FINDING FOOD DESERTS BASED ON FOOD ACCESS INDEX AND TRANSPORTATION MODES: CASE STUDY OF SARASOTA COUNTY, FL

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN URBAN AND REGIONAL PLANNING

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To my mother and father, for all their support and myself

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Access to healthy food has become a vital issue in urban and rural for better quality of life, disease prevention, and an essential element for health growth. The areas with limited access to food are examined as ‘food desert’ and this area include physical and socioeconomic disparities. This thesis evaluated the spatial accessibility of ‘healthy food outlets’ in relation to walking and driving transportation network.

This study created criteria to evaluate physical distance to healthy food outlets: Food access index. (1) Geographic Information System (GIS) is applied to measure Manhattan block distance to the nearest healthy food outlets for 204 Census block neighborhoods in Sarasota County, FL. (2) Using street network analysis, walking (0.5 mile) and driving (10 miles) buffers around healthy food outlets are created to determine residents’ food accessibly and to assess food desert. (3) Additionally, t-test for each transportation mode is used to understand the relationship between food access index and vehicle ownership.

The findings from this study (1) illustrates three levels of demographical distribution of food access (high, medium, and low) and (2) identifies there are about

34.1% of the total population live in food desert areas. (3) Additionally, statistical result shows a positive relationship between vehicle ownership and food access when residents drive to buy healthy foods. This basically implies population with low percentage of vehicle ownership has less healthy food accessibly in the case study area.

This study found that there is a noticeable disparity in geographic access to healthy food outlets based on transportation mode, auto vs. walking. These findings have implications for future transportation planning food policy planning.

CHAPTER 1
INTRODUCTION

Problem Statement

In early 2010, First Lady Michelle Obama brought Americas' health problems to the forefront and initiated the "Let's Move" campaign. As part of the campaign proposal to combat the rise of Type-2 Diabetes among American youth, one of the United State's goals was to decrease the rate of obesity by providing greater access to affordable, healthy foods. In 2004, the Centers for Disease Control and Prevention (CDC) stated that obesity increases when food consumption takes place far from people's homes (CDC, 2004).

Areas that are isolated and lack easy access to wholesome foods have been dubbed "food desert," the rate of diabetes and obesity are higher among racial/ethnic minorities and lower-income individuals in these areas. Inhabitants of theses "food deserts" have fewer supermarket options, and must rely on smaller convenience stores. A study in San Diego found that supermarket chains offer twice the average volume of "heart-healthy" foods, compared to neighborhood stores, and sell four times the average volume of these foods compared to convenience stores (Morland et al., 2002a). Emphasizing the importance of supermarkets for better access to healthy food, the "Let's Move" campaign's website explains:

> More than 23 million Americans, including 6.5 million children, live in low-income urban and rural neighborhoods that are more than one mile from the nearest supermarket. These communities, where access to affordable, quality, and nutritious foods is limited, are known as 'food deserts.' In these communities, grocery stores that sell healthy foods such as fresh fruit and vegetables are inaccessible or healthy foods are too expensive. ("Let's Move" Campaign, 2010)

Food access has become a critical issue in urban and rural areas for the achievement of a better quality of life, disease prevention, and healthy childhood growth. However, these problems may be worse in food deserts, which are also influenced by particular neighborhood environments and transportation networks. Therefore, the existence of food deserts and restricted access to wholesome foods have been highlighted as features of the built and physical environment that have a socioeconomic dimension, and this may influence a community's current health status.

Research Objective and Questions

The objective of this thesis is to address two factors related to food deserts: importance of proximity to determine physical food access and the pedestrian' or driver's perspective to acknowledge food deserts. More specifically this study looks at how the network of roads and pedestrian walkways and paths that lead to neighborhood stores where food can be purchased determines access to healthy foods.

For the objective, providing a spatial overview of where food deserts are located in our local area is needed and Sarasota County has been selected as a case study area. Sarasota County has been named one of a highest- ranked "healthy counties" in the State of Florida (2011 County Health Ranking[1]). According to 2011 County Health Ranking, about 83% of total population has an access and resources to wholesome foods, compared to other counties in Florida. Throughout this work, the following "big picture" questions have guided this research:

[1] Access to healthy food is measured based on the percent of residential Zip codes in a county with a healthy food outlet, defined as grocery stores or produce stands/farmers' markets

- What is the definition of a “food desert”? Is it absolute or does it varies from case to case?
- What types of factors would accurately determine food desert in terms of physical access to foods?
- Where is spatial inequality with regard to food access based on physical proximity?
- How can this study contribute to the solutions to reduce food deserts?

CHAPTER 2
LITERATURE REVIEW

The food environment is understood differently by every one of its stakeholders, ranging from the government to industry leaders to general residents (Rex and Blair, 2003). It is influenced by interactive factors, such as social class, food culture, life style of the population, and economic status insofar as it influences food purchasing behavior.

This chapter provides an organized overview of the literature on spatial access to the food environment and its potentially adverse health outcomes. The first section introduces a measurement method from previous studies. Then, the chapter continues with a review of food environment inequalities drawn from the consideration of socioeconomic factors and the physical barriers that community residents experience based on the automobile-dependent life style in the United States. Next, brief examples of methodological approaches will be discussed to provide comparisons among the latest studies, with the intention of identifying a variable related to geographic or physical access that is based on physical distance, the variability of neighborhood boundaries among different populations, and the difficulty of creating units of analysis in spatial mapping. Thereafter, food access policy issues will be introduced, because those organizations that are attempting to understand their local food environments would benefit tremendously from the ability to analyze particular food disparity areas spatially. To conclude this chapter, a recap offers insight into social inequities in the distribution of affordable food sources and its relevance to a car-dependent culture. Additionally, in the final section of this chapter, an examination of quantitative methods and policies would suggest some possible models to follow.

Definition of Terms

Food Environment

What makes the food environment a current issue? The current interest in improving American's food environment has been sparked by the steady rise in the consumption of high calorie food since the 1970s. Physically, this increased consumption appears to be linked to the distance between communities and their sources of healthy foods (such as full-service grocery stores), consequently this may promote the consumption of unhealthy foods and increase the need for a better-quality food environment. The CDC, on their website, defines a "food environment" as follows:

- The physical presence of food that affects a person's diet (Babey, 2008),
- A person's proximity to food store locations (Morland et al., 2002a),
- The distribution of food stores, food service, and any physical entity by which food may be obtained, or (Morland et al., 2002a)
- A connected system that allows access to food (Morland et al., 2002a).

Food environments that offer a greater variety of healthy food options at affordable prices may promote healthier food choices, and could be called a "healthy, nutritious food environment". A healthy, nutritious food environment accompanied by increased rates of physical activity, could help reduce the incidence of leading illnesses in the U.S., such as obesity, heart disease, cancer, and diabetes (CDC, 2010). Although the interaction between food and city planning is limited, planners and local governments have suggested certain strategies for the creation and maintenance of healthy food environments that relate to zoning, land use planning, transportation infrastructure, community gardens, and so on (Clifton, 2004). With regard to planning, it is important to define the important terms (such as food security/insecurity, and food deserts) to

promote greater understanding of the connection between planning and the food environment (Reisig &Hobbiss, 2000).

Food Security and Insecurity

Food security refers to food environment in which people have physical access to foods that meet the national standard for safety, freshness, and nutrition. However, challenges for planners arise when some households do not get enough foods – in other words, when food is unequally distributed. Food security is a complex issue related to sustainable development, health, economic growth, the environment, and trade (World Health Organization, 2011). “Food insecurity” has been defined by the United States Department of Agriculture’s Economic Research Service (USDA ERS) as a situation in which particular households are “unable to have or unable to acquire enough food to meet the needs of all their members because they have insufficient money or sources for food” (2009). In Florida, one study found that 14.2 percent of households, or over 1,000,000 households, are “food insecure” according to the USDA’s definition (Nord, 2010). The percentage of food insecure was lower than the national average, but it nonetheless constituted a significant number of households in Florida. Some reports indicate a relationship between socioeconomic status and food insecurity. For example, approximately 46.2 million Americans are classified as “poor” and the poverty rate has now increased to 15.1%, the highest level since the early 1990s (Census Bureau, 2000). Many of these people rely on federal food programs, such as Food Stamps. Bloch et al. (2009) provide evidence that food stamp use in Florida has increased by a staggering 70% between 2007 and 2009, which may help us to draw a conclusion about the relationship between individuals’ economic status and food insecurity. Another study examined the association between food insecurity and

obesity. Jyoti et al.(2005) reported that 'children from persistently food insecure households had a 0.35 kg (0.77lbs) /m^2 greater gain in body mass index (BMI) and a 0.65kg (1.43lbs) greater gain in weight compared with children from persistently food secure households.' Living in a food insecure environment potentially presents many health and wellness challenges, and may be induced by inhabiting a food desert.

Food Desert

The term food desert implies the presence of some form of food insecurity. Wrigley et al. (2002) elaborate on the subject of food deserts, including particular factors like food availability, variety, and price. Those areas that are commonly indicated as food deserts are often regions that experience socioeconomic disparities. The USDA's ERS (2009) has defined food deserts as those areas in the U.S with limited access to affordable and nutritious food, particularly areas composed of predominantly lower income neighborhoods and communities. Morton et al. (2005) identified several characteristics of a food desert; namely, that a food desert has a larger proportions of residents without a high school degree, higher poverty rates, lower median family incomes, a low rate of vehicle ownership, a larger older population, and higher numbers of small grocery stores and convenience stores per capita. Because food desert neighborhoods are believed to exhibit these extreme tendencies, their inhabitants may experience more profound effects than simply a lack of food access to nutritious, healthy food. Indeed, food deserts also appear to be, areas of worrying social isolation (Furey et al, 2001).

Geographic Measures of Food Accessibility

What types of variables do we need to measure food accessibility? Firstly, "accessibility" refers to the physical distance between a point of origin and a destination.

Geographic access or physical access is generally based on the physical distance and travel time to a food store (Algert et al.,2006). Many of the studies in this area have calculated the distance from a centroid ZIP code to a food store, from which healthy foods can be purchased (Sharkey et al., 2010; Zenk et al., 2005; and Powell et al., 2007), while other studies measure the density of the food stores in a defined area (Block, 2004). For an actual distance, some studies have used grid distance to food stores, which would reflect the street network more accurately (Larsen & Gilliland, 2008; Zenk et al., 2005), while others have used the road network in their calculations instead of measuring straight distances, because this would enable a more precise prediction of actual travel time. Table 2-1 briefly shows the examples of geographical accessibility measurement in previous studies.

Socioeconomic Food Inequality in the U.S.

According to a report by the Economic Research Service in 2009, the existence of "food deserts" in United States has recently caused increasing concern, because of their role in promoting health inequality though the amplification of deprivation; as we saw earlier, minorities and low-income individuals are more likely to reside in food deserts. Identifying the socio-demographic factors that affect the food environment of a particular region can often help us dentify the barriers that communities encounter, e.g., the inability to afford wholesome food. This broad category of factors can be broken into three sub-factors: low-income households, racial/ethnical disparities, and an aging population.

Low-Income Households

Low-income areas are defined as food deserts when the individuals residing in these communities do not have access to healthy food. A crucial dimension of the

designation “food deserts” is access to ‘healthy foods’, but in this section, the economic status of a community’s residents is emphasized. Factors influencing economic access, such as a household’s income level, are considered when evaluating that household’s food security (McEntee & Agyeman, 2010). It has been found that consumers with an annual income of less than $8,000 paid about 1% more for their food, relative to those with higher incomes of between $8,000 – $30,000 (Broda and Weinstein, 2009). However, while Macintyre (2007) has not found a consistent pattern in which food resources are located to the disadvantage of households in poorer European communities, North American studies suggest that low-income communities may not have equal access to a variety of healthy food choices compared to wealthy communities (Morland et al, 2002a). In Canada, 35% of households classified as low-income have experienced food insecurity, i.e., either reduced access to food or low consumption of healthy food (Che & Chen, 2001). In New York City, those areas with the lowest median household incomes (East and Central Harlem, and North and Central Brooklyn) have the lowest scores for food access. In contrast, the highest scores for food access belong to the Upper East Side, a predominantly upper-income area (Gordon et al., 2010). There is a potential spatial mismatch between low-income neighborhoods and access to full service grocery stores (USDA, 2009), which reflects poorer community health, because higher-than-average numbers of convenience stores, fast food restaurants, and liquor stores are concentrated in low-income areas as well (Dannenberg et al., 2003, pp. 1500-1805). Thus, a low income level and poverty are relevant when assessing physical access to wholesome food and overall health.

Racial Segregation

What racial group, if any, associated with low incomes, and does this have relationship to that group's food access? In addition to a neighborhoods' wealth, residential racial segregation is a socio-economic characteristic of current U.S. society. In terms of food access, minority groups are present in unaffordable locations and accompanied by a low number of healthy food stores, a low percentage of vegetable/ fruit intake, and abundant fast food restaurants (Morland et al, 2002a; Morland et al., 2002b). In essence, minority groups have fewer opportunities to obtain healthy foods. African Americans are considered the largest minority group (nearly 13% of the country's population), while Hispanics constitute 15% of the total population. A recent study, conducted by Galvez et al.(2008), investigated East Harlem in New York City and found that, while African Americans and Hispanics are both considered minority groups, African Americans are less likely to have supermarkets and convenience stores in their occupied census block, while the Latinos' block is more likely to offer access to food stores and full-service restaurants. This implies there are differences among minority groups based on dietary quality and eating habits. Research has shown that the existence of food deserts is relevant to African American agglomeration, while food affordability may differ according to the characteristics of a neighborhood's physical environment. Baker (2006) found that African Americans, regardless of income level, have reduced access to restaurants that provide healthy food choices. (Baker's case study took place in St. Louis, MO.) A study conducted in New Orleans, LA, reported that predominantly Black neighborhoods had 2.4 fast-food restaurants per square mile compared to 1.5 fast-food restaurants per square mile predominantly White neighborhoods (Block, 2004).

Elderly Population

Walking, driving, and using public transportation, such as rail and bus services, provides access to food stores, but easy access to wholesome foods may present a challenge to the elderly population (Burns & Inglis, 2007). Older individuals may experience jeopardized access to food, i.e., greater difficulty in getting to the grocery store and also in getting around the store itself. In the Public Health Management Corporation's Household Health Survey for Philadelphia (2010), the elderly reported their need for a meal program, which indicates that they were encountering problems with shopping for their groceries and preparing their meals. To address the difficulties that accompany aging, the Hartford Food System in Connecticut runs programs linked to the local full-service supermarkets. The program provides free delivery for the aged population, and offer shopping services at a reasonable price for elderly individuals who do not own a car, so that they can have access to a variety of fresh food (Hartford Food System Report, 2009). Physical or either financial limitations are often the reasons why the aged population gives up access to food, and alternatives to public transportation are not readily available to the aged population in many communities. Yamashita and Kunkel (2011) created a conceptual model of the link between age, food access, and health outcomes (Figure 2-1). There are two factors that we must consider with regard to how people make the decision to buy food; namely, geographic and economic access. For better health outcomes among the elderly, the interaction of wise food choices for a nutritious diet, and geographic and economic access to good food is crucial. Whelan et al. (2002) demonstrate that food consumption patterns may change as people age. When purchasing food, the aged population tends to weigh convenience and ease of preparation more heavily than price. Over the long term, poorer food

choices may result in greater problems for the older population, because nutritional intake is particularly crucial to their health.

Transportation and Food Access

Public Transportation Infrastructure

Another obstacle to food access is the lack of public transportation infrastructure. The barriers to healthy foods do not simply relate to price or the socioeconomic status of customers, but also relate to transportation. Since, for the majority of Americans, healthy food is not usually available in places other than full-service grocery stores, if such a store is not easily accessible, those seeking good food must travel outside of their neighborhoods. Residents who do not own a personal vehicle and who live in a food desert are not particularly mobile, and have limited access to full-service grocery stores. Over the long term, lack of access to healthy food may promote illness as a result of poor dietary intake. The USDA National Food Stamp Program Survey (1996) reported that a little less than half of low-income U.S. households are able to use a car that they own (Morton et al., 2005). This means that many low-income families must rely on other family members, friends, neighbors, and public transportation for their food shopping trips.

Opportunities to purchase healthy food may be enhanced by transit-oriented development (TOD), which would involve increasing the number of transportation stops to enable easier access to fresh, wholesome food (Belzer & Autler, 2002). While TOD focuses on future growth of bus and metro transportation, zoning and land use could also be modified to encourage food retailing (Belzer & Autler, 2002). There is no direct research that investigates the relationships between TOD and food access, but in El Segundo, CA, a number of farmers' markets are located in areas that are accessible

from two bus lines. TOD could dramatically reduce the travel distances for families to stores offering good food, and provide greater choices and more frequent travel opportunities. Litman (2010) has argued along similar lines; in that study, TOD impacts people's health beyond physical activity rates, as communities benefit from better mental health, improved access to healthy food, and greater food affordability.

Vehicle Ownership

Private vehicles have become the primary form of transportation in American cities and towns. Most settlements have grown alongside rapidly increasing auto-dependence, and the automobile remains integral to the culture and everyday functioning of American society (Conveney and O'Dwyer, 2008). Common areas, such as shopping districts, whole cities, and even suburbs, are designed and developed with car ownership and mobility in mind (Burns and Inglis, 2007). Major cities in the U.S. discourage the development of a public transportation infrastructure that alternates automobile reliance with other forms of transport, such as walking, biking, or public transit. Vehicle availability is a deciding factor in whether or not residents of these communities can travel for grocery-shopping purposes (Morland, et al., 2002b). Owning a personal vehicle, perhaps obviously, is linked to residents' economic status. Low-income households are 6 to 7 times less likely than other U.S. households to own cars (Murakami and Young, 1997). Nevertheless, most low-income households attempt to use cars for food shopping, even though more than half cannot rely on a car that they own.

While cities offer alternative public transportation opportunities, rural residents mostly do own cars. Those families that do not or cannot afford a dependable automobile have even greater problems with food access than their counterparts in

urban areas. About half of rural counties in the U.S., including the most isolated areas, have no public transit system at all (Stommes and Brown, 2002). Because of limited public transportation opportunities, rural areas are more exposed to food insecurity than even those cities that have food deserts. Nord (2002) found that in agricultural areas, 13.5% of rural inhabitants faced food insecurity, compared to the nationwide figure of 10.5%. However, Sharkey (2010) catalogs the different types of food stores to which people have access in rural areas, and the related distances: 9.9 miles to a full-service supermarket, 6.7 miles to fresh fruits, and 7.4 miles to fresh vegetables in one case study in Texas. In addition, this research proves that although these neighborhoods may have low vehicle ownership, they could have better spatial access to a good variety of fresh fruits and vegetables and may have greater shopping opportunities than those in the cities.

In summary, vehicle ownership could influence the level and composition of one's food environment. First, vehicles permit improved access to large-scale retailers, which often offer lower prices. This should boost food expenditure and the quality of a constant basket of food. Residents can also purchase larger quantities of food per shopping trip, reducing the time costs associated with acquiring food and increasing their opportunities for both labor and leisure. Since food deserts are related to food safety and poor dietary intake, vehicle ownership can promote reduced expansion of food deserts.

Types of Food Stores

An ERS report (2009) defined "food deserts" as locations in which resident households were unable to have or unable to acquire enough food to meet the needs of all their members, because they have insufficient sources of food. People who live in

food deserts often have no options, so they rely on smaller stores where the quality and variety of fresh foods are more limited (Wrigley, 2002). Many previous studies have measured the nearest distance to grocery stores selling either healthy, unhealthy, or both types of foods. The definition of a food store is broad, and Sharkey (2010) separates the types of food stores as shown below, in Figure 2-2. Full-service supermarkets are considered “healthy” food stores, as they generally offer a variety of nutritious, wholesome foods in addition to processed fare. Compared to other food stores, these supermarkets tend to offer a variety of high-quality products at reasonable prices (Chung and Myers, 1999). The California Center for Public Health Advocacy (CCPHA, 2007) includes supermarkets, supercenters, and produce vendors as healthy food stores based on the assumption that these locations have a wide variety of higher-quality healthy foods. In contrast, convenience stores are generally considered unhealthy food stores, since they offer mostly prepared, high-calorie food and little fresh food (Zenk, 2006). The ERS (2009) includes fast food restaurants and convenience stores in its category of unhealthy food stores, since these establishments sell more high-calorie foods and less fresh produce, and the fresh produce they do sell tends to be offered at higher prices than in full-service supermarkets. Assessing the food resources in a community is significant in determining whether that area is a food desert or not. Morland (2006) shows that the abundant presence of supermarkets is related to a lower obesity rate, while the presence of convenience stores is associated with a higher rate of obesity.

Food Purchasing Behavior and its Associations with Health

There are many cultures in the U.S., and the country’s population can be categorized into several socioeconomic groups. Indeed, food consumers have

purchasing habits that are unique to their individual groups. Yoo et al. (2006) found that major food-purchasing patterns were a weekly big trip with a few small trips (34.9%), bi-weekly big trips with a few small trips (21.9%), no big shopping trips (15.4%), a weekly big trip without small trips (13.9%), a monthly big trip (8.3%), and biweekly big trips without small trips (6.4%), while 67% of the U.S. population went to restaurants for fruits and vegetables. By socioeconomic status, African-American families shopped for food the least frequently, while Asian-American families shopped for food the most frequently. Educational level was negatively associated with the use of convenience stores, and was positively associated with obtaining take-away food from restaurants (Yoo et al., 2006). From the perspective of the built environment, the distance to the supermarket impacts residents' decisions as to where and when to buy food.

Most healthy foods are produced in suburban areas, and are sold in full-service supermarkets, so when an individual does not have access to healthy food choices, the only option available is the consumption of unhealthy foods that are high in fat and calories. Several studies have shown that individuals living in food deserts have a significantly lower consumption of fruits and vegetables than other residents of the same community, which suggests that food deserts result in compromised diets (Smith and Morton, 2009). Residents of these neighborhoods are faced with the burden of traveling outside of their neighborhoods to purchase healthy foods, or staying in their neighborhood and consuming unhealthy foods. Often, people tend to shop at convenience stores, where food is typically more expensive and less healthy, which is a problem from a planning perspective, as well a public health concern (Larsen, 2009, p. 1159).

The USDA Food Desert Study (2009) observes that several studies link unhealthy behaviors to increased BMI and increased obesity rates. In recent years, there has been a noticeable increase in obesity rates among adults (CDC, 2007). No precise pattern has been observed for obesity and socioeconomic status, but many Americans who are classified as obese are racial minorities and low-income individuals. The CDC (2004) has also found evidence linking this epidemic to the increased consumption of food away from home; to the increased consumption of salty snacks, soft drinks, and pizza; and to increased portion sizes. The lack of nutritious food intake contributes to obesity, but the disease can be more readily linked to unequal access to healthy food sources. Morland (2006) found that the highest rates of adult obesity (32%– 40%) were observed in census tracts with no supermarkets, with access only to grocery stores or grocery and convenience stores (32%–40%). Research on adolescents indicates that greater access to convenience stores may contribute to more unhealthy food choices, and to a greater risk of obesity (Powell, 2007). Other factors that contribute to obesity, combined with physical disparities in access to food sources, are race, income level, and cultural characteristics that are associated with preferred food-purchasing habits and patterns. A study conducted in Los Angeles found that lower-income ZIP codes with a predominantly Black population had fewer healthy food options than higher-income ZIP codes with a smaller Black population (Lewis et al., 2005). Additionally, The Office of Minority Health (2009) reported that Black Americans were 1.4 times more likely, and Hispanics were 1.1 times more likely, to be obese compared to non-Hispanic whites. These studies indicate that better supermarket access is related to a reduced risk of developing obesity.

Summary

Many factors contribute to our ability to identify and define food deserts. One of those factors is the socioeconomic disparities of those communities situated within a broader food environment. Research has suggested that low-income individuals (Chung& Meyers, 1999; Zenk et al., 2006; Morland et al., 2002a), minority groups (Morland et al., 2002a; Zenk et al., 2005), and the aged population (Whelan et al., 2002; Yamashita and Kunkel, 2011) have limited access to supermarkets, chain stores, and healthful foods. A limited built environment, especially related to the public transportation infrastructure, potentially also decreases a community's chances of obtaining healthy foods, while a vehicle-oriented culture (characterized by a high private vehicle ownership rate) reduces food-access opportunities for groups experiencing socioeconomic disparity. Most previous studies in this area have divided food sources into two groups: healthy food stores and unhealthy food stores, and have scrutinized food purchase habits related to socioeconomic status, and their influence on health issues. The proposed socioeconomic, built-environment and food-environment variables will help researchers and practical planners to understand the various definitions of food deserts from their own perspective. By performing a review of the literature, however, this study aims to address two limitations of previous studies. First, most studies have applied both healthy and unhealthy food stores such as convenience stores, suggesting a partial understanding of the built environment. Secondly, recent studies have measured residents' proximity to food outlets based on socioeconomic factors alone, and have not utilized a transportation network base.

The research presented in this thesis aims to bridge two gaps in the previous food desert research in the category of healthy food outlets, and to evaluating a community's

proximity to its closest food outlets using two transportation methods: walking and driving in the sample area of Sarasota County, FL. The next chapter provides a detailed description of the methodology that will be used in these case studies

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Table 2-1. Examples of geographical accessibly measurement in previous studies

Author	Target food stores	Origin	Transportation method	Study area	Unit	Definition of access
Algert et al. (2006)	• Stores with variety of fresh produce • Stores with limited variety of fresh produce	Location of food pantry client residences	Walking	Pomona, CA	Road network distance	0.5 mile (0.8 Km)
Block et al. (2004)	• Fast food restaurant	Census Track		New Orleans, LA	Shopping area buffer	1/0.5 mile buffer (shopping area)
Burns and Inglis (2007)	• Major supermarket • Major fast food outlets	Census block group boundary	Bus Walking	City of Casey, Australia	Travel cost time based on road network	Assessed in Minute
Larsen & Gilliland, (2008)	• Local business supermarkets	Canadian Census tract	Bus Walking	City of London, Canada	Manhattan block distance	
Powell et al. (2007)	• Food outlet (supermarket, grocery, convenience store) • Food store (chain, non-chain)	28,052 ZIP Codes 2000 Census				Access by ethnicity, race, socioeconomic status and income
Sharkey et al. (2010)	• Food stores with fruits and vegetables	2000 Census Block group		6-county rural regions in Texas	• Distance to the nearest food store from the population-weighted center of each CBG • Coverage (number of shopping opportunities)	
Zenk et al. (2005)	• The nearest supermarket (national/regional chain)	2000 Census tract centroid	Not specified	Detroit, MI	Manhattan block distance	

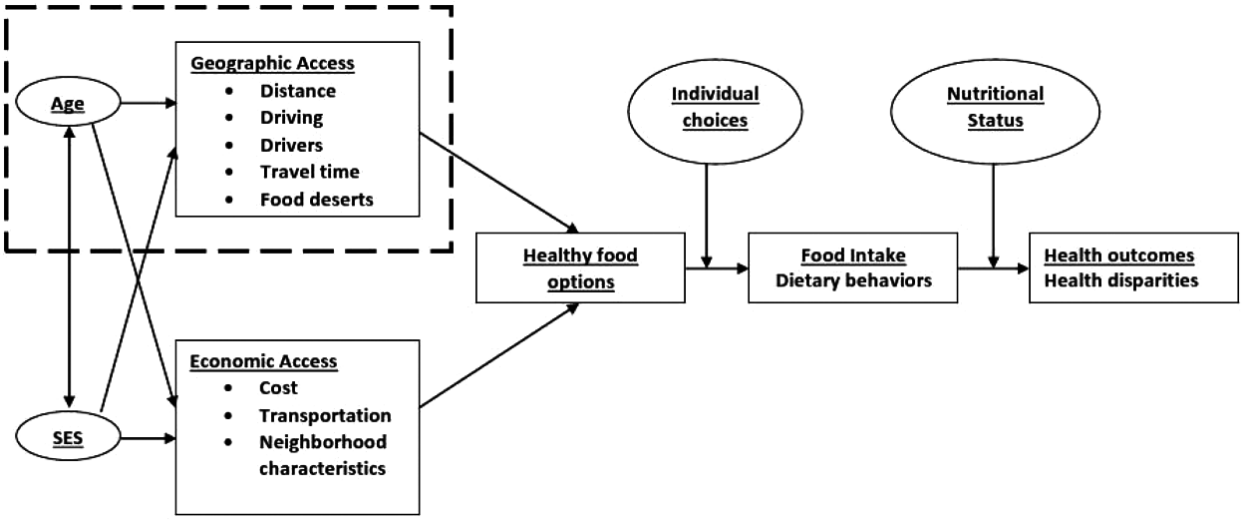


Figure 2-1. A conceptual model of the link between age, food access, and health outcomes.Source: Yamashita and Kunkel (2011)

Supercenters or superstores	Very large stores that primarily engage in retailing a general line of groceries in combination with general lines of new merchandise, such as apparel, furniture, and appliances (e.g., Super Wal-Mart, Super Kmart).
Supermarkets	Primarily engage in retailing a general line of food, supermarkets are larger in size (>20,000 sq ft), number of employees, and sales volume.[4] Chain store identification and number of parking spaces (>100) were used to distinguish supermarkets from grocery stores.[5]
Grocery stores	Primarily engage in retailing a general line of food, grocery stores are smaller in size, not identified as a chain store and have fewer than 100 parking spaces.
Convenience stores or food marts	Primarily engage in retailing a limited line of goods that generally includes milk, bread, soda, and snacks. The convenience store category also included convenience stores with gasoline and gasoline stations with convenience stores.
Dollar stores	Limited-price general merchandise “value” stores, such as Dollar General or Family Dollar.
Pharmacies and drugstores	Pharmacies and drug stores that were part of national chains (e.g., CVS, Walgreens).

Figure 2-2. Types and definition of food stores. Source: Sharkey et al. (2010)

[4] Moore LV, Diez Roux AV: Association of Neighborhood Characteristics With the Location and Type of Food Stores. Am J Public Health 2006, 96:325-31.

[5] Hale T: Dollar Store, No Frills: The New Retail Landscape. Consumer Insight 2004, Spring 2004:11-3, 42.

CHAPTER 3
METHODOLOGY FOR MAPPING AND ANALYZING POTENTIAL FOOD DESERTS

The goal of this chapter is to identify variables that can use to measure food access and can be adopted to define a food desert for the case study area. The methodologies are both quantitative and qualitative, and are intended to present a spatial overview of the area where lack of food resources. This chapter is divided into three sections. The first two sections offer an overview of Sarasota County, explain why an attempt to assess this food environment is needed, and then demonstrate what types of methodology other studies have applied to measure food access/food deserts in Sarasota County. The last section presents a food access index that has been created quantitatively, and which is an indicator of where to find food desert candidates.

Establishing Case Study Area

Sarasota County has a remarkable natural agricultural heritage, and its residents anticipate sustainable agricultural growth. Sustainable agriculture emphasizes nutritious and affordable food, while contributing to economic growth and healthy diets. However, somewhat in opposition to the promotion of healthy food choices, the number of grocery stores in which customers can buy fresh food appears to be on the decline in Sarasota County, which now has a low density of grocery stores (1.81/10,000 population) in comparison to state of Florida as a whole (2.04/10,000 population). These numbers are expected to decrease even further in the coming years, as 83 number of grocery stores closed their business from October 2010 to August 2011 while the total population increases from 325,957 to 388,262 (Sarasota County Economic Report, 2011). Therefore, determining accessibility to healthy food stores is reinforced as an indicator of the general affordability of food, which may in turn, influence a community's current

health status. It is important to understand the built and physical environment as they relate to this food-access crisis.

Food Access/ Desert Study of Sarasota County

Previous studies in this area have each proposed their own definition of food deserts and low access to food outlets, and have deemed Sarasota County one of the highest-ranked "healthy counties" for access to wholesome, nutritious foods in Florida. Government studies and the literature on public health have promoted supermarkets as the critical retail outlets for healthy food access, and have emphasized people's physical access to supermarkets as a key factor in a community's ability to access affordable, quality food. National research from the U.S. Department of Agriculture (USDA) and The Reinvestment Fund (TRF) recognize that poor access to food outlets is strongly correlated with socioeconomic problems, while the County Health Ranking 2011 and Sarasota County's research to "measure the distance to a gallon of milk" examined the proximity to grocery stores as a vital element in determining a group's access to food.

USDA Food Desert Locator: Food Desert in Sarasota County

The objective of the food desert locator is to obtain a spatial dispersion overview of low-income neighborhoods with high concentrations of people who live far away from grocery stores. The first attempt to locate food deserts was initiated by the Healthy Food Financing Initiative (HFFI), to assess the availability of nutritious food support (USDA, 2009). From the geographic perspective, 1km square grids were adopted as the base spatial unit of analysis, and grids outside of a specified distance from a food source were designated as "low food access" areas. Grids with high concentrations of low-income individuals that met the aforementioned criteria received particular attention as food deserts. To improve its methodological approach, HFFI created a partnership with

the USDA, and two socioeconomic indicators were applied to explain food deserts, low-income census tract, and residents with reduced access to supermarkets or large grocery stores, as below:

- Low-income community- A census tract must have either: 1) a poverty rate of 20 percent or higher, or 2) a median family income at or below 80 percent of the area's median family income
- Low-access community- In urban area, at least 33 percent (or 500 people) of residents population(in census track) inhabit more than a mile from supermarket or large grocery store

TRF Policy Map: Food Access in Sarasota County

As an initial step towards a thorough assessment of the food environment, TRF defined a Low Access Area (LAA) using a geographical and socio-economic approach to identify those areas where residents faced a longer distance to the grocery store than the average distance of a high-income area. Additional socioeconomic variables (e.g., concentration of neighborhood income, education level, and ridership of transit to work) were prepared to observe whether there could be a relationship between LAA and the aforementioned socioeconomic variables. Household population, residential land area population, and vehicle ownership data were derived from the U.S. Census (2000), and supermarket locations were obtained from Trade Dimensions (2009). This research settled a hypothesis that block groups with a higher-income level (median household income greater than 120% of their respective urban area) enjoyed reasonable distance to food sources.

County Health Ranking 2011: Access to Healthy Food in Sarasota County

The final rankings are a combination of each health outcome and health factor ranking, which are weighted under certain weights (Appendix A). The accessibility of healthy foods, which is 2.5% weighted under the physical environment element, is

measured because residents consider the distance to grocery stores over which grocery stores carry healthy foods. The lack of local access to healthy foods makes it difficult for families in low-income urban communities to maintain a well-balanced, nutritious diet. U.S. ZIP codes and healthy food outlets[6] are used to calculate the percentage of residential ZIP codes in a county without access to healthy food outlets.

Place to Buy a Gallon of Milk Analysis, Sarasota County

The goal of this study was to estimate the percentage of Sarasota County's 2010 population that had access to a gallon of milk within a quarter-mile drive. The analysis was performed using the census block to estimate the 2010 population, and quarter-mile drive distances to grocery stories were calculated based on the street networks, with a quarter mile deemed a "walkable" shopping distance. The criteria for grocery stories were consistent with the North American Industry Classification System (NAICS), and 228 stores were defined as food sources based on the criteria below:

- NAICS 4451 Grocery Stores (Includes Grocery Stores and Convenience Stores)
- NAICS 44611 Pharmacies and Drug Stores: Select WALGREENS and CVS PHARMACY
- NAICS 446191 Food (Health) Supplement Stores: Select RICHARD'S WHOLE FOODS, GRANARY, and GRANARY NATURAL FOODS
- NAICS 452 General Merchandise Stores: Select DOLLAR GENERAL, DOLLAR TREE, FAMILY DOLLAR STORE, KMART, SUPER TARGET, TARGET, WALMART, and WALMART SUPERCENTER

Summary of Previous Studies

When evaluating food deserts in Sarasota County, methodologies in each earlier studies have limitations of factors they used; USDA, TRF policy map, and County

[6] Healthy food outlets are identified by their North American Industry Classification System (NAICS) code. Those food outlets considered "healthy" include grocery stores (NAICS 445110) and produce stands or farmers' markets (NAICS 445230).

Health Ranking 2011 methodologies have linked low income households with residential density; whereas Sarasota County's analysis only provides physical distance where has an access to food. The first three studies shows that food deserts are inherited from areas with low income level households but did not prove any relations with physical distance, while the last study regards none of socioeconomic factors.

This thesis aims to address the gap in previous "food desert" researches using both socioeconomic and physical distance factors. It would start by narrowing down the definition of "'food resources" to "healthy food outlets" and evaluating physical distances with socioeconomic disparities that mentioned in literature review. The types of transportation modes residents use to get food in Sarasota County is an important factor as well. The following section provides a detailed description of methodology to create food access index.

Creating Food Access Index: Indicators for Analysis

The primary goal of this section is to create an index that can measure food access. This sections is separated into three parts: 1) define healthy food outlets for the purposes of this research; 2) create a food access index using proximity and coverage to healthy food outlets; and 3) apply the food access index to the transportation network then running t-test which would support whether there is a relationship between food access and vehicle ownership in each walking and driving network. Using data from the 2000 U.S. Census Summary File 3, this study categorized census block groups in terms of vehicle ownership composition. The proportion of the population with no vehicle ownership has been calculated from each block's population. Additionally, when food access index based on census block data has been developed, it is possible to predict food access index using the distance from residential zones to healthy food outlets from

parcel 2009 data to better understand the relationship between land use and access to healthy foods.

These analyses will help to assess potential food-desert candidates, which are deprived of access to healthy food outlets, in Sarasota County and determine which areas of Sarasota County have high, medium, and low access to food outlets.

Indicator 1: Healthy Food Outlet

In this paper, 'healthy food outlets' are defined as those places where healthy, fresh, and/or organic food is offered, that can enhance consumers' health status. While convenience stores, food marts, gas-station food stores, and drug stores contribute to the local food environment (Morland et al. 2002a). They are excluded from this study, because convenience stores are often viewed as providing an abundance of unhealthy food (Lucan et al., 2010). Farmers' markets and mobile stands are excluded as well, since those food sources are operated on a seasonal basis and during limited hours (Schafft, 2009).

In Sarasota County, 94 healthy food outlets met the criteria and were retrieved from the 2007 North America Industry Classification System (NAICS) codes. Table 3-1 denotes the NAICS codes used to define a food desert in this study.

Indicator 2-1: Proximity and Coverage to Healthy Food Outlet

After defined healthy food outlets, two criteria are assessed to measure distance to "healthy food outlets", which is basically a food access: 1) Proximity (distance) to healthy food outlets from Census block centroid points, constituting the balance point of the polygon (Census Block, 2010); and 2) Coverage (number) of healthy food outlets within a census block boundary and store size (square footage). The size of healthy food outlets are assessed when determining food accessibility, because it can be

assumed that larger grocery stores provide various food choices. The calculation is based on a Manhattan block distance to the nearest healthy food outlet in each census block boundaries, as follows:

$$d_{ij} = (\sum|x_i - x_j| + |y_i - y_j|)^* \text{ Size / } n$$

Where d_{ij} is the distance between origin i and destination j, x and y are the latitude and longitude coordinate points, and n is the number of healthy food outlets in each of the 204 census blocks in Sarasota County. The Manhattan distance measure assumes that residents travel to the food outlet via an angular route rather than in a straight line (Gimpel and Schuknecht, 2003).

Indicator 2-2: Re-assessing Food Access Index with Proximity to Healthy Food Outlets

The food access index depends on the number, size, and distance from centroid census block point to healthy food outlet and it reveals proximity to, and variety of, food choices, but includes some of the limitations. For example, assume there are two food outlets, A and B. A is five miles away from the census block centroid point, which is included in the same block boundary, and B is two miles away, but it is included in the block next to the centroid point block that includes A. In this case, the food access index applied earlier would ignore B, while it is closer than A. To address this limitation, an additional food access index has been created that calculates the distance to the closet food outlet using spatial join tool in ArcMap 10 software (ESRI, Inc., Redlands, CA).

To determine those areas that suffer inequality of access to healthy food outlets, each low access block in is selected in two types of index; one with proximity and coverage (indicator 2-1); and the other only with proximity to the closest distance to

healthy food outlets (indicator 2-2), then overlaid into one demographic map to show more accurate food deserts

Indicator 3: Network according to Transportation (walking and driving) Modes

American cities are designed in an auto-dependent manner, and the automobile remains integral to the culture and everyday functioning of U.S. society (Clifton, 2004; Conveney and O'Dwyer, 2008). In other words, in terms of the food environment and people's independent access to food stores, those who have their own vehicle drive to the grocery store, while those who have the physical capacity to walk to nearby stores may have independent food access as well. The importance of transportation for food access among people with limited mobility is highlighted by the findings (Burns and Inglis, 2007). This section aims to provide answers relating to the current aspects of life, under the objective: Find food outlets within a half-mile walking distance and 10-miles driving distance using street path to identify how food access is distributed.

The accessibility of healthy food outlets has been defined from two transportation modes: that of the pedestrian, and that of the driver. The pedestrian's perspective is focused on walking alone, and, according to the ERS report of 2009, the average pedestrian's walking speed has been assessed as 2 miles/hr; thus high access would equal a half-mile walking distance (or 15-minute walk, approximately). For driving speed, 40 miles/hr has been calculated as the average speed from origin to destination; thus a high access distance from a driver's perspective would be 10 miles (40 mph * ¼ hr drive). Table 3-2 illustrates each transportation street network source used to assess these mobility measures.

Geographic or physical network is generally based on physical distance and travel method to food stores (Algert et al., 2006). In order to determine whether a personal

vehicle or walking are related to the areas with low access to food outlets, the food access index and the percentage of vehicle ownership must be examined then need to investigate the relationships between food access index and vehicle ownership under each transportation modes. The population number of 'no vehicle ownership' from 2000 U.S. census Summary File 3 is calculated from total population and this percentage has been grouped into two categories; census blocks with high and low percentage of vehicle ownership under equal distribution. To determine whether there is a relationship between vehicle ownership and food access index, T-test will be applied for both walking and driving network to healthy foods.

Distance from Residential Zone to Healthy Food Outlets

Another spatial overview can be represented by the distance between residential zones and healthy food outlets because residential zones indicate areas where actual housing with actual residents, who are ultimately customers of healthy food outlets, predominates. Using 2009 parcel data, categories under characteristics of residential lands was selected and Table 3-3 shows the number of parcels for each housing type. This is used to replicates the methods employed by indicator 2-2 which also sought to determine the shortest distance between healthy food outlets and residential lands.

Application of Methodology: Using GIS to Measure Food Access

The Geographic Information System (GIS) is "a computer based system for integrating and analyzing geographic data" (Cromley and McLafferty, 2002), which can be used to view, quantify, and analyze information within a geographic context, such as spatial patterns and additional statistical information (Vine, Degnan, and Hanchette, 1997). This research used ArcMap 10 software (ESRI, Inc., Redlands, CA) to calculate the Manhattan block distance from neighborhood centroid points (Census Block, 2000)

to healthy food outlets (NAICS 2007). This study conducted a block-by-block assessment of proximity to healthy food outlets for the entire county of Sarasota. In this sense, the GIS was also utilized to analyze the relationships between transportation network variables and the food access index in the following chapter.

To determine the transportation network around healthy food outlets, the network analysis extension tool in ArcMap 10 has been employed to create half-mile and ten-mile network service areas around healthy food outlets. Each network is derived from sidewalk and major road maps in Sarasota County respectively. This helps to determine the proximity, or minimum distance, either for walking or driving, to the nearest healthy food outlet(s). Figure 3-1 illustrates how these pedestrian (walking) and driver networks are created around the local healthy food outlets.

Table 3-1. 2007 NAICS codes selected for healthy food outlets and its example of food services

NAICS Code Index	NAICS Code Definition	Examples	SIC Code Index
NAICS 445110	Supermarkets and other groceries (except convenience store)	Whole Foods Market, Publix, Winn-Dixie, etc	SIC 5441105
NAICS 445210	Meat markets	Herman meats, Butcher's block, etc	SIC 5144
NAICS 445220	Fish and seafood markets	National fish& seafood Inc., etc	SIC 5146
NAICS 445230	Fruit and Vegetable Markets	Osprey produce, Pioneer farmers market, etc	SIC 5148

Sources: Provided from Sarasota County GIS Department

Table 3-2. Data inventory used to measure food outlet street network

Customer type	Method	Service area	Network sources
Pedestrian	Walking	0.5 mile(15min walk)	Sidewalk
Driver	Personal vehicle	10 mile (15 drive)	Major roads

Table 3-3. Types and number of parcel data defined in residential land uses

Residential lands from parcel data	Number of parcel
Condominium	1871
Hoes for aged	47
Mobile homes	11643
Multi-family	203
Multi-family less than 10 units	4122
Retirement homes	11
Single family	128546

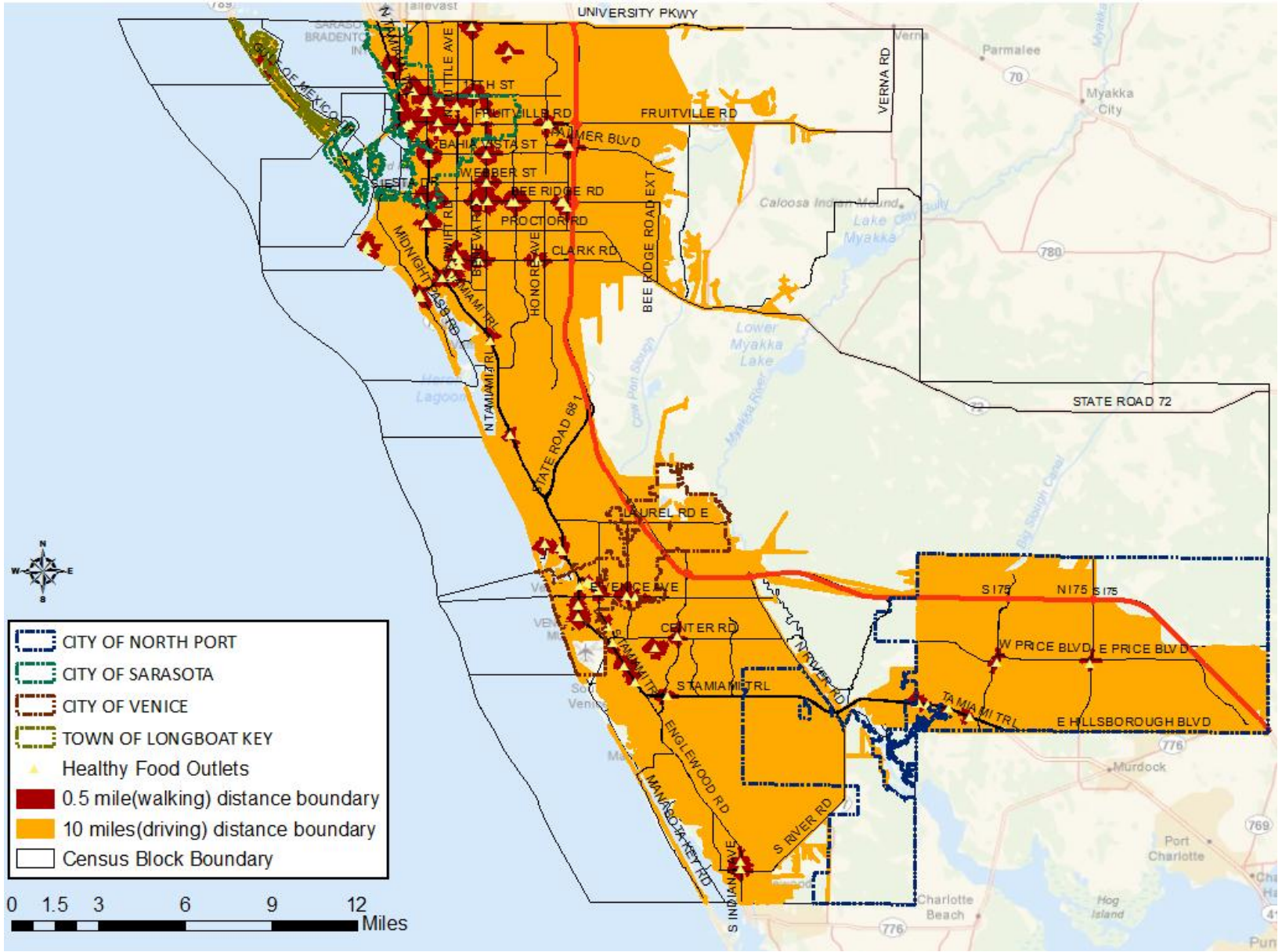


Figure 3-1. Walking and driving distances from healthy food outlets (transportation network)

CHAPTER 4
FINDINGS AND RESULTS

In order to evaluate any area that has no affordable access to food, the population, the proximity to healthy food outlets, and the walkable/drivable distance network must be examined. Based on the analysis conducted in Microsoft Excel using the GIS, taking a statistical approach, this chapter illustrates three levels of demographical distribution of food access (high, medium, and low) and evaluate the relationship between vehicle ownership (which is a neighborhood inequality) and access to healthy foods.

Result from Previous Studies

USDA Food Desert Locator: Food Desert in Sarasota County

Seven census tracks in Sarasota County qualified the food desert criteria where low income tract has less than 33 percentage of accessibility to grocery stores out of residents' population (Figure 4-1). Food deserts are dispersed over the County and out of seven tracts five are located along the coast. The total number of people living in the identified tract groups is 28,920 and the total number of population outside of the one-mile boundary is 17,598. High percentage of populations is above median income level; however there are 5,738 of residents that are low income who have little food access (20.0%). Two tract groups located North of City of Sarasota (#1,2) and one in City of North Port (#6) have low-income with low access levels over average percentage. Two of the food desert tract groups have a somewhat high percentage of households with no vehicles (over 5%); each tracts located north of the City of Sarasota (#2) and City of Inglewood (#3) have a percentage around 10% of no vehicle that lack of opportunity to grocery stores. Table 4-1 reveals the numeric analysis of these findings of Sarasota County.

TRF Policy Map: Food Access in Sarasota County

There are three food access indicators in this study; LAA overlays with density of income; and density of workers who commute to work via public transit. LAAs (blue-outlined polygon) are observed in North City of Sarasota, on North Siesta Key Island and near the city of Inglewood (Figure 4-2.A). Figure 4-2.B illustrates that the location of LAAs varies for high- (purple), medium- (blue), and low- (orange) income groups. The darkest orange polygon in north Sarasota City shows that the residents are mostly low-income, and inhabit areas commonly associated with poverty, while the residents of LAAs adjacent to the Gulf of Mexico are medium- and high- income individuals. Lastly, the result shown in Figure 4-2.C illustrate that residents in LAA block groups barely use public transit when they commute to work (0.04 to 1.45% over the track population).

Compared to the USDA Food Desert Locator, the TRF research concludes that there are fewer areas that have low accessibility to grocery stores. While no significant correlation was found demographically among LAAs, income level, and public transit usage, it appears nonetheless that there could be a relationship between low food access areas and socioeconomic indicators.

County Health Ranking 2011: Access to Healthy Food in Sarasota County

The County Health Ranking 2011 placed Sarasota County among the highest - ranked “healthy communities” across 67 counties in Florida, with a; health outcome rank placed in second ranking; and a health factor in forth ranking. Among Sarasota County residents, 83% have access to healthy food outlets (Table 4-3), whereas the state as a whole has 82% access to healthy foods.

Although this study proves that Sarasota County is one of healthiest counties in Florida, it is uncertain to tell that the county really has high healthy food proximity, since

this study used ZIP codes alone to define neighborhood characteristics, and does not specify the scope under track or either block group level. Because of these limitations, it is difficult to compare where low access to food is concentrated in the county, or which areas in the county possess the healthiest status from a broader perspective.

Place to Buy a Gallon of Milk Analysis, Sarasota County

The ESRI Business Analyst tool estimated that there were +/-390,472 people in 2010 in Sarasota County, while the number of residents in this quarter-mile grocery boundary was estimated as +/-9,999 (+/- 2.6% of total population). With the quarter-mile grocery stores identified, the spatial distribution of food access was represented, and three substantial cities (Sarasota, Venice, and North Port) were identified as those with the lowest potential to be food deserts in Sarasota County (Figure 4-3).

This analysis found that 2.6% of population has “walkable” access to milk, but that because of the broad food-source definition (including food supplement stores, gas stations, and convenience stores with limited availability of fresh foods), the investigation cannot draw conclusions about fundamental food accessibility, i.e., the distance to healthy foods. Some of the “food desert” literature includes in its analysis food sites such as farmers’ markets, community gardens, or farm stands, due to the fact that such food sources sell seasonal, fresh foods.

Food Access Index

The food access index has been created using the 94 healthy food outlets identified, and 204 census block groups in Sarasota County. Results show that there are 143 block groups identified as having “no food outlets;” in other words, if there is no single healthy food outlet within a certain block boundary, that block is defined as having “no food outlet.” Apart from the “no food outlet” blocks, others have been divided

into equally percentage of each categories pertaining to high, medium, or low access to food outlets. Results show that there are 40 blocks with high food access; 20 blocks with medium access; and 21 blocks with low physical access to food outlets. Figure 4-4 below represents the map of the food access index overlaid with the locations of healthy food outlets. Of the total population, 9.9% are dwelling in areas that have high access to food outlets (green polygon), while the population with medium (orange polygon) and low (red polygon) access to food outlets make up 11.6% and 13.2% of the total population respectively. As shown in the figure, the population with low access to food outlets occupies a patterned cluster in North City of Sarasota, including New Town, South City of Venice, and City of North Port. While the majority of the areas in the city of North Port were identified as having low food access, the other two cities, particularly the city of Sarasota, had all three types of access. The area between Fruitville Rd. and Bahia Vista St. corridors between N. Tuttle Ave. has low access to food outlets compared to the rest of the city, even though food outlets tend to cluster in this area. This may relate to the size of the food outlets, since this is weighted in the calculations of the index.

Figure 4-5 shows the map of the re-assessed food access index based on the distance to the nearest food outlets. As legend illustrates, every block is categorized in one of the three levels (high, medium, and low access), excluding the “no food outlets” zones because blocks are measured using the closest distance to food outlets.

Relationship between Food Access Index and Vehicle Ownership in each Transportation Network Boundary

After calculating the food access index for Sarasota County, the findings revealed the geographic distribution of access to healthy foods. Figures 4-6 and 4-7 show the

food access index cropped within two types of transportation network (half-mile and 10-miles). Compared to the food access index of the walking distance network, the driving network covers a larger area, because using one's personal vehicle limits one's access to food to a lesser extent than walking does. Based on the figure, pedestrians who reside in the center and the eastern part of the city of Sarasota, west of the city of Venice, and in the center of the city of North Port, have poor access to healthy foods. For residents who drive to obtain healthy food parcels along I-75, the city of North Port provides fewer chances to get healthy foods. However, since the majority of the areas are defined as "no food outlets" zones, customers' preferences may influence the accessibility of healthy foods. Demographic findings improvise healthy food accessibility in each network, but those do not prove whether vehicle access, or a lack thereof, is related to one's food access.

Statistical Approach to find Relationship between Vehicle Ownership and Food Access Index: 8,975 (2.8%) of total population in Sarasota County does not own vehicle, whereas 69,282 (21.3%) and 56,989 (17.5%) own single and two vehicles respectively. Table 4-4 shows the results of the t-test to determine whether a high percentage of vehicle ownership would be relevant to food access. Two groups of vehicle ownership were divided by average of no vehicle ownership (3.38%) that interpreted areas with high (NOVEHPER (Less than 3.38%)) and where has less (NOVEHPER (More than 3.38%)) vehicle ownership. Since the mean for the less-vehicle-ownership group is higher than the other, the null hypothesis means that census area blocks with less vehicle ownership have low food access in the walking network. The results of the t-test suggest that there is no significant difference between the two

groups, because the significance level (0.09) is more than 0.05 with a 95% confidence interval for the difference. Therefore, this proves that there is no relationship between vehicle ownership and food access in the walking network.

Similar to Table 4-4, Table 4-5 shows the results of the t-test to assess the relationship between food access and vehicle ownership in the driving network. Null hypothesis suggests that census block areas with lower vehicle ownership have low food access in the driving network. The results suggest that there is a significant difference between the two groups, because the significance level (0.03) is more than 0.05 (95% confidence interval of the difference). Therefore, this proves that the population with no vehicle ownership has lower food access in the driving network.

Food Deserts in Sarasota County

Figure 4-8 provides a geographical illustration of the finding where has low food access from each index. A total of 145,322.363 acres have been identified as food desert areas, and the total number of people living in identified block groups is 111,184, which is about 34.1% of the total population. These areas are obviously clustered east and south of the county, including the city of North Port and Venice. While there is a clear concentration of healthy food outlets around the city of Sarasota, fewer food deserts are designated because of the distance to, and coverage of, these food stores. While this chapter clarified where food deserts exists in Sarasota County, a majority of land in the east of the county include environmental protected lands (EPL) which do not incorporate with people's access. Across the state of Florida, about 27% of the land is protected environmental lands and Sarasota County has one of the most successful natural land protection programs. As shown in Figure 4-9, EPLs and public lands are located east of the county and west of the city of North Port, and it is forbidden to

develop these lands or reside on them. Figure 4-10 is a final food-desert candidate map, excluding EPLs and public lands that have proximity to healthy food outlets.

Food Deserts for Pedestrian and Drivers

A visual examination of the map data, and a statistical analysis, revealed disadvantaged areas where the people's access to healthy foods was poor. This study bases the classification of food-desert candidates on block groups that are placed in the transportation network category. Depending on the type of transportation that users employ to reach their destination, the definition of food desert changes. In recent years, "food desert" has been used to describe those areas that do not permit easy access, within walking distance, to healthy foods in cities, or easy access, within reasonable driving distance, to healthy foods in rural areas. This study's own definition of a "food desert" applies both to the walking (half-mile distance) and driving (10-mile distance) criteria within the low food access index (Ploeg et al., 2009). Two types of food deserts are derived from the general food desert map (Figure 4-8), and each half-mile/10-mile transportation network was excluded respectively, because each polygon illustrates a fairly accurate measurement using a street grid, to take into account how people actually travel by walking and driving. Additionally, protected environmental lands are excluded as well, because the area does not include a grid street connection to food outlets. As shown in Figure 4-11, the cities of Venice, North Port, and Inglewood, and north-central-south of the county fall within a range of food deserts when residents walk to do their grocery shopping. Figure 4-12 shows the distribution of food-desert candidates for drivers. Similar to the walking network food-desert candidate map, the overall distribution is concentrated in the north-central-south areas rather than other areas of the county. However, there are fewer food deserts in the city of North Port and

Venice, suggesting greater access to food outlets in the drivable network. It visually proves the statistical results that there are relationships between vehicle ownership and the food access index (see previous chapter) and represents the county's car-dependent lifestyle, because there are more opportunities to access food outlets when customers drive to those food outlets.

Food Deserts with Parcel Data

There are 216,910 parcels in the county and 110,277 of them parcels are within a food desert boundary (Figure 4-10). The shortest distance from residential zones and healthy food outlets measures 1.3m (0.0008mile) and the longest is 19683.41m (12 miles). Compared to the distance from census block centroid point to healthy food outlets (2,713.6m to 141784.2m which is same as 1.69 to 88 miles), it becomes clrear that using residential zone to healthy food outlets can more accurately represent distance than using this centroid point of census block polygon approach though the number of samples (parcel vs. census block) are different (Figure 4-13). Figure 4-14 shows the values of the aggregated level of food access index in each city in Sarasota County. The comparison in Figure 4-5 shows that by determining food access with residential parcel assessments the city of Sarasota has affordable access to wholesome foods. In the city of Venice, it turns out that east of the city has medium and low access to wholesome foods while west of the city has high access as shown earlier. The city of North Port shows major differences in that residents in the east have high access to wholesome foods whereas low access has been assessed in an earlier map. Table 4-6 shows the list of land uses in food deserts by numeric order of acres. It is evident that the majority of land is either vacant or used as grazing lands but about 13.7% is counted as single family land use.

Food Deserts Assessment with Socioeconomic Disparities

Sixty-five Census blocks are identified as food deserts out of 204 blocks according to the criteria described in finding chapter. The overall distribution of healthy food outlets is fairly random, but the City of North Port showed fewer healthy food outlets than other municipalities. Each household population that is below poverty level, has no vehicle ownership, and aged 65 and over is considered as socioeconomic disparities in Sarasota County based on the literature reviews. Following maps (Figure 4-15 through 4-17) shows the spatial pattern of food deserts in each transportation modes and overview of socioeconomic disparities distributions.

Figure 4-15 shows the distribution of below poverty population and overlay maps of food deserts. Over the 325,957 residents, approximately 7.7% (24,817) fall below poverty line in Sarasota County. Among this population, 6,156 or about 24% from total below poverty population, are living in food deserts and isolated from food affordability. A High concentration (6.24 - 9.6%) of below poverty level population was moderately resides in two city centers (Sarasota and Venice) and adjacent areas, whereas fewer below poverty population were observed in areas around Town of Longboat key and City of North Port. In City of Sarasota, for customers who drive to healthy food outlets, there was fewer concentration of below poverty population contrast to pedestrians. In City of Venice and North Port, 3.2 to 6.5% of the population poverty level lives in areas with food deserts. Compare to the City of Sarasota, these two cities represent that there is not much relationship between poverty level and food desert observation.

Figure 4-16 shows the distribution of no vehicle ownership and food deserts for each pedestrian (brown polygon) and drivers (purple polygon). As noted earlier chapter, there is a relationship that Census blocks with less vehicle ownership have lower

access to healthy foods when customers drive to go grocery shopping. Notably, a high density of no vehicle ownership was observed in food desert both for pedestrian and drivers in City of Sarasota and Venice. However, similar to the below poverty level, City of North Port's food deserts shows less density level of no vehicle ownership than other areas.

Last, as shown in Figure 4-17, a high density of older population is concentrated in adjacent areas of each municipality's core. Over the 102, 477 individuals over the age of 65, about 37.3% (38,177) are living in identified food deserts and visually they are concentrated in Town of Longboat and coast of City of Venice. In City of Sarasota, three high density centroid tract (about 61 to 90%) of aged population blocks are included in food deserts, whereas aged population are dispersed over the City. In the City of Venice, it was easily identified that older populations are highly agglomerated in food deserts and its adjacent areas. However, compared to other cities, there is less concentration of aged population in food deserts in the City of North Port.

Table 4-1. USDA Food Desert Locator result of Sarasota County

	TRACT_FIPS	TOTALPOP	PERCENT_ LOWA_Pop	LOWA_POP	PERCENT_ LOWI	LOWI	PERCENT_ HUNV	HUNV	PERCENT_KIDS	KIDS	PERCENT_ SENIORS	SENIORS
1	12115001000	3033	69	2094	22.8	691	4.2	54	10.6	320	11.2	338
2	12115000300	3926	49.2	1932	27.7	1089	9.7	141	14.7	577	7	275
3	12115002402	3399	22.2	753	6.3	215	9.5	178	1.4	46	13.4	457
4	12115002509	4728	66.2	3129	17.9	845	1.9	38	12.7	601	20.5	968
5	12115002603	1965	100	1965	19.2	378	3.9	37	15.9	313	33.4	656
6	12115002701	6855	57.2	3920	24.2	1657	3.1	89	14.1	966	13.5	923
7	12115002703	5014	75.9	3805	17.2	863	2.9	80	0.3	14	59.9	3003

Source: ERS Food desert report (2009)

Table 4-2. Explanation of Table 4-1

Variable Short Name	Variable Long Name
TRACT_FIPS	Federal Information Processing (FIPS) Tract Identifier
URBAN	Census Urbanized Area Tract
TOTALPOP	Number of people
PERCENT_LOWA_Pop	Percentage of people with low access to a supermarket or large grocery store (Lives more than 1 mile from supermarket- urbanized track)
LOWA_POP	Number of people with low access to a supermarket or large grocery store
PERCENT_LOWI	Percentage of total population that is low-income and has low access to a supermarket or large grocery store
LOWI	Number of low-income people with low access to a supermarket or large grocery store
PERCENT_HUNV	Percentage of housing units without a vehicle with low access to a supermarket or large grocery store
HUNV	Number of housing units without a vehicle with low access to a supermarket or large grocery store
PERCENT_KIDS	Percentage of children age 0-17 with low access to a supermarket or large grocery store
KIDS	Number of children age 0-17 with low access to a supermarket or large grocery store
PERCENT_SENIORS	Percentage of people age 65+ with low access to a supermarket or large grocery store
SENIORS	Number of people age 65+ with low access to a supermarket or large grocery store

Source: ERS Food desert report (2009)

Table 4-3. Summary of Sarasota County access to healthy foods from County Health Rankings

County	Zip codes with healthy food	Number of Zip codes	Healthy foods percentage	Z-score*
Sarasota	19	23	83%	-0.33

*Z-score= (Measure - Average of FL counties)/ (Standard Deviation)
Source: County Health Rankings, Sarasota County

Table 4-4. Result of t-test between two variables: vehicle ownership and food access index in ½ miles walking network

t-Test: Two-Sample Assuming Equal Variances		
	NOVEHPER (Less than 3.38%)	*NOVEHPER (more than 3.38%)*
Mean	62804844.19	89682935.43
Variance	7.91791E+15	8.81999E+15
Observations	100	48
Pooled Variance	8.20831E+15	
Hypothesized Mean Difference	0	
Df	146	
t Stat	-1.689512411	
P(T<=t) one-tail	0.046627796	
t Critical one-tail	1.655357345	
P(T<=t) two-tail	0.093255591	
t Critical two-tail	1.976345623	

Table 4-5. Result of t-test between two variables: vehicle ownership and food access index in 10 miles driving network

t-Test: Two-Sample Assuming Equal Variances		
	NOVEHPER (Less than 3.38%)	*NOVEHPER (more than 3.38%)*
Mean	43919471.46	70570178.7
Variance	6.35551E+15	8.28027E+15
Observations	143	61
Pooled Variance	6.92722E+15	
Hypothesized Mean Difference	0	
Df	202	
t Stat	-2.09385746	
P(T<=t) one-tail	0.018760175	
t Critical one-tail	1.652431964	
P(T<=t) two-tail	0.037520349	
t Critical two-tail	1.971777338	

Table 4-6. Land uses from parcel data included in food desert

DESCRIPT	Count	Acres
GRAZING LAND SOIL CLASS 3	354	51739.449
FOREST, PARK, AND RECREATIONAL AREAS	187	23541.342
SINGLE FAMILY	55119	19804.464
VACANT RESIDENTIAL	45766	15596.051
SEWAGE DISPOSAL, BORROW PITS, AND WETLANDS	974	4837.683
GOLF COURSES	31	4458.451
ACREAGE NOT ZONED FOR AGRICULTURAL	76	2207.137
VACANT COMMERCIAL	337	1654.116
MULTI-FAMILY LESS THAN 10 UNITS	1072	1075.384
PARKING LOTS, MOBILE HOME SALES	65	1063.899
PUBLIC SCHOOLS	18	999.067
VACANT INSTITUTIONAL	41	931.763
UTILITIES	112	797.883
CHURCHES	121	612.458
ORCHARD, GROVES, CITRUS	10	513.132
AIRPORTS, MARINAS, BUS TERMINALS, AND PIERS	8	473.896
WAREHOUSES, AND DISTRIBUTION CENTERS	299	427.151
MORTUARIES, CEMETERIES	9	406.147
MINERAL PROCESSING	19	385.921
COMMUNITY SHOPPING CENTERS	70	337.652
VACANT INDUSTRIAL	115	324.052
MULTI-FAMILY	56	280.033
PARCELS WITH NO VALUES	1884	276.618
CLUBS, LODGES, AND UNION HALLS	30	266.094
ORNAMENTALS, MISC. AGRICULTURE	22	222.211
RETIREMENT HOMES	7	221.252
MOBILE HOMES	2099	218.711
LIGHT MANUFACTURING	90	207.391
STORES ONE-STORY	280	206.953
CROPLAND SOIL CLASS 2	1	169.264
AUTOMOTIVE REPAIR, SERVICE, AND SALES	144	165.714
RIGHTS-OF-WAY STREETS, ROADS, AND CANALS	68	165.468
DEPARTMENT STORES	11	147.991
OTHER COUNTIES	19	112.517
ORPHANAGES	19	108.98
RIVERS, LAKES, AND SUBMERGED LANDS	31	104.438
PROFESSIONAL SERVICE BUILDINGS	96	101.937
COLLEGES	2	101.585
OTHER MUNICIPAL	16	97.898
REGIONAL SHOPPING MALLS	5	93.959
TIMBERLAND	4	89.972

Table 4-6. Continued.

DESCRIPT	Count	Acres
HOMES FOR AGED	20	89.67
ONE-STORY NON-PROFESSIONAL OFFICES	159	88.886
INDUSTRIAL STORAGE (FUEL, EQUIP, AND MATERIAL)	67	82.028
CONDOMINIA	715	79.489
MULTI-STORY NON-PROFESSIONAL OFFICES	98	79.053
PRIVATE SCHOOLS	18	76.992
FINANCIAL INSTITUTIONS	64	73.564
PUBLIC HOSPITALS	1	63.692
SANITARIUMS, CONVALESCENT, AND BEST HOMES	7	60.74
LUMBER YARDS, SAWMILLS, PLANNING MILLS,	4	50.564
RESTAURANTS, CAFETERIAS	61	48.612
OTHER STATE	6	39.85
HOTELS, MOTELS	22	38.834
DRIVE-IN RESTAURANTS	34	29.107
PRIVATE HOSPITALS	1	28.188
FLORIST, GREENHOUSES	4	22.732
GOV. OWNED LEASED BY NON-GOV. LESSEE	14	21.654
RACE HORSE, AUTO, AND DOG TRACKS	4	19.57
BOWLING ALLEYS, SKATING RINGS, ENCLOSED ARENAS	3	16.424
OTHER FEDERAL	6	10.783
CAMPS	1	9.586
NIGHT CLUBS, BARS, AND COCKTAIL LOUNGES	11	9.527
REPAIR SERVICE SHOPS	20	9.393
CULTURAL ORGANIZATIONS	7	8.042
TOURIST ATTRACTIONS	2	5.396
SERVICE STATIONS	10	5.286
HEAVY MANUFACTURING	2	5.087
SUPERMARKET	2	4.822
ENCLOSED THEATERS, AUDITORIUMS	4	2.725
FRUIT, VEGETABLES, AND MEAT PACKING	1	2.278
Total		145322.363

Source: Sarasota County Parcel 2009

Figure 4-1. Food desert locations in Sarasota County. Source: USDA Food Desert Locator

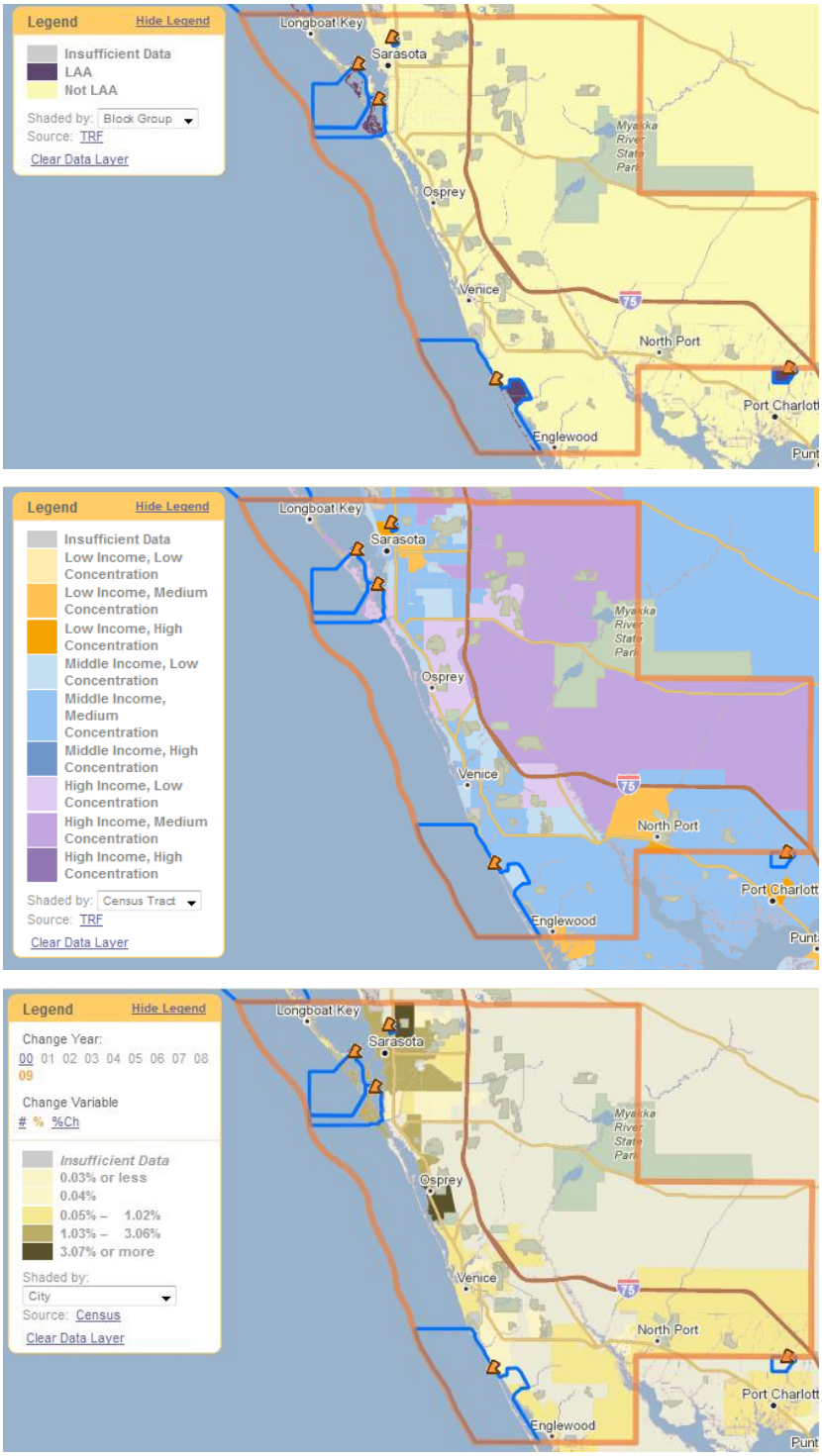


Figure 4-2.TRF policy map of Sarasota County. A) Low Access Area(LAA) Status, as of 2010 B) TRF's 2007 Neighborhood Income Distribution Analysis C) Estimated percent of workers who commuted to work using public transit in 2005-2009.Source: TRF policy map

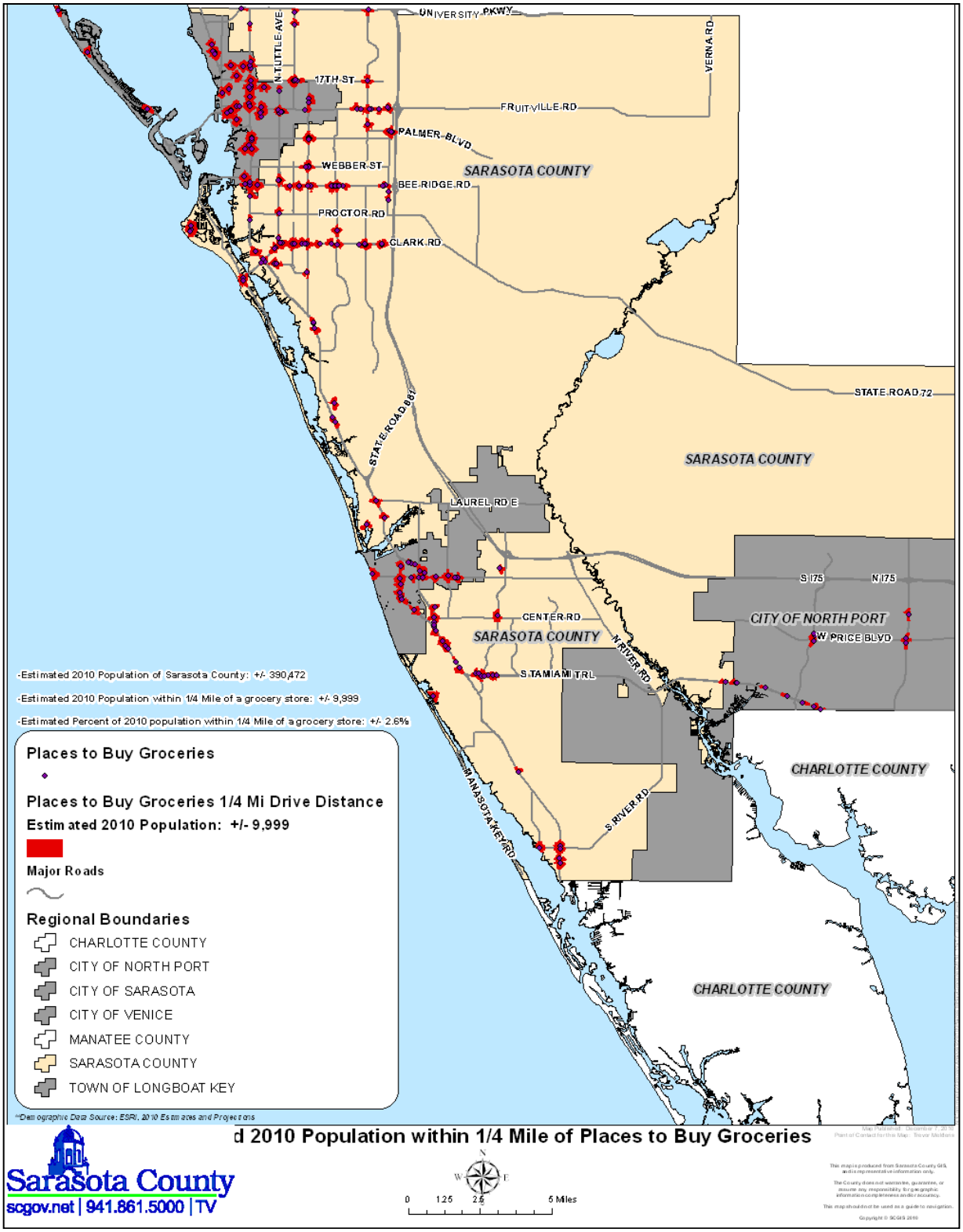


Figure 4-3. Place to buy gallon of milk analysis, Sarasota County. Source: Source: Sarasota County GIS Department

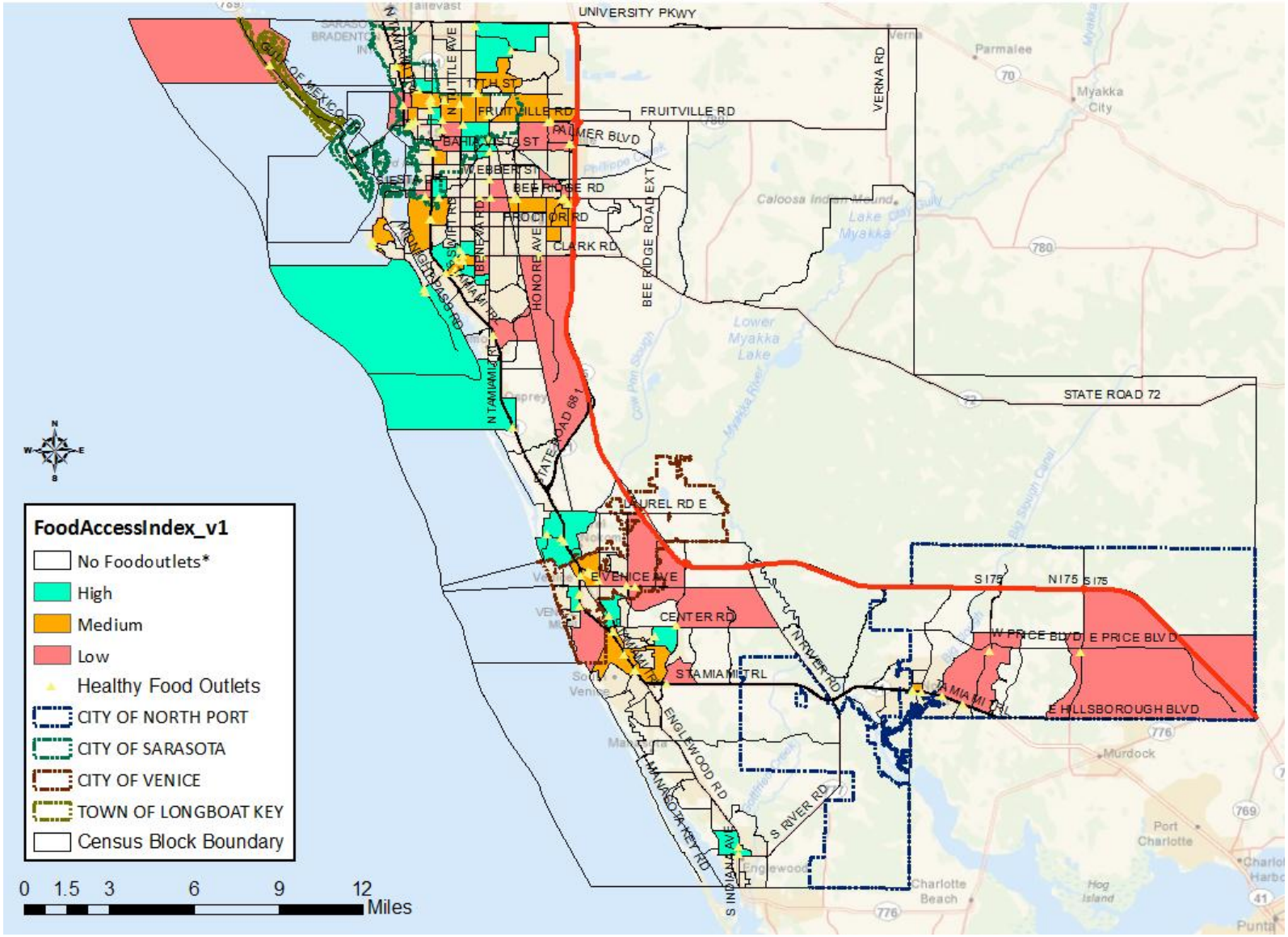


Figure 4-4. Food access index from Census block centroid point to healthy food outlets in Sarasota County using Manhattan distance (without 'No food outlet')

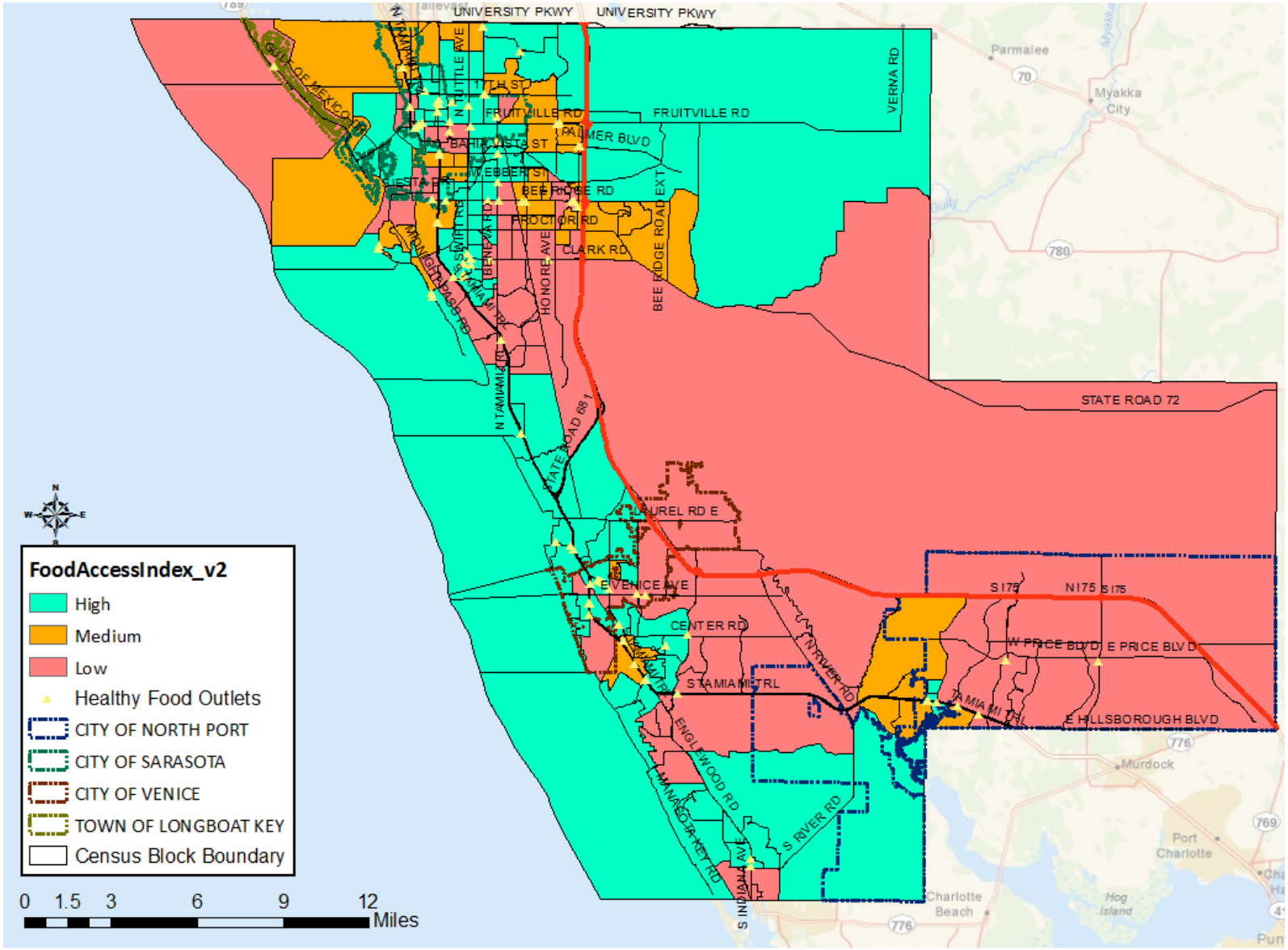


Figure 4-5. Food access index from Census block centroid point to healthy food outlets in Sarasota County using Manhattan distance (without 'No food outlet')

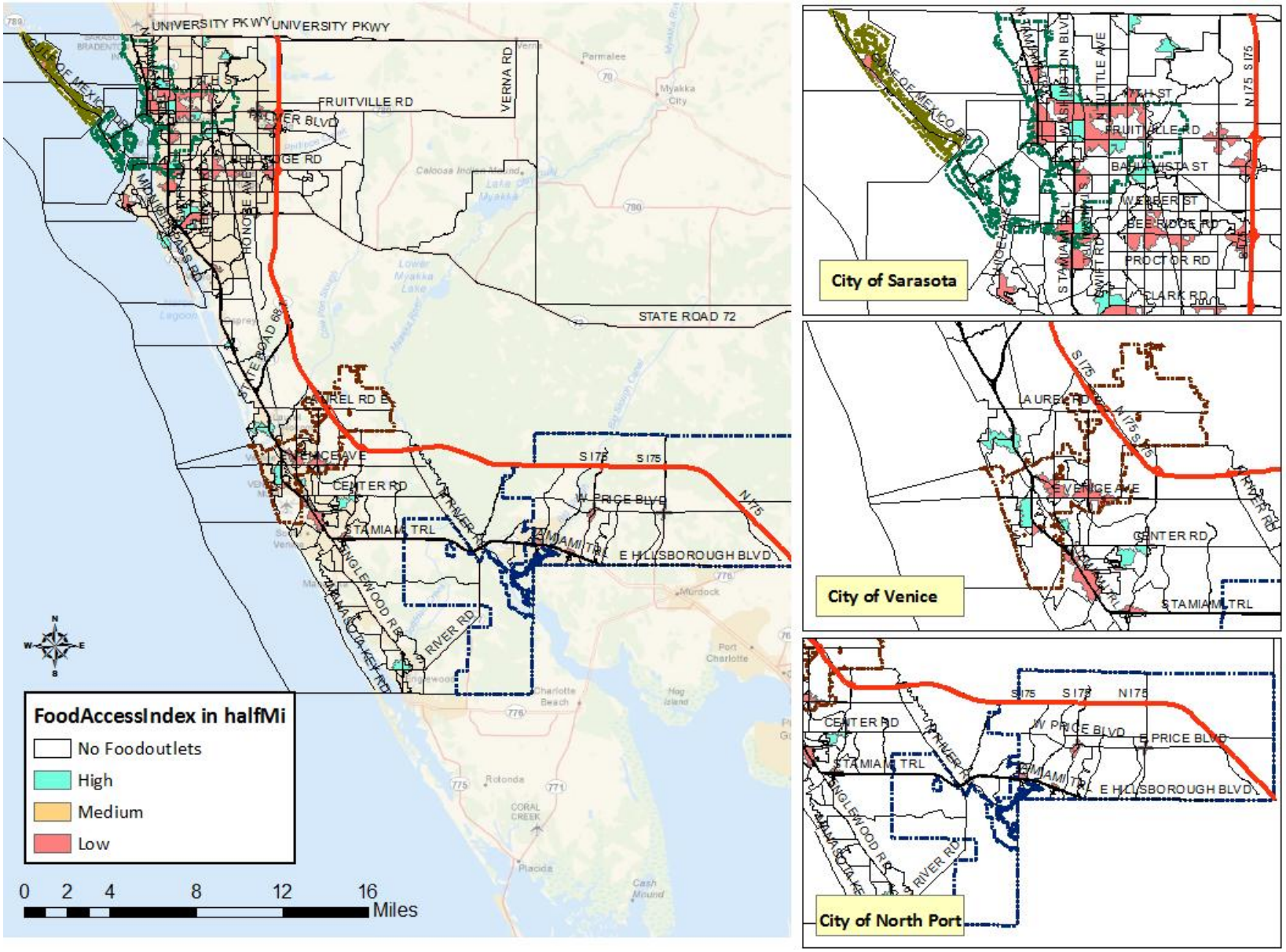


Figure 4-6. Food access index of Sarasota County in walking network (1/2 mile)

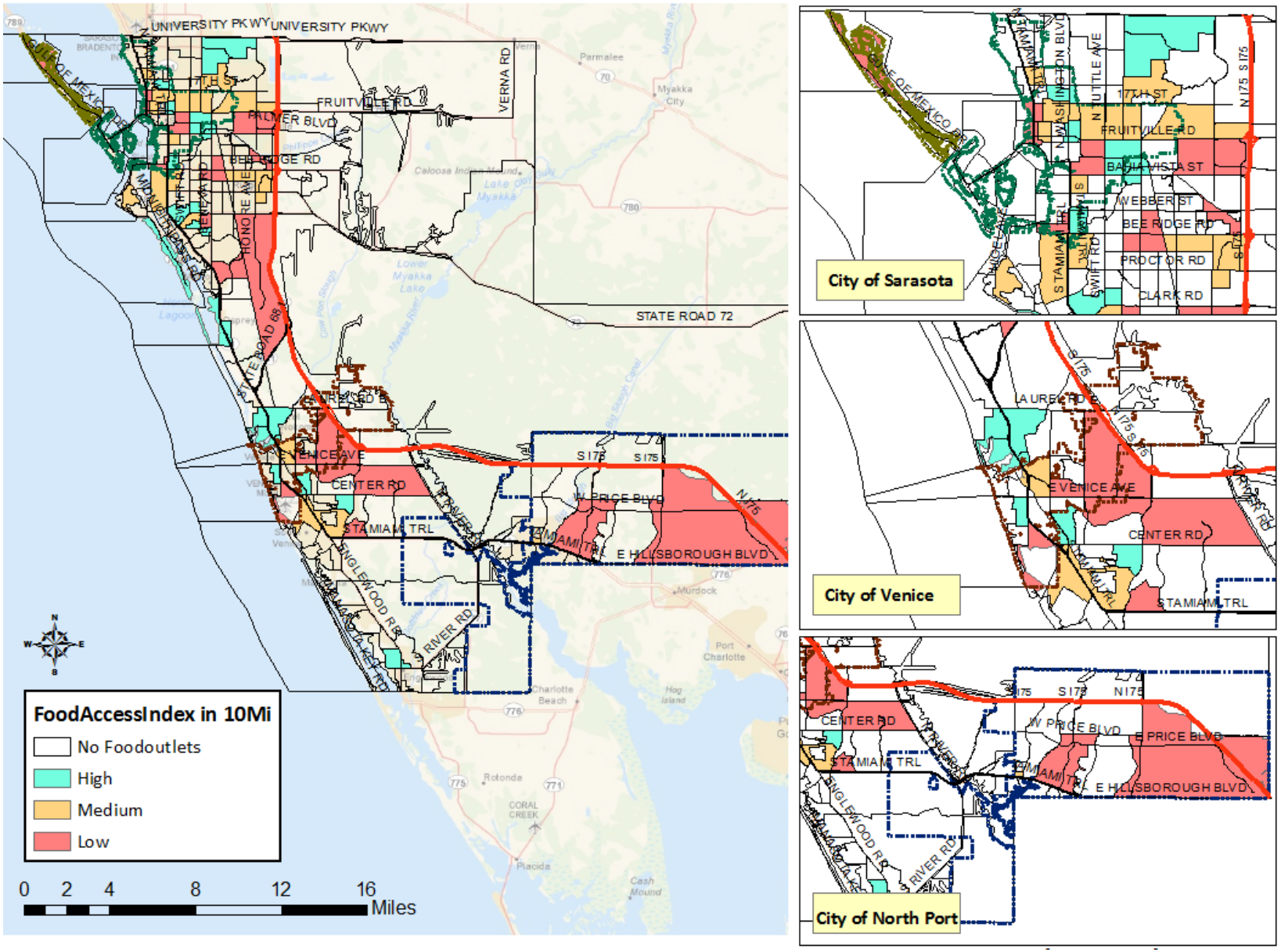


Figure 4-7. Food access index of Sarasota County in driving network (10 miles)

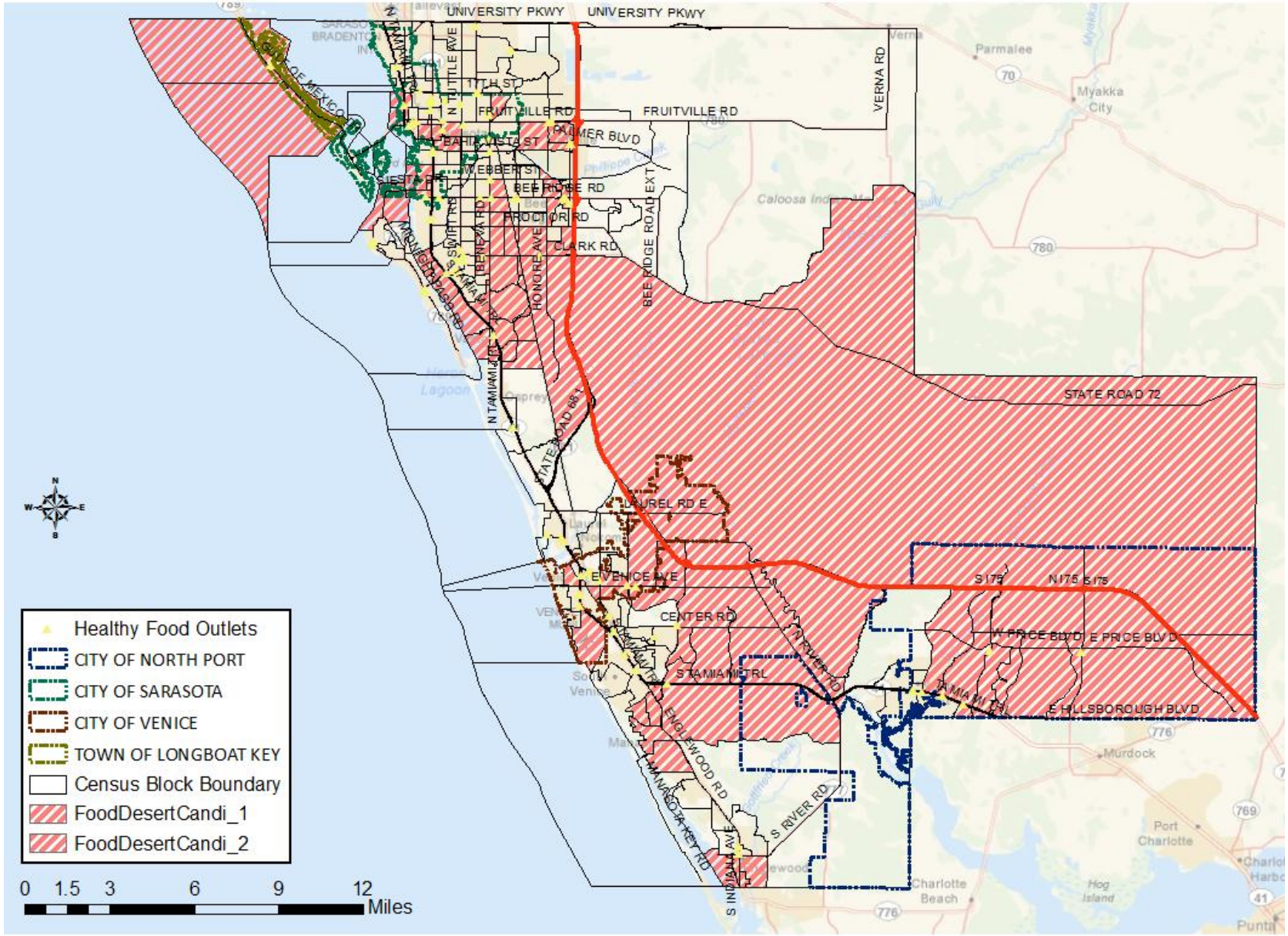


Figure 4-8. Food deserts based on proximity to healthy food outlets and proximity and coverage to healthy food outlets

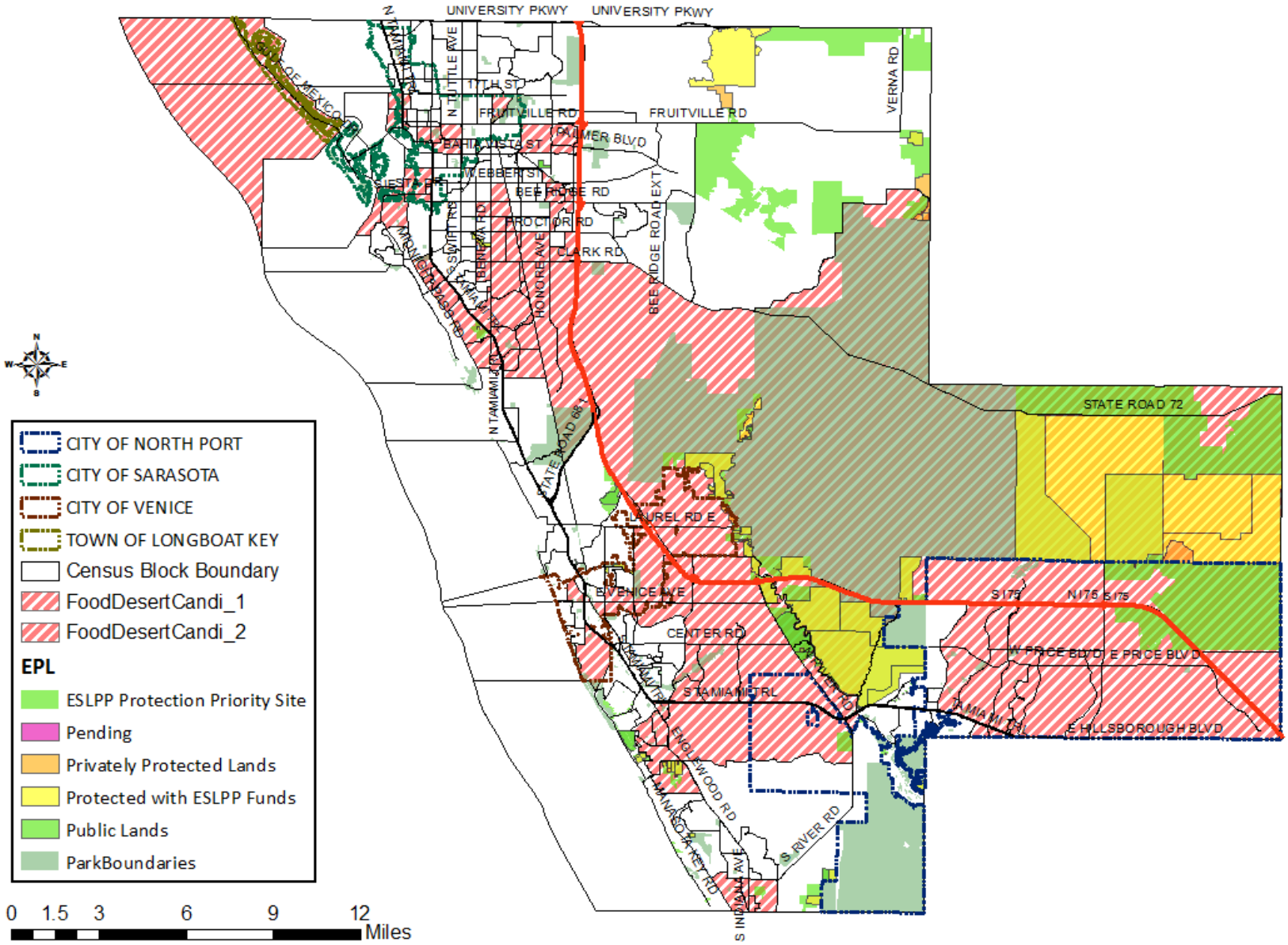


Figure 4-9. Food deserts and EPLs

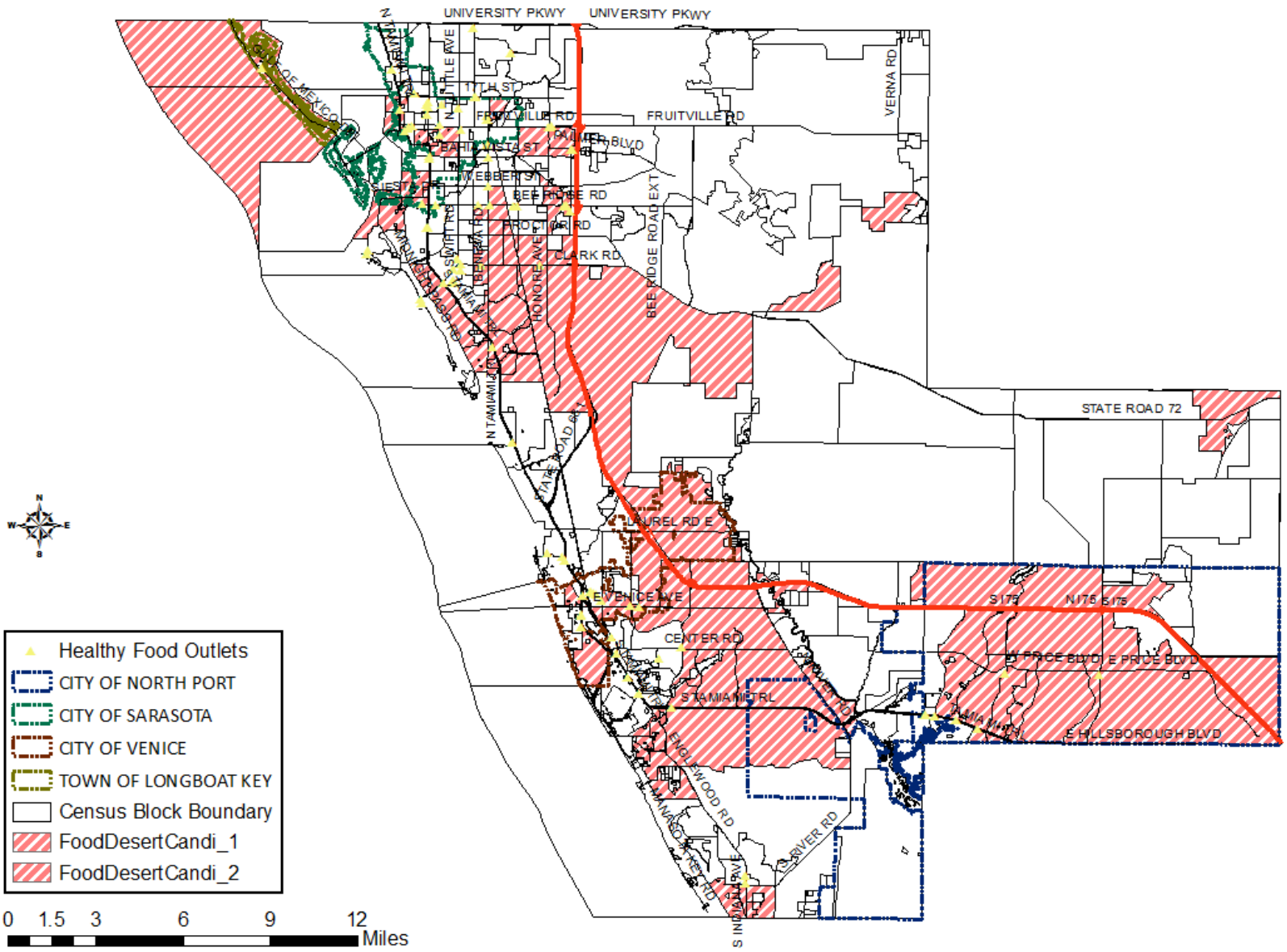


Figure 4-10. Food deserts, Sarasota County, FL (excluding EPLs)

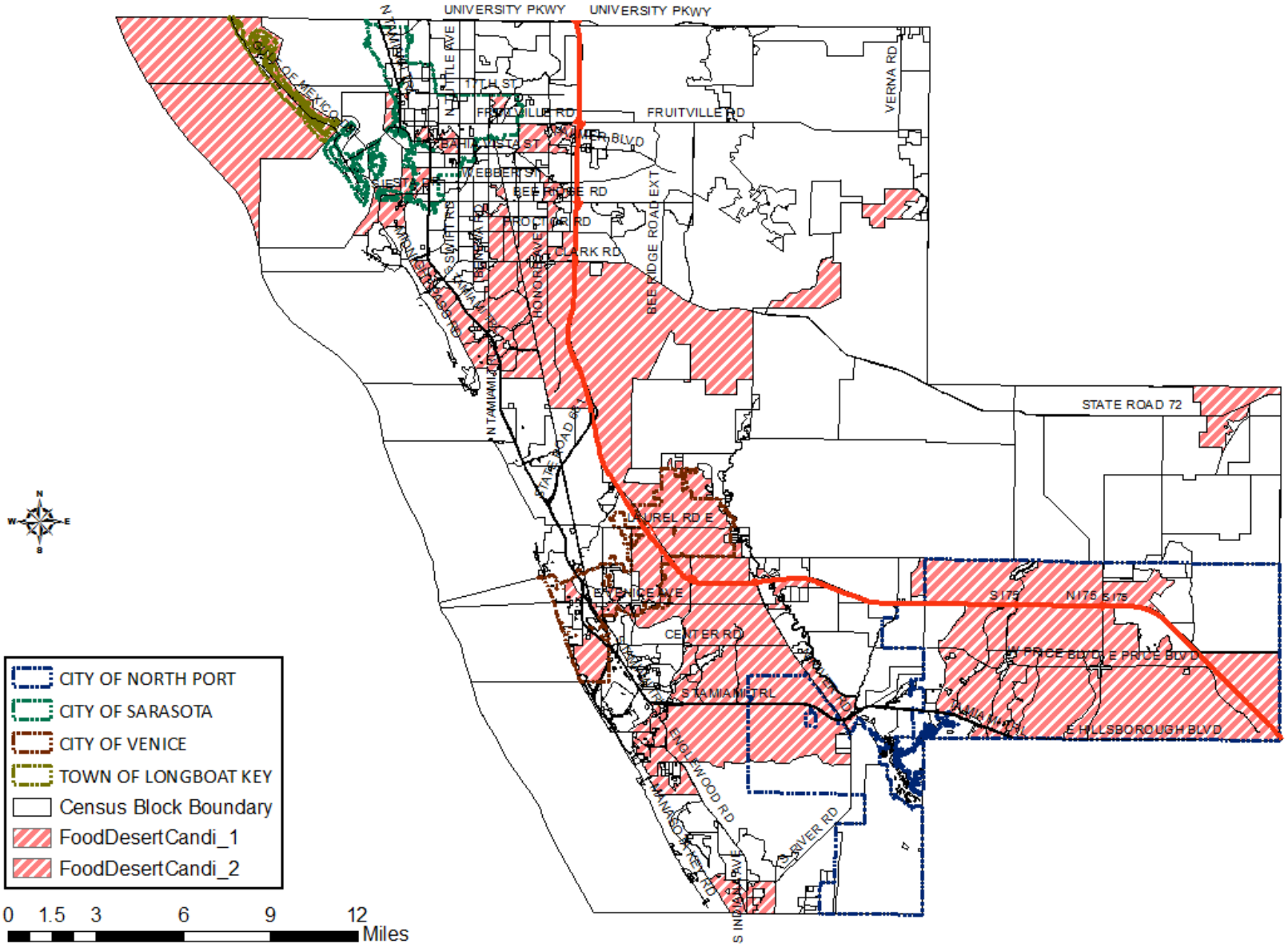


Figure 4-11.Food deserts for pedestrian

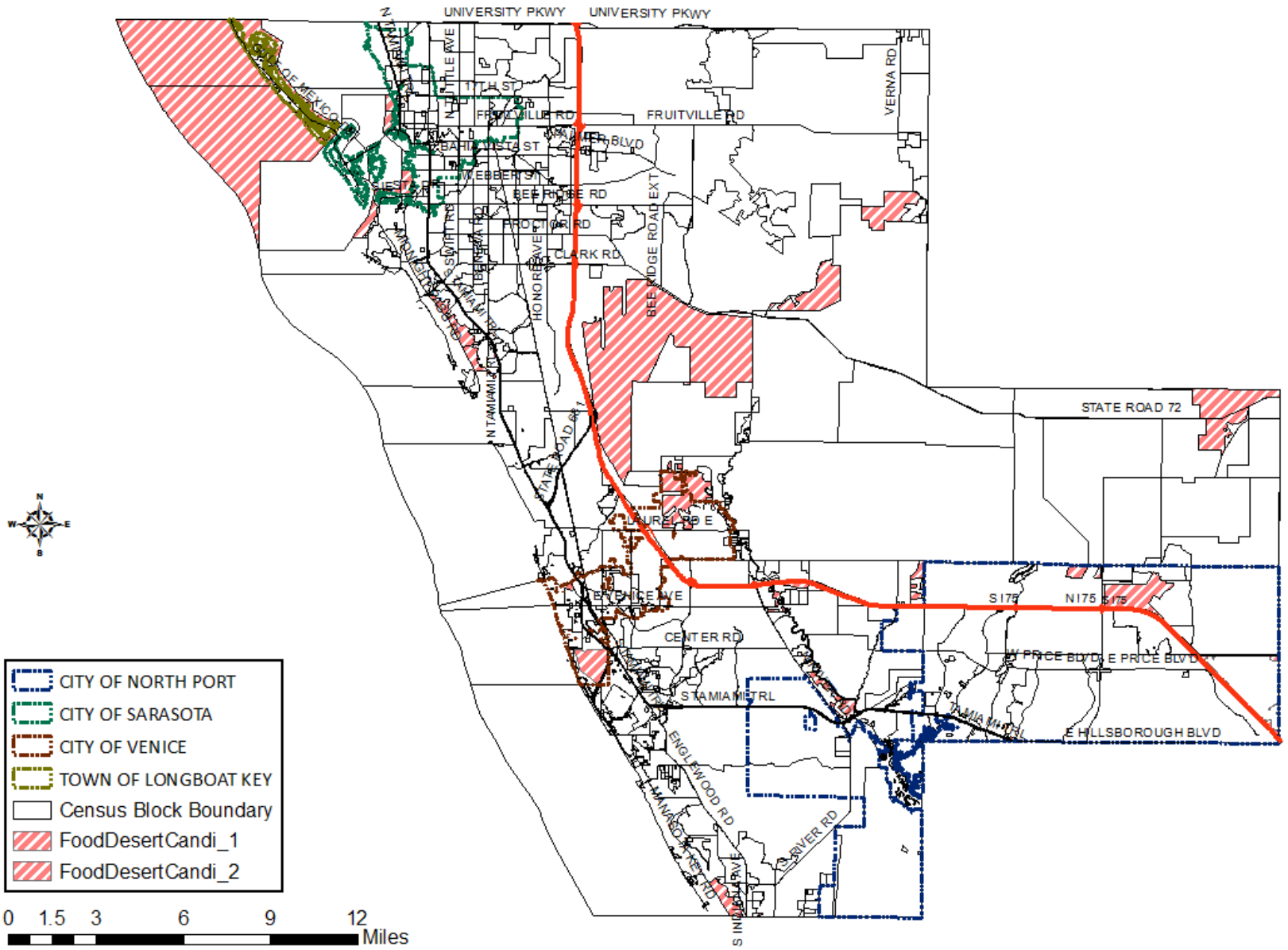


Figure 4-12. Food deserts for drivers

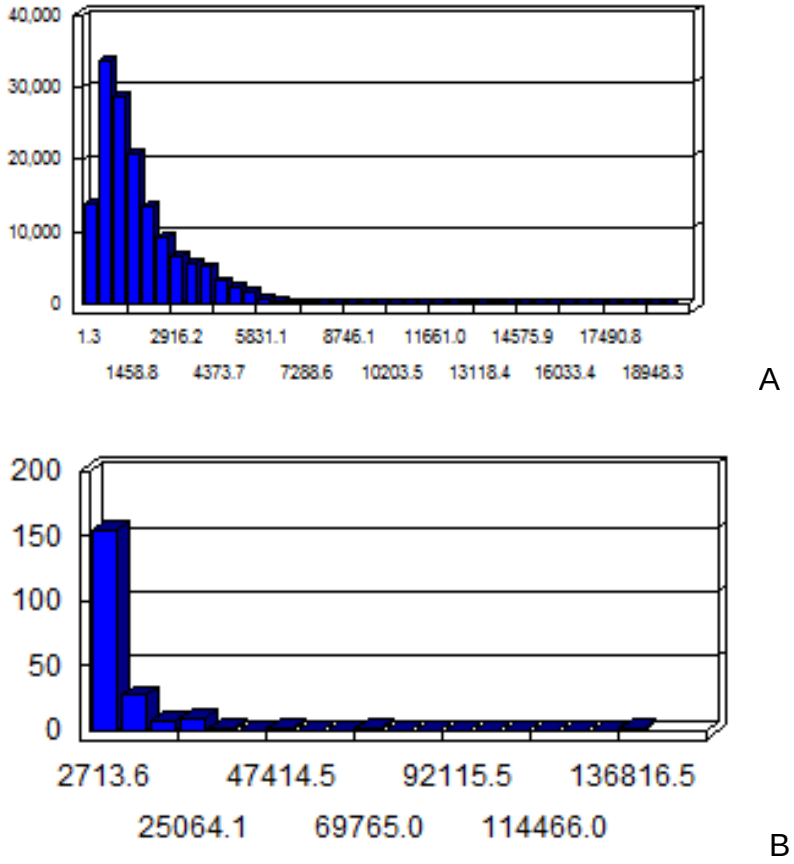


Figure 4-13. Comparison between residential parcel and census block centroid point. A) Distance (the nearest distance) from residential parcel to healthy food outlets B) Distance (the nearest distance) from census block centroid point to healthy food outlets

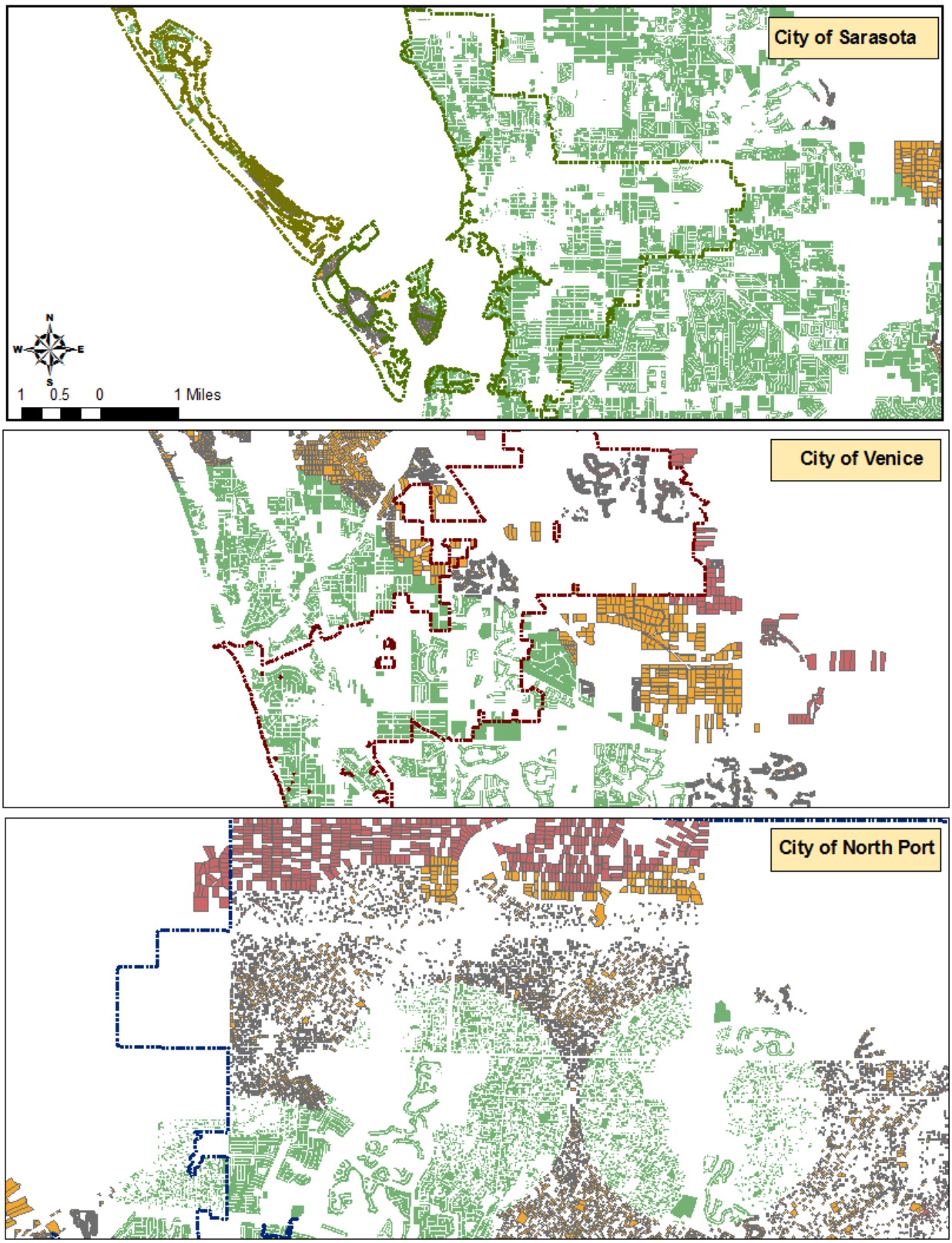


Figure 4-14. Food access index overlaid in residential land use parcel. It is distributed in three equal percentage of overall distances to the nearest healthy food outlets from each residential parcel.

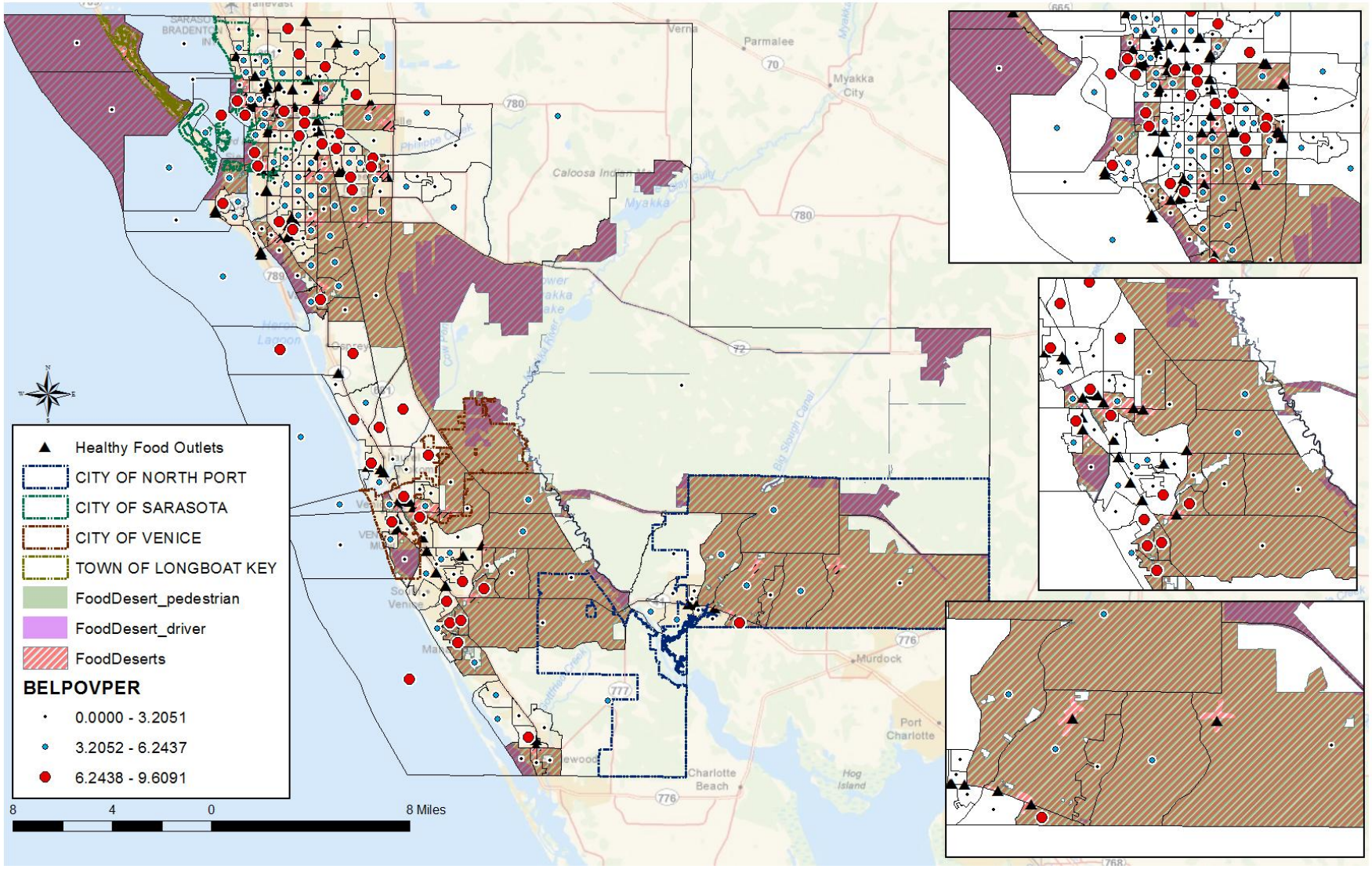


Figure 4-15. Distribution of population with below poverty, and food deserts in Sarasota County, FL

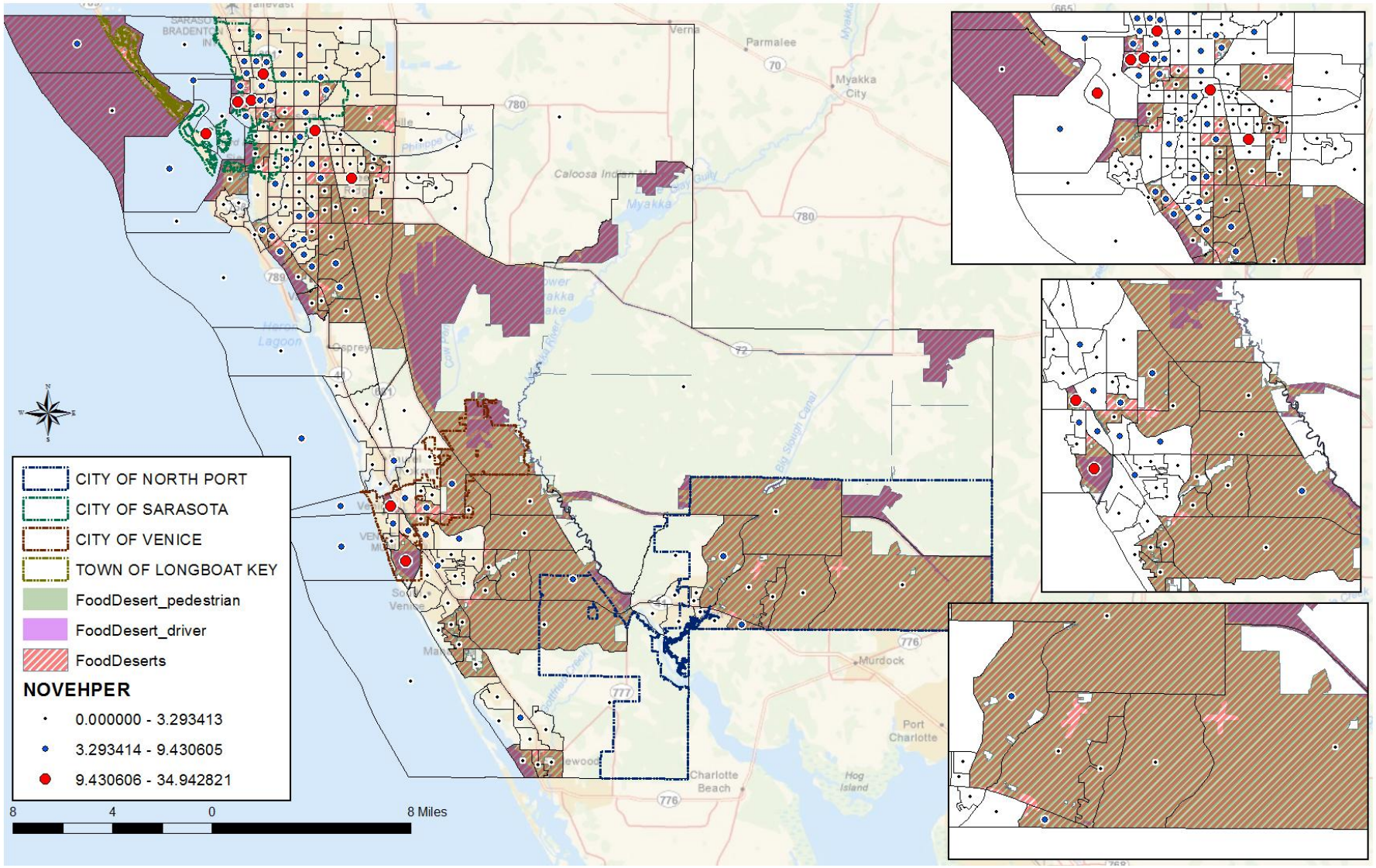


Figure 4-16. No vehicle ownership distribution, and food deserts in Sarasota County, FL

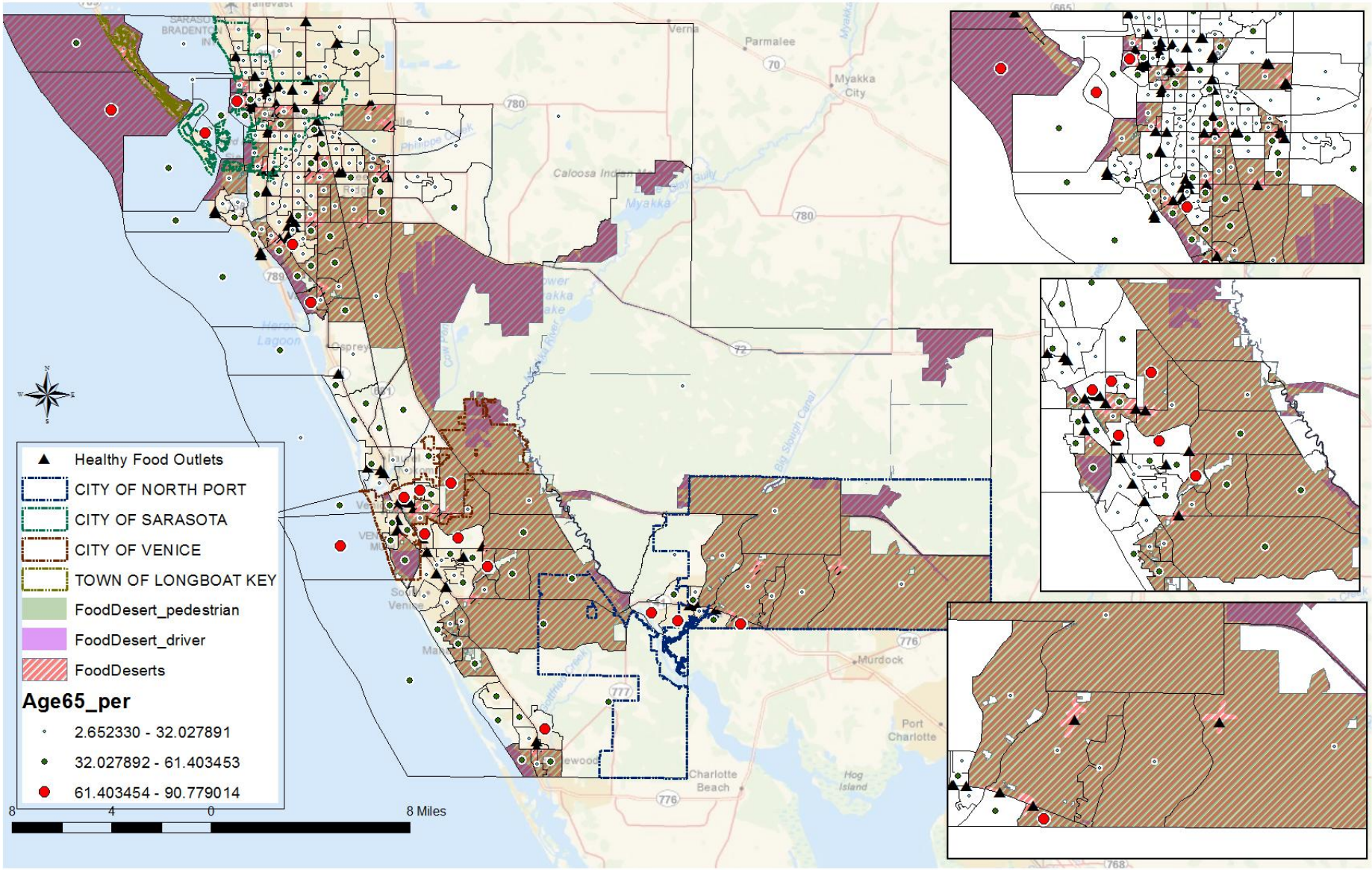


Figure 4-17. Population 65 years older, and food deserts in Sarasota County, FL

CHAPTER 5
DISCUSSION

This thesis demonstrates how GIS technology can effectively analyze local food environments and benefit residents based on spatial analysis. Most importantly, the overlay analysis and the creation of a food access index contribute to identify food-desert candidates and address the research questions under examination in this study.

What is the definition of food desert? Is it absolute or does it varies from one case to another? Yes, the definition of a food desert can be broad, because it incorporates questions from social theory, and relating to the physical environment, the residents' behavior, and human rights. For example, a widespread assertion from human rights would be that access to safe, nutritious food is a fundamental concept (Furey et al., 2001).

By all accounts, food deserts in Sarasota County have been distributed for pedestrians and drivers separately, and then spatially illustrated under census block scope, which is assessed by applying the food access index. Because residents who may walk to healthy food outlets have a maximum of a half-mile eligible buffer to hold products, excluding the walking buffer from Census blocks that had been assessed as "low food access" yields food deserts. The same evaluation for the 10-miles buffer (drivable distance to healthy food outlets) yields food deserts for drivers.

What areas in Sarasota County have spatial inequality of food access? Food desert candidates in Sarasota County were explored in combining food access index and transportation network. This study has found City of North Port, Venice and North central South of County are the areas with spatial inequalities in access to food outlets within both transportation network. It can be argued that food deserts underlay on

locations of food outlets and where street network are affordable for customers to reach food outlets. A major contribution of this research resulted from the utilization and evaluation of different measures to determine accessibility. For the residents without personal vehicle while inhabit in transportation network, assessing public transit lines/routes will be needed to more accurately measure food desert candidates. Since drivable network was applied in this study, not only the residents currently live these areas but population in 10 miles distance visit as well if there are related attractions such as community garden which addresses the importance of fresh foods for healthier life style. County should actively encourage food outlet development, increasing public transit network and building community garden in areas currently identified as food deserts.

Food Policy and Food Assistance Programs

Once physical food access assessment has been evaluated, one of the obvious solutions is to implement policies that locate more full-service food retailers in identified food deserts in the U.S. and across the globe. Morland et al.(2002a) and Wrigley et al. (2002) supports this policy because introducing new food stores in British cities in low food access areas has helped eradicate lack of food access while also promoting the increase of healthy food consumption such as fruit and vegetable (U.S Census track). Fresh Food Financing Initiative (FFFI) in Pennsylvania is represented as an example of policy intervention. Over the six years of commitment, purpose of FFFI succeeded to locate 83 new or improved grocery stores and food access has been encouraged for 400,000 residents (USDA 2009). Additionally 4,860 jobs have been created as well due to this economic opportunity.

According to Conveney and O'Dwyer (2009), living in food desert does not restrict food access by itself but it is a matter of transportation form. Policies suggested in several regions focus on developing more accessible transportation infrastructure as another option. Expanding local bus routes or frequency is generally implied in providing transportation needs for many socioeconomic disparity households. Other than that, providing shuttle service that connects food retailers to residents was proposed in order to supplement alternative transportation methods as well.

To provide more opportunity to purchase food, while physical limitations such as food access exists, food assistance programs increased food security, a healthy diet, and access to food. Generally Supplement Nutrition Assistant Program (SNAP[7]) from USDA is well known all over the U.S. and each county or state has their own assistance programs due to its environments. For example, New York City implemented Healthy Bodegas which aimed to lessen access inequality for healthy foods. The program aimed to increase the amount of healthy foods in small grocery stores to promote healthy eating by improving the availability, quality and variety of healthy foods in targeted areas.

To prevent forms of food desert, Sarasota County has included agricultural food policy in Comprehensive Plan in 2006 and established Sarasota Food Policy Council (SFPC) in UF/IFAS Sarasota County Extension Office to support the goals of sustainable agriculture, reinforce County's distinctive character, and enhance food environments to residents. For instance, SFPC programs include building community

[7] In fiscal year 2010, about 40.3 million people living in 18.6 million U.S. households participated in the Supplemental Nutrition Assistance Program (SNAP), on average, per month. SNAP households are a diverse group. Because benefits are available to most low-income households with few resources, regardless of age, disability status, or family structure, participants represent a broad cross-section of the Nation's poor.

gardens that emphasize the needs of healthy fresh foods and it is actively in process by educational workshops. The UF/Sarasota County Extension Long Range Plan 2012-2016 (2011) addresses the objective of programs that has been aimed to improve local foods and agriculture as below:

- Support provision of fresh and nutritious food options and nutrition education in schools
- Generate increased awareness about locally-grown foods
- Provide education on food safety issues

The residents of Sarasota County expect a sustainable food system and want to buy local food which would be a catalyst healthy living. It is represented though the online survey from April 14th to June 1st, 2011 with 257 responses; 71 percentages of respondents pointed out the needs of fresh nutritious food option programs and; 61 percentages of responses were about priority issues of food safety. In the Listening Session held on May 12, 2011, 15 votes from 62 attendees stressed County needs make efforts on local foods and agricultural programs as priority as well (Sarasota County Long Range Plan, 2011).

Community Gardens

Developing methods to distribute healthy foods to at-risk communities is not an easy task. To solve this problem, as mentioned above, Sarasota County has initiated building community gardens in urban areas. Forty-three of gardens already exist with the city's boundary. Community gardens are clustered in City of Sarasota and Venice where dense population has because designated urban agriculture area by property criteria which do not necessarily show correlation with local food access and community garden (Figure 6-1). These benefits like an urban agricultural purpose. Gardens

promote fresh and healthy products that offer population more choices for healthy foods. In addition, when gardens locate near residential and institutional land uses, they provide snacks and meals to schools and support communities. Overall it offers a better quality of life and beautifies the populations and areas, all of which are health benefits.

This study suggests GIS can be helpful at creating spatial case-studies that can identify unique characteristics about specific areas that may not follow the general patterns found in other regions. Although some of the findings from this study contrast with literatures and previous research, the proximity measures were able to effectively identify vulnerable regions in Sarasota County. In terms of food policy, GIS may prove to be extremely valuable for organizations concerned about the healthy eating of their community. Once these at-risk areas are identified, it opens up the possibility for targeting specific neighborhoods and implementing effective programs running in County Extension office such as creating community garden and educating importance of local foods.

Limitation of this Study

This study presents few limitations:

Needs of Survey and Health Outcome

First, data and methodology are limited to a qualitative method. Although the food access index is derived from previous empirical studies, relying on quantitative data for a sizable portion of this study means that the information does not represent residents' actual time, distance, and frequency to go grocery shopping. With more time and resources, this limitation can be overcome by completing resident surveys or conducting interviews with the criteria below:

- How many fruit and vegetable servings do you consume a day?

- Where do you go grocery shopping?
- Do you either walk or drive to grocery?
- Does anyone in the household suffer from a weight related disease such as obesity? If so, are they aware of how diet can contribute to its onset?

While the built food environment was used to examine the geographic distribution of potential health disparities at the neighborhood level, the health outcome data was unable to be incorporated into this study. Since it was not available to join within Census block group scope, the potential access acts as a proxy for actual physical wellbeing.

Transit Routes and Opportunity with Euclidean Distance

Second, the methodology used two distinct measures to evaluate food access: proximity to healthy food outlet and walking/driving network. In determining walking/driving network, network analysis tool in ArcMap 10 computed potential walking and driving boundary from healthy food outlets because this measurement has been deemed sufficient by previous food proximity study (Larsen and Gilliland, 2008). However more realistic determination for walking and driving distance could be made by examining actual travel time, and the actual pedestrian network, which would consider element such as sidewalks, crosswalks, speed limits, informal paths, and lanes of traffic (Bejleri et al., 2009). This calculation also fails to account for the other alternative transit transportation modes or routes that residents may use to visit these food locations. Additionally, limitation from using Manhattan distance to measure proximity, from census block centroid point to the nearest healthy food outlets, may occur because it does not represents the minimum distance may be assessed as shortest path (Euclidean distance).

Definition of Healthy Food Outlets

Last, because this study assessed healthy food outlets as places where residents can reach constant fresh and organic food, farmers markets and food stands are excluded due to their mobile characteristics.

The results show a majority of food deserts are near I-75 in Sarasota County, but these areas also have an abundance of food stands. Food stands are one way to increase access to healthy foods. Although food stands sometimes sell food that is unhealthy and contaminated because they are often located near busy streets, these businesses unlike grocery stores, adjust their inventory quickly to fit the fresh food demands of the community. While conducting this study, food stands are not included in the overall analysis due to limitation on the availability of GIS data but it is possible that they could impact the findings of this study if they are included.

Opportunity for Future Research

While this thesis only limits transportation mode into walking and driving personal automobile, future studies would benefit from incorporating measurements of public transit transportation and trips relating to commuting to commute to work, school, and shopping.

Additionally as shown in findings, physical environment (distance) plays an important role to understand food deserts and guide decisions where healthy food stores are needed to be placed. Additional revision of the definition of food deserts using health related issue, such as obesity rate and with Body Mass Index (BMI) would benefit analyzing food desert in reality. For example, using GIS in conjunction with multivariate models to evaluate the relationship between obesity rate and food access

index to healthy or either unhealthy foods, may provide how these healthy and unhealthy food outlets contribute to disparities in the obesity epidemic.

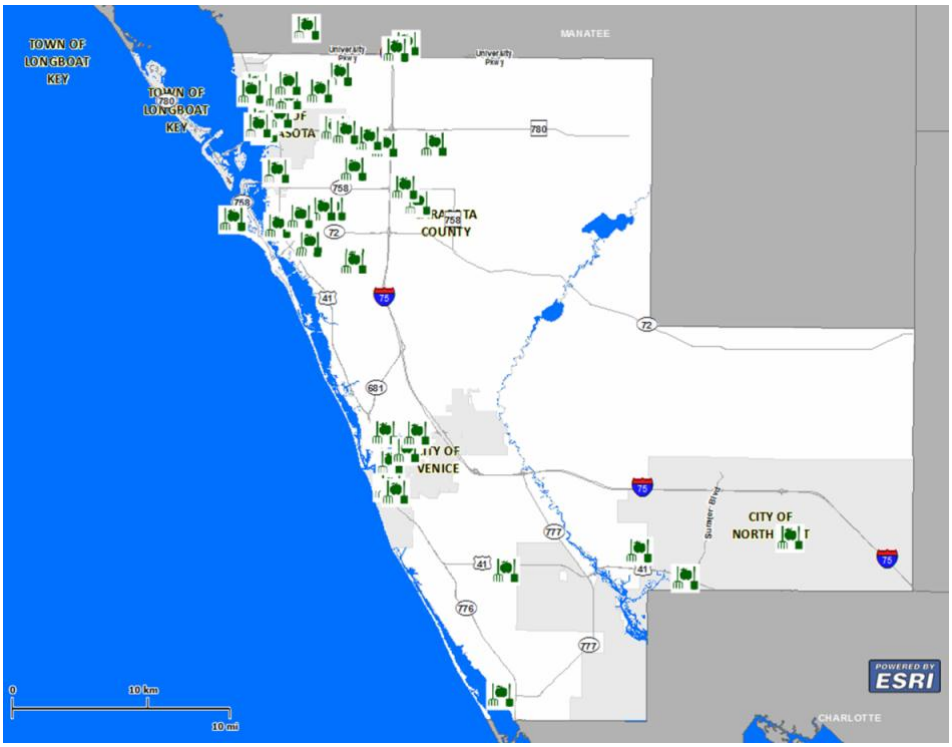


Figure 5-14. Community gardens in Sarasota County, FL Source: Sarasota County Green Map

CHAPTER 6
CONCLUSION

This study aimed to explore the socioeconomic and physical factors that define food deserts, assessing Sarasota County as a case study area. The first chapter introduced the problem statement that highlights increasing food access/food desert, and explained the objectives and questions related to this issue. The second chapter reviewed previous studies, introduced food environment terms, and continued with a review of food environment inequalities derived from socioeconomic factors and physical barriers, all of which helped to create the food access index. Both empirical and quantitative methods were applied to support and measure the food access index, which is an indicator used to find food deserts. This study's findings and results represent two steps toward finding food deserts:

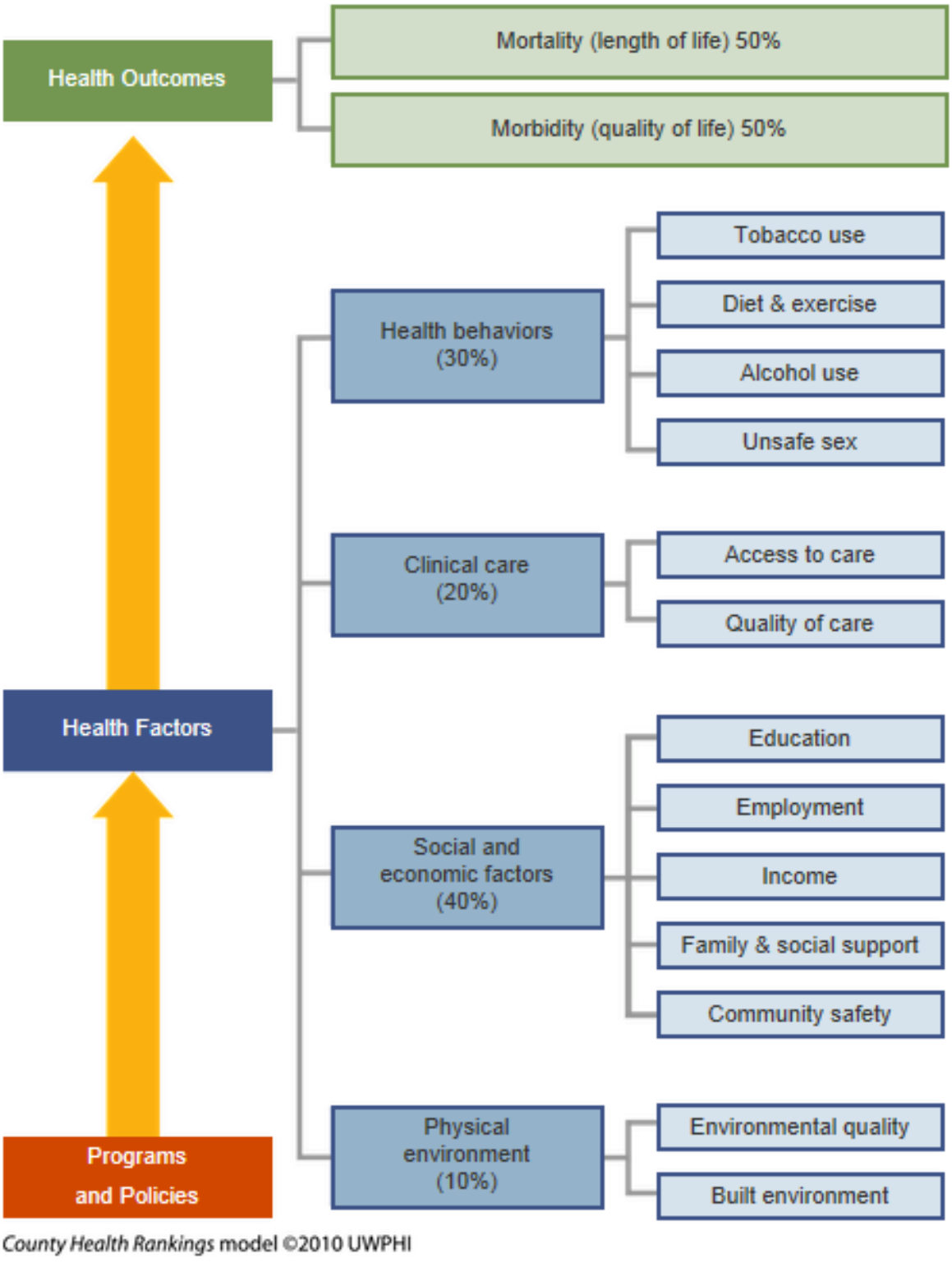
Step 1. The findings confirmed that some areas of the county have comparatively better food access than others; the southern portion of the city of Sarasota, the eastern portion of the city of Venice, and the city center of North Port are food deserts.

Step 2. The results of the study suggest that the assessment of food deserts should depend on the modes of transportation that residents of a given area employ to reach areas where food is available.

The conclusion is that food deserts do exist in Sarasota County, FL. As shown in the literature review, food deserts appeared in areas with a high density of low income households, a low per capita vehicle ownership, and an older population. For example, much of the population living in downtown Sarasota is at or below poverty level, has very poor levels of pedestrian access to food outlets, and due to low vehicle ownership, cannot access food by driving. This is true of the elderly population as well. Although

food deserts did appear more often in Sarasota County than in other counties with similar socioeconomic disparities, it is still difficult to prove a strong correlation between physical distance to food and the existence of food deserts.

APPENDIX
METHODOLOGY OF COUNTY HEALTH RANKING 2011



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BIOGRAPHICAL SKETCH

Sulhee Yoon was born in Seoul, South Korea in 1986 as an only daughter of Kyungshin Kim and Hyun-mo Yoon. Sulhee was named as “Sunny” when she started to learn English in her childhood. She started her college life with urban design and engineering major for two years, and later transferred to biotechnology/bioscience then received her Bachelor of Science and Engineering degree at Sejong University, South Korea, 2009. While in her senior summer vacation, Sulhee interned in Red Cross in Los Angeles and wished to start her master’s degree in United States. Toward the end of Sulhee’s undergraduate career, she decided to coming back to pursue a master’s degree in urban planning and focus on environmental planning in United States.

Sulhee began her master’s in urban and regional planning at University of Florida in fall, 2009. After her first semester, she had been worked as a research assistant in ‘Childhood Obesity GIS project’ for a year and also embarked on an internship with Alachua County Growth Management as a CRA project intern. In Summer 2011, Sulhee completed an internship at the UF/IFAS Sarasota Extension office and conducted food desert research for County.

Sulhee‘s main planning interests are in the collaboration between urban design/form and transportation with applying GIS modeling. After graduation she hopes to pursue a career in comprehensive planning, especially where she can use her GIS skills.