 45 living with diabetes compared to the state at 20.1%. While this statistic does not include persons under 18, according to a Behavioral Risk Factor Surveillance Survey by the CDC done in North Carolina, 33.6% of youth reported that they consume one or more sugar sweetened beverages per day [15]. This alarming statistic calls for us to identify and address the factors that contribute to poor health; in-access to healthy food, low income, and environmental disparities.

In 2020, 13% of black Americans and 16% of Hispanic Americans experience poverty when compared to their white non-Hispanic American neighbors at 5%. For two years during the COVID-19 pandemic, NC public schools provided all students with free meals. As society shifted back to "normalcy", the federally funded program ceased and left many children without meals. Families that meet certain qualifications such as a low-income status can continue to access free meals. However, language barriers and lack of assistance filling out required documentation make it difficult to even access the program. 60% of students statewide qualify

for the program but the required forms meant to facilitate equity act as a barrier to food access as it ignores the nuances in issues faced by local communities like adult literacy levels [16]. This is an example of how general metrics diminish the potential efficacy of policies supporting food accessibility. To meaningfully increase food access, the policy metrics must be targeted and focused on local needs.

Another barrier to food security is securing quality food items. While students may surpass the hurdles of obtaining free food, the food may be shelf-stable and not culturally specific to that community. In efforts to address this, Wake County released an update to their *Moving Beyond Hunger: 2023 Wake County Food Security Plan* in March of 2023. The report outlined an updated food security model that supports food hub aggregators and allocates funds for pantry innovation grants [17]. Based on preliminary observations, there is promise to improve the local children's wellbeing near WNP.

## **Part A: Network Model Analysis Methods and Results**



## Knightsdale Geospatial and Landscape Data Method Section

With the introduction of millions of dollars available for environmental justice initiatives, decisionmakers are using environmental justice principles and scientific findings to determine how the funds are dispersed. Before pursuing this avenue of change, researchers must question the validity and quality of their work as it is easy to “deceive” or make presumptions when using maps. While there are many web map interfaces out there, we have yet to find an interactive online network model that can show users their place in their local food system. In addition, the spatial data is displayed at different resolutions (e.g. counties vs. census block groups) and does not contain all food sources. For example, the Center for Environmental Farming Systems (CEFS) at North Carolina State University is recognized for their innovative research, agricultural advisory services, and education curriculum on “sustainable agriculture and community-based food systems”. CEFS hosts the NC Local Food Infrastructure Inventory Map that has point spatial data of farmers markets, cold storage, food hub (aggregation), community supported agriculture programs and other local food resources statewide [18]. The map can be used to locate local food infrastructure but, the points are not linked and does not contain “end retailers” such as grocery stores. Thus, the mapping system poses a challenge for farmers to identify efficient routes to get their food products to consumers or intermediaries such as processing plants. In addition, it is unclear how up to date the information is. Moreover, current geospatial data on food availability and access lacks the large-scale details needed to address local needs. Researchers have measured food availability, food access, or both using a variety of geographic information systems and statistical methods. However, there is a common thread of unanswered questions in the literature: what scale should the spatial data be and how will it affect the study’s results? Does the scale accurately depict “local” communities? What hidden metrics impact the results of the study (ex. Consumer spending habits)? [19,20]. Our project’s narrow scope allows us to address these shortcomings during analysis.

Benez-Secanho et al. used spatial statistical analysis to analyze the association between Georgia census tracts socioeconomic characteristics and the mean travel time to the nearest fresh food location [21]. In this study, the authors created a 30-meter spatial resolution travel raster layer by converting speed limits on each road type to minutes per meter. In addition, the National Landcover Dataset (NLCD) was used to identify all developed pixels to represent an individual’s work or home. Finally, the ArcMap *Cost Distance* tool was used to estimate the time traveled along the raster-based road network. The socioeconomic variables assessed were race (percentage of White and Hispanic people), median income, employment status, education level, and the rate of urbanization. The study found that census tracts with a higher percentage of White people have better fresh food availability as they have more options and must travel a shorter distance to them compared to other tracts. The researchers noted that associations were seen between travel time and socioeconomic variables such as race and urban rate and median income when combined with other dependent variables. Moreover, the study demonstrated spatial autocorrelation, but it is limited due to its spatial resolution being at the census tract level and affordability is not considered. Although state-wide studies such as this investigate the larger food landscape, county level research is needed to create a more local picture of community specific barriers to accessing fresh food options.

Over the years, Timothy Mulrooney and other scholars have completed several food availability studies on the state and county levels in North Carolina. Various sampling methods and geospatial analysis frameworks assessed proved that modeling local food environments in a

desktop space is an arduous task [22, 23, 24] riddled with data imperfections. Authors emphasized the importance of data format, chosen method of generating the travel surface, data spatial resolution, and the absence of consumer behavior data. While raster-based travel time surfaces have been used, there did not appear to be a significant difference in results between it and vector-based distance methods [25]. Most of the literature reviewed used large population units (e.g. census tracts) instead of individual parcels due to the immense storage and processing required. The most common dependent variables used to develop an association between socioeconomic characteristics and food availability were Social Vulnerability Index (SVI) values, race, median income, vehicle access, and urbanization rate. Overall, secondary data reliability was a significant challenge because of temporal inaccuracies and map aerial unit problems (MUAPs). Moreover, large study areas with hundreds of food locations statewide, contribute to the lack of ground truthing to ensure quality assurance and control of secondary data.

In Part A, vector-based travel times using network model analysis is coupled with spatial clustering to illustrate food availability within 1 mile and 5 miles of homes in Knightdale and Wake County block group centroids. Then, the percentage of food assistance program recipients and the food available in their local environment are analyzed to measure food accessibility.

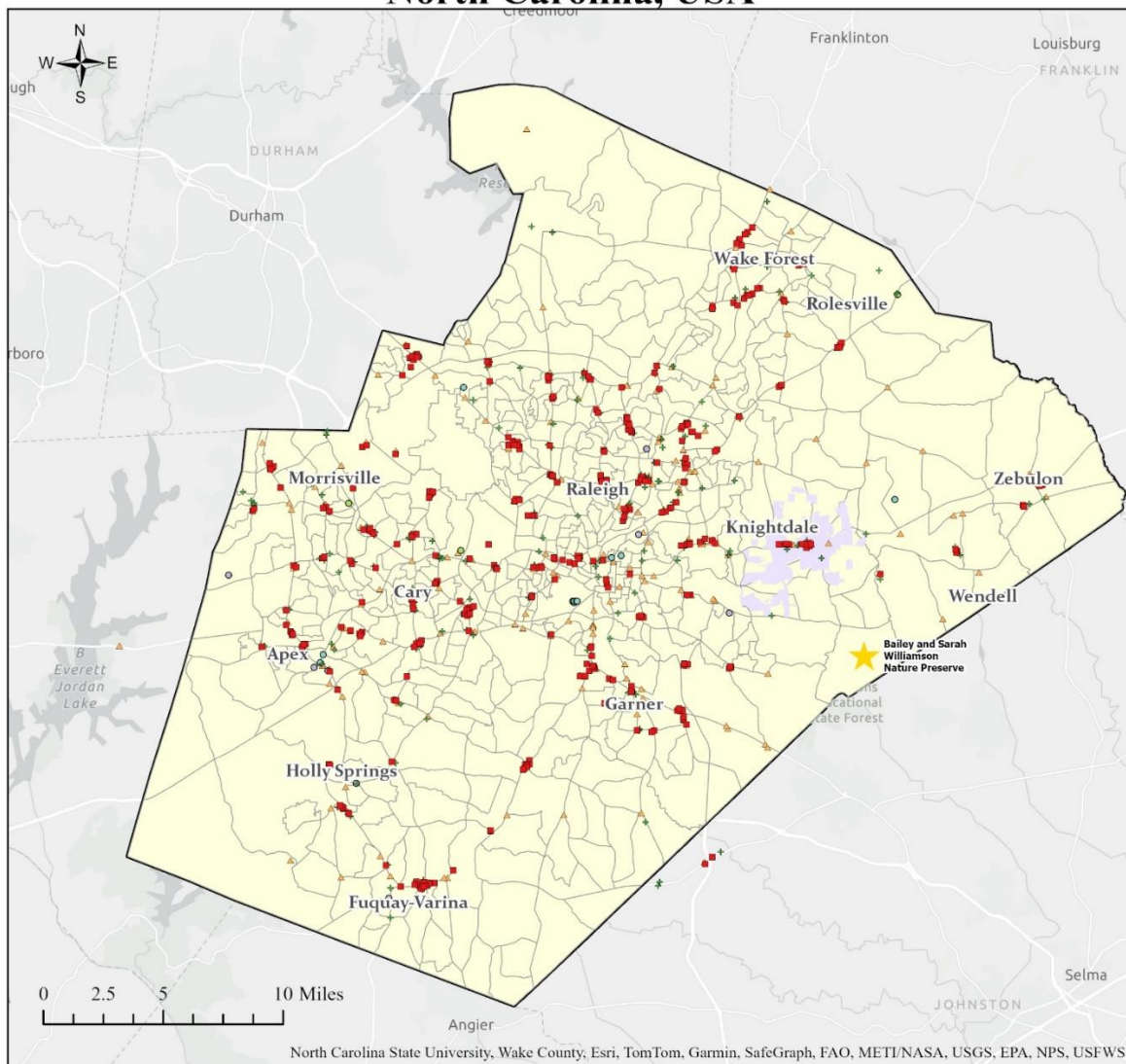
## **Materials and Methods**

In this study, ESRI's suite of ArcGIS Network Analyst tools, spatial clustering, and census demographic data are utilized to obtain an initial picture of the local food environment in Knightdale and Wake County. First, we use the *Closest Facility tool* to demonstrate food availability for individual parcels in Knightdale, NC and Wake County block group centroids. Secondly, 2021 Census demographic data is joined to block groups and overlaid to determine an association between the percentage of families that receive food assistance program benefits such as cash or Supplemental Nutrition Assistance Program (SNAP) benefits. The food locations within 5 miles of census block group centroids were clustered and deemed the "local food environment".

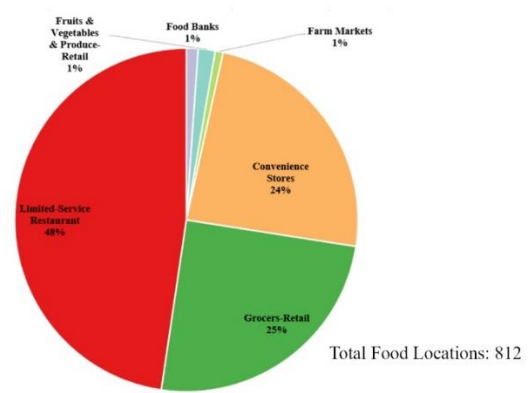
### Study Area

Wake County has a population of over 1.2 million composed of twelve municipalities: Apex, Cary, Fuquay-Varina, Garner, Holly Springs, Knightdale, Morrisville, Raleigh, Rolesville, Wake Forest, Wendell, Zebulon. Nearby municipalities Durham and Angier have jurisdictions extending into Wake County [26].

## Food Locations in Study Area Knightdale, Wake County, North Carolina, USA



- ▲ Convenience Stores
- Farm Markets
- Food Banks
- Fruits & Vegetables & Produce-Retail
- + Grocers-Retail
- Limited-Service Restaurant
- Knightdale Corporate Limits
- ★ Potential Food Hub Location
- Block Groups
- County Boundary



**Figure 1.** Map of the study area and available food locations in Wake County, North Carolina. Knightdale is the area of interest and census block groups are also shown.

## Food Sources

When creating a feature class of food sources within the study area, business types were chosen by their primary 6-digit North American Industry Classification System (NAICS) codes. The addresses of food sources or points of interest were obtained from the Business Search database hosted by the NC Department of Commerce. While we did adhere to most standard conventions outlined by similar network model analysis studies, we chose to not require a minimum employee threshold to accommodate smaller-scale establishments. For example, food sources such as ethnic grocery stores and convenience stores (ex. 7Eleven) that have less than 10 employees are recognized as integral components of the local Wake County food system. In contrast, multipurpose retailers that also sell food (ex. Target) were excluded. However, food giants such as Walmart Supercenter were manually added due to their substantial food retail presence and acceptance of SNAP. Although community residents may travel a greater distance outside of the county due to personal preferences or proximity to the county's edge, food sources greater than 5 miles outside of the county lines were also excluded. Satellite imagery, customer reviews and available photos on Google Maps were used to verify the location of each food source and its current operation status.

Six categories of food sources were included: community food sources, fruit and vegetables retailers, supermarkets and grocery stores, limited-service restaurants, convenience retailers, and other gasoline stations (except those that operate fuel pumps). As seen in other literature [20,21,24], the temporal accuracy of the Business Search tool was problematic. Some businesses were excluded because they were permanently closed or did not have a physical location (i.e. the address on the file was a private residence). In addition, food retailers within private buildings that were open for a limited period such as a hospital or university building were excluded. It should be noted that these locations require ground-truthing for improved spatial accuracy. Table A1. lists the food source categories, their corresponding NAICS code definition. We began with 891 businesses but after a manual screening for these categories and data accuracy, we eliminated 79 food locations for the reasons mentioned and were left with 91% of the original data.

## Socioeconomic Variables

Socioeconomic variables at the block group level were retrieved from the 2021 American Community Surveys (ACS) database and then joined to census block group polygons. While other variables were considered, the percentage of families receiving SNAP may be a more explicit proxy measure of food accessibility within block groups because SNAP beneficiaries redeem their benefits at accepting food retailers with an Electronic Benefits Transfer (EBT) Card. Recipients can use their card to purchase typical grocery store foods with the exception of alcoholic beverages and hot or preprepared foods [27]. Therefore, families reliant on SNAP benefits as their primary food budget are restricted to food sources that accept EBT.

## Road Network

Given the project's extensive scope, various data was curated from multiple government data repositories. Spatial and demographic block group and parcel level data was collected from the

United States Census Bureau. Municipal and county level geospatial data was downloaded from the Wake County government ArcGIS Online portal. The *NCRoute Arcs* dataset from the NC Department of Transportation was clipped 5 miles beyond Wake County boundary's edge to remain within a local context. Some food sources not contained in this study such as Dollar Tree, Family Dollar and Costco Wholesale Corporation were not included in this study. During the closest facility solve, the individual parcels were snapped to the network to eliminate errors during processing. Therefore, residences are offset no more than 3,300 feet from their original geographic location and the route solutions are +/- 0.625 mile of margin of error.

### Procedure

Using the Closest Facility Tool, the count of individual residences (“incidents”) within 1 and 5 miles of a food source (facilities) will measure food accessibility in Knightdale. Coupled with the count of individual residences, the category of food sources that residents can reach is used to measure food availability. The higher the food source count and the range of categories, assumes that a resident has accessible and available food options.

When preparing the geodata, inconsistent geographic identification system and boundaries made it difficult to join census block groups and its associated demographic data by municipalities. To resolve the issue, the Closest Facility tool was used with block centroids (incidents) and food sources (facilities). After the network model ran, the block groups were spatially joined by intersecting municipality boundaries. This choice of sampling and processing method is supported by similar research done in Guilford County, North Carolina [24].

## Results and Observations

In general, food sources are clustered in or around densely populated areas. Most of the food locations in Wake County are centralized in Raleigh. Based on the filtered sample of food locations, fresh produce retailers, farm markets and community food sources make up about 4% of the Wake County food environment (Appendix A. Figure 1,7). Limited-service restaurants are the most abundant, making up almost 48% of food locations. While grocery stores seemed to be spread throughout the county, the combined total of 19 farmers markets and produce retailers were mostly in Raleigh with one of two locations in Apex, Wake Forest, Morrisville, and Wendell (Appendix A. Figure 3).

The closest facility analysis found 23 food sources available within 1 mile of Knightdale residences. Of the 23 food sources identified, most Knightdale residents were within a 1-mile drive of two fast food chain restaurants and a small grocery store. Only 9% of the food locations exist within 5 miles of Knightdale homes at a total of 77 food sources. Of the 8,016 households in Knightdale, roughly 10% were within 5 miles of the one fresh produce retailer available (Appendix A. Figure. 6) The mean distance to the nearest food source within the 5-mile food network was 1.9 miles for Knightdale residences (Appendix A. Figure 4,5).

Eastern Wake County appeared to have a higher percentage of families receiving cash assistance of Supplement Nutrition Assistance Program (SNAP) benefits and existed on the fringes of the central food environment (Appendix A. Figure 8). The subset of block groups selected to represent Knightdale had a higher percentage of SNAP beneficiaries than the county average (Table A2) and had 8 SNAP eligible food sources within 1 mile of residences (Appendix A. Figure 9).

Demographic Characteristics	Knightdale*	Wake County
Population	35,751	1,112,883
Percentage of SNAP Beneficiaries – Families	12.49%	7.03%
Population under 18	26.79%	23.81%
Number of SNAP Eligible Food Locations	8	194

**Table A2.** Table of select demographic characteristics of Knightdale and Wake County block groups using 2021 US Census Data. Only SNAP eligible food sources within the 5-mile food network were included in the information above.

*\*The values listed are estimates. 14 block groups were selected to represent Knightdale. They do not reflect the municipal/corporate limits but where intersections occur between the feature layers.*

<b>Municipality</b>	<b>SNAP Eligible Food Sources</b>	<b>SNAP Ineligible Food Sources</b>
Raleigh	194	161
Knightsdale	8	15
Wendell	7	4
Fuquay-Varina	14	20
Holly Springs	9	8
Zebulon	5	7
Wake Forest	22	22
Rolesville	-	-
Garner	19	24
Apex	18	8
Cary	33	33
Morrisville	18	11
Clayton*	2	-
<b>Total</b>	<b>349</b>	<b>313</b>

**Table A3.** The number of eligible and ineligible food locations within 1 mile of SNAP block groups by municipality. 662 total food locations were generated in the results, which was approximately 82% of sample food locations.

*\*Clayton is not incorporated in Wake County, but food locations in Clayton were included because they were within 5-miles of the Wake County boundary.*

## **Part B: Community Engagement Methods and Results**



## Methods

Given the client's specifications, needs, and constraints, the research team decided to develop two surveys that met the following criteria explored throughout the paper: access, availability, utilization and stability. The survey component explores the last two dimensions of food security: utilization and stability. To aid the client in determining the need and wants of the community for a potential Outdoor Learning Space and Aggregated Food Hub, we all decided that these two surveys would be useful. It is important to note that the team also decided that the survey would be used later and not conducted by the Duke team. Therefore, the surveys will be addressed as "Service Tool 1" or "Service Tool 2" moving forward. The service tools help the client find a prescribed indicator of food insecurity status ranges within the Knightdale community; there is potential to expand their study population as well with data ownership of the service tool live form and results.

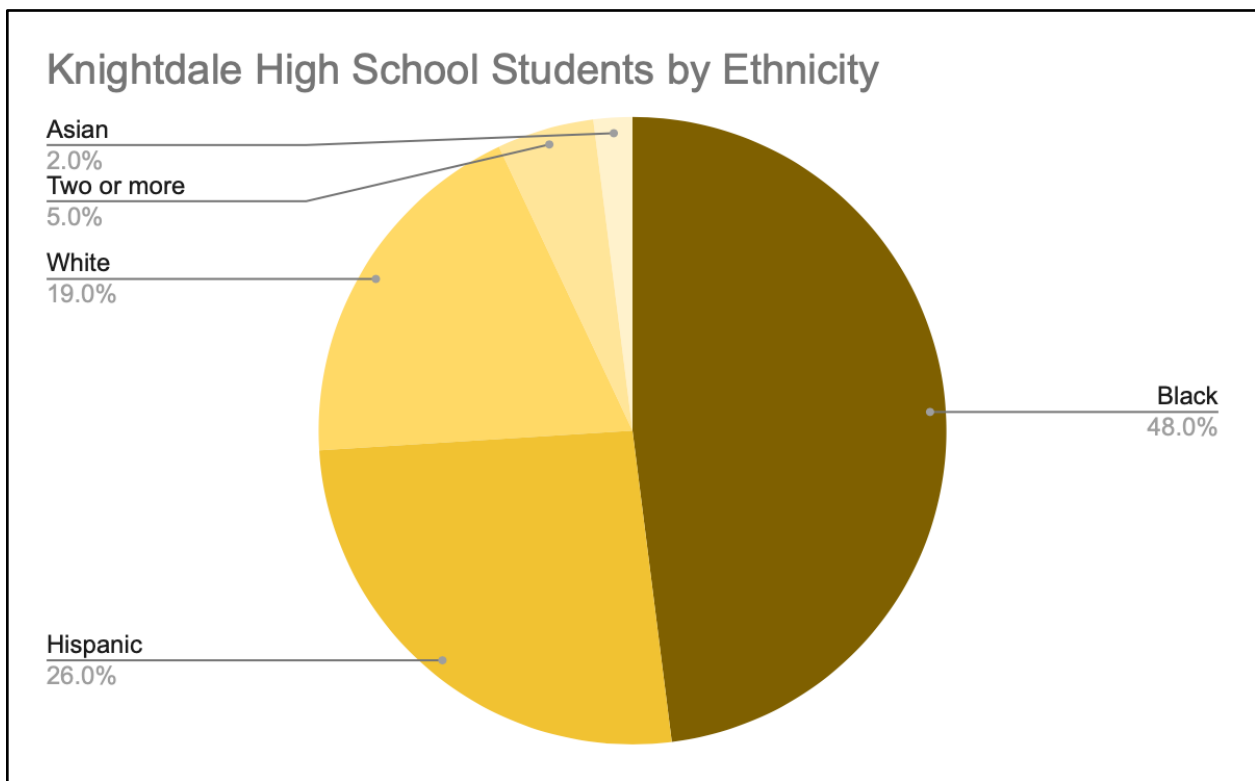
We utilized Microsoft Forms as the interface survey software for both service tools. Our reasoning for this includes high user-friendly competence level, allowance of PDF conversions to be printed and distributed [with accompanying Quick Response codes], participant anonymity, live document easily augmented according to clients taste for different settings and finally, the rapid utilization of computer-generated tables and graphs from saved responses.

## Study area and Literature Review

In Wake County, where many fast-life cultures exist, there is the rural agricultural community of Knightdale. Unfortunately, the data is skewed to represent all of Wake County, Knightdale included, therefore there are limited food insecurity statistics available for the town. While the investigative literature is very limited in the prescribed study area of Knightdale in relation to food, we aim to remedy and boost its representation with our project findings. The Wake County Public School System was the second-largest public school district in North Carolina back in 2007, according to the results of our review. Fast forward to today, Wake County is now the largest public school system in North Carolina [29]. Knightdale High School is included in this school district and is a major component of our project's community outreach in accordance with the Agriculture Pavilion. Knightdale High School has a total of 1,692 students and ~104 full time teachers [30].

Ethnicity	Percentage	Percentage to Physical Amount	District Comparison
Black	48%	808	12,416
Hispanic	26%	442	6,907
White	19%	320	23,248
Two or more	5%	80	1,809
Asian	2%	31	3,108
American Indian	0%	8	154
Pacific Islander	0%	3	64

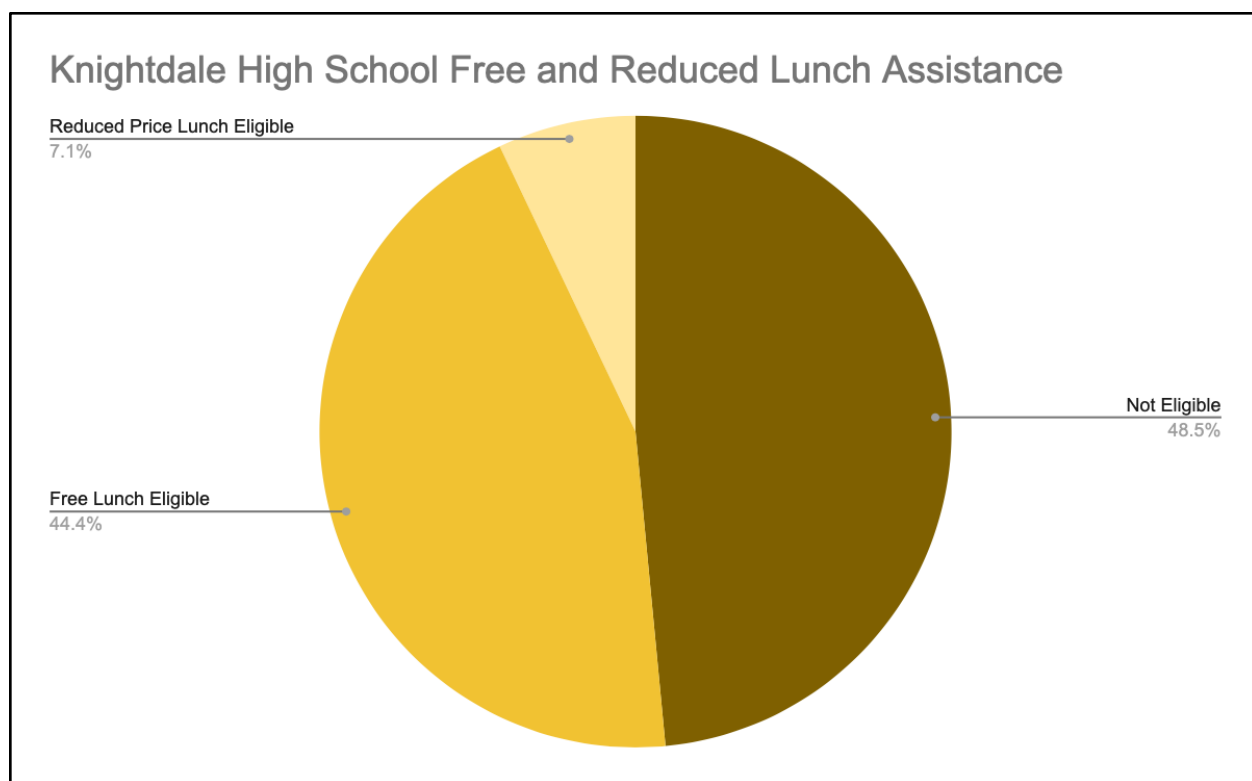
**Table B1:** Knightdale High School student demographics in comparison to all Wake County High Schools.



**Figure B1:** Knightdale High School Demographics.

	School %	Physical Amount	District Comparison
Not Eligible	48%	814	33,494
Free Lunch Eligible	44%	752	12,207
Reduced Price Lunch Eligible	7%	126	2,005

**Table B2:** Student at Knightdale High School eligible for free lunch and reduced price lunch, together with students ineligible for free or reduced price lunch.



**Figure B2:** Students at Knightdale High School eligible for free lunch and reduced price lunch, together with students ineligible for free or reduced price lunch.

<b>Race/Ethnicity</b>	<b>Percentage</b>
White	37.50%
Black/African America	47.20%
American Indian and Alaska Native	0.20%
Asian	2.70%
Hispanic/Latino	8.60%
Population	19,703

**Table B3:** Demographics of Knightdale.

Due to the school's Title 1 designation, specific systemic adjustments are required to raise student achievement in reading, writing, and math. These adjustments include increasing parental involvement, teacher knowledge, and the application of best practices through staff development based on empirical research [31]. As we continue our project, we are navigating with this program in mind. Unstable living conditions, including in-access to affordable and sufficient nutrition, adversely affect student ability to learn and be successful. The investigation into families with children is important given that this is the fastest growing group of people experiencing housing insecurity [32]. In our Service Tool 2, we tailor questions and statements that, while directed at parents of Knightdale school children, are focused on their understanding of their child's/children's behaviors concerning food as well (*See Methods - Service Tool 1 for further details*).

## **Appropriation of Finalized Questions - *Service Tool 1*:**

To ensure that the questions were appropriate we created a justifications table for Service Tool 1 (*See Appendix B - Justifications Table 1 Service Tool 1*).

## **Participant Protections and Anonymity and Considerations - *Service Tool 1*:**

We utilized the help and oversight of Dr. Max Allamong from the Duke Social Science Research Institute (SSRI) to guide the development of Service Tool 1. To prevent collecting unnecessary data about survey participants we excluded the need for certain questions. One such question was to ask if the participant is or has been enrolled in government assisted services such as the Supplemental Nutrition Assistance Program (SNAP) or Women, Infants and Children (WIC). These questions were very important to the client, but they also wanted a holistic survey where the participants can feel a sense of belonging and compassion. Therefore, we address these questions in Service Tool 2, our more comprehensive and numeric approach to a survey (*See Participant Protection and Anonymity - Service Tool 2*). Another question that the client wanted to be mandatory was “What is your preferred email address?”. We made this question optional to protect participants and provide a voluntary opportunity for further involvement which the client decided as more meaningful. Initially, the client wanted to include children by conducting a survey separate to that of the adults. Since this is meant to be a service tool for future reference and getting approval for surveying children proves difficult, we instead included questions within the adult survey that address their children’s wants and needs. Another drastic consideration was the language we used. First, we intended to ask participants what their definition of local food was and instead realized the definition itself was not a target metric. Instead, we ask how important it is that their food comes from local sources. Second, refraining from using sensitive language such as “spoiled food” and other trigger words. Finally, the Microsoft Form interface incorporates an option to not require and relay participant names or email addresses regardless of the account (personal or work related) that they complete it on. Moreover, we strove to dismantle survey fatigue as we learned it is extremely difficult to get a 100% return response. Microsoft forms is a format accessible to the masses online and via printable format in an elegant, non-flashy, and pleasing fashion. We hope that this transformative approach we have taken in tailoring these questions and surveys will help participants feel more comfortable, truthful, and for TLC to foster a sense of community in the town of Knightdale.

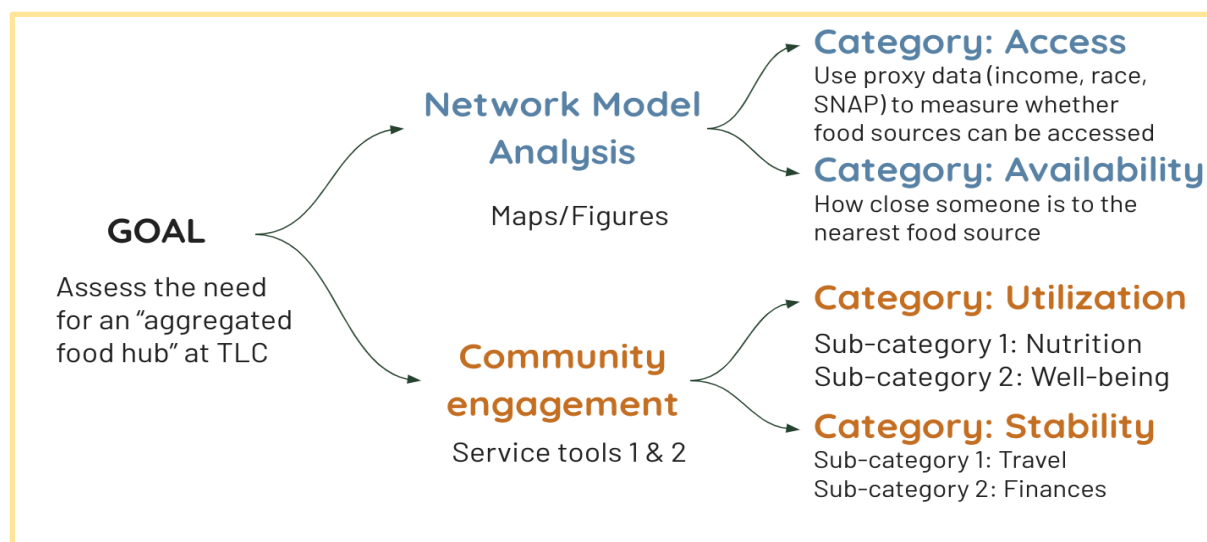
See *Service Tool 1* here:



## **Current Survey Criteria and Standard Measure of Values - *Service Tool 2***

### **Grid Categorization Breakdown & QDA - *Service Tool 2*:**

Two grids were made in formulating questions for service tool 2. In alignment with Qualitative Data Analysis (QDA), these grids were influenced by the processes of analysis that incorporate “identification, examination, and interpretation of patterns and themes in textual data to determine how these patterns and themes help answer the research questions at hand” [33]. More specifically, a code was developed to be adaptive come time of actual survey deployment. In navigating our research under the 4 dimensions we chose to address food security, (access, availability, utilization, and stability) we expanded on this code in depth within the Service Tool 2 as it addresses the last two dimensions: utilization and stability. Being that the survey investigates utilization and stability, we separated the survey into two grids with four sub-categories. In the “Utilization” grid exists two sub-categories: nutrition and well-being. This grid is dedicated to establishing each participant’s relationship to food via the lens of their own nutrition and well-being. In the “Stability” grid exists another two sub-categories: travel and finances. This grid focuses on participant’s relationship to their personal travel and finance perspective concerning the food they do get. QDA codes are essentially the creation of an overarching category in which sub-categories (or, sub-codes) further define the main code. For instance, the first grid within service tool 2 which contains the 6 of 12 questions is concerned with the code titled “Utilization”. Its sub-codes are titled “well-being” and “nutrition”. The subcodes further account for the spectrum of participant responses in reference to answering our research question of whether they will be used for a food hub near Knightdale. Next, the second grid titled “Stability” is concerned with the sub-codes titled “travel” and “finances” of the participant. These questions would then be tailored to address the barriers that exist within that grid type; barriers to travel, barriers to nutrition, etc. Ultimately, in defining these barriers within each code, the intention is to determine if such barriers demand a need for the food hub to be built or not.



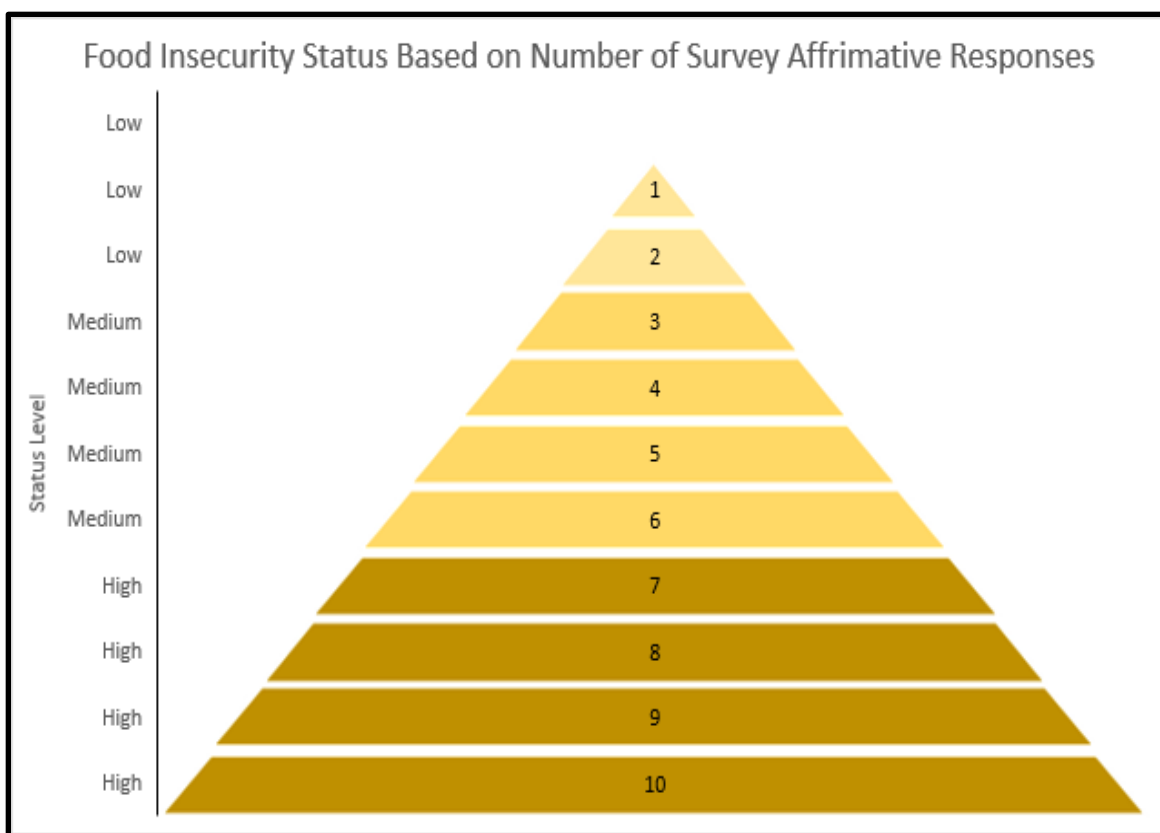
**Figure B3:** Flow chart illustrating the goal of our research, the methods utilized, and the 4 dimensions guiding the methods including the code and sub-codes within Service Tool 2.

### Assessment Criteria - Pyramid of Accumulative “Yes” Responses

The development of our criteria standard measure of values for Service Tool 2 was chosen to represent a pyramid that showcased the spectrum of food access. Essentially, the bottom of the pyramid represents the maximum of “yes” or affirmative responses a participant can supply to indicate intervention is needed. This looks like constantly clicking on a “Strongly Agree” or “Agree”. The top of the pyramid represents the closest a participant can be to the “gold standard” of food access. Each affirmative response indicates a specific barrier to access depending on the grid type. Therefore, Service Tool 2 is designed to demonstrate food in-access as the sum of affirmative responses via the question structure as outlined by its grid categorization.

Food Security Status Based on the Number of Affirmative Responses	
Number of Affirmative Responses	Food Security Status
0	Low
1	Low
2	Low
3	Medium
4	Medium
5	Medium
6	Medium
7	High
8	High
9	High
10	High

**Table B4:** Final guidance table for determining food security status based on affirmative responses from the service tool 2.



**Figure B4:** The final pyramid representation of the standard measure of values dependent on the amount of affirmative survey responses in establishing an individual’s household food insecurity status. The “gold standard” holds the least number of affirmative responses at the top out of 12 questions. The low end of the pyramid displays the greatest number of affirmative responses out of 12 questions.

### **Initial Survey Criteria and Standard Measure of Values - Service Tool 2:**

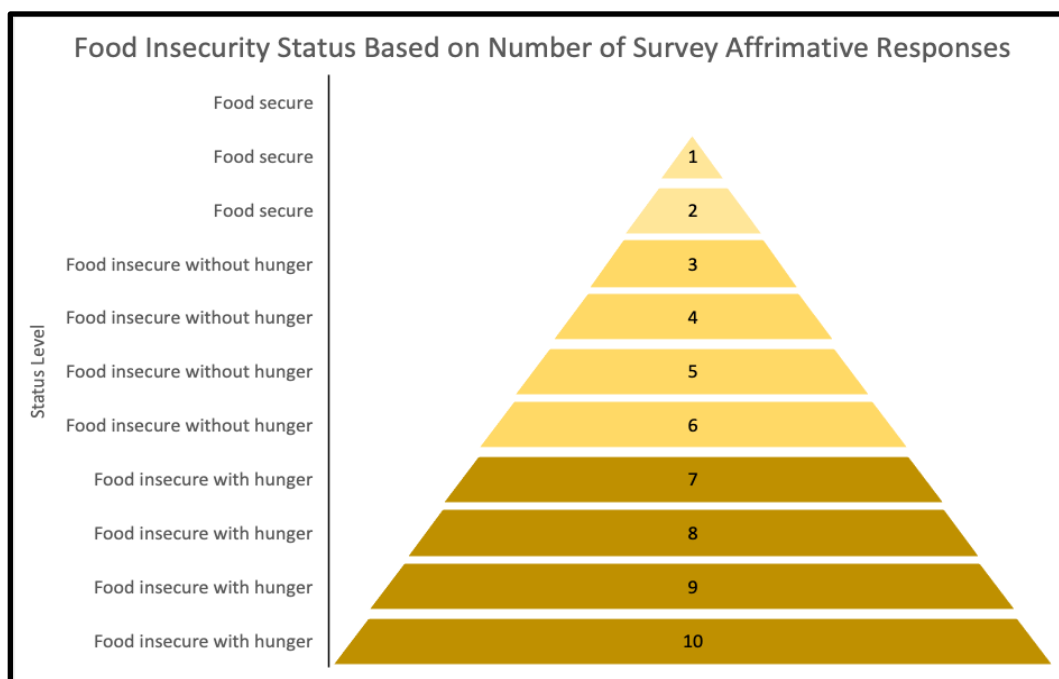
For Service Tool 2, we determined that the client needs a standard measure of values to look back on to confirm “Food Security Status” of the prescribed population they choose for study.

<b>Food Insecurity Status Based on the Number of Affirmative Responses</b>	
<b>Number of Affirmative Responses</b>	<b>Food Security Status</b>
0	Food secure
1	Food secure
2	Food secure
3	Food insecure without hunger
4	Food insecure without hunger
5	Food insecure without hunger
6	Food insecure without hunger
7	Food insecure with hunger
8	Food insecure with hunger
9	Food insecure with hunger
10	Food insecure with hunger

**Table B5:** Initial guidance table introducing the number of affirmative responses within the survey. This table was to be used with each response upon completion of each form



Therefore, we created another survey of strictly scaled response questions to make an exclusive quantitative service tool out of the survey.



**Figure B5:** A visual pyramid of the initial assumptions dependent on the amount of affirmative survey responses in establishing an individual’s household food security status. The least number of affirmative responses would have been at the top to mimic a “gold standard” of where we want individual community members to reside within. The low end of the pyramid symbolizes where we would not have wanted them to be.

### **Appropriation of Finalized Questions - *Service Tool 2:***

We duplicated the justifications table for Service Tool 1 for the appropriation of the questions used in Service Tool 2 (*See Appendix B - Justification Table 2 Service Tool 2*). As with Service Tool 1, we did not go through the Duke Institutional Review Board (IRB) to finalize these survey questions. This survey is to supply the client with guidelines to pursue their own quantitative survey later via their own reviewing process. Ultimately, the team and Dr. Allamong decided that a five-point scaled response was the best option for what the service tool is meant to provide. This five-point scale consists of “Strongly disagree,” “Disagree”, “Neither Agree nor Disagree”, “Agree” and “Strongly Agree”. In this process we decided that responses such as “Neither agree nor disagree”, “Disagree” and “Strongly Disagree” would not count toward the calculation of one’s food security status unlike the “Strongly Agree” and “Agree” options. Therefore, we have formulated the questions to be dynamic in this way; affirmative responses, “Agree” and “Strongly Agree” are all contributions to being deemed as “food insecure” or in this case medium to high status. The reasoning behind not following through with explicit labels for food security status like “food insecure with hunger” was

because we did not feel confident in establishing such a standard with that language for what could potentially be a variety of circumstances. Another reason is that the point of service tool 2 was to be solely quantitative and we did not want to incorporate many qualitative factors into the physical criteria itself - just the survey.

### **Participant Protections and Anonymity and Considerations - *Service Tool 2:***

For Service Tool 2, we duplicated the same permissions within the Microsoft Forms format as Service Tool 1. For reference, this was the implementation of using the anonymous function, i.e. no identifiers such as names and email addresses, to complete the survey. Because of this, we can include such statements that use the second person's point of view. Anonymity also promotes participant honesty when referring to themselves. We considered that the question regarding whether the participant relies or has relied on government assistance programs may be quite an obstacle for the client in the review process. Nonetheless, it was incorporated as this was one of the things the client really wanted included. In the future if it is a problem, the live format of the Microsoft Form will allow them to exclude or tailor it to their liking.

*See Service Tool 2 here:*



## Results - Service Tools 1 & 2

Most of the literature in which survey analyses were used to determine food security status is extensive. While this is within good reason and measure, this did not serve our purposes nor the client's. Commonly, the survey content included these main grid separations: race/ethnicity, household composition (including the presence of children), household income, and metropolitan versus non-metropolitan locations/region. These assessments are typically done nationwide, in contrast to our community specific local scale. Of course, we thought it beneficial to incorporate some of these items because they are still important. The most influential was the household composition regarding the presence of children and the regional comparison of the Knightdale area to Wake County. These were the clients' main concerns as they intend for families with children to participate and utilize the proposed space on their property and gauge the extent of the need for the Agricultural Pavilion.

### Survey Case Study 1:

This assessment study was done to enhance the current USDA Questionnaire Framework and Guidelines for Food Insecurity Assessments. From the "Assessing Potential Technical Enhancements to the U.S. Household Food Security Measures" USDA 2012 project, Nord proposed 5 different scales that incorporated various scaled and non-scaled responses. For example, the first panel had three items. "Worried food would run out," "Food bought did not last," and "Could not afford to eat balanced meals." Nord coded these three items into trichotomies of "Never," "Sometimes," and "Often." The following three items, "Adult cut size of meals or skipped meals," "Respondent ate less than should," and "Respondent hungry," were coded into four category polytomies: "Never," "In-only-1-or-2- months," "Some-months-but-not-every-month," and "Almost-every-month," [34]. These are just two examples from the first scale. Instantly, we knew this was not how we wanted to pursue the tool. This, however, was helpful as we easily decided we wanted the surveys to be as straightforward and consistent as possible while maintaining an accessible coding structure for analysis.

Service Tool 1 is in opposition to this case study as it does not incorporate grids of themed questions with varying scaled responses. Service Tool 2 also does not abide by the variance in scaled responses as we only use one series of scaled responses that remain consistent. Service Tool 2 does however, mimic the use of grids where we chose the two grids (utilization and stability) with two sub categories in each grid totaling to 4 subcategories (*See Appropriation of Finalized Questions - Service Tool 2 for further explanation*). From this study, we ultimately found that grids can be useful for separating and organizing certain indicator criteria like finances and personal well-being for more well-rounded analysis.

### Survey Case Study 2:

In Gulliford et. al, they sought to assess whether the United States Department of Agriculture Food Security Assessment Guidelines would be indicative of similar food security status in a Caribbean context in the country of Trinidad and Tobago. The research team's desire to examine the characteristics of the food security items for adults and children referenced to support the accuracy of the USDA's response models and classifications was most alluring. Similar to our initial intention, the study participants included school aged children as they were to be the primary focus. However, the parents were instead asked to answer questionnaires for their children. This is how we navigated both surveys being filled out: asking parents questions about their children because they know their child's habits best. Thus, we were

influenced to ask questions relative to their children's nutritional habits. Moreover, this study acknowledged that certain terms can be foreign to people unfamiliar with the USDA framework. While this was an important consideration for this study taking place in another country, we saw it as an opportunity to inform future participants of what confusing terms may mean. This led to incorporating definitions within the surveys themselves or to the complete scrapping of certain terms. An example from the study was the use of “balanced meal” and its potential to be problematic. They were able to remedy this by simply defining it within the survey, “balanced meal items: a balanced meal may contain starchy food like rice, potatoes, bread, ground provisions or macaroni; a protein rich food like meat, fish, milk, or peas or beans; and a fruit or a vegetable,” [35]. Overall, this study aided in our use of structure for the surveys and their appropriateness. The questions were dense and opposed our intentions and promotion of the pavilion, potentially being a safe community space. While we refrained from provoking confirmation bias with the questions we asked, we also tried not to incite ill feelings with the idea of the Agricultural Pavilion. Some examples from the study include, “I have/have not cut my children’s portion sizes,” “My child has/has not skipped meals often,” and the like. However, the language used in the study to confirm status ultimately influenced our initial survey criteria and status language for Service Tool 2, (*See Initial Survey Criteria and Standard Measure of Values* - Service Tool 2 Table) with the use of statements like “Food insecure without hunger” because they adapted the USDA questionnaire framework which uses the same language.

### **Considerations and Limitations - *Service Tools*:**

We understand we took a risk in trying to define food security status. We do not think these parameters are representative of other communities and circumstances outside of the community of study. How we went about these tools were intentional to the client’s needs and desires. All the language used was used with caution and knowledge of their gravity. The literature today is straying away from using the term “food insecure” and instead moving toward other language like “the improperly nourished”. We appreciate and acknowledge the need for a more dynamic and holistic language to approach these circumstances.

## **Part C: Discussion and Conclusion**

Based on the findings of the study, it is evident that Knightdale's local food environment lacks available and accessible fresh produce options. When comparing food locations within a 5-mile radius in Knightdale and Wake County, the distribution of food location types was almost consistent except for fresh produce and community food options becoming available, which are notably scarce (Appendix A. Figure 7). There are only 8 farmers markets in Wake County and not all vendors accept SNAP-EBT for their fresh produce [36]. Moreover, the market openings are seasonal (spring to early fall) and generally located in urban areas near Raleigh. Knightdale families receiving SNAP benefits were well outside of the central food network containing farmers markets. Therefore, emphasizing the need for fresh produce options that partner with SNAP accepting vendors. Further supporting the need for a farmers' market in the area is a study done by McGuirt et al., where they found that farmers markets are hosts of inexpensive fresh produce options in contrast to supermarkets [37]. Thus, providing consumers with a cost-effective option across the board, EBT beneficiary or not. This underscores the need for affordable fresh produce options that accept EBT like farmers markets near Knightdale.

When compared to past literary works, our study expanded on the categories of food sources considered fresh food options. By including convenience stores and other gas stations, the sample of available locations was larger than other similar studies. As opposed to other common proxy measures of food access like income level and presence of public transportation, using cash assistance and SNAP provided a more direct measurement when identifying whether community residents can purchase or afford food. In alignment with some of the issues listed in Wake County's 2023 Food Security Plan Update, our study further affirms the imperative need to expand accessibility of fresh produce sources to communities with families receiving food assistance program benefits [17]. Although, our spatial findings are insightful, the unseen nuances of Knightdale's local food environment can be revealed by intentionally integrating our community engagement service tools in the following manner.

In Clay et al., the survey approach utilized was made to determine the likelihood that participants would visit a food bank in 2020 during the COVID-19 pandemic, but it also brought attention to something that many scientific surveys overlook and what the pandemic generated more discussion on: mental wellness. The research was done in collaboration with many research institutions such as, Johns Hopkins University, University of Arizona, University of Vermont, Arizona State University and the University of Arizona. The data sharing is with the National Food Access and COVID Research Team (NFACT) based in New York. By means of this collaboration, the survey produced by these researchers is extending from a once localized scale to a national scale with sites at major universities along the east coast and with 1-2 sites across the west and south coasts [38].



**Figure B6:** Accessed via the NFACT [website](#) is this map of where the survey has been and is currently deployed [39].

This is important to note as we are approaching our research with a similar intention: starting at local scales to more accurately define metrics of food access and sovereignty for nationwide efforts.

The COVID-19 pandemic aided in the exposure of various flaws in our food system and food environments. Those who relied on food banks no longer felt safe in accessing them. More surprisingly, those with benefits to purchase fresh produce who were granted benefit boosts via emergency allotment funds under the Families First Coronavirus Response Act, did worse as soon as that relief concluded. Once the pandemic ended, prices for most food products adjusted for inflation and families were left with an average of \$82 per month in benefits [40]. Most important to consider is the mental wellness of these households. One grid in this study asked 5 scaled response question statements exactly like what we explored in Service Tool 2.

Please choose the appropriate response for each item:					
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I am worried about the paperwork I need to share to enroll in food programs					
I do not want to rely on food programs because I value personal independence					
I'm worried that I have too many personal assets (savings, house, car) to qualify for a food program					
I'm worried people will find out I use these programs					
I feel respected by the staff and volunteers of these programs					

**Figure B7:** Part 1/5 grid entitled “General Food Access” from Clay et al. (2021) that has a designated section for paperwork fatigue and stress when applying for food assistance programs.

Asking questions about paperwork is important as many factors cut off access to such resources being applied for. For example, Spanish speaking households need translated forms and financial translators; families may not live near their benefit distribution facility; families may work during hours of operation for required application interviews; and more. This is why we made sure to incorporate questions about mental wellness; to gauge if participants struggle when conceptualizing where they may be getting their food from. For example, in Service Tool 2 a question statement reads, “You experience anxiety or stress related to food insecurity.” Another reads, “There were times where you had to choose between buying medicine and buying food.” While we have just one question regarding SNAP and other government assistance programs in Service Tool 2, we make up for defining access via available data of those who actively receive such benefits in the network model analysis. We do acknowledge that this information is essential in conducting this research now and for the future.

Where this study lacks in intention is the language used in some parts of the survey concerning wellness.

<p><b>Has your household engaged in any of these potentially risky behaviors to obtain food in the last 4 months? For example, shoplifting food, obtaining food from dumpsters or the garbage, eating roadkill, eating petfood, or eating spoiled food?</b></p> <ul style="list-style-type: none"> <li>• Yes (please describe)</li> <li>• No</li> </ul>
---

**Figure B8:** Example of a question from the finalized survey that incorporates insensitive language “risky behaviors”.



A question like this can be asked more sensitively, especially when trying to determine the mental status of participants. For instance, a simple switch to “Has your household engaged in non-traditional ways of accessing food such as...” would be a significant change toward sensitivity. This is a great example of language we intentionally avoided in the creation of the two surveys.

To offer one last example from the survey questions, this one is related to the connection of defining distance traveled by participants to access their food.

	In the year before the COVID-19 outbreak	In the last 4 months	Did not use this transport
Bus or other public transit			
Own vehicle, walk, bike			
Ride from friend/family/neighbor/taxi			
Someone brings food to me (delivery service or friend/family member)			
Other (please specify below if selected)			

**Figure B9:** Grid associated with the question: “What were the typical types of transportation you used to get food for your household, in the year before COVID-19 and in the last 4 months? Check all that apply.”

We included similar versions of this question in Service Tool 1 because we thought it most essential in gauging how each participant may have varying lived experiences. Questions in Service Tool 1 regarding travel include, “How far (in miles) do you typically travel to get groceries for your household?” and “Would you, or would you not be willing to commute a further distance for fresh food?”. We did not want to assume routes of transportation and even included an option that states, “My household does not travel for groceries.” In Service Tool 2, we provide a 5-point scaled response statement that reads, “You have had to choose between paying for transportation to get groceries and buying the food itself.” Distance specific questions help our client to further manipulate the geospatial data we will be sharing with them via the network model analysis after they’ve deployed the surveys.

A study from Olcott et al. (2020), is a preliminary investigation of the local food environment in Cambridge, Massachusetts via two surveys: the Food Retail Survey and the Food Shopping Survey. The assessment stems from a partnership with the city’s “Mass in Motion” program which teaches communities across the state how to “understand social determinants of health and disparities of health.” The Food Retail Survey allowed the researchers to focus on two food accessibility contributions: retail prices and a nutritional quality score. The two measurements were then combined into a “Food Access Score” and this score was visualized via geospatial

analysis to determine the Cambridge food environment. The Food Shopping Survey allowed researchers to obtain information on participant retail preferences, mode of transportation when getting groceries, and an option to self-select the Cambridge neighborhood a participant resides in, who also happen to attend community events [41].

Three metrics were used by the researchers in the “Food Retail Survey” to evaluate the local food environment. The first category was “Food Store Types” which covered establishments like convenience stores, supermarkets, and neighborhood shops, among others. The price of a grocery basket served as the second indicator of affordability. The Healthy Food Availability Index (HFAI) scores provided the final measure of food quality, with questions pertaining to food offerings' cultural significance, variety, and healthfulness.

Through three additional sets of measures, the Food Shopping Survey allowed them to evaluate the respondents' primary food store accessibility and general patronage. The first is the neighborhood where the respondent resides; the second is the primary grocery store they visit; and the third is the main mode of transportation used to go grocery shopping.

<b>HFAI Score and Price Tiers for Cambridge Food Stores</b>				
	<b>HFAI Scores</b>		<b>Prices</b>	
<b>Tier</b>	<b># Stores</b>	<b>HFAI Score Ranges</b>	<b># Stores</b>	<b>Price Range</b>
<b>High HFAI (Low Price)</b>	9	69-78	8	\$10-\$16
<b>Medium HFAI (Medium Price)</b>	10	54-68	9	\$17-\$26
<b>Low HFAI (High Price)</b>	7	35-53	9	\$27-\$48

*Figure 1. HFAI Score and Price Tiers for Cambridge Food Stores*

**Figure B10:** Above is a table taken from the Olcott et al., in which they placed tiers on the 3 HFAI scoring types they were able to produce from the surveys (High, Medium, and Low).

This study is an illustration of how the survey tools created here can be used to further analyze Knightdale’s local food environment through the lens of Knightdale residents. Granting data ownership to TLC of the Network Model Analysis will allow them to add more localized perspectives to the mapping system after survey deployment. While this study showcases an example of how the client can go about visualizing the survey data, there are certainly multiple ways they can achieve doing so. Furthering this point, the authors mention that there is a general need to gather resident-focused perspectives to further interpret data collected to properly “guide future programs, policy, systems and environmental change initiatives to equitably increase food

access.” With our assessment pyramid of affirmative responses, mean averages can be generated to mimic HFAI scores with the corresponding variables in our research: access, availability, stability, and utilization. The scores will ultimately account for different variables as we did not focus on retail baskets and physical pricing, but they will account for variables that nonetheless are important regarding food access and sovereignty. Variables measured in our surveys include mental and physical well-being, travel, finances, and overall nutrition.

### **Conclusion and Recommendations**

This study has demonstrated an initial need for an increase in fresh food availability and accessibility in Knightdale. Our client, The Triangle Land Conservancy (TLC), is in a unique position as a land conservancy to progress towards developing the operational capacity of local producers and aggregators to meet the demands for locally sourced produce and farm products in disadvantaged communities. The Wake County Food Security Plan Update does not list a land trust as a potential partner in achieving the goal. In this case, it would be an oversight to not consider The Triangle Land Conservancy in expanding food hub aggregation due to their large organization size, established farmer partnerships and existing agricultural operations within the Bailey and Sarah P. Williamson Nature Preserve. However, before pursuing a food hub aggregation project, it is imperative to thoroughly assess the needs of the surrounding communities that can benefit from it beyond this initial study. We recommend investigating demographics within the service tools as they are investigated in the NMA visualization and help to determine who we are representing when we are conducting such research. Because the intent of these service tools is to engage the community, we do not recommend a set sample size as this can exist in varying numbers. Another thing to consider that we would have liked to try is the use of Q-methodology sort interviews, a method the client can pursue as a form of interactive in-person surveying. See Appendix B for an example of an oversimplified Q-sort called a “tier-list”.

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## **Appendix A: Network Model Analysis Figures, Tables, and Graphs**



## Network Model Analysis Figures and Appendix

### 1. Assumptions

- a. We assume that all limited-service restaurants in the study area do not accept Electronic Benefits Transfer (EBT) card payments due to hot food items being ineligible for purchase under SNAP program regulations.
- b. In-situ there are instances where convenience stores such as 7Eleven accept EBT card payments so for the sake of the study and time constraints, we assume that all convenience stores in this study accept EBT card payments, although this may not be the case.
- c. Food sources where the listed address was a residential home were excluded because it is assumed there isn't a physical store for food sale.

### 2. Conditions

- a. Common grocery wholesalers such as BJ's Wholesale Club and Sam's Wholesale Club were excluded because their business classification does not meet the definition and their membership requirements pose a barrier to access.
- b. Moreover, food locations classified as grocery-retail included specialty grocery stores that only offered a very small range of food products (only jams, donuts, or fish) were excluded from the final food environment. For example, although the Bayleaf Market in Raleigh is classified as a grocery-retailer, their main product of sale is art.
- c. Pizza restaurants were excluded because they are classified as full-service restaurants under NAICS Code. A full-service restaurant is an establishment that serves food by order, is served while seated and patrons pay after eating.

Source: *NAICS Code: 722511 Full-Service Restaurants*. (n.d.). NAICS Association.

<https://www.naics.com/naics-code-description/?v=2022&code=722511>

### 3. Critiques

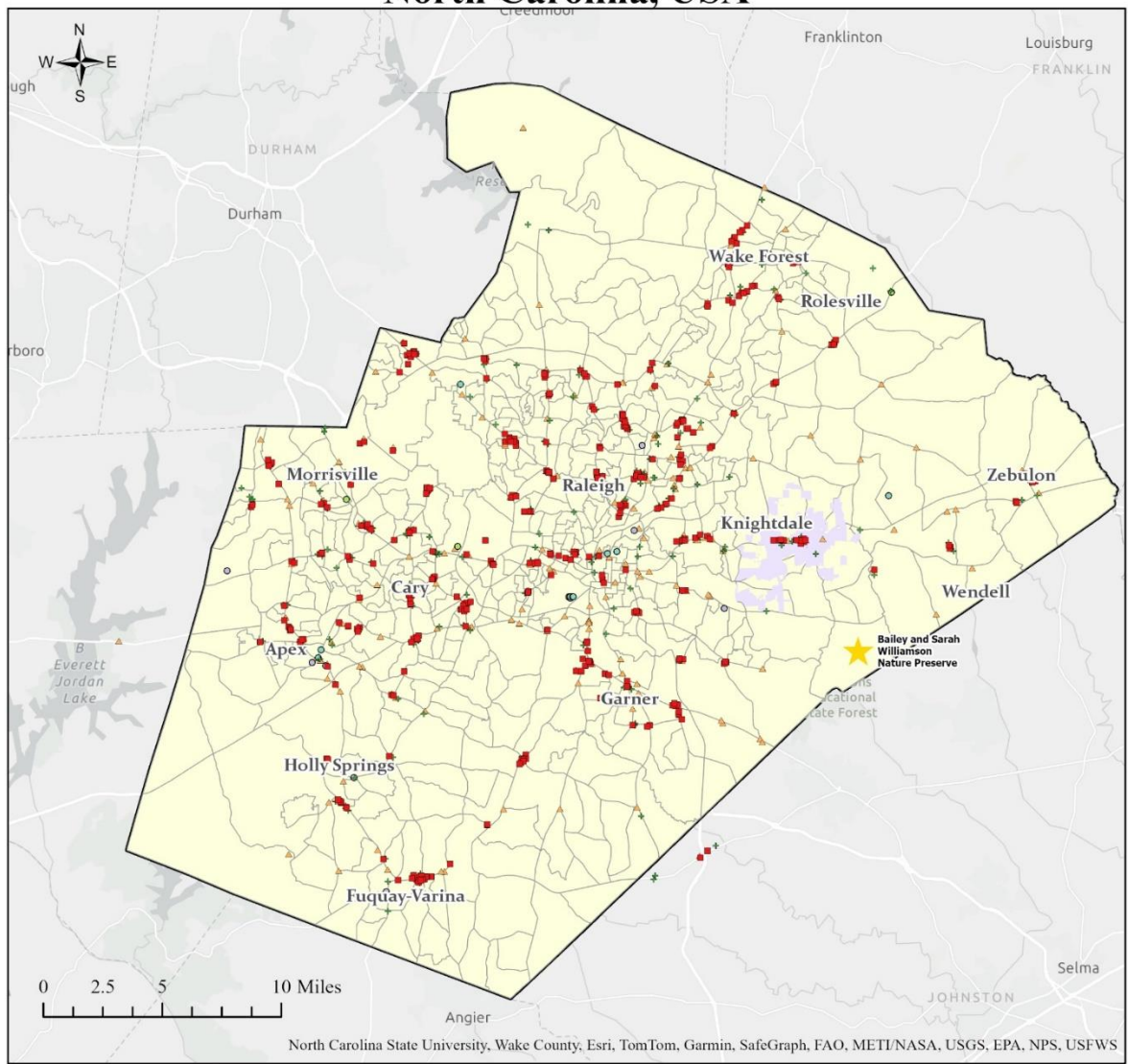
- a. NAICS codes and the NC Department of Commerce definitions for food locations may not reflect how the average person subjectively views locations. For example, a person may frequent Chipotle Mexican Grill and deem the restaurant fast food. Thus, full-service restaurants and especially affordable pizza restaurants are excluded from the local food environment. According to a market report by IBISWorld, most consumers opt to order pizza for takeout or delivery. Affordable options like Little Ceasars Enterprises are categorized as a fast-food chain and full-service restaurant (IBISWorld, 2024). It is important to change the way businesses are categorized, especially since pizza restaurants and convenience stores included in this study fit multiple NAICS categories.

Source: IBISWorld. (2024). *Pizza Restaurants in the US – Jan 2024*. IBISWorld.com.

2022 NAICS Code	Business Description	Definition	Fresh Produce Available/ EBT Accepted?	Final Count within Study Area
624210	Community Food Services	“...establishments primarily engaged in the collection, preparation, and delivery of food for the needy.” Some examples include food banks, food pantries and soup kitchens. ( <a href="#">link</a> )	Yes/Yes	9
722513	Limited-Service Restaurants	“...establishments primarily engaged in providing food services (except snack and nonalcoholic beverage bars) where patrons generally order or select items and pay before eating.” Some examples include delicatessen restaurants and fast-food restaurants. ( <a href="#">link</a> )	No/No	387
457120	Other Gasoline Stations (except those with Convenience Stores)*	“...establishments generally known as gasoline stations (except those with convenience stores) or truck stops primarily engaged in retailing automotive fuels or retailing these fuels in combination with activities, such as providing repair services; selling automotive oils, replacement parts, and accessories; and/or providing food services.” ( <a href="#">link</a> )	No/Yes*	161
445131	Convenience Retailers (except those operating fuel pumps) *	“...establishments primarily engaged in retailing a limited line of groceries that generally includes milk, bread, sodas, and snacks, such as convenience stores or food marts (except those operating fuel pumps).” ( <a href="#">link</a> )	No/Yes*	33
445110	Supermarkets and other Grocery retailers	“...establishments generally known as supermarkets and other grocery retailers (except convenience retailers) primarily engaged in retailing a general line of food, such as canned and frozen foods; fresh fruits and vegetables; and fresh and prepared meats, fish, and poultry.” ( <a href="#">link</a> )	Yes/Yes	203
445230	Fruit and Vegetable retailers	“...establishments primarily engaged in retailing fresh fruits and vegetables.” ( <a href="#">link</a> )	Yes/Yes*	19
<b>Total Food Source Count</b>				812

**Table A1.** The list of the food sources included in the study by their primary 6-digit NAICS code. Source: NAICS code search website [Code Search | NAICS Association](#) \*We assume that convenience stores and other similar retailers accept Electronic Benefits Transfers (EBT) card payments.

### Food Locations in Study Area Knightdale, Wake County, North Carolina, USA



- ▲ Convenience Stores
- Farm Markets
- Food Banks
- Fruits & Vegetables & Produce-Retail
- ✚ Grocers-Retail
- Limited-Service Restaurant
- Knightdale
- Corporate Limits
- ★ Potential Food Hub Location
- Block Groups
- ▭ County Boundary

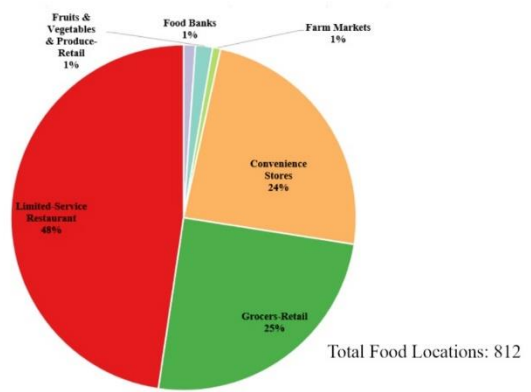


Figure 1. Map of the study area and available food locations in Wake County, North Carolina. Knightdale is the area of interest and census block groups are also shown.

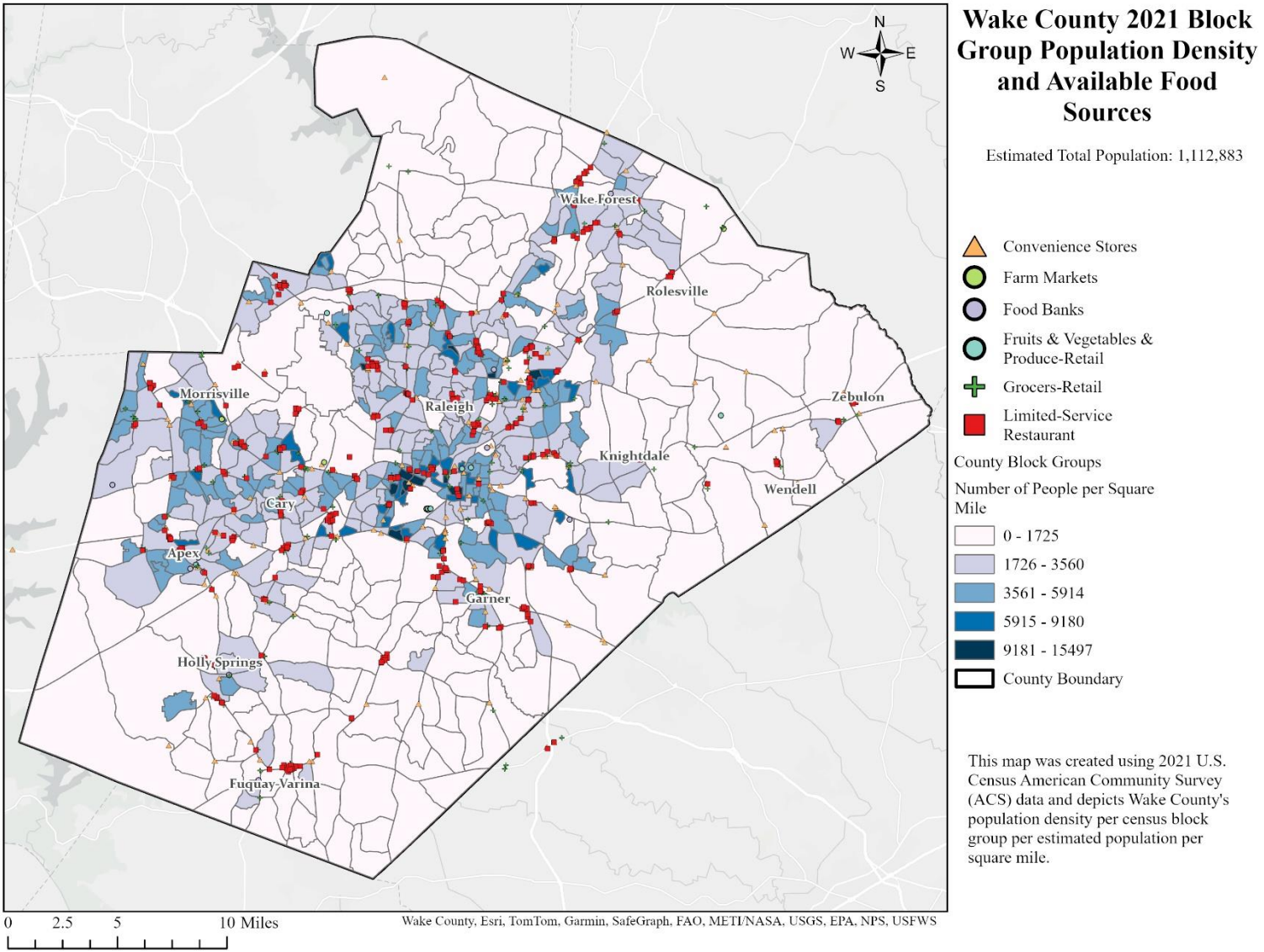
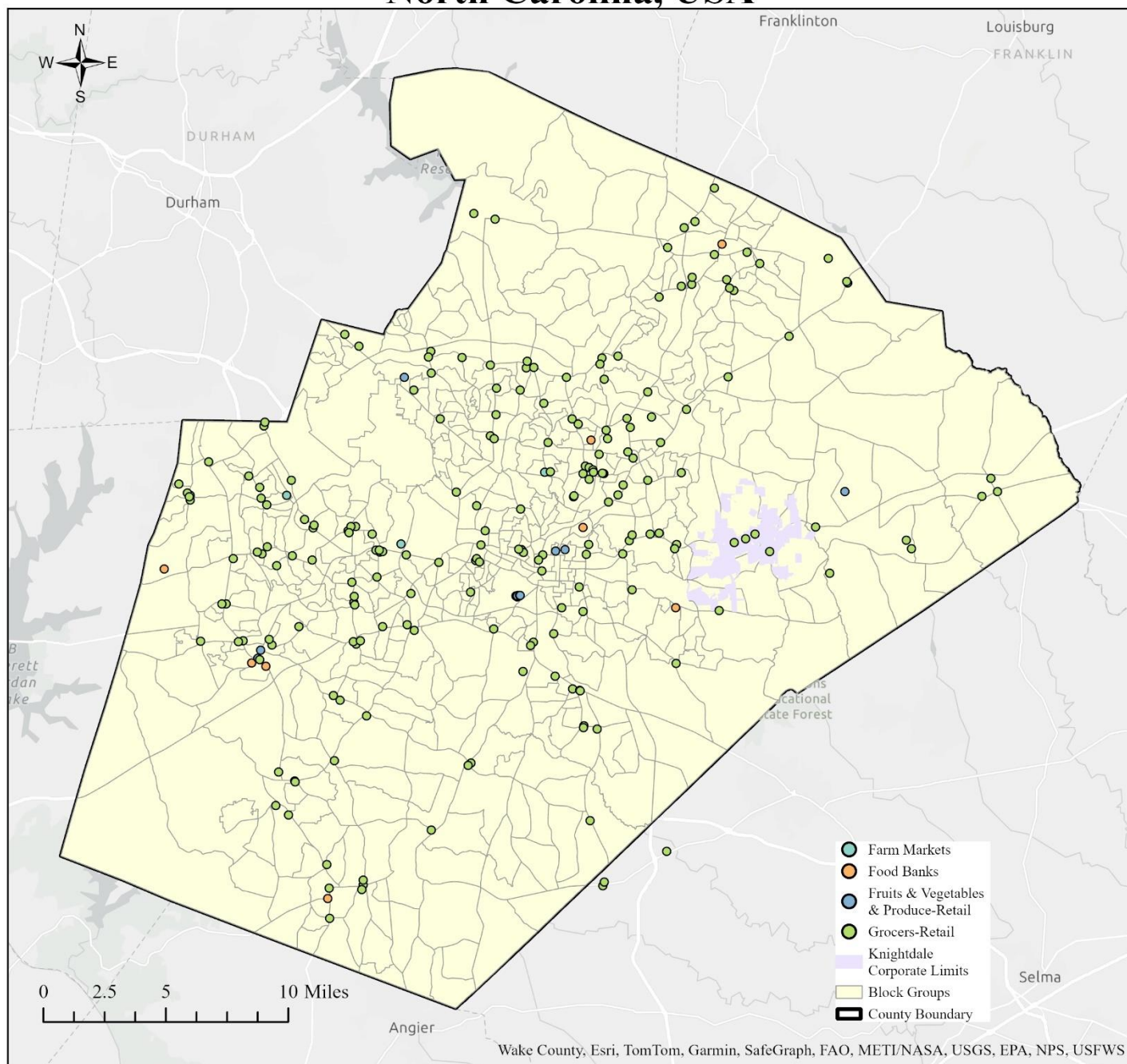


Figure 2. Map displaying census block group population density and available food sources.

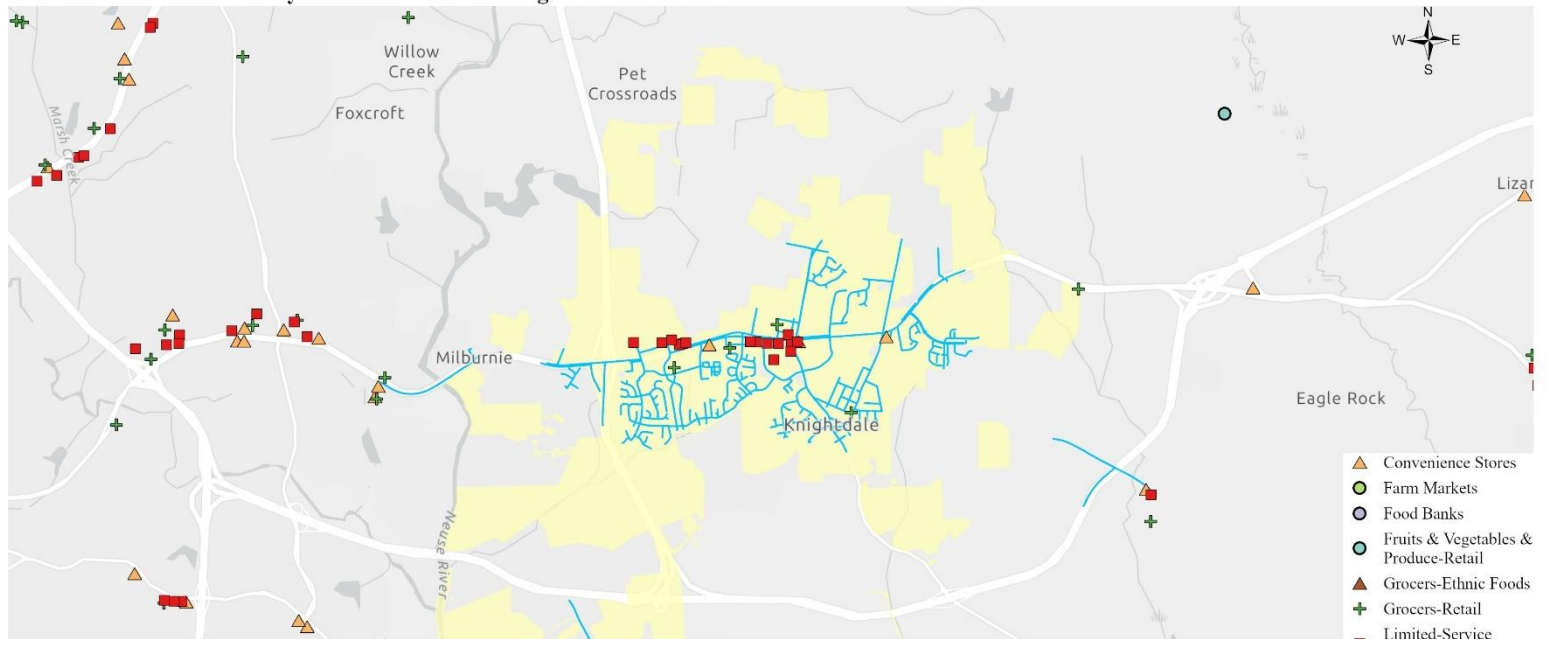


## Fresh Food Locations in Study Area Wake County North Carolina, USA

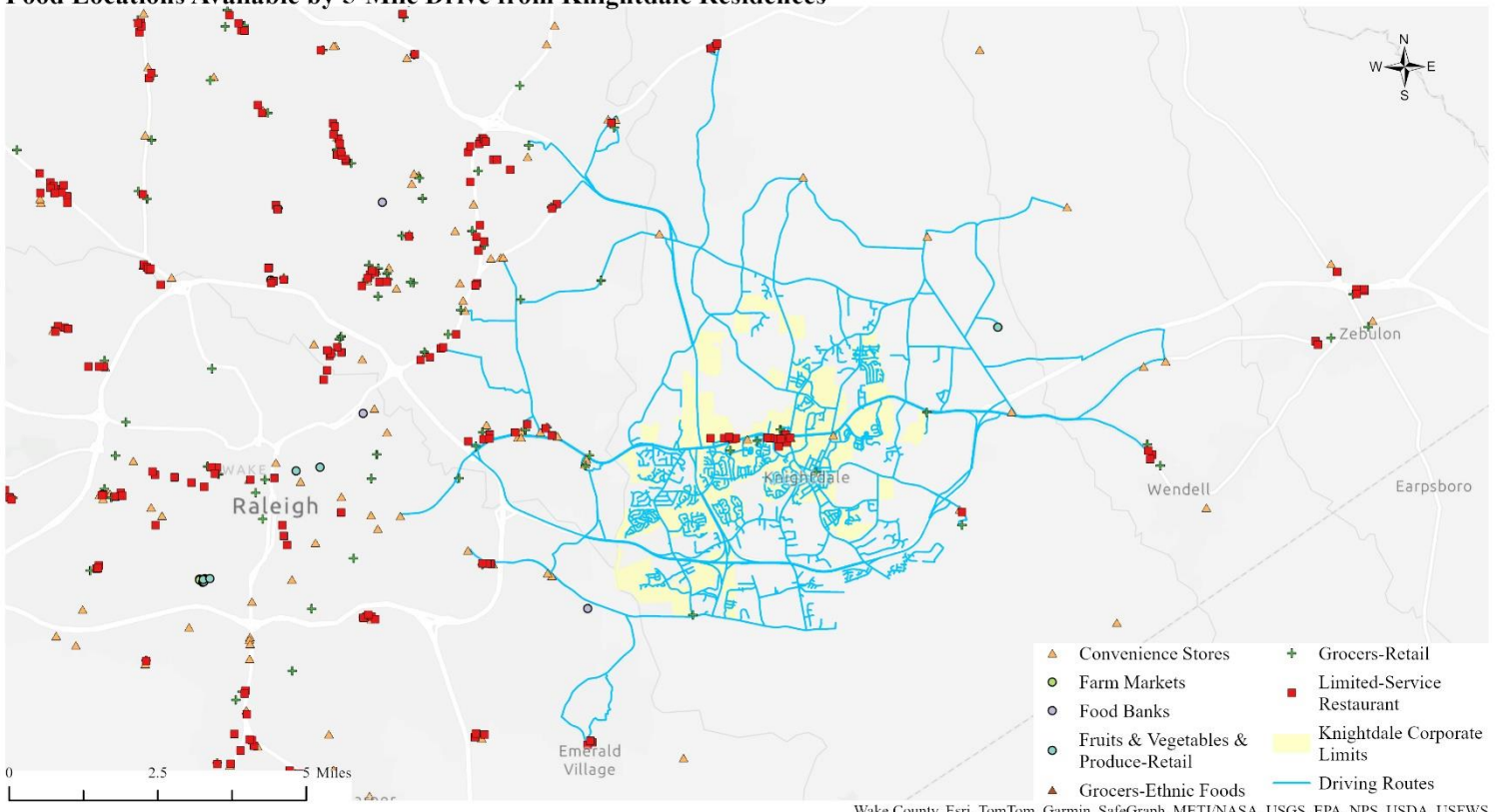


**Figure 3.** Map showing sample of fresh food locations: farms market, food banks, produce retailers and grocery stores in Wake County. Census block groups and Knightdale corporate limits are shown as well.

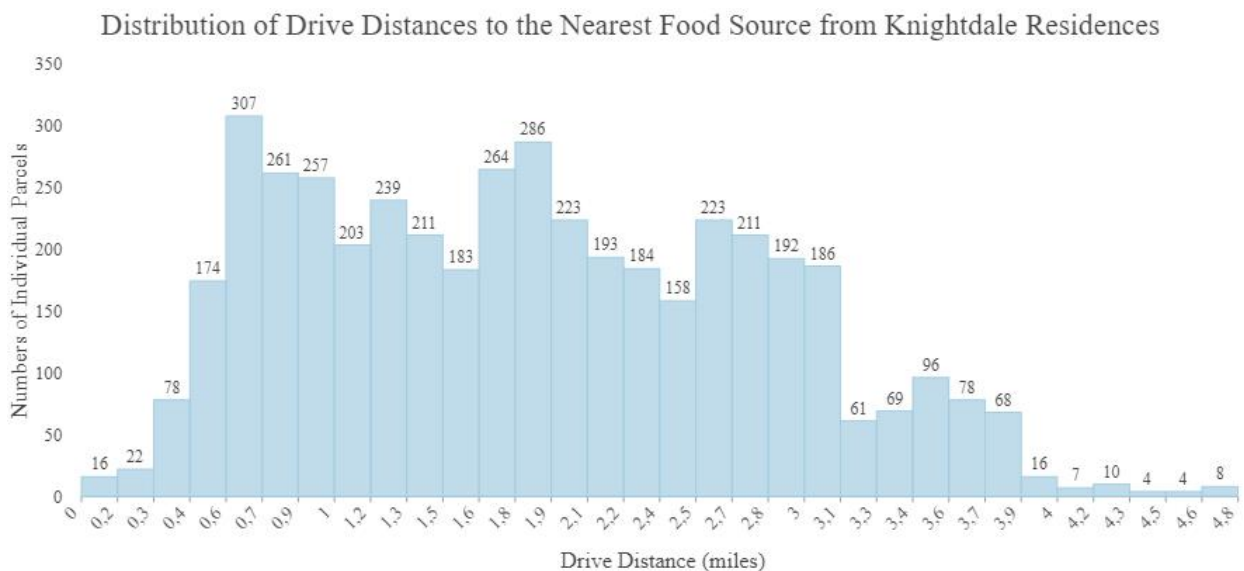
### Food Locations Available by 1-Mile Drive from Knightdale Residences



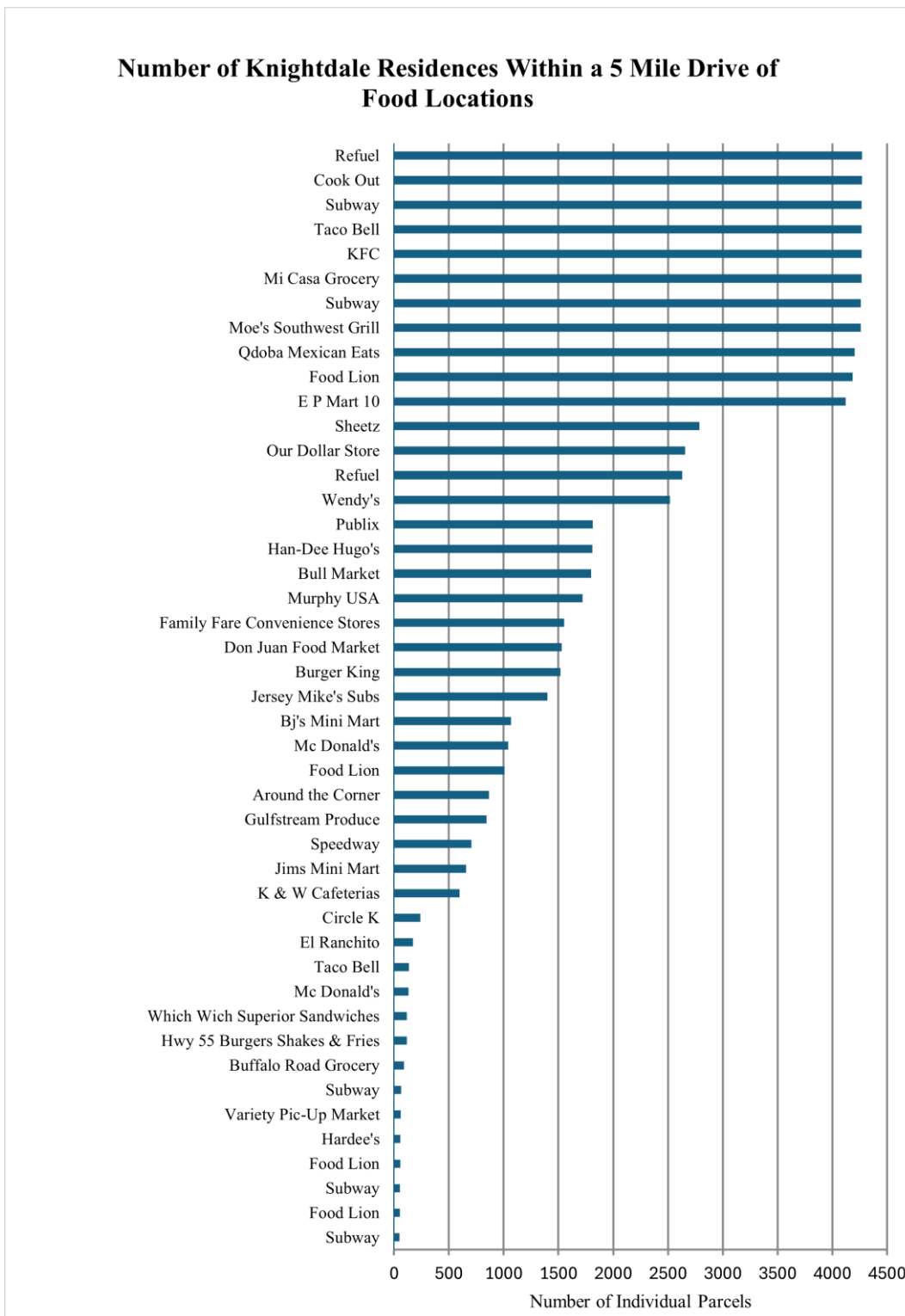
### Food Locations Available by 5-Mile Drive from Knightdale Residences



**Figure 4.** Maps of food locations within 1 mile (top) and 5 mile (bottom) drive of Knightdale individual parcels.



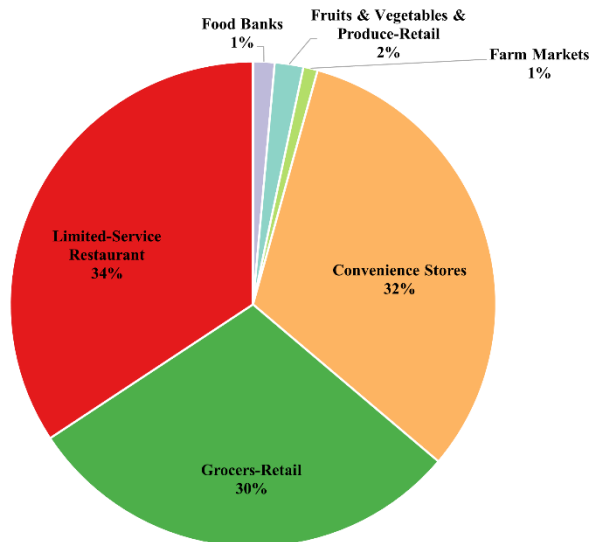
**Figure 5:** Distribution of drive distances to the nearest food source from Knightdale residences. The mean distance is approximately 1.9 miles. The results shown are a partial solution from the 5-Mile Closest Facility Analysis layer as 3,524 (44%) of individual parcels did not have a food source within the 5-mile cutoff.



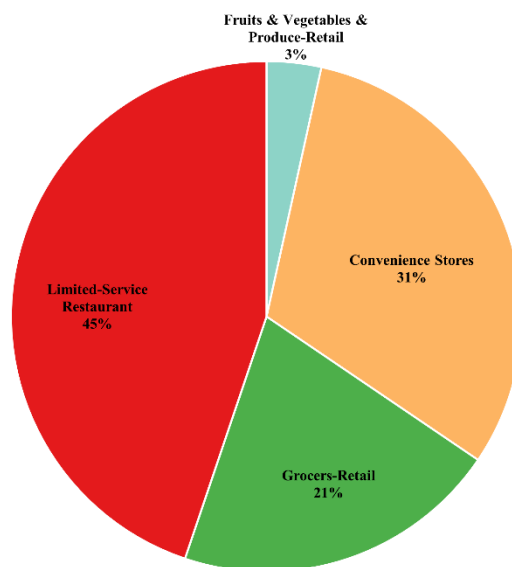
**Figure 6.** Histogram depicting the number of Knightdale residences (individual parcels) within a 5-mile drive of food locations. There are a total of 77 food locations but 45 are displayed here. Food locations that reached less than 50 residences were excluded for scaling purposes.



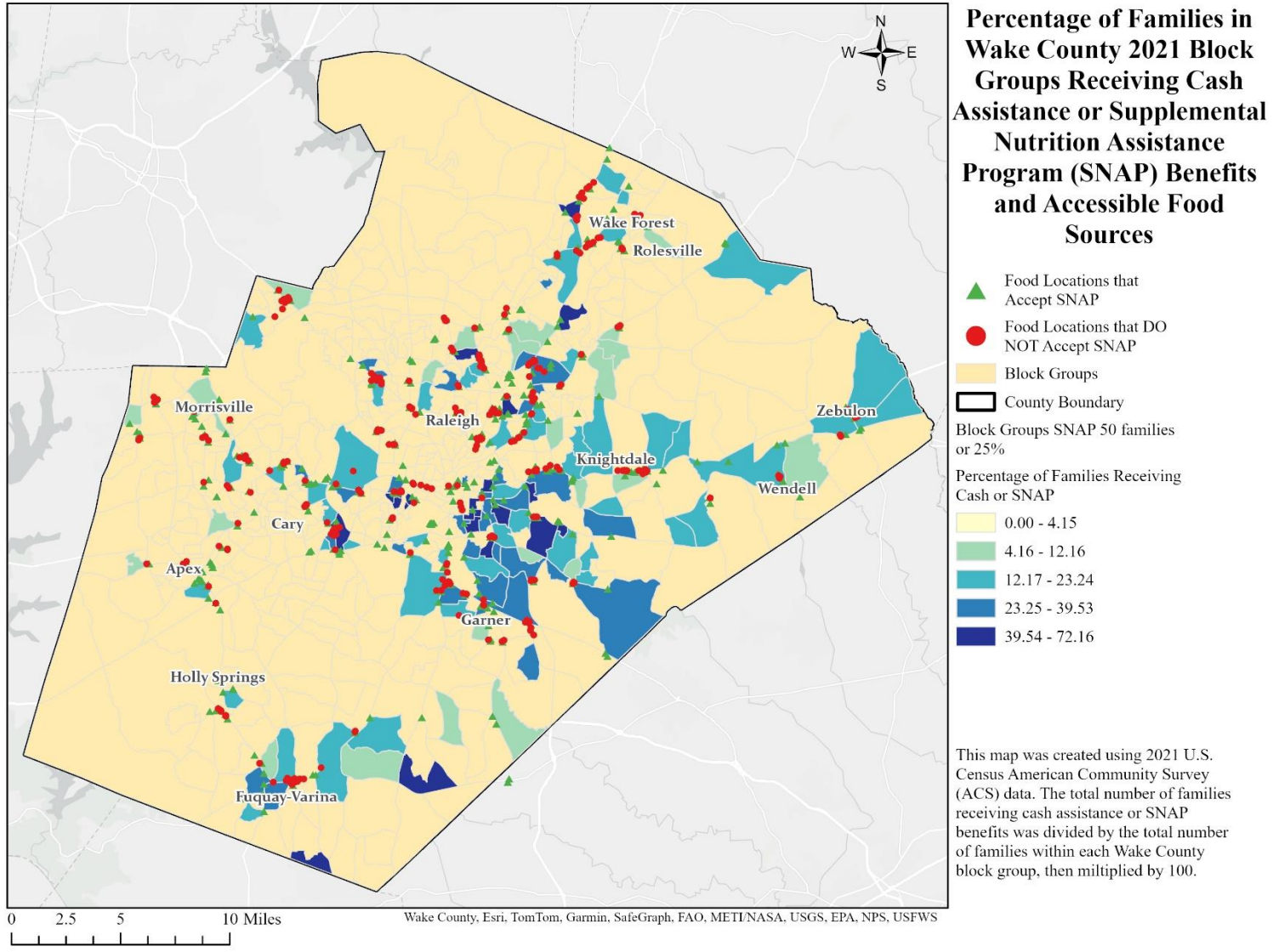
Distribution of Nearest Food Locations to Wake County Block Group Centroids - 5 Miles



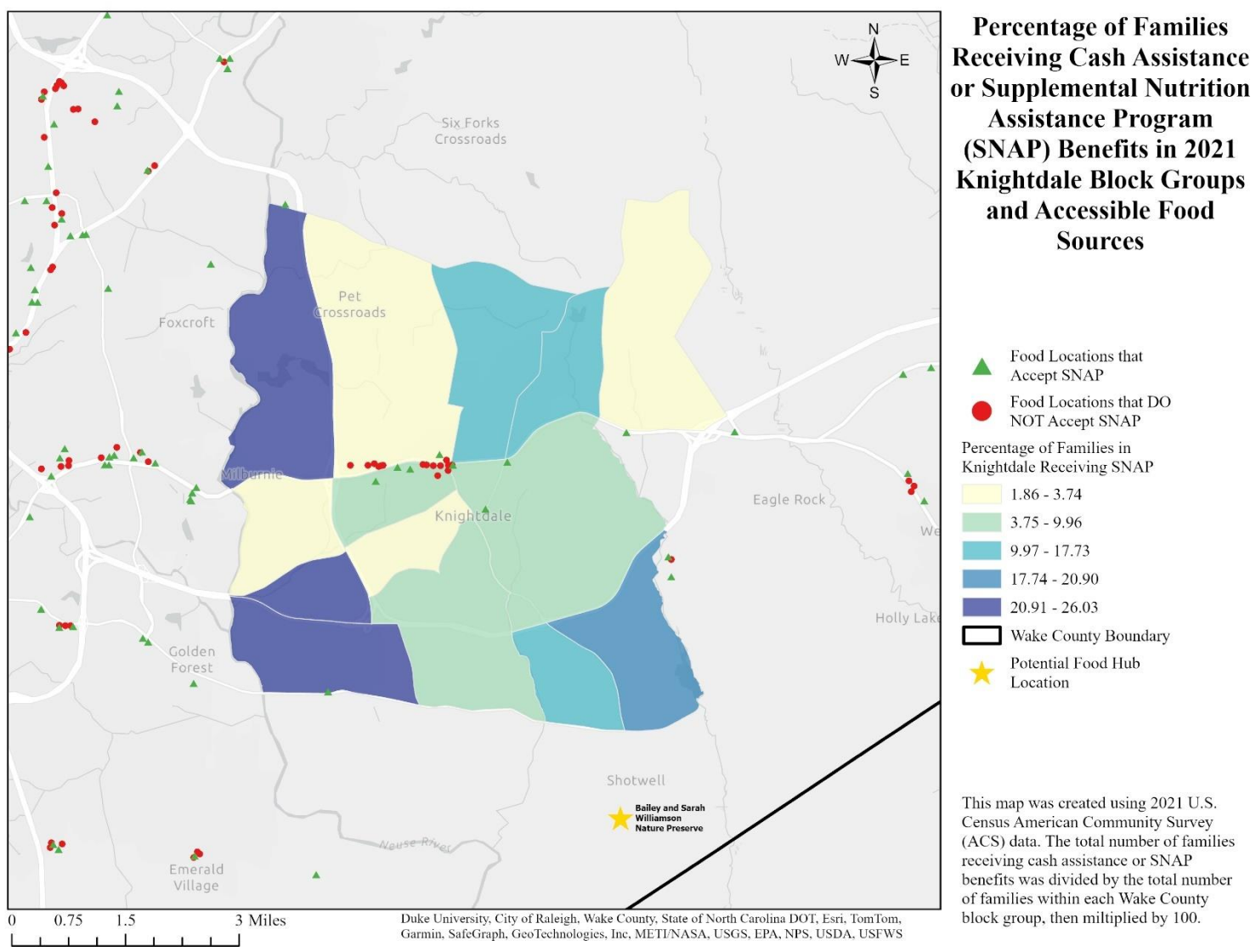
Distribution of Nearest Food Locations to Individual Knightdale Parcels - 5 Miles



**Figure 7.** Pie chart depicting the distribution of available food sources within 5 miles of Wake County Block Group Centroids (left) There are 210 food sources. Pie chart depicting the distribution of available food sources within 5 miles of Knightdale individual parcels. There are a total of 29 food sources. The total number of food sources differ from earlier totals because food availability is defined as the distance to the nearest food source. Therefore, each parcel of block group centroid was restricted to 1 food source match along the road network in the Closest Facility Analysis layer.



**Figure 8.** Map of Wake County census block groups containing more than 50 families or 25% of the population receiving cash assistance of Supplemental Nutrition Assistance Program (SNAP) benefits and the accessible food sources.



**Figure 9.** Knightdale census block groups containing families receiving cash assistance of Supplemental Nutrition Assistance Program (SNAP) benefits and the accessible food sources. 14 Wake County block groups that intersected Knightdale corporate limits are shown.

## **Appendix B: Community Engagement Tools Justification Tables**

## Appendix B. Community Engagement Service Tools

Justifications - Table 1 Service Tool 1










Table 1 Justifications for Service Tool 1			
Question	Purpose	Responses	Question type
Have you heard of the Triangle Land Conservancy?	Gauge community's awareness of the Triangle Land Conservancy and the Agriculture Pavilion	I have heard of the Williamson Nature Preserve; I have not heard of the Williamson Nature Preserve	Multiple Choice
How often do you, or someone in your household, purchase fresh produce?	Context for how often the Agriculture Pavilion should be open	Daily; Weekly; Bi-weekly; Every 3-4 weeks; Never	Scaled Response
How important is it to you, if at all, that your food come from local sources?	To obtain a sense of the ideas around local produce shopping; is there already a gravitation toward local markets/food sources or are they avoided?	Not at all important; Somewhat important; Moderately important; Very important; Extremely important	Scaled Response
How far (in miles) do you typically travel to get groceries for your household?	Provides consumer habits/context for the GIS network model analysis.*	Less than a mile; 1-5 miles; 6-10 miles; More than 10 miles; My household does not travel for groceries	Scaled Response
Where do you (or someone in your household) get fresh produce from typically?	Providing specific examples of common grocery stores in the area helps distinguish which is most often visited, if any. The option of "Other" allows for further analysis of places not considered "common" in the area.	Food Lion; Walmart; Lowes Foods; Publix; Convenience Store; Other	Multiple choice and optional short response with choice of "Other".
Would you, or would you not, be willing to commute a further distance for fresh food?	Determines if the outcome of this project is wanted and if travel is indeed a problem for the community.	I would be willing to commute further than I do for fresh food if a more affordable option were available; I would not be willing to commute further than I do for fresh food if a more affordable option were available.	Multiple Choice
At what time of day do you typically go shopping for food?	More context offering when the Agriculture Pavilion should be open for the public.	In the morning (8am-11am); In the afternoon (12pm-3pm); In the evening 4pm-8pm)	Multiple Choice
Which food category do you typically spend the most money on?	Provides guidelines for what the Pavillion should have available if there is commonality among community members for the same category.	Meat; Poultry; Fish; Dairy; Non-Perishables; Other	Multiple choice and optional short response with choice of "Other".
What is the typical shelf-life for produce that is purchased in your household?	Addresses if the Pavillion can host food storage workshops and similar events.	1-3 days; 4-6 days; More than a week but less than 2 weeks; 2 weeks or more	Multiple Choice
Which of the following, if any, do you view as barriers to getting fresh produce for your household?	Provides community knowledge on the issues surrounding food insecurity in their point of view.	Cost; Distance to market; Availability; Quality of available products; Other	Multiple choice and optional short response with choice of "Other".
Which types of fruits and vegetables are your children likely to eat if you brought them home? Select all that apply.	Incorporates children without the need for a separate survey.	Berries (strawberries, blueberries, raspberries, blackberries); Tree Fruits (apples, pears, peaches, plums, figs, avocado); Roots (sweet potato, potato, yam); Leafy greens (collards, lettuce, spinach, herbs); Cruciferous (cauliflower, broccoli, brussel sprouts, cabbage)	Select all that apply
(Optional) If you or a child in your household could participate in an event at the Williamson Nature Preserve, what would you be interested in attending? Be as creative as you'd like.	Further provides more detailed events/workshops that the community would like to see.	No pre-inserted responses.	Short written response
(Optional) Where is your favorite community outdoor space and what does it look like? Be as descriptive as you can and provide the name if possible.	Provides the client with ideas on what to incorporate in the design plans of the Agriculture Pavilion.	No pre-inserted responses.	Short written response
What is your preferred email address for information regarding future Williamson Nature Preserve events and for survey updates?	Provides the community members with a voluntary opportunity to be more involved in the Agriculture Pavillion process and with what the client/space has to offer them outside of the Pavillion.	No pre-inserted responses.	Short written response

\*There are tradeoffs between using travel distance and time



Justifications - Table 2 Service Tool 2

<b>Table 2 - Justifications for Service Tool 2</b>				
<b>Question</b>	<b>Purpose</b>	<b>Responses</b>	<b>Question type</b>	
You or someone in your household experienced weight loss or malnutrition due to lack of food.	Emphasizes the need for access to healthy foods at an urgent scale.	<b>Strongly Agree; Agree; Neither agree nor disagree; Disagree; Strongly Disagree</b>	<b>Five-point Scaled</b>	<b>Utilization</b>
You consider the overall quality of your diet as low in nutritional value.	Establishes knowledge surrounding food choices and what could be available.			
There were times where you had to choose between buying medicine and buying food.	Outlines the need for a budget friendly food hub so that participants can extend their earnings to an essential item like healthcare.			
You experience anxiety or stress related to food insecurity.	Dives into ideas regarding overall health and wellbeing surrounding food and perhaps what the client can provide in future workshopping events.			
You have cultural or dietary preferences that make it harder for you to access affordable, culturally appropriate foods.	Establishes if there is a need in the community to reconnect to themselves and their roots via the land and what the client can provide food wise.			
You believe that food insecurity is a significant issue in your community.	This statement can be affirmative regardless of one's specific situation; if they think it is a problem it helps the client establish need.			
You skip meals or reduce portion sizes because there is not enough money for food.	Defines the participant's struggles in obtaining food a bit further through the financial lens.			
You have had to make trade-offs between buying fresh produce and cheaper less nutritious alternatives.	Displays if the participant distinguishes fresh versus cheap.			<b>Stability</b>
You rely or have relied on government assistance programs such as the Supplemental Nutrition Assistance Program (SNAP).	Aside from client wishes, this question highlights how many participants are already deemed by the government in need of financial assistance for food. This helps the client determine need a bit further.			
You do not have access to affordable nutritious food options within a reasonable distance from your home.	Determines whether or not the participant is aware of nutritious food options nearby.			
You have had to choose between paying for transportation to get groceries and buying the food itself.	Illustrates that the participant needs to consider travel expenses for groceries with or without a vehicle.			
You would be willing to commute a further distance if fresh produce were cheaply available to you.	Establishes further if there is a need for a low cost food hub.			

<b>S</b>		
<b>A</b>		
<b>B</b>		
<b>C</b>		
<b>D</b>		
<b>E</b>		
<b>F</b>		
<b>G</b>		

**Table 3:** A type of user-friendly Q-methodology called a “tier list” where users can easily place where they rank certain items tailored to their specific tastes as an individual. S being the top tier, G being the bottom tier. The user can rank only the items given to them and may place more than one within a rank. For the sake of the example, I chose 9 fruits that can be ranked easily among the 8 tiers.

- A Q-methodology is used as an investigative research method in which participants representing varying perspectives or stances on a particular issue may sort or rank a series of statements.