

**Using GIS Technology to Identify and Analyze  
'Food Deserts' on the Southern Oregon Coast**

by

Pamela R. Opfer

MPP Essay

Submitted to

Oregon State University

In partial fulfillment of

the requirements for the

degree of

Master of Public Policy

Presented June 2, 2010  
Commencement June 12, 2010

## **ABSTRACT**

This study analyzes food access patterns on the Southern Oregon Coast using GIS technology. The utility and capacity issues of GIS technology are explored as well as the ability for community-based organizations to apply GIS analysis at a local level. A comprehensive literature review is presented which addresses the definition of 'food deserts' and the applicability of different methods to measure food access in urban and rural areas. Throughout this paper, the qualitative and quantitative differences between urban and rural food deserts are illustrated. Two types of analysis are employed in order to examine the food environment of Coos and Curry Counties. One method involves using a coverage measure to determine the location and characteristics of all food stores in the study area. This measure will establish whether there is a pattern of unequal supermarket access between higher and lower-income areas. For proximity measures, several methods are used to investigate whether the study area has low-income areas lacking access to supermarkets that would be considered 'food deserts'.

## **Table of Contents**

Introduction.....	1
Literature Review.....	1
Methodology.....	14
Results.....	25
Discussion.....	31
Policy Recommendations.....	34
Conclusions.....	37
References.....	39
Appendices.....	43

## **Introduction**

Many food activists consider access to healthy food a basic human right, and insist that policies that affect our food system should be enacted accordingly to ensure that everyone has access to healthy food. This is a complex issue that involves many different players but it is generally more of a concern for lower income groups because they have limited resources and mobility. There have been numerous methods used to identify and analyze food access. Mapping patterns of access to food stores using GIS technology is becoming more prevalent and increasingly effective. This technology allows users to identify areas of low food access depending on specific criteria and enables the possibility for detailed spatial analysis. However, GIS technology and spatial data are not readily accessible to everyone. Community organizations are often the most concerned about food access for local residents but they are especially limited by their capacity to utilize GIS technology. This paper explores the concept of ‘food deserts’ within a given study area and discusses the effectiveness and accessibility of GIS technology for identifying and analyzing food access.

## **Literature Review**

### *Social Construction Theory*

Although the constitution demands that all citizens be considered equal before the law, many groups receive very different treatment in public policy. The social construction framework is helpful for understanding who benefits and who loses from policy change. The theory posits that actors within the policy process often socially construct groups in positive and negative lights and allocate benefits and burdens according to these constructions. “Policy designs affect participation through rules of participation, messages conveyed to individuals, resources such as money and time, and actual experiences with policy as it is delivered” (Sabatier 2007: 100).

Social constructions are formed according to two dimensions: political power and positive or negative construction. There are four classifications that groups can be placed in: *advantaged, contenders, dependents, and deviants*. This paper will focus mostly on the *dependent* category because people experiencing poverty and hunger are generally placed in this category by policy makers. They are positively constructed as deserving in a moral sense but they often lack the political power to effectively demand more benefits. This is not to suggest

that these group traits are completely homogenous or that policy makers view these groups the same as the general public. However, the literature states that policy makers tend to construct policies based on their view of certain groups. Camou (2005) points out that the *dependent* group is typically helpless and usually in need of discipline. How certain target groups are perceived can encourage or discourage political participation. *Dependent* groups tend to accept passive roles in the policy process and participate at low levels. Funding to this group is often the first to get cut because policymakers would rather allocate resources to groups in the *advantaged* category (Sabatier 2007). Therefore, many community organizations that serve individuals in the *dependent* category often operate with little or no funding from the government.

Community agencies are usually left with the difficult task of determining who will not be served or who needs their services the most. Camou (2005) notes that credits of deservedness are most often linked to the needs of the most disadvantaged, the *dependents*. Camou (2005) also argues that community organizations make judgments of personal competence and contribution in their decision-making. Such behavior shapes how particular groups may be viewed, regardless of whether particular groups potentially have the capacity to advocate for their own needs. The social construction framework works to increase understanding about why certain policies are implemented and how they shape public participation and political orientation (Sabatier 2007). In this paper, social construction is used as a lens through which to view the issues and policies that affect healthy food access for low-income households.

### *Barriers to Accessing Healthy Food*

Public health researchers and officials and community organizations have been concerned for decades about people's capacity to satisfy the recommendations for a healthy diet. On one side of the spectrum are families that are experiencing food insecurity and struggling to get nutritious food on the table. Households that are experiencing 'low food security' report reduced quality, variety, or desirability of diet with little or no indication of reduced food intake. Apart from this group are households that experience 'very low food security' (hunger); these families report multiple signs of disrupted eating patterns and reduced food intake (USDA Economic Research Service 2009b). In Oregon, the USDA estimated in 2009, that the rate of people experiencing 'very low food security' was at 6.6%, which equals 95,000 households (Edwards 2010). Paradoxically, the United States is also experiencing a major obesity epidemic. The Oregon Department of Human Services (DHS) estimates that the percentage of adult Oregonians who were obese or overweight in 2005 was 59.7% (Oregon Department of

Human Services 2007), a figure which has more than likely increased since then. Studies have proven that people with lower incomes are more prone to be obese than those in the middle and upper class. As contradictory as it may seem, these concerns stem from the same fundamental problem: increasing numbers of individuals and families are finding it difficult or impossible to maintain a healthy diet.

Much research has addressed the fact that healthy food is often more expensive and difficult to obtain compared to a less healthy diet that contains calorically dense food (Furey et al. 2001). The result is that lower income groups do not get adequate nutrient intake when compared to people in higher income brackets (Clifton 2004; Donkin et al. 1999; Morland et al. 2002). Healthy food may also cost more for low income households because purchases are made in smaller quantities (Morland et al. 2002). Many healthy foods, such as fruits, vegetables, and fish, are a more expensive type of calories and are often viewed as luxury items by those with low incomes. Morland et al. (2002) and Sharkey et al. (2009) report that the price of healthy food and the variation between prices is of major concern for those living on low incomes.

These health concerns illustrate the importance of better understanding the complexities of our food environments. Food choices are affected by an intricate combination of variables such as nutrition, cost, convenience and taste. Health literature acknowledges that there are inequalities in health between individuals, between socioeconomic and ethnic groups, and more recently, between geographic groupings of individuals (Pearce et al. 2007). Depending on how these disparities are viewed by, whether individuals should be held responsible or whether it is a result of how society functions, can affect the social construction of certain groups. However, it is becoming more accepted that certain inequalities are inherent to our society. This acceptance leads groups such as the poor and homeless people to be positively constructed as deserving *dependents*. Economic factors such as poverty and low car ownership, as well as personal reasons like lack of motivation, education and poor eating habits have a sizeable impact on what individuals eat (Reisig and Hobbiss 2000). There has been a shift from a focus on individual and behavioral factors that influence food choice, to an assessment of physical or environmental factors and the geographical distribution of affordable healthy food (Clark et al. 2002; Clifton 2004; Morland et al., 2002; Sharkey et al. 2009). Studies have shown that geographic areas or neighborhoods differ in their access to various services that enable them to live a healthy life. The term 'food deserts' has been implemented in much of this emerging literature to refer to these geographic areas that have low access to healthy groceries.

### Defining 'Food Deserts'

The food desert literature addresses many ambiguities with regard to the actual definition of the term and its usefulness for identifying and solving real world problems. The term, food desert, implies a setting in which some form of food insecurity takes place. Some studies debate whether they even exist, arguing that healthy food consumption is more associated with cultural and behavioral variables. For example, Pearson et al. (2005) found that distance to the nearest supermarket was not significantly associated with better fruit and vegetable consumption. Instead, the study found that gender and age affected consumption of fruit and vegetables. Nonetheless, research emphasizes the need to look deeper into this issue to determine the extent to which physical environment shapes individuals' eating habits. Donkin et al. (1999) define food deserts as areas that are more than a critical distance from a food store. Wrigley et al. (2002) elaborate on the definition to include particular food provisions such as food availability, variety, and price. The 2008 Farm Bill defines a food desert as an "area in the United States with limited access to affordable and nutritious food, particularly such an area composed of predominantly lower income neighborhoods and communities" (USDA Economic Research Service 2009a: 1). Schafft (2009) emphasizes that the presence of supermarkets is the most important source of a wide selection of healthful foods, particularly fresh produce. A study conducted by Coveney and O'Dwyer (2008) considers areas to be food deserts if the census collector district had high proportions (top quartile) of households without a car and if the dwelling was more than 2.5 km from the nearest supermarket. Morton and Blanchard (2007) identify several characteristics that food desert areas tend to have: larger proportions of residents without a high school degree, higher poverty rates, lower median family incomes, greater fractions of families living in rural areas, a larger elderly population, and higher amounts of small grocery stores and convenience stores per capita.

A correlated problem involves an abundance of less healthy foods available from convenience stores and fast food restaurants which are more likely to be located in low income areas. Some researchers use the term 'food swamps' for neighborhoods that have easier access to less healthy foods compared with access to healthy foods. More available energy-dense foods, especially if it is cheap and convenient, may "swamp" out healthier choices (Ver Ploeg 2010). Morland et al. (2002) report in their study conducted in London that foods that are not typically part of a healthy diet are more readily available than healthier food choices. Additionally, in their study about *Colonias* in the Lower Rio Grande Valley, Sharkey et al. (2009) concluded that

residents had the best access to fast food restaurants, convenience stores, and dollar stores for their nutrition needs. After taking population density into account, families in highly deprived neighborhoods had to travel significantly farther to the nearest supermarket or grocery stores. Morland et al. (2002) found that fast-food restaurants are much more common in the low and medium wealth neighborhoods compared to the high wealth neighborhoods. By looking at the issue from this angle, food deserts become particularly relevant to understanding the rising rates of obesity. The USDA Food Desert Study (2009) observes that several studies link proximity of unhealthy options (such as fast food restaurants) to BMI and obesity. Instead of the problem being that nutritionally adequate foods are inaccessible, from this view the problem shifts to focus on how less healthy food is much easier to obtain because it is often less expensive, requires less time to prepare, and is nearby.

### *Methodology and Findings from Previous Studies*

The methodology to measure food access has employed a wide array of qualitative and quantitative techniques. Many studies that have attempted to identify and describe food deserts have implemented different criteria based on whether the study area was considered rural or urban. The majority of the current literature centers attention on the issue of urban food access. However, more studies are beginning to understand how various factors affect food access differently in rural locations. Furey et al. (2001) note that 42% of English villages and Scottish towns with populations around 5,000 people are left without any kind of grocery store. The authors studied areas in Northern Ireland, which are generally sparsely populated, and listed several consumer groups that may end up being vulnerable as the retail industry pursues consolidation. The groups include the elderly, consumers without access to a personal vehicle, and isolated consumers that live in extremely rural regions. Consistent with these findings, Coveney and O'Dwyer (2008) claim that the consequences of poor access to nutritious foods can be seen most starkly in the rural indigenous communities of Australia. Morton and Blanchard (2007) use data from the Zip Code Business Patterns (ZCBP) to examine food deserts and socioeconomic disadvantage in the United States, with particular focus on rural counties. They found that across U.S. regions, counties classified as food deserts in their analyses have a greater percentage of rural residents than non-food desert counties. Morton and Blanchard (2007) contrast 'low access' counties with 'food deserts'. They define areas of low access as counties where at least half of the residents have 'low-access' to healthy food, or they live more than 10 miles away from a supermarket. They classify areas as food deserts as counties in which all of the residents have low-access to large food retailers. Clearly, many different techniques have

been utilized in an attempt to measure local food access to determine areas where residents may be at-risk for food ‘desertification’.

### Consolidation of the Supermarket Industry

There may be a variety of reasons for the food desert phenomenon, but a major factor is the consolidation of the supermarket industry (Schafft 2009). Supermarkets are considered a central part of the retail landscape and they are the most significant source for healthy food items such as vegetables and fish. The consolidation of the supermarket industry has resulted in a steady increase in store size, while the total number of stores has decreased (Clarke et al. 2002). Megastores like Wal-Mart have expanded into food retail and often provide customers with inexpensive goods. Mamen (2007) notes that the supermarket retail industry is now dominated by only a few highly integrated companies. These businesses, the main ones being Wal-Mart, Kroger, Costco, Supervalu/Albertsons, and Safeway, have acquired extraordinary market power. By 2003, these five firms controlled over half of all grocery sales (Mamen 2007). They rely on industrialized production facilities and centralized distribution systems, which enables them to keep prices relatively low compared to smaller grocery stores. Many researchers agree that the increased consolidation of food retail will become the most important force for change in the food system.

As the grocery store sector continues to restructure, large grocery retailers are sprouting up in suburban areas and forcing smaller independent stores within the inner-city out of business. In general, these big-box stores are locating to serve the middle class in the suburbs, while leaving urban centers where many low income people reside (Furey et al. 2001). Areas may not have supermarkets nearby for a number of factors: higher costs of building/operating a store in certain locations, high price of land, or zoning rules such as parking requirements for new businesses (Ver Ploeg 2010). In contrast to smaller grocery stores, most owners, managers, and shareholders of supermarket chains do not have strong ties to the community and therefore, have no trouble relocating. Additionally, large, discount retailers such as Wal-Mart, tend to be located along highways or freeways and less readily accessed by transit or non-motorized forms of transportation. Mamen (2007) notes that the term for this practice has been dubbed “redlining” and has created a country that is scattered with food deserts. This leaves many low-income consumers to rely on smaller, higher priced grocery stores, convenience stores, dollar stores and fast food for much of their dietary needs (Clifton 2004; Donkin et al. 1999; Morland et al. 2002).

The consolidation of the supermarket industry is also greatly affecting rural areas as many small grocery stores have completely abandoned small rural communities. Filling the void in some parts of rural America are convenience stores and gas stations, which charge a premium for a limited range of food choices, often with low nutritional value (Morton and Blanchard 2007). Schafft (2009) highlights how in the midst of the increasing national obesity rate, rural obesity is especially high. The food desert literature alludes to the prospect that food desert characteristics in rural areas in the United States may be qualitatively dissimilar when compared to urban food deserts. Rural America has been experiencing significant economic and labor-market shifts from traditional agricultural and natural resources sectors to more service industries (Schafft 2009). This in turn has led to the phenomenon of well-educated adults and young families relocating to more populated areas in order to secure employment (Morton and Blanchard 2007).

Obviously, areas that are densely populated are able to support more supermarkets and grocery stores. Thus, rural areas will inherently have fewer food stores and residents will travel farther on average than urban residents (Schafft 2009; Morton and Blanchard 2007). Families living in rural areas recognize that they will likely be dependent on automobiles because services and residences tend to be much more spaced out than in urban areas. Unfortunately, many of the smaller grocery stores serving these rural populations may not have the required space and equipment needed to accommodate large amounts of fresh produce or other perishable products. Furthermore, many stores in rural food deserts may be far away from convenient delivery routes and therefore, more affected by changes in food distribution channels (Ver Ploeg 2010). These route shifts tend to favor larger food retailers at the expense of smaller food stores in rural areas (Morton and Blanchard 2007). This current shift in the food stores industry leaves remote rural areas as the most vulnerable populations to food ‘desertification’. Many rural areas have even experienced the closing of the only grocery store within their town, forcing residents to travel unreasonable distances to acquire healthy groceries. This trend also suggests that there may be more areas with low healthy food access now, when compared to the food environment of the past couple of decades.

### Automobile Dependency

Another primary concern, especially in rural areas, is the lack of effective public transportation infrastructure in areas that would support improved food access. American cities and towns were designed in an auto-dependent nature and the automobile remains integral to the culture and everyday functions of society (Clifton 2004; Coveney & O’Dwyer 2008). The layout and transportation infrastructure of the majority of U.S. communities discourage alternative

forms of transportation such as walking, biking or taking public transportation. In turn, this forces consumers with lower incomes, who typically have lower mobility, to be more restricted in grocery choice. The USDA National Food Stamp Program Survey of 1996 testified that a little less than half of U.S. households with low incomes are able to use a car that they own (Morton et al. 2005). This means that many low income residents are forced to rely on family, friends, neighbors and public transportation for their food shopping trips. Studies conducted by Morland et al. (2002) and Turrel et al. (2002) also support the notion that poor households have less access to private transportation. Ultimately, low income families are more likely to base their shopping destination choice based on transportation limitations instead of price, quality, or variety. In small towns and rural areas with limited food access, the lack of reliable transportation infrastructure is particularly crucial.

### *Coping with Rural Food Environments*

Gross and Rosenberger (2005) conducted a qualitative analysis in two rural communities in Oregon and identified residents' different strategies for coping with food insecurity. These include having knowledge of how to grow, prepare, and preserve their own food. Access to discount grocery stores and the ability to clip coupons and locate sales was also a common approach used to make the most of a low income. Furthermore, low-income people and residents in rural communities often rely on social networks for services such as childcare, lodging, transportation, and food sharing. Hofferth and Iceland (1998) also report that there are high levels of interpersonal exchange among families living in rural towns. In their study, roughly 60 percent of their sample admitted to giving or receiving time, money or food in times of crisis. In a place where food sources are not evenly distributed, Morton et al. (2005) also discovered that residents frequently depend on personal relationships to address struggles of food insecurity. In this study, high civic structure (social capital) was found to be negatively correlated with food insecurity. Individuals are usually more comfortable receiving help through social networks than relying on social service aid arrangements (Gross and Rosenberger 2005). Although these networks are often insufficient social capital is important link to considering when developing strategies to eradicate food insecurity.

### *Legislation*

Currently, no federal legislation exists to address the food desert issue. The call to action has mostly been indebted to local community organizations that have enacted many innovative

policies and programs to increase access to healthy food. However, the food desert concern is starting to be visible on state and national agendas as increasing amounts of individuals and households are impacted by this phenomenon. In the Food, Conservation, and Energy Act of 2008, Congress directed the USDA to conduct a one year study to analyze the problem of food access. Additionally, there was a workshop held in October of 2008 that invited experts studying food and grocery stores access, food retailers, leaders from community development organizations, government agencies, congressional members and staff, and public interest groups. The findings from the USDA food desert study are listed below:

- Access to a supermarket or large grocery store is a problem for a small percentage of households
- Supermarkets and large grocery stores have lower prices than smaller stores
- Low-income households shop where food prices are lower, when they can
- Easy access to all food, rather than lack of access to specific healthy foods, may be a more important factor in explaining increases in obesity
- Understanding the market conditions that contribute to differences in access to food is critical to the design of policy interventions that may be effective in reducing access limitations
- Food has been used as a tool for community development
- The current state of research is insufficient to conclusively determine whether some areas with limited access have inadequate access (USDA Economic Research Service 2009a: vi)

Although this national study recognizes that access to healthy food is a problem for certain households, mostly low-income residents, it finds that there are still many unanswered questions. The report suggests that policy recommendations should focus on the market factors that may affect food access. However overall, it proposes that the current state of the literature is still not conclusive enough to determine the extent to which location of supermarkets and grocery stores impact healthy eating habits.

In the fiscal year 2011 budget proposal, the Obama Administration announced \$400 million toward its “Healthy Food Financing Initiative,” which aims to bring grocery stores and healthy food retailers to underserved urban and rural communities in the United States (PolicyLink 2010). This initiative is modeled after the successful Pennsylvania Fresh Food Financing Initiative which offers loan and grant financing in order to attract investment in low-income neighborhoods. First Lady, Michelle Obama, is pioneering the effort and asserts that this project would not also help improve the health of residents, but it would also create jobs and improve local economies. Furthermore, legislation is expected to be proposed to the United States Senate and House of Representatives (PolicyLink 2010).

### **Employing GIS technology to identify and analyze food access patterns**

The food desert literature stresses how income level and location can critically affect social advantage in regards to obtaining nutritionally balanced food. It asserts that “residential locations and activity patterns differ among social groups, affecting their exposure to healthy and unhealthy environments” (McLafferty 2004: 52). In order to identify patterns of food access, many studies have employed the use of Geographic Information Systems (GIS) technology. GIS is a computer-based technology composed of hardware, software and data that is used to capture, display and analyze spatial data information. Today, an escalating number of organizations are using maps to address social problems, develop solutions and influence policy decisions. The range of applications that can utilize GIS include land use planning and tax assessment, management of natural resources and environmental analysis, transportation and logistics planning, emergency and dispatch services, and more recently, socioeconomic issues. The potential for more organizations and agencies to utilize GIS as an effective planning and policy tool is ever expanding.

Burtman (2009) claims that GIS mapping technology has the ability to give underprivileged communities the chance to get better services, ranging from education and transportation to health care and law enforcement. Ramasubramanian (1999) notes that accurate information is often seen as a source of power in the planning and decision-making process. He also argues that GIS has the potential to facilitate decentralization that will aid community based decision-making, ultimately contributing to a more empowered society. Countless states, towns, municipalities, counties, and community based organizations are starting to incorporate GIS as a necessity in their planning toolkit. This tool can enable organizations to increase their influence over the decision making processes that affect them. GIS is extremely beneficial for doing cross-site studies and for gaining knowledge about the dynamics of neighborhood change.

### **History and Description of GIS Technology**

GIS technology, in its most basic form, is able to incorporate geography and information into a system that can manage and analyze spatial data for many different purposes. Alibrandi and Sarnoff (2006) refer to geo-references as the “pins” that attach information such as facts, image, and events to certain points on a map. For example, demographic, economic, and environmental data can be visually linked with actual features on a map like a house, a tract of

land, or a stand of trees. GIS has the capability to provide users with representations of historical, cultural, and socioeconomic information in a way that is unique when compared to other data analysis tools. The technology dates back to the days of mainframes and punch cards in the 1960s. In 1962, the Canadian government introduced the Canada Geographic Information System designed to map national land-use data (Burtman 2009). During the 1970s a landscape architect, Ian McHarg, created a method to vertically overlay environmental data (topography, soils, etc.) with infrastructure such as roads and buildings. Saelens et al. (2003) claims that this innovative work outlined the basis of which geographic information systems (GIS) function. Roughly a decade later GIS was made available to anyone with enough technical background as further modifications to the software package combined with decreasing hardware prices (Burtman 2009). Market researchers were the first to utilize the technology on a large scale by mapping demographic data on household income, population density and the location of competitors to choose the best sites for retail expansion. Federal, state and local government agencies soon found GIS to be an invaluable way to drastically decrease inefficiencies in their planning processes.

#### *Applicability of GIS Technology*

GIS provides the opportunity to integrate “measures of proximity, connectivity, and density” with characteristics of household/individual behavior (Saelens et al. 2003). Kellogg (1999) identifies two main issues to consider when organizations desire to implement the use of GIS as part of their problem solving tool-kit: utility and capacity. Due to its ability to manipulate diverse geographic units to analyze and present information, GIS is the most appropriate technology to mold spatial representation to community perception. GIS has been used to examine critical environmental and public health issues, such as evaluating the efficiency of social service delivery (Kellogg 1999). The technology is able to track changes in neighborhood conditions over time and can analyze spatial relationships among socioeconomic conditions down to the census block level. Saelens et al. (2003) employ GIS to measure the distances from where people live to parks, gymnasiums, and other recreational opportunities that may affect physical activity. It allows users to visualize and simply complex data, store and maintain large amounts of geographically referenced information, and create superior maps at a variety of scales.

### Obtaining Data

Many organizations and agencies are posting their base maps and other layers on local websites. “Affordable, user-friendly GIS software, online-mapping systems and the explosion of government data available on the Web have combined to speed the spread of GIS into the public arena” (Burtman 2009: 1). Grassroots, community based organizations have been inspired by its potential application, but locating, gaining access to and manipulating the data into the correct format are often significant limitations to using the technology. Much of the literature (See Ramasubramanian 1999 and Kellogg 1999) stresses the need for a specific type of infrastructure that is able to facilitate the sharing and integration of GIS data, while at the same time addressing dilemmas of accuracy, security, and compatibility. In local organizations, it is very important that the groups have access to public information and data in order to encourage participation in this technology. Cynthia Taeuber, with the Census Bureau, calls for better integration of local and federal data: “As local communities begin to collect spatial data to increase efficiency, this data has the potential to be integrated into nationwide databases” (Knowledge@Emory 2002). Many initiatives are needed to increase access to the technology, work on developing data standardization measures and data sharing mechanisms (Ramasubramanian 1999).

However, due to certain perceived risks, such as national security, many government agencies have begun to restrict public access to GIS data by pulling the data off the internet or by charging high fees for downloads (Burtman 2009). Furthermore, Alibrandi and Sarnoff (2006) point out that GIS data can also produce major flaws in data and documentation. Even the smallest mistakes in ArcMap can produce major errors that could render certain information void. Furthermore, McLafferty (2004) highlights that with this technology also comes a heightened awareness about data confidentiality. GIS tools increase the potential for privacy violations by making it feasible to connect personal information to specific geographic locations.

### Limitations to GIS Technology

The application of GIS requires a certain amount of resources devoted to the many elements of utilizing the technology effectively. Having access to the necessary data and the specific hardware and software components, such as ArcGIS, is an issue for many organizations. Additionally, funds are needed for hardware and software maintenance and upgrades in order to have sustained use of GIS. Ramasubramanian (1999) cites how there is substantial evidence that

community groups, especially from low income areas, have a more difficult time obtaining and using information technologies, such as GIS.

One major limitation to the implementation of GIS is the lack of people who understand the complex procedures. Many organizations do not have the ability to draw upon the training and skills, such as working knowledge of certain computer operations, needed to use GIS effectively. Kellogg (1999) states that the presence of a staff person who specializes in GIS is an extremely important factor when determining the success of GIS in municipal or county planning agencies. Yet, it is unlikely that many organizations will have the necessary resources to provide a full time GIS support specialist. Often times, community groups are easily deterred by this because they would have to spend a lot of time, energy, and resources gathering, manipulating, and analyzing the data in a GIS program.

Kellogg (1999) and Ramasubramanian (1999) report that many community organizations make use of the assistance of intermediary organizations, such as universities, to assist with certain programs and financial support. Community and university partnerships have proven to be mutually beneficial in many cases. For example, in a 1992 study about homelessness in Milwaukee, the actual data management and the computer mapping tasks were performed by local university students and the research was directed by the needs and interests of the organization (Ramasubramanian 1999). Universities are capable of providing students in experiential learning classes that have the training and support of an academic institution. Moreover, universities can help community organizations in many aspects of the process including problem definition and program development, asset mapping, training and technical assistance, program evaluation and leadership training (Kellogg 1999). Universities may also provide avenues to develop more funding opportunities for civic organizations.

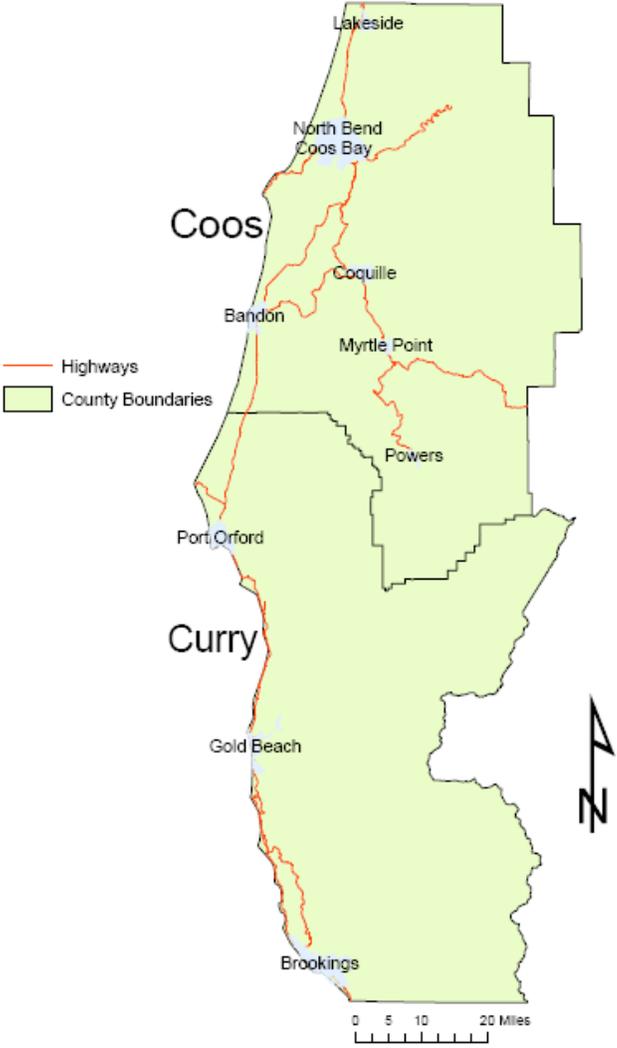
As the literature documents, there are multiple concerns to consider when defining, measuring, and documenting food deserts. Food access in urban areas may have different qualitative components that that in rural areas. Additionally, the methodology used to measure food access in these various regions may differ significantly in order to capture an accurate portrayal of the food environment. Organizations that are concerned with healthy food access, such as community action groups, could notably benefit from analyzing the food landscapes of local neighborhoods by using GIS technology.

## **Methodology**

### *Study Area: Coos and Curry Counties in Oregon*

Based on findings from the literature, this study attempts to provide a food access assessment for two counties on the Southern Oregon Coast. The study area is located on the Southern Oregon Coast, and represents 3,227.86 square miles of land. According to the 2000 U.S. Census, Coos and Curry Counties have a combined population of 84,318 residents. The study area is home to ten towns with urban growth boundaries including: Bandon, Brookings, Coos Bay, Coquille, Gold Beach, Lakeside, Myrtle Point, North Bend, Port Orford, and Powers. Most of the towns are small in size but the most population dense area is the towns of Coos Bay and North Bend with a combined population of 25,301 residents (U.S. Census Bureau 2010). Although the majority of these towns are quite small, many of them located near the coast cater to a large number of tourists during the summer months. This may prove to be a unique characteristic of this area. A national study conducted by Morton and Blanchard (2007) found that Coos County was classified as having low access to supermarkets. Yet, according to their criteria neither Coos nor Curry County as a whole, was considered a food desert. This study will provide a more intricate analysis of the study area to determine vulnerable areas down to the block group level.

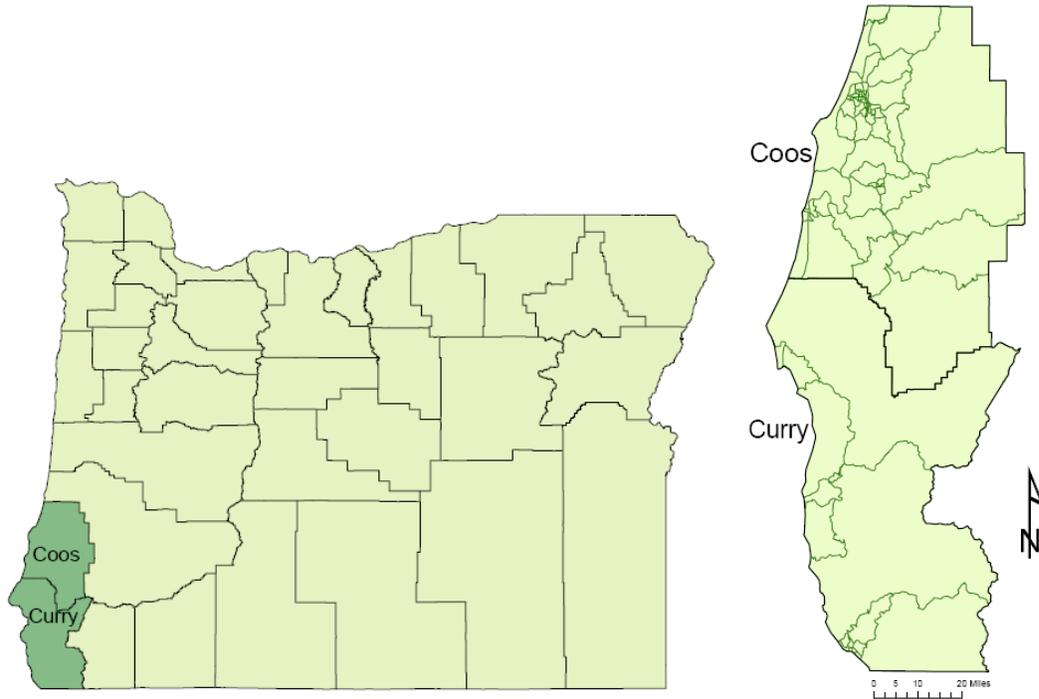
**Figure 1: Study area – Towns in Coos and Curry County**



Block groups were chosen as the unit of analysis for this study. There are 81 block groups in the study area (see Figure 2 below). The block group is the smallest area of which the U.S. Census Bureau collects aggregate data about socioeconomic information. This level provides geographic analysis that is necessary to infer neighborhood characteristics about specific areas. Census block groups are more homogeneous in regards to population characteristics than census tracts and generally contain between 600 and 3,000 people, depending on population density (Iceland and Steinmetz 2003).

**Figure 2: Study area in Oregon – Coos and Curry Counties**

**Block group boundaries**



*Classification of Urban and Rural Areas*

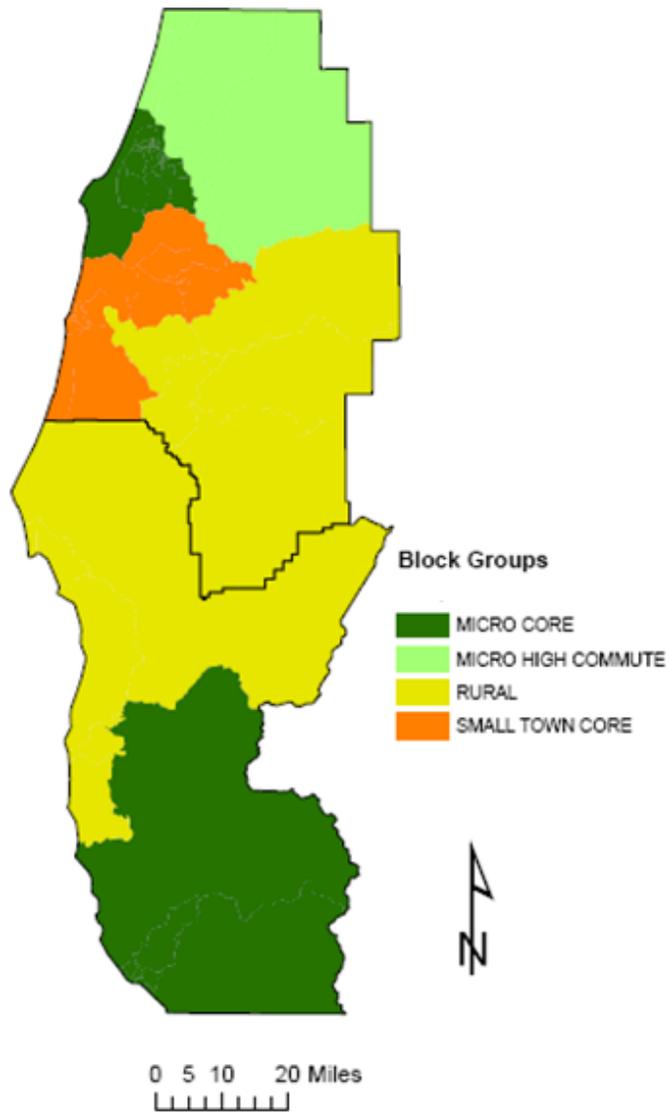
Overall, the study area does not have a very high population density and is fairly isolated. Many agencies consider the entire region rural. However, for the purposes of this study, it was necessary to explore different classification systems that more accurately represent the area. The exact definition of the term ‘rural’ continues to be debated by academics, and the story is no different for Oregon. For the diverse state of Oregon, many different definitions of rural have been proposed by several agencies based on specific criteria. The U.S. Census defines territories as rural if they have less than 2,500 people and a block group population density of less than 1,000 persons per square miles. However, this may not be the most effective measure due to the complexities of social, economic and demographic characteristics in urban and rural areas.

Weber and Crandall (2006) examine various classification systems for defining rural and urban areas in Oregon. Four classification systems are analyzed in the study and the authors concluded that the Economic Research Service Rural – Urban Commuting Area Codes (RUCA) classification is the most applicable. The authors feel that this coding system represents the most logical way to organize detailed spatial data because it incorporates commuting behavior. The

geographic basis for the RUCA Codes is census tracts (Weber and Crandall 2006). For the purposes of this study, the RUCA classification system will be used to categorize block groups. Coos and Curry Counties consist only of Micro core, Micro high commuting, Small town core, and Rural RUCA census tracts. Weber and Crandall (2006) point out that under this classification system there is little difference in the demographics of Micropolitan RUCAs and those in Small Town and Rural RUCAs. However, there are major differences in population density and street network density.

<b>Table 3. RUCA classification</b>	
Metropolitan Core	an Urbanized Area with population greater than 50,000
Micropolitan Core	a large Urban Cluster with population 10,000 – 49,999
Small Town Core	a small Urban Cluster with population 2,500 – 9,999

**Figure 3. RUCA classificaiton for study area**



GIS Analysis

All GIS analysis is conducted using ArcGIS Version 9.3. In addition to the direct population information from the 2000 U.S. Census, shapefiles for all 2000 Census block groups in Coos and Curry Counties are obtained. Block group shapefiles are added to additional data for Coos and Curry Counties including county boundaries, state boundaries, urban growth boundaries, water bodies, and roads to create a functional map of the study area for analysis purposes. Each shapefile is available to download from the internet without charge. Table 1

details the online source where each shapefile is obtained from.

Table 1. Online Sources for GIS Data	
Shapefile	Source
Urban Growth Boundaries	GEO Spatial Data Library: Oregon Geospatial Enterprise Office (GEO)
Highways	Oregon Spatial Data Library: Oregon Explorer
Water Bodies	Oregon Spatial Data Library: Oregon Explorer
State Boundary	Oregon Spatial Data Library: Oregon Explorer
County Boundaries	The GIS Data Depot
Block Group Boundaries	Census 2000 TIGER/Line Data
Roads	The GIS Data Depot
Food Stores	Custom layer created by geocoding addresses of all food stores
(Projection: GCS North American 1983)	

### Food Store Data

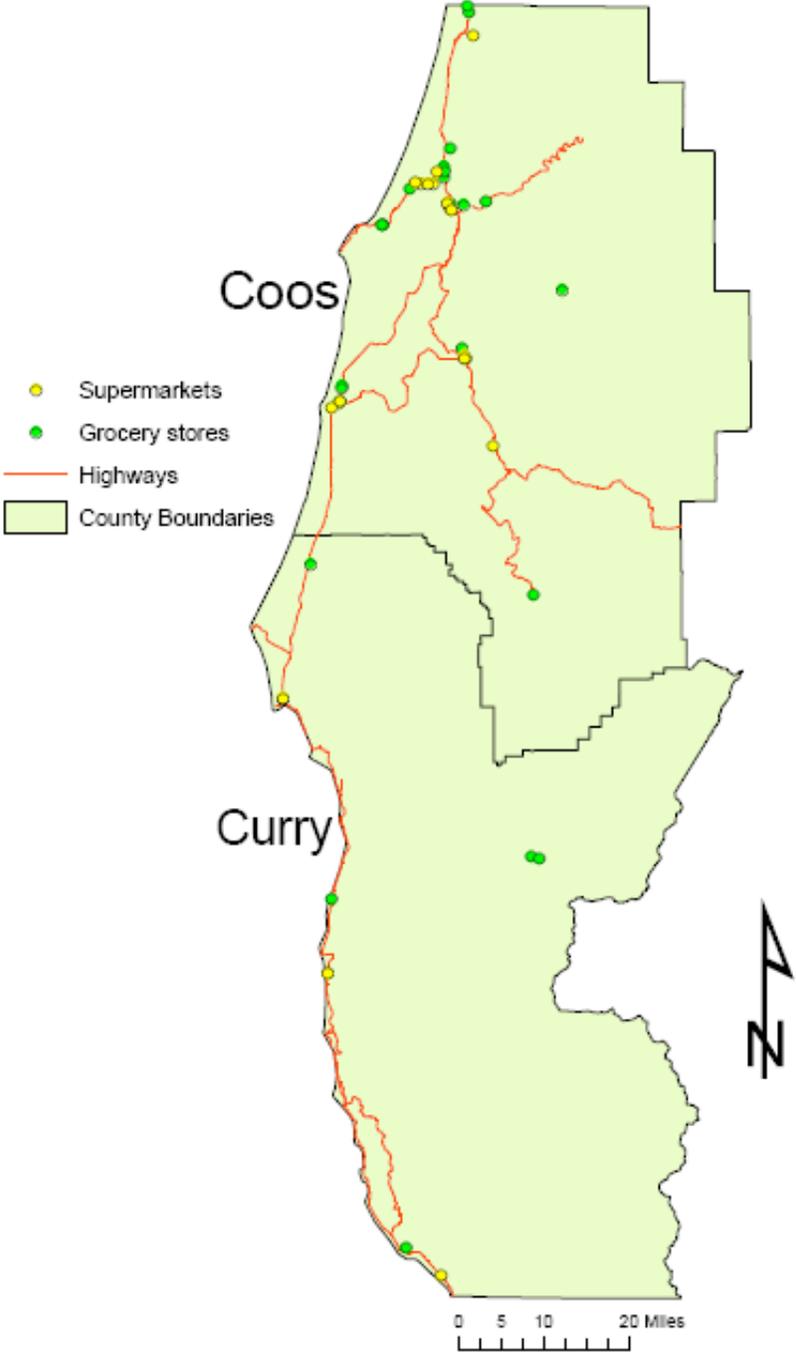
Information is collected for any retail facility that sells food (excluding prepared food such as restaurants): supermarkets, grocery stores, convenience stores, gas stations with food marts, certain department stores that sell food, pharmacies/drug stores, and all other specialty food stores. The classification of food stores is consistent with the food desert literature and the North American Industry Classification System (NAICS). Supermarkets are defined as large, corporate-owned “chain” stores, while grocery stores are defined as smaller noncorporate-owned food stores. Additionally, convenience stores, gas stations with food marts, certain department stores (such as Bi-Mart) and drug stores are included in the study because they contribute to the local food environment (Morland et al. 2002). Any specialty food stores, such as meat or vegetable markets are grouped together and categorized according. Food business characteristics and addresses are collected using ReferenceUSA, an online database of business information compiled from phone books, public records, and US Postal Service records (“ReferenceUSA: An infoUSA Company”). Searches within the database are conducted using the 2007 NAICS codes. Table 2 denotes the NAICS food store classifications that are found in the study area.

<b>Table 2. 2007 North American Industry Classification System (NAICS) codes and examples of food stores and food service places</b>			
<b>Industry Group</b>	<b>NAICS Definition</b>	<b>NAICS Index</b>	<b>Examples</b>
Supermarkets	445110 Supermarkets and other grocery stores (except convenience stores)	444110 Supermarkets	Safeway, McKay's, Rays Food Place
Grocery stores	445110 Supermarkets and other grocery stores (except convenience stores)	445110 Grocery stores 445110 Food stores	Davey Jones Locker Grocery, Four Corners Grocery, Wagon Wheel Grocery
Convenience stores	445120 Convenience stores	445120 Convenience stores	7-Eleven, Highway Deli Mart, Pelican Market
Convenience stores with gas stations	447110 Gasoline stations with convenience stores	447110 Gasoline stations with convenience stores	Shell, Harbor Chevron Food Mart, Northgate 76 Svc Station
Drug stores	446110 Pharmacies and Drug Stores	446110 Pharmacies and Drug Stores	Corner Drug, Chetco Pharmacy & Gifts, Bandon Pharmacy
Department Stores	452111 Department stores (except discount department stores)	452111 Department stores (except discount department stores)	Bimart
Specialty food stores	4452 Specialty food stores	445210 Meat markets 44522 Fish markets 445230 Fruit/vegetable markets 445291 Baked goods 445299 All other	Coquille Valley Produce Market, Bandon Fish Market

This study is focused on the availability of food stores through local, routine sources. Major supermarkets are the most likely site to supply the range of foods necessary for a healthy diet (Coveney and O'Dwyer 2008; Schafft 2009). Food sites such as farmers markets, community gardens, or farm stands are not included in this study due to the fact that food sources such as these often operate on a seasonal basis and limited hours (Schafft 2009). Churches, community groups, hospitals, schools, and nursing homes are excluded in this study because it is assumed that few people rely on these places for a significant portion of their diet (Morland et al. 2002).

Based on this criterion, 88 unique food stores and food service places were identified to be included in the study. Of these 88 stores, 83 were successfully geocoded to a street file, made available by the ArcGIS server. Of these 83 stores, there are 20 supermarkets, 27 grocery stores, 17 convenient stores (including gas stations with food marts), 6 drug stores, 2 department stores, 4 fish and seafood markets, 2 fruit and vegetable markets, 1 meat market, and 4 other specialty food stores. See Figure 4 below for the spatial distribution of supermarkets and grocery stores of the study area.

Figure 4. Spatial distribution of supermarkets and grocery stores



Demographic Data

Cross-sectional data are used to examine the relationship among block groups in regards to their socioeconomic characteristics. Data on neighborhood attributes for the study area are taken from the Summary File 3 of the 2000 U.S. Census at the census block group level. This

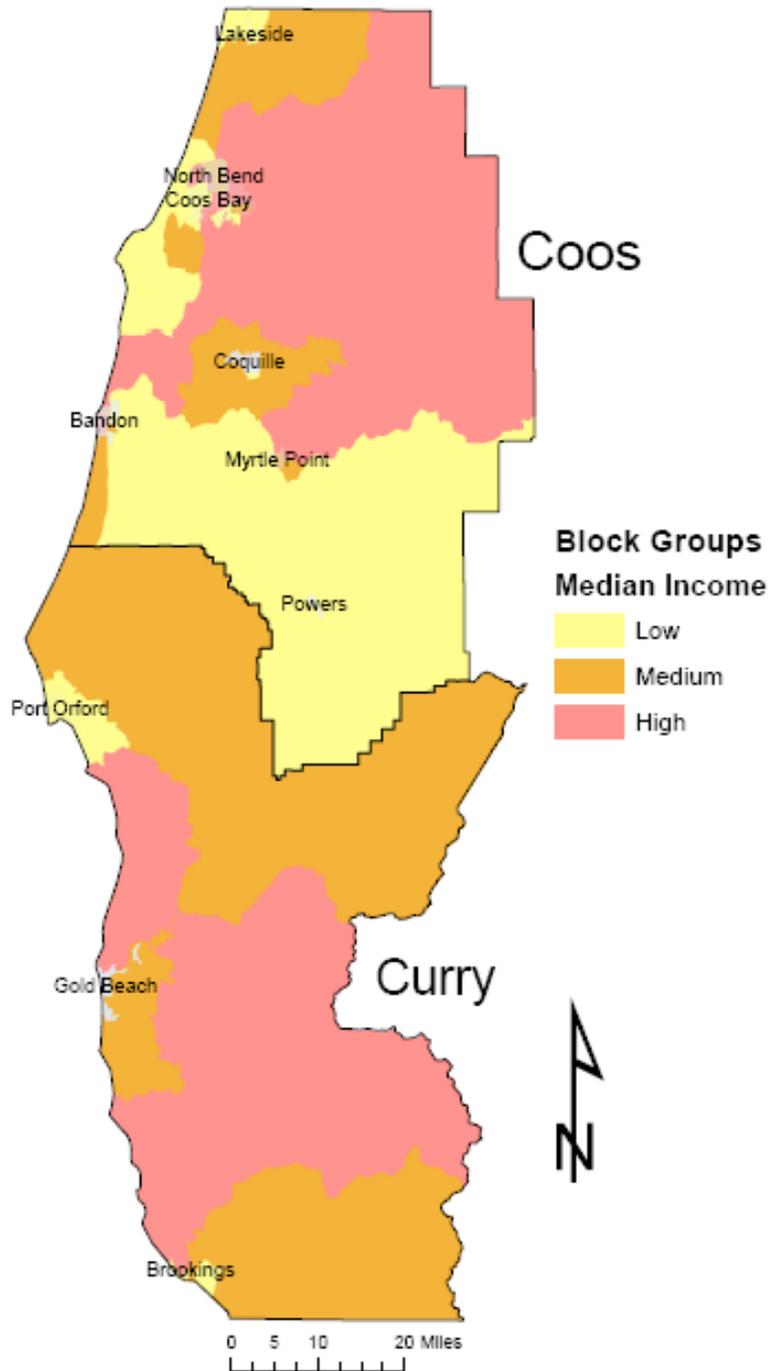
includes detailed population and housing data collected from a 1-in-6 sample and is weighted to represent the total population (U.S. Census Bureau American Fact Finder, 2010). Neighborhood characteristics included in the study are percent of the population whose household income is below 1999 poverty level, population density, percent of the population that is 65 or older, percent of households that are renters, percent of households without access to an automobile, and household income.

Due to the fact that the geographic centroid of each block group may not actually represent where the majority of the population resides (especially in rural areas), population-weighted centroids are used as the reference point of each block group. The U.S. Census Bureau estimates latitude and longitude points for the population-weighted centroid of each block group. The coordinates for each population-weighted centroid of all block groups in the study area were imported into ArcMap and converted into a shapefile. For analysis purposes, each block group is represented by its population-weighted centroid.

### Household Income

The median household income of each block group is used as a measure of household income for the purpose of this study. However, in the absence of household-specific data, it must be noted that homogeneity cannot be assumed among households in neighborhoods. The median household income for each block group are separated proportionately into three ordinal categories of income: low (\$11,141-27,386), medium (\$27,387-34,643), and high (\$34,644-58,472). By dividing census blocks into proportional thirds based on median income, it yields three groups of 27 census block groups. However, this measure does not take into account household size when considering income. Figure 5 below shows the spatial distribution of median household income.

**Figure 5: Block groups categorized by median household income**



### Measures of Food Access

This study employs the use of two criteria of food environment access: 1) Coverage (number) of food stores and store types within specified neighborhoods and 2) Proximity (distance) to the nearest food store from each population weighted centroid. Consistent with Morland et al. (2002), the number and type of each food store are recorded for each block group, and broken down by household income.

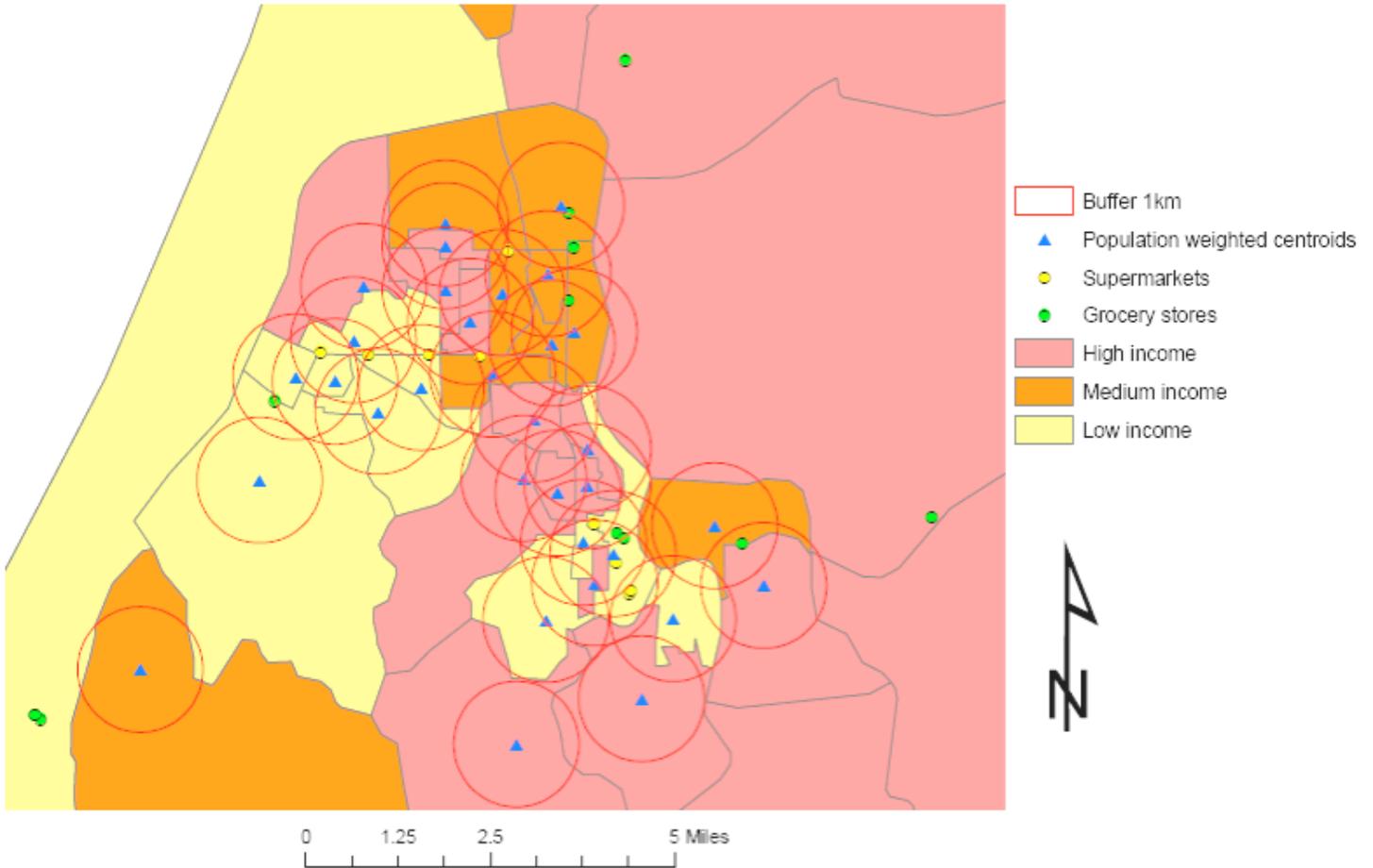
Because the micro core tracts are the only RUCA classification in the study area that have a relatively high population density and are centered on the three largest towns in the study area, a critical distance is chosen that is consistent with food desert studies that have been applied in urban areas. In the micro core RUCA block groups, a critical distance of 0.62 miles (1 km) is used to represent a maximum reasonable walking distance for an adult. This distance is used in Sparks et al. (2009) and highlighted in the USDA Food Desert Report to Congress (2009) as being the critical distance that is most often implemented.

Comparable concepts for less populated suburban and rural areas have been applied. However, what is considered to be a “reasonable” distance to food stores in rural areas is somewhat ambiguous. Nonetheless, for micro commuting, small town core, and rural RUCA block groups, a critical distance of 10 miles is used to represent an acceptable driving distance to a supermarket or a grocery store in a rural area. This proximity measure is consistent with studies conducted by Morton and Blanchard (2007) and Schafft (2009).

As done in Schafft (2009), ArcGIS is used to create geographic buffer zones of 0.62 miles or 10 miles (depending on the RUCA classification) around each population-weighted centroid (See Figure 6). If a population centroid of a particular block group is farther than the respective critical distance from a supermarket or grocery store, then that block group is identified as having the potential to be a food desert. Block groups that are classified as low-income and have population centroids that are more than the critical distance away from a supermarket are classified as food desert candidates. This process is illustrated below in Figure 6.

**Figure 6. Geographic buffer zones around population weighted centroids of block groups (Zoomed into the towns of Coos Bay and North Bend)**

Buffers of 1 km (red circles) are drawn around the population weighted centroid of each block group (blue triangles). Proximity to food stores is determined by identifying how many supermarkets or grocery stores intersect each buffer.



\*For a sensitivity analysis, a critical distance of one mile was also analyzed in the micro-core block groups. The classification for food desert candidates were very similar when using this critical distance measure except for one block group (Tract 7; blockgroup 6) that would not have been considered a food desert candidate.

## **RESULTS**

The means and standard deviations of census block group characteristics by median household income are shown in Table 4. On average, the low-income block groups contain fewer people, and the areas of these block groups are the smallest. Residents of the low-income neighborhoods are more likely than wealthier neighborhood residents to be renters. The low-income block groups also have a higher percentage of elderly residents, on average. Interestingly, the average percentage of households without a vehicle remains constant across all income categories.

	Median Household Income		
	Low	Medium	High
	(n=27)	(n=27)	(n=27)
<b>Characteristics</b>	<b>Mean (SD)</b>	<b>Mean (SD)</b>	<b>Mean (SD)</b>
Population	997 (313)	1039 (309)	1072 (391)
Area (sq Mi)	50.2 (113.5)	79.5 (229)	95 (223.6)
Population density (person/sq Mi)	520 (564.2)	546 (686.4)	668.2 (850.2)
Percentage of households whose income is below 1999 poverty level	19 (6)	13 (6)	11 (7)
Percentage of residents who are renters	36 (17)	33 (11)	25 (9)
Percentage of residents who are 65 or older	24 (9)	20 (7)	18 (5)
Percentage of households without a vehicle	3 (3)	3 (2)	3 (3)

Considering the RUCA classification, the low and medium-income block groups have a higher percentage of rural block groups than the high-income block groups (22% and 19% compared to 7%). The high-income block groups have a higher percentage of Micro high commute block groups than both low and medium-income block groups (19% compared to 7% in both low and medium-income).

	Median Household Income		
	Low	Medium	High
	(n=27)	(n=27)	(n=27)
<b>RUCA Classification</b>			
Percent Micro core	56	48	59
Percent Micro high commute	7	7	19
Percent Small town core	15	26	15
Percent Rural	22	19	7

To demonstrate the coverage measure of food stores across neighborhoods of various levels of income, frequencies of food stores by median household income are shown in Table 6. The types of food stores that exist in poor and wealthy neighborhoods are different. The initial findings conflict with most food access studies that claim that stores carrying more nutritional food options (supermarkets) are more prevalent in wealthier neighborhoods. The results here show that there are 40% more supermarkets in low-income neighborhoods when compared to medium-income neighborhoods and 55% more supermarkets when compared to high-income neighborhoods. The number of smaller grocery stores is fairly evenly spread out across all income block groups. In Coos and Curry Counties, the expected pattern of supermarkets being out of reach of poorer residents is not evident.

However, these findings do support the literature with regard to convenience stores, such food stores are more prevalent in low-income areas. In the study area, approximately twice as many convenience stores are located in low-income neighborhoods. The most prevalent type of food store is the grocery store with 27 stores out of the 83 total stores.

<b>Table 6. Frequency of food stores by household income</b>			
	<b>Median Household Income</b>		
	<b>Low (n=27)</b>	<b>Medium (n=27)</b>	<b>High (n=27)</b>
<b>Industry group</b>			
<b>Supermarkets (n=20)</b>	13	5	2
<b>Grocery stores (n=27)</b>	6	7	6
<b>Convenience Stores (n=17)</b> (including gas stations with food marts)	8	5	4
<b>Drug Stores (n=6)</b>	3	2	1
<b>Department Stores (n=2)</b>	1	1	0
<b>Specialty Stores (n=11)</b>	6	4	1

The frequencies of food stores by RUCA classification are shown in Table 7 to display the coverage of food stores across micro core, micro commute, small town core and rural areas. Not surprisingly, the results are fairly consistent across the board. There are significantly more food stores in the micro core block groups than anywhere else.

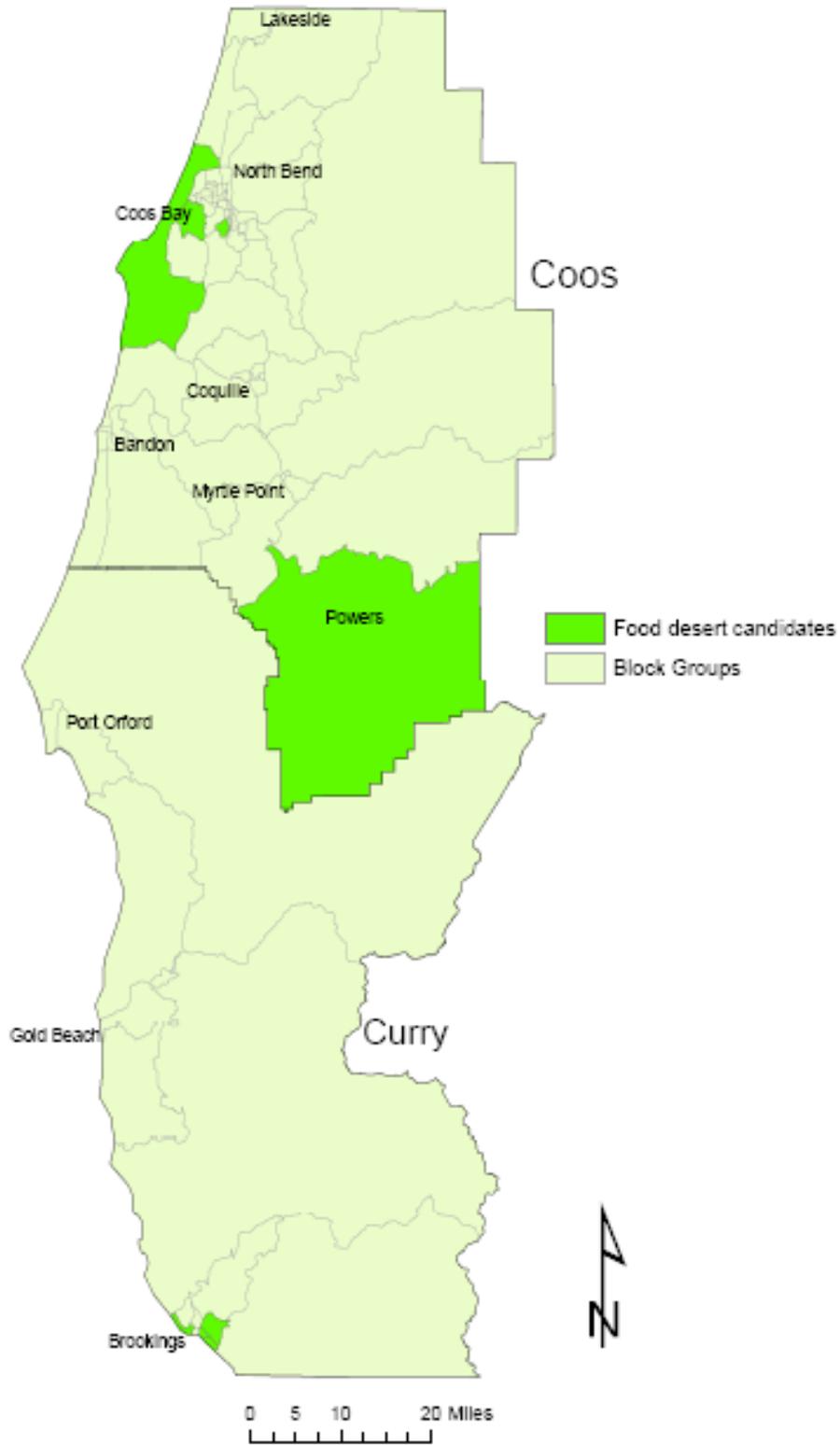
	RUCA classification			
	Micro core (n=44)	Micro commute (n=9)	Small town core (n=15)	Rural (n=13)
<b>Industry group</b>				
<b>Supermarkets (n=20)</b>	10	1	5	4
<b>Grocery stores (n=27)</b>	12	5	5	5
<b>Convenience Stores (n=17)</b> (including gas stations with food marts)	13	0	2	2
<b>Drug Stores (n=6)</b>	3	0	2	1
<b>Department Stores (n=2)</b>	2	0	0	0
<b>Specialty Stores (n=11)</b>	7	0	4	0

The second food access measure, proximity, is used to describe several patterns of food access within the study areas. Table 8 confirms that residents in the core areas of the study area (micro-core and small town-core) have a shorter distance to travel to get to a full-service supermarket. However, the micro-core area that centers on Brookings covers a larger area and the average distance to supermarket in that region was more similar to the distances traveled in the micro-commute and rural RUCA block groups.

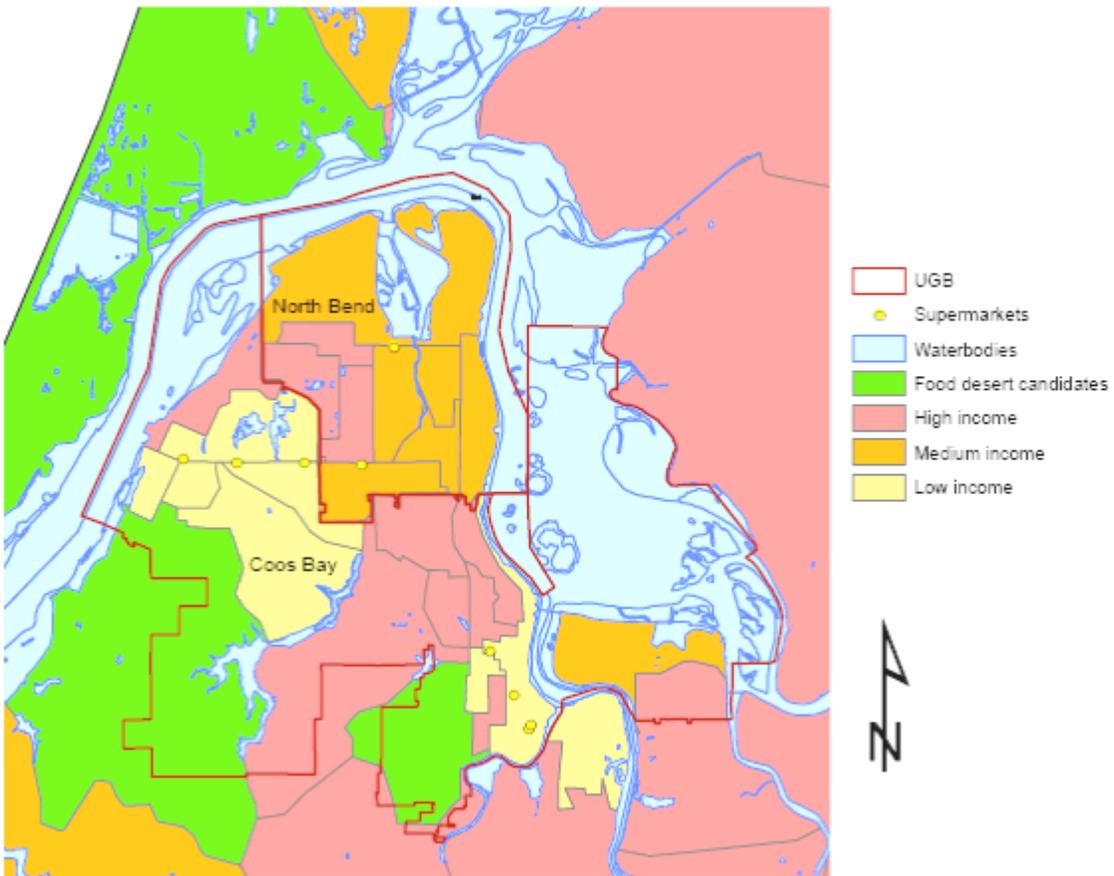
RUCA classification	Mean distance (Standard deviation)			
Micro-core (Coos Bay/North Bend)	1.41 mi (1.67 mi)			
Micro-core (Brookings)	5.23 mi (2.78 mi)			
Micro-commute	5.19 mi (3.68 mi)			
Small town-core	2.87 mi (2.89 mi)			
Rural	5.27 mi (5.47 mi)			

This study determines which block groups are candidates for food deserts based on the criteria outlined in the methodology section. Figure 7 shows the location of the eight micro core block groups and one rural block group that were chosen as food desert candidates. Figure 8a and 8b are close-up views of Coos Bay/North Bend and Brookings in order to show the micro core food desert candidates in more detail.

Figure 7: Food desert candidates in study area



**Figure 8a: Micro core food desert candidates in Coos Bay and North Bend**



**Figure 8b: Micro core food desert candidates in Brookings**

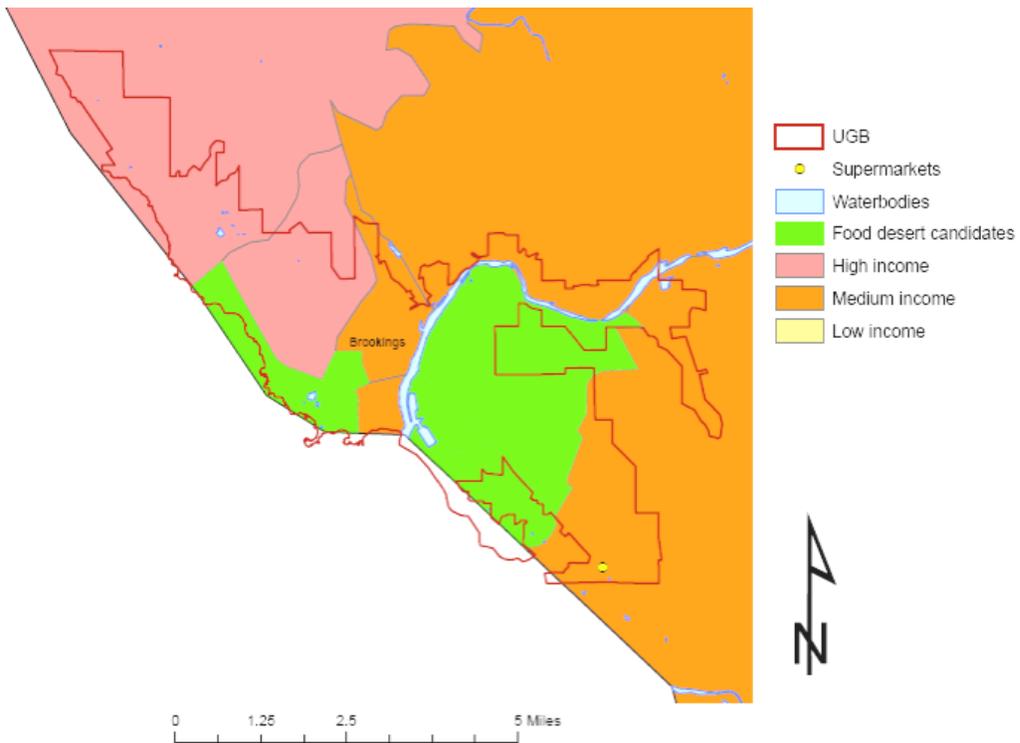


Table 9 below illustrates the demographic characteristics for each block group that was characterized as a food desert candidate. The total number of people living in the identified block groups is 9,794 and the total number of households is 4,011. There are still a relatively high percentage of renters in the food desert candidate block groups; however most are still below the average percentage of renters (38%) for all of the low-income block groups in the study. Two block groups located in Coos Bay have poverty levels over 20%. Five of the food desert candidate block groups have a somewhat high percentage of households without a vehicle (over 5%); two block groups located in Brookings have a percentage at or around 10% of household that do not have access to a car. This is much higher compared to the average percentage of all low-income block groups. Lastly, the results show that the food desert candidate block groups located in Brookings and one block group from Coos Bay have elderly populations that are much higher than that of the average of all low-income block groups. The numbers at the bottom of the table represent statistics for all the low-income block groups from the study. These numbers represent the average percentage of individuals/households for certain demographic characteristics. This sub-table is included as a comparison measure for the demographic characteristics of the food desert candidate block groups.

<b>Tract; block group</b>	<b>Town center</b>	<b>Total population</b>	<b>Total households</b>	<b>% renters</b>	<b>% households whose income was below 1999 poverty level</b>	<b>% no vehicle</b>	<b>% over 65</b>	<b>Population density (per sq. Mi)</b>
501; 6	Coos Bay	1934	788	36	26	4	16	187
7; 6	Coos Bay	1293	493	31	21	6	14	673
502; 2	Coos Bay	779	416	29	13	6	35	3
11; 7	Powers	1027	449	29	19	3	21	3
950302; 3	Brookings	1108	532	57	13	0	39	577
9504;3;	Brookings	1681	789	21	14	2	31	291
9504; 2	Brookings	848	491	21	15	9	43	1102
9504; 1	Brookings	1124	535	18	12	10	38	975
<b>Socio-economic characteristics for all low-income block groups for comparison</b>								<b>Mean (Standard deviation)</b>
				38 (15)	17 (84)	3 (3)	18 (69)	624 (585)

This study bases the classification of food desert candidates on block groups that are placed in the low-income category (a median household income under \$27,386). Due to the fact that the income measure in this study may not reflect the number of block groups that would be considered “low-income” on a national scale, income sensitivity is considered. A frequently used method for categorizing low-income is households below 200 percent of the poverty line. By using this definition, a family of two in 2000 would be considered low-income if their income was under \$22,470 or for a family of four, \$35,208 (U.S. Census Bureau 2008). Appendix A and Appendix B contain illustrations of the block groups that would be considered food desert candidates if *medium-income* block groups were included as well as low-income block groups (a median household income under \$34,643). This would add six block groups in Coos Bay/North Bend and four block

groups in Brookings to the food desert candidate category. In addition, Appendix D and Appendix E display the block groups that would be considered food desert candidates if income was not a determining factor and the criteria was based solely on the critical distance. This measure would add nine block groups to the Coos Bay/North Bend area and three block groups in Brookings to the food desert candidate category. Altering the income measure for this study only affects the micro-core block groups; the results remain the same for all other RUCA block groups. It is important to consider the sensitivity of income classification when considering which block-groups to label as food desert candidates.

## **Discussion**

This study demonstrates how effective GIS technology can be to analyze local food environments. GIS can be an extremely useful tool for community organizations that would benefit from being able to spatially analyze the area and residents that they serve. Using specific methodology, I was able to determine what types of food stores exist in the study area and exactly where they are located. Additionally, I was able to use specific criteria to identify and characterize areas that have the high risk of not being able to meet their nutrition needs. These neighborhoods have been labeled ‘food desert candidates’.

The results from the food store coverage analysis support the literature in some aspects but not in others. Previous research maintains that there is a general pattern of fewer full service supermarkets located in low wealth neighborhoods. However, in Coos and Curry Counties, there are almost three times as many supermarkets in low-income areas compared to medium income, and roughly six times as many supermarkets when compared to high-income areas. This could possibly be due to the unique layouts of coastal towns. When most towns and cities in the United States started to increase in size, they had physical room to sprawl outwards and many supermarkets relocated to the suburbs. Due to geographical limitations, such as bodies of water, the coastal towns in Southern Oregon may have been constrained to keep supermarkets within the inner centers of the town. For example, almost all of the supermarkets in the Coos Bay/North Bend area are located along major highways or streets (Newmark Ave. and Hwy 101) where many low-income block groups reside. The impact of tourism or seasonal residents may also play a role in this particular study, but it is unclear from these results.

Consistent with the literature, results from the food store coverage analysis of this study also demonstrate that there are approximately twice as many convenience stores located in low-income neighborhoods when compared to medium and high-income block groups. This supports the ‘food swamp’ theory which claims that healthy food access research should focus more on the abundance of unhealthy food options that tend to swamp out better choices.

The results from the proximity analysis reveal interesting information about the characteristics of the residents and households that are identified as living in food desert

candidate block groups. There are about 9,000 people who reside in these areas, confirming that many people in the study area could potentially be affected by location when trying to access healthy foods. The two block groups located in Coos Bay have poverty levels over 20%. This stresses the importance of reaching out to these particular areas and shaping policies that are designed with this in mind. Two of the food desert candidate block groups in Brookings have high percentages of households without a vehicle (9 and 10%). For these neighborhoods, it might be effective to construct policies oriented towards transportation. Finally, the food desert candidate block groups in Powers and Brookings have particularly high percentages of elderly residents. Powers has a rate of over 20% and the block groups in Brookings have rates of 31%, 38%, 39%, and 43% of residents who are over the age of 65. The literature states that elderly individuals are especially susceptible to being at-risk due to limited mobility and high rates of fixed incomes (Morton and Blanchard 2007; Furey et al. 2001). So policies in these block groups may be focused more on this specific population statistic.

As expected, there were much fewer food stores in the micro-commute, small town-core, and rural RUCA block groups. Residents in these block groups also had to travel further (roughly four miles on average) than the micro-core block groups in the Coos Bay/North Bend region where most of the food stores in the study area are located. So although there was only one rural block group that was categorized as a food desert candidate in this study, these areas outside the micro-core remain extremely vulnerable for becoming food deserts. As the food retail industry continues to consolidate, supermarkets and grocery stores in these regions may be more at-risk for closure. It is important to monitor the status of the food store landscape of the rural block groups to ensure that residents are maintaining reasonable access to healthy groceries.

This study suggests how GIS may 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 conclusions from this study contrast with findings from the literature, the proximity measures were able to effectively identify vulnerable regions in Coos and Curry Counties. In terms of public policy, this technology may prove to be extremely valuable for organizations concerned about the health and well-being of their communities. Once these at-risk areas are identified, it opens up the possibility for targeting specific neighborhoods and implementing effective policy.

The biggest and most influential community organization in the study area is the Oregon Coast Community Action (ORCCA) agency. It is located in the town of Coos Bay and serves the entire Southern Coast of Oregon. It is a nonprofit network of programs that offers a variety of

assistance to disadvantaged families. The South Coast Food Share is focused on providing hunger relief in Coos and Curry counties and serves as the regional food bank for Oregon Food Bank (ORCCA 2010). A program like ORCCA that is committed to assuring that everyone in their region is able to obtain healthy foods, would greatly benefit from the help of GIS technology. From this study, ORCCA will now have a more detailed picture about what their food environment looks like. This study was able to effectively identify potential areas where healthy food access is low. The organization could now focus more resources in the neighborhoods that have been identified as food desert candidates or other areas which they determine are vulnerable from this study. This may include implementing policies designed to alleviate the stresses that low-income families face when attempting to access healthy food.

Although GIS can help answer some pressing questions, it is important to keep in mind the limited capacity and utility elements that are mentioned in the literature review. If ORCCA had access to a GIS technician, they would be able to update spatial and residential data and manipulate analyses based on criteria that are more specific for their needs. The technology enables users to categorize areas of geography to suit their needs. For example, they might benefit more from knowing which rural block groups are 5 miles away from supermarkets instead of the critical distance of 10 miles that was used in this study. Furthermore, they would be able to apply spatial analysis to a variety of other social problems that they are faced with such as affordable housing, providing energy assistance, and disaster planning. “It is anticipated that spatial mapping and analysis will be valuable to community organizations and groups because it can be used skillfully to identify issues, make comparisons, analyze trends, and support socio-political arguments thereby facilitating policy analysis, service delivery, and community participation” (Ramasubramanian 1999: 88). Spatial analysis opens up the possibility of answering pressing questions in a different way, and provides users with a unique opportunity to become more empowered when tackling problems such as food access.

### **Policy Recommendations**

Healthy food access for socio-economically disadvantaged communities will continue to remain a complex issue. With so many possible factors affecting an individual’s consumption of a nutritionally balanced diet, it will be difficult to pinpoint the extent to which environmental and physical elements hinder or encourage healthy behavior. However, this study proves that having access to GIS technology significantly improves the ability to identify and analyze at-risk areas. The policy recommendations will be separated into two foci: 1. Suggestions for making GIS

technology more available to community organizations and 2. Specific proposals to mitigate the problem of healthy food access for low-income residents. Depending on the social constructions of target populations, particular policy tools are frequently used. The powerless but deserving group of the *dependents* is likely to be given a minimal amount of benefits from policy makers. These benefits tend to be clearly visible to the public because of their positive construction and burdens, although rare, are often hidden.

Organizations that are attempting to understand their local food environments would greatly benefit from being able to spatially analyze particular areas. It significantly improves their ability to examine and target at-risk regions. Unfortunately, the application of this technology requires very specific resources and expertise in order to effectively analyze data. And, as Ramasubramanian (1999) points out, many community organizations, such as ORCCA, struggle to get access to information technologies. Because many of these community organizations tend to focus on providing aid for groups of people that are socially constructed as *dependents*, they tend to receive little support from the government. Although policy makers try to avoid being blamed for not helping this group more, they do not offer much support due to the fact that *dependents* usually have limited political resources to offer in return.

In these cases, it would be extremely valuable to enact the support of intermediary entities, such as universities, to help overcome some of the barriers of utilizing GIS. Community and university partnerships are known to be mutually beneficial; the organizations are able to access expertise and additional resources, and students are able to develop important skills. Furthermore, the utilization of GIS technology demonstrates a unique understanding of particular issues that has the possibility of attracting new funding sources for community organizations. Institutions concerned about food access can use GIS to identify vulnerable areas, make comparisons, and examine trends. If used effectively, it would be able to empower community groups and give them the support they need to influence policy.

Another possible proposal to make GIS technology more accessible involves converting the data into a more user-friendly format. This would enable users who only have minimal skills to update, manipulate, and analyze spatial data. This process would still most likely involve an intermediate organization to construct the initial data frame. However, if a technology was implemented that could convert GIS data into easy-to-use software, it could encourage more independence amongst many community organizations. One example of this is the Food Environment Atlas developed by the USDA Economic Research Service (2010). It provides

users with statistics on food environment indicators about factors affecting food choice and it displays this information spatially. However, this information is only available at the county level, making it difficult to analyze on a more detailed level. Another example of this type of technology is the Oregon Explorer advanced mapping tool. It is an online spatial data library that houses more than 200 data sets and provides access to all statewide ‘framework’ data available for Oregon (Oregon State University 2010). The possibility of an effective web-based browser would expand access even further because it could provide convenient ways to utilize spatial data at no cost to the user.

The second component of the policy recommendations from this study will focus on potential efforts to eradicate problems in areas that lack good access to healthy foods. Once the local food environment has been analyzed, there are several actions that parties can pursue. One of the most obvious solutions is to encourage large supermarket retailers to locate in identified food desert areas. Wrigley et al. (2002) cites research that shows how introducing new food stores to areas of low food access has a positive effect on healthier diets. Morland et al. (2002) also claims that locating an additional supermarket in a U.S. census tract could potentially increase fruit and vegetable consumption. An example of this type of policy intervention is the Fresh Food Financing Initiative (FFFI) in Pennsylvania. Over the course of six years, this organization has developed 83 new or improved grocery stores in underserved communities in Pennsylvania (USDA 2009a). It claims to have increased access to healthy food for 400,000 residents and to have generated 4,860 jobs in the process. However, major retailers are clearly reluctant to consider locating to low income neighborhoods for a variety of reasons (Clarke et al. 2002). From an economic standpoint, access to affordable and nutritious food depends on supply (availability) and consumer demand. Depending on the market barrier, effective policies might involve government subsidies or restructured zoning rules for small retailers that place stores in susceptible neighborhoods. Policies such as these are often geared towards groups that are social constructed as being in the *advantaged* category, such as small grocery store businesses.

Another policy strategy that has been suggested and implemented in several regions involves focusing on developing a more accessible transportation infrastructure. Coveney & O’Dwyer (2008) found that living in a food desert did not, by itself, restrict food access. It was more dependent on the available forms of transportation. For many low-income households without a car, the local bus system is often inadequate in providing for their transportation needs. Creating van pools/shuttles for connecting residents to supermarkets was proposed in several

studies, as well as providing taxi vouchers to qualified households. Conversely, Clifton (2004) asserts that transit based policy recommendations do not get at the root of the problem, and generally conflict with other sustainability goals like decreasing congestion and pollution.

Several examples of innovative public policy interventions have been cited in the literature as possible models to follow. The Healthy Bodegas and Health Bucks program that has been implemented by New York City is attempting to mitigate access disparities to certain healthy foods. The program encourages small grocery stores (bodegas) that are located in potential food deserts to increase the amount of healthy foods in their stores, namely fresh produce. The city also provides educational materials to persuade residents to purchase the new food offerings (Ver Ploeg 2010). Short et al. (2007) also note how certain small markets participating in good neighbor programs generally receive subsidies and other incentives for stocking more nutritional food choices. Additionally, the Fresno Fresh Access Project was highlighted in the USDA Report to Congress (2009) as an example of a successful community food access project. The Fresno Metropolitan Ministry trained more than 80 community leaders, performed more than 850 surveys of consumers, and surveyed 131 retail stores. The project utilized GIS mapping software to develop a base map of the food system in Fresno County that was used as a reference for the entire project.

Developing alternative and innovative methods for distributing healthy foods to at-risk communities is no easy task. Because this problem stretches across so many sectors, it is imperative that an inter-disciplinary approach is taken that may involve local authorities, health officials, local/state government, community programs and retailers. Viewed through the lens of social construction, the *dependent* group is offered policies that appear to provide rewards, but the benefits are usually too small to have a major effect. This reality leaves community organizations and local governments that have limited resources to develop innovative strategies to provide support to these groups. A synthesis of approaches is required in order to improve access to nutritious food for individuals who are struggling to lead a healthy life.

### Limitations to this Study

To the extent that the physical environment does affect healthy eating habits, several limitations are involved with the methodology of this study. First of all, intermediate methods were used to collect the location and characteristics of all the food stores. Direct methods, referred to as “ground-truthing”, such as in-person audits or inventory, was not conducted in this

study (Sharkey 2009). Data on the actual availability of healthy food options was not obtained via in-store visits; therefore, it is solely reliant on the NAIC classification system to determine which stores are considered supermarkets that are found to have the best availability of healthy foods. Furthermore, the measures of distance are all Euclidian (straight-line distance), which may not represent the actually distance that must be walked or driven to access a supermarket. This limitation would be more apparent when studying rural food deserts as opposed to studying areas that have a higher population density and a more concentrated street/sidewalk grid. Furthermore, the methods used in this study assume that consumers only use their nearest shop, which may not be realistic. Future studies would benefit from measuring the range of shopping opportunities that are available to consumers. Lastly, the proximity analysis in this study is based off of the population-weighted centroids of each block group; it does not account for the commuting patterns of residents, such as grocery shopping before or after work.

## **Conclusions**

There are obvious restrictions to the view that proximity to or coverage of food stores in particular neighborhoods has a significant impact on individual food choices. The factors affecting healthy food consumption are multiple and most likely extend well beyond spatial or geographic features (Schafft 2009). Although the food desert literature addresses just one piece of the food access problem there is plenty of valuable information that can be gathered from spatial analysis. It is critically important for future studies to consider how the local food environment may be creating barriers to healthy eating, especially for underprivileged areas. The implementation of GIS technology for identifying at-risk communities is key to understanding these complex spatial relationships. By taking advantage of the help of intermediary institutions, community groups would greatly benefit from using GIS to analyzing local food access patterns. With the support and credibility that comes from high-quality data analysis, organizations could be more effective at acquiring additional sources of funding and influencing policy.

## **Further Research**

The subject of healthy food access would greatly benefit from further research. Additional refinement of the definition of food deserts, particularly in rural areas, would allow researchers to more accurately classify regions as having low food access. Using GIS in conjunction with multivariate models to examine the relationship between neighborhood need and potential spatial access to food stores might give researchers a better understanding of situations in particular areas. Lastly, as the consolidation of food stores becomes more of a

concern in rural areas, an important focus of research would be to explore the pattern of food stores closing down or limiting healthy food options in these areas. GIS technology could also be applied to examining other aspects of the rural food environment such as delivery routes.

## References

- Alibrandi, Marsha and Herschel Sarnoff. 2006. Using GIS to Answer the ‘Whys’ of ‘Where’ in Social Studies.” *Social Education* 70(3): 138-143.
- Burtman, Bob. “The Revolution Will Be Mapped.” 2009. Miller-McCune. Retrieved January 1, 2010 ([http://www.miller-mccune.com/culture\\_society/the-revolution-will-be-mapped-1650](http://www.miller-mccune.com/culture_society/the-revolution-will-be-mapped-1650)).
- Camou, Michelle. 2005. “Deservedness in Poor Neighborhoods: A Morality Struggle.” Pp. 197-218 in *Deserving and Entitled: Social Constructions and Public Policy*, edited by Anne Schneider and Helen Ingram. Albany: SUNY Press.
- Clarke, Graham, Heather Eyre, and Cliff Guy. 2002. “Deriving Indicators of Access to Food Retail Provision in British Cities: Studies of Cardiff, Leeds and Bradford.” *Urban Studies* 39(11): 2041-2060.
- Clifton, Kelly. 2004. “Mobility Strategies and Food Shopping for Low-income Families.” *Journal of Planning Education and Research* 23: 402-413.
- Coveney, John and Lisa O’Dwyer. 2008. “Effect of Mobility and Location on Food Access.” *Health & Place*. 15: 45-55.
- “Current Population Reports, P60-235.” 2008. The United States Census Bureau. Retrieved June 4, 2010 (<http://www.census.gov/hhes/www/poverty/histpov/hstpov1.xls>).
- Donkin, Angela J.M., Elizabeth A. Dowler, Simon J. Stevenson, and Sheila A. Turner. 1999. “Mapping Access to Food in a Deprived Area: The Development of Price and Availability Indices. *Public Health Nutrition* 3: 31–38.
- Edwards, Mark. 2010. “Understanding Food Insecurity and ‘Hunger’ in Oregon.” Fact Sheet No. 10-01. Rural Studies Program, Oregon State University, Corvallis, OR.
- “Food Security in the United States: Definitions of Hunger and Food Security.” 2009b. United States Department of Agriculture - Economic Research Service. Retrieved May 5, 2010 (<http://www.ers.usda.gov/Briefing/FoodSecurity/labels.htm>).
- Furey, Sinead, Christopher Strugnell, and Heather McIlveen. 2001. “An Investigation of the Potential Existence of “Food Deserts” in Rural and Urban Areas of Northern Ireland.” *Agriculture and Human Values* 18: 447–457.
- “Food Environment Atlas”. 2010. United States Department of Agriculture - Economic Research Service. Retrieved May 10, 2010 (<http://maps.ers.usda.gov/FoodAtlas/>).
- “GIS Holds Promise of Launching Next Big Information Revolution.” 2002. Knowledge@Emory. Retrieved February 16, 2010 (<http://knowledge.emory.edu/article.cfm?articleid=602>).

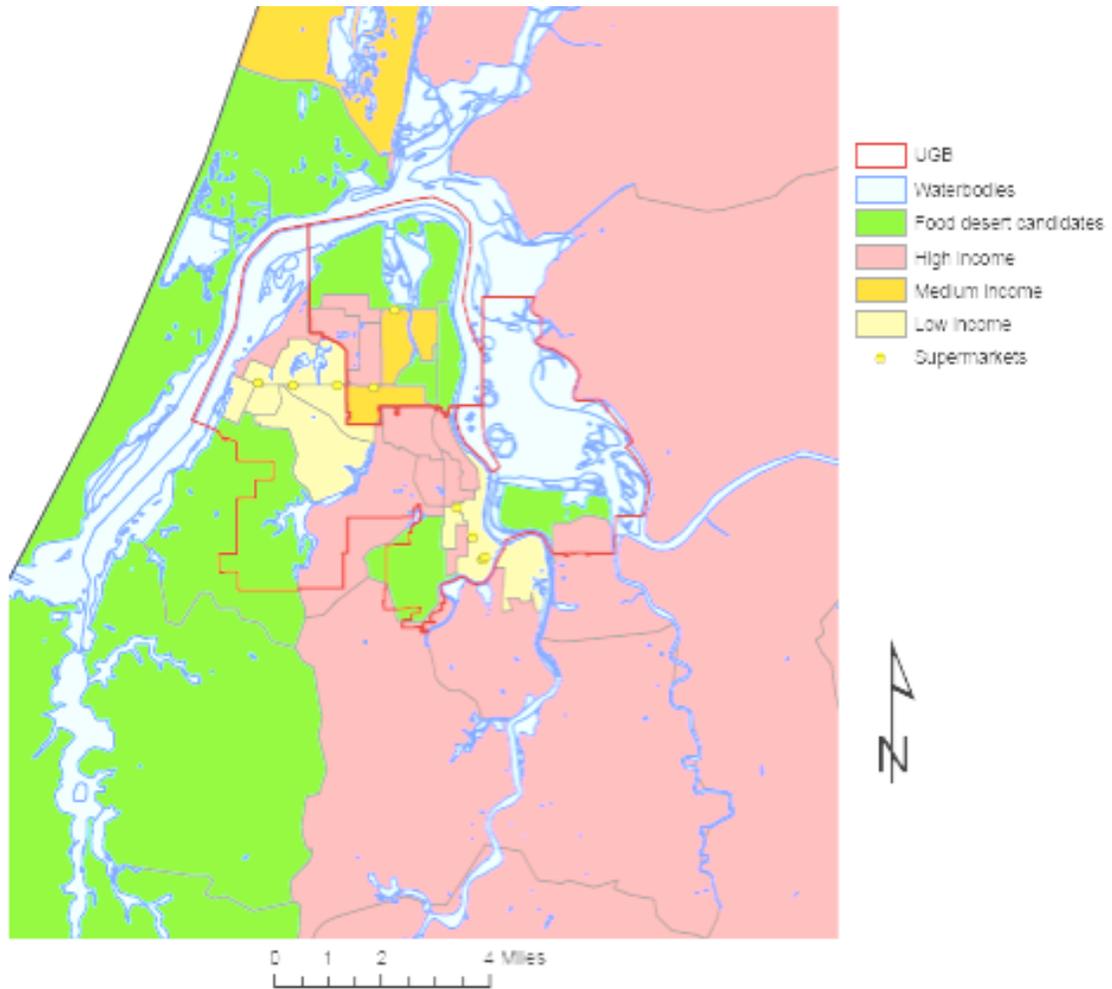
- Glanville, Jo. 2001. "How to Survive in a Food Desert." *New Statesman*: 1.
- Gross, Joan and Nancy Rosenberger. 2005. "Food Insecurity in Rural Benton County: An Ethnographic Study." Working Paper No. 05-02, Rural Studies Program, Oregon State University, Corvallis, OR.
- Hawkes, Corinna. 2008. "Dietary Implications of Supermarket Development: A Global Perspective." *Development Policy Review* 26(6): 657-692.
- "A Healthy Food Financing Initiative: An Innovative Approach to Improve Health and Spark Economic Development". 2010. PolicyLink. Retrieved May 26, 2010 ([http://www.trfund.com/financing/realestate/HealthyFoodFinancing\\_2\\_17\\_10.pdf](http://www.trfund.com/financing/realestate/HealthyFoodFinancing_2_17_10.pdf)).
- Iceland, John and Erika Steinmetz. 2003. "The Effects of Using Census Block Groups Instead of Census Tracts When Examining Residential Housing Patterns". Retrieved March 10, 2010 ([http://www.census.gov/hhes/www/housing/housing\\_patterns/pdf/unit\\_of\\_analysis.pdf](http://www.census.gov/hhes/www/housing/housing_patterns/pdf/unit_of_analysis.pdf)).
- Kellogg, Wendy. 1999. "Observations on Using GIS to Develop a Neighborhood Environmental Information System for Community-Based Organizations." *URISA Journal* 11(1): 15-32.
- Mamen, Katy. 2007. "Facing Goliath: Challenging the Impacts of Supermarket Consolidation on our Local Economies, Communities, and Food Security." *Policy Brief, The Oakland Institute* 1(3): 1-8.
- McLafferty, Sara. 2004. "The Socialization of GIS." *Cartographica: The International Journal for Geographic Information and Geovisualization* 39(2): 51-53.
- Miller, Roger P. 1995. "Beyond Method, Beyond Ethics; Integrating Social Theory into GIS and GIS into Social Theory." *Cartography and Geographic Information Science* 22: 98-103.
- Morland, Kimberly, Steve Wing, Ana Diex Roux, and Charles Poole. 2002. "Neighborhood Characteristics Associated with the Location of Food Stores and Food Service Places." *American Journal of Preventive Medicine* 22(1): 23-29.
- Morton, Lois Wright, Ella Annette Bitto, and Mary Jane Oakland. 2005. "Solving the Problems of Iowa Food Deserts: Food Insecurity and Civic Structure." *Rural Sociology* 70(1): 94-112.
- Morton, Lois Wright and Troy C. Blanchard. 2007. "Starved for Access: Life in Rural America's Food Deserts." *Rural Sociological Society* 1(4): 1-10.
- "Oregon Explorer". 2010. Oregon State University. Retrieved May 10, 2010 (<http://oregonexplorer.info/>).

- “Oregon Overweight, Obesity, Physical Activity, and Nutrition Facts.” 2007. Physical Activity and Nutrition Program at the Oregon Department of Human Services. Retrieved April 14, 2010 ([http://www.oregon.gov/DHS/ph/pan/docs/Oregon\\_PANfacts\\_06.pdf](http://www.oregon.gov/DHS/ph/pan/docs/Oregon_PANfacts_06.pdf)).
- Pearce, Jamie, Karen Witten, Rosemary Hiscock, and Tony Blakely. 2007. “Are Socially Disadvantaged Neighborhoods Deprived of Health-related Community Resources?” *International Journal of Epidemiology* 36: 348-355.
- Pearson, Tim, Jean Russell, Michael Campbell, and Margo E. Barker. 2005. “Do ‘Food Deserts’ Influence Fruit and Vegetable Consumption? – A Cross Sectional Study.” *Appetite* 195-197.
- Pothukuchi, Kameshwari. 2004. “Community Food Assessment: A First Step in Planning for Community Food Security.” *Journal of Planning Education and Research* 23: 356-377.
- Ramasubramanian, Laxmi. 1999. “Nurturing Community Empowerment: Participatory Decision Making and Community Based Problem Solving Using GIS”, Pp. 87-102 in *Geographic Information Research: Trans-Atlantic Perspectives*. Briston, PA: Taylor & Francis.
- “ReferenceUSA: An infoUSA Company”. ReferenceUSA. Retrieved March 10, 2010 (<http://www.referenceusa.com/UsBusiness/Result/aa360ad585af4f77954b292d7137d591>).
- Reisig, VMT and A Hobbiss. 2000. “Food Deserts and How to Tackle Item: A Study of One City’s Approach.” *Health Education Journal* 59: 137–149.
- Sabatier, Paul. 2007. *Theories of the Policy Process*. Boulder: Westview Press.
- Saelens, Brian E., James F. Sallis, and Lawrence D. Frank, L.C. 2003. “Environmental Correlates of Walking and Cycling: Findings from the Transportation, Urban Design, and Planning Literatures.” *Annals of Behavioral Medicine* 25(2): 80-91.
- Schafft, Kai. 2009. “Food Deserts and Overweight Schoolchildren: Evidence from Pennsylvania.” *Rural Sociology* 74 (2): 153-177.
- Sharkey, Joseph. 2009. “Measuring Potential Access to Food Stores and Food-Service Places in Rural Areas in the U.S.” *American Journal of Preventive Medicine* 36: S151–S155.
- Sharkey, Joseph, Scott Horel, Daikwon Han, and John C. Huber Jr. 2009. “Association Between Neighborhood Need and Spatial Access to Food Store and Fast Food Restaurants in Neighborhoods of Colonias.” *International Journal of Health Geographics* 8: 1-17.
- Shaw, Hilary. 2006. “Food Deserts: Towards the Development of a Classification.” *Swedish Society for Anthropology and Geography* 2: 231-247.
- Short, Anne, Julie Guthman, and Samuel Raskin. 2007. “Food Deserts, Oases, or Mirages?: Small Markets and Community Food Security in the San Francisco Bay Area.” *Journal of Planning Education and Research* 26 (3): 352-364.

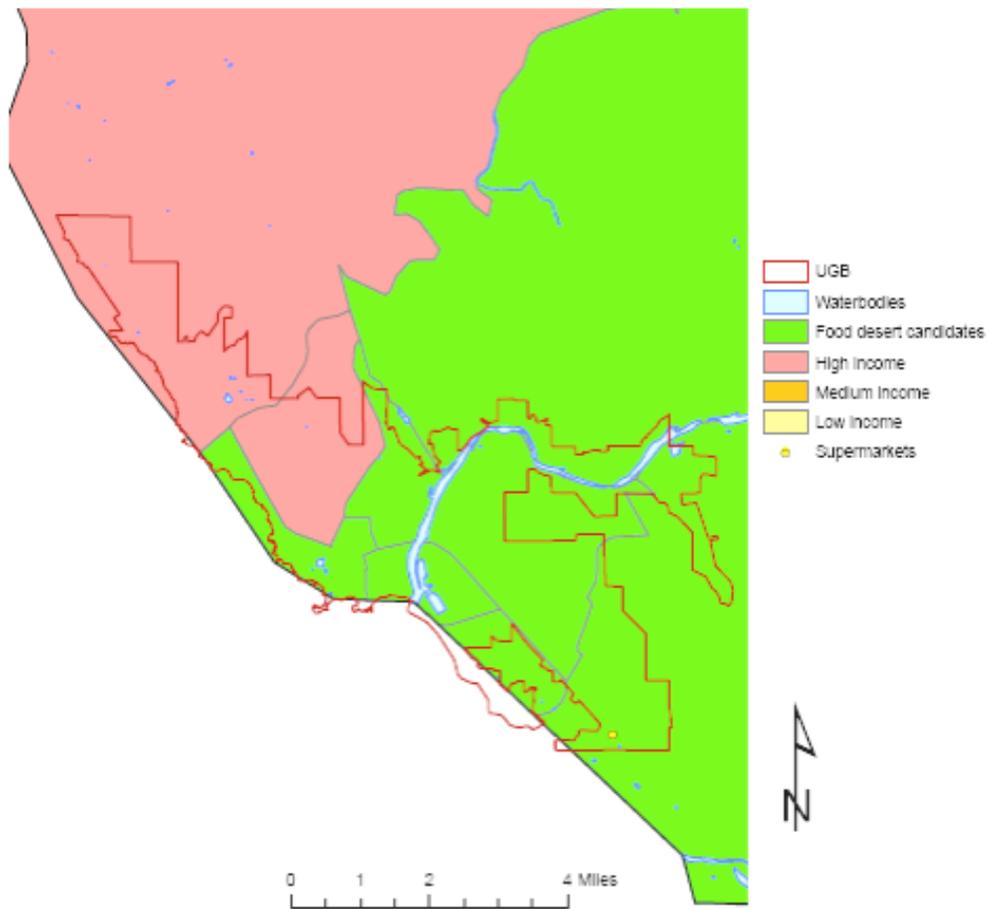
- Smith, Dianna, Steven Cummins, Mathew Taylor, John Dawson, David Marshall, Leigh Sparks, and Annie S. Anderson. 2009. "Neighborhood Food Environment and Area Deprivation: Spatial Accessibility to Grocery Stores Selling Fresh Fruit and Vegetables in Urban and Rural Settings." *International Journal of Epidemiology* 1-8.
- "South Coast Food Share." 2010. Oregon Coast Community Action (ORCCA). Retrieved May 5, 2010 (<http://www.orcca.us/programs/foodshare.html>).
- Sparks, Andrea, Neil Bania, and Laura Leete. 2009. "Finding Food Deserts: Methodology and Measurement of Food Access in Portland, Oregon." Paper presented at the National Poverty Center/USDA Economic Research Service research conference, January 23, Washington DC.
- Turrell, G., B. Hewitt, C. Patterson, B. Oldenburg, and T. Gould. 2002. "Socioeconomic Differences in Food Purchasing Behavior and Suggested Implications for Diet-related Health Promotion." *Journal of Human Nutrition & Dietetics* 15 (5): 355-364.
- "U.S. Census Bureau American Fact Finder." The United States Census Bureau. Retrieved April 1, 2010 ([http://factfinder.census.gov/servlet/DatasetMainPageServlet?\\_program=DEC&\\_submenuId=&\\_lang=en&\\_ts=](http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_submenuId=&_lang=en&_ts=)).
- United States Department of Agriculture - Economic Research Service. 2009a. *Nutritious Food: Measuring and Understanding Food Deserts and Their Consequences*. Washington, DC: Government Printing Office. (Also available at <http://www.ers.usda.gov/publications/ap/ap036>).
- Ver Ploeg, Michele. 2010. "Access to Affordable, Nutritious Food is Limited in 'Food Deserts'." Amber Waves, USDA Economic Research Service. Retrieved March 5, 2010 (<http://www.ers.usda.gov/AmberWaves/March10/Features/FoodDeserts.htm>).
- Weber, Bruce and Mindy Crandall. 2006. "Rural Oregon: Alternative Definitions." Working Paper No. 05-03, Rural Studies Program, Oregon State University, Corvallis, OR.
- Wrigley, Neil, Daniel Warm, Barrie Margetts, and Amanda Whelan. 2002. "Assessing the Impact of Improved Retail Access on Diet in a 'Food Desert': A Preliminary Report." *Urban Studies* 39(11): 2061-2082.

Appendices

**Appendix A: Micro-core food desert candidate block groups in Coos Bay and North Bend including low and medium-income areas**



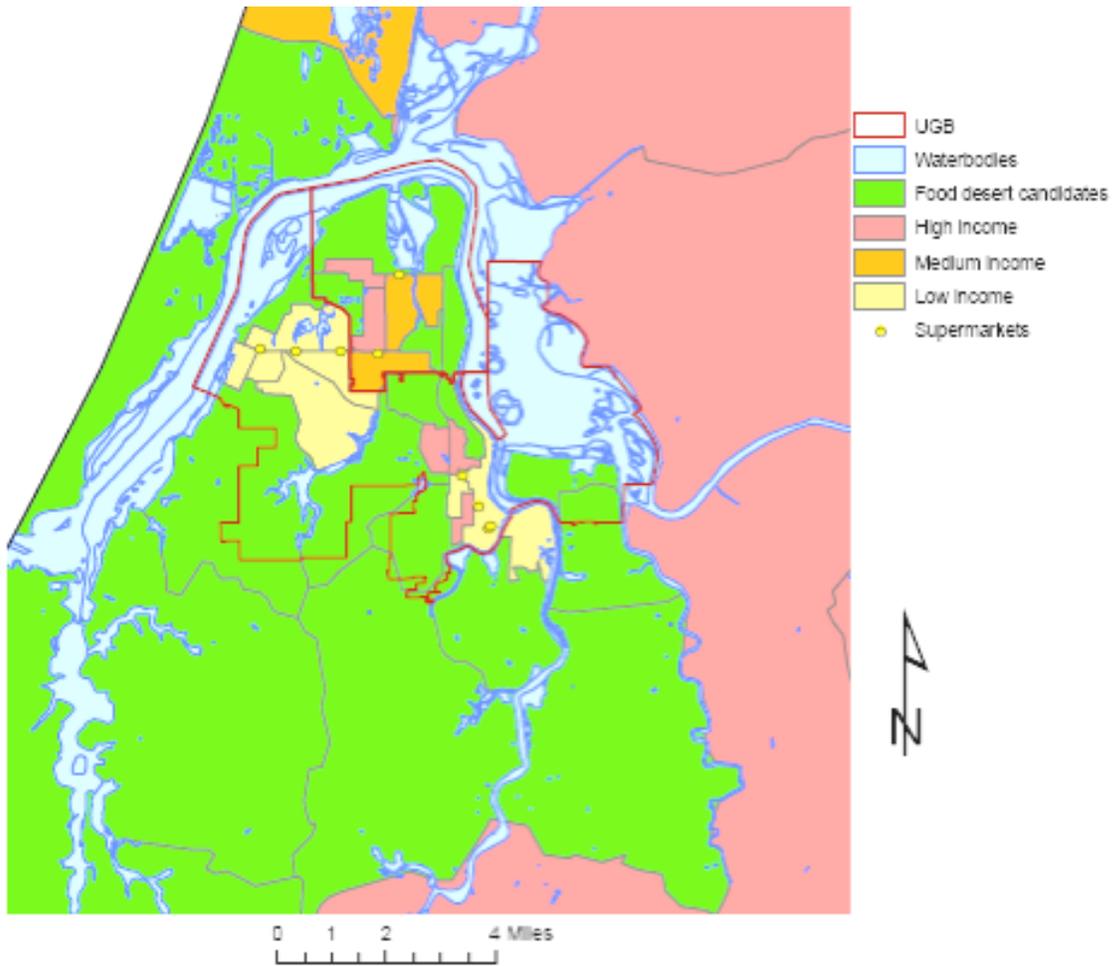
**Appendix B: Micro-core food desert candidate block groups in Coos Bay and North Bend including low and medium-income areas**



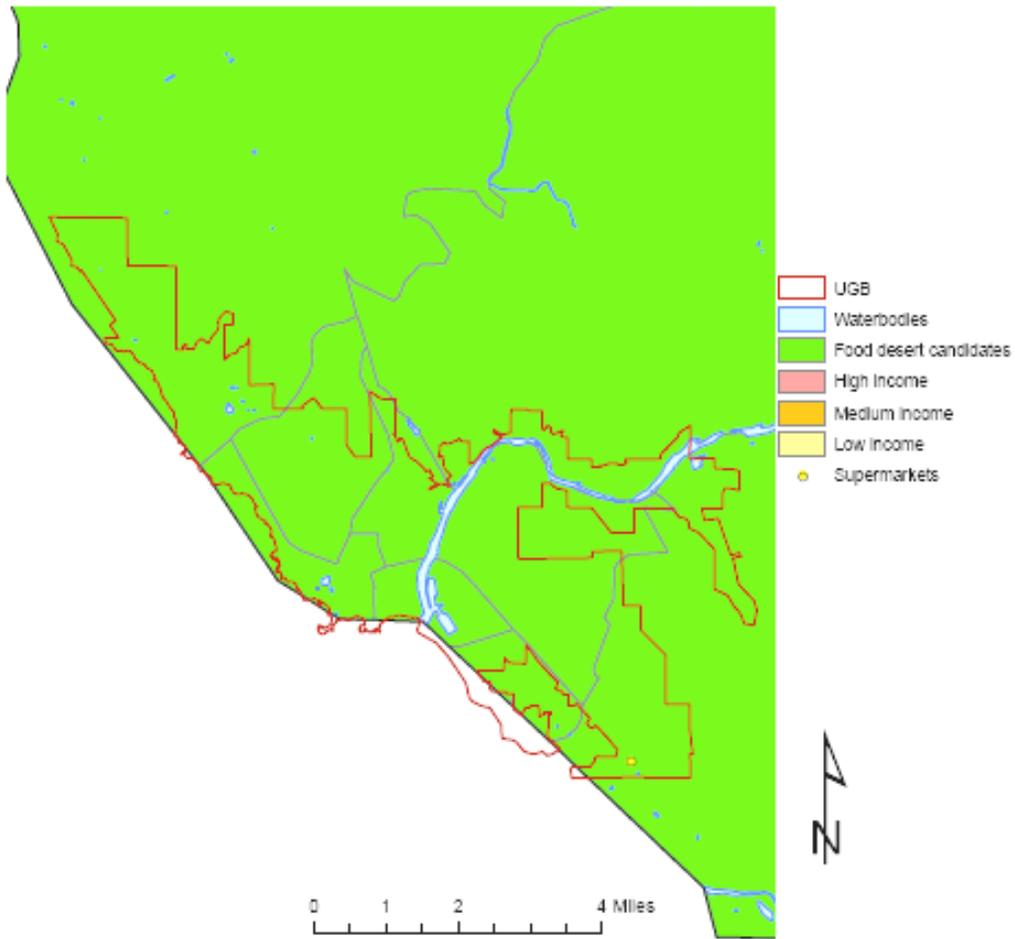
**Appendix C: The table below depicts the socio-economic characteristics of micro-core low and medium-income food desert candidate block groups**

Socio-economic characteristics of food desert candidate block groups									
Tract; block group	Town center	Total population	Total households	% renters	% households whose income was below 1999 poverty level	% no vehicle	% over 65	Population density (per sq. Mi)	Median household income
501; 6	Coos Bay	1934	788	36	26	4	16	187	Low
7; 6	Coos Bay	1293	493	31	21	6	14	673	Low
502; 2	Coos Bay	779	416	29	13	6	35	3	Low
11; 7	Powers	1027	449	29	19	3	21	3	Low
950302; 3	Brookings	1108	532	57	13	0	39	577	Low
9504;3	Brookings	1681	789	21	14	2	31	291	Low
9504; 2	Brookings	848	491	21	15	9	43	1102	Low
9504; 1	Brookings	1124	535	18	12	10	38	975	Low
4;1	North Bend	1038	478	48	21	5	20	173	Medium
4;2	North Bend	882	254	32	3	0	18	126	Medium
3;1	North Bend	992	403	49	23	3	31	496	Medium
3;2	North Bend	720	300	33	7	8	13	720	Medium
8;1	Coos Bay	540	212	37	11	1	17	90	Medium
502;1	Coos Bay	1981	842	29	22	1	22	34	Medium
9504;4	Brookings	1180	540	22	12	4	37	1	Medium
950301;2	Brookings	720	300	21	9	0	27	6	Medium
950301;3	Brookings	1331	537	49	20	3	14	266	Medium
950302;1	Brookings	1211	483	51	5	1	20	606	Medium

**Appendix D: Micro-core food desert candidate block groups of all incomes in Coos Bay and North Bend (only based on critical distance)**



**Appendix E: Micro-core food desert candidate block groups of all incomes in Brookings (only based on critical distance)**



**Appendix F: The table below displays the socioeconomic characteristics of micro-core food desert candidate block groups of all incomes (only based on critical distance)**

<b>Socio-economic characteristics of food desert candidate block groups</b>									
<b>Tract; block group</b>	<b>Town center</b>	<b>Total population</b>	<b>Total households</b>	<b>% renters</b>	<b>% households whose income was below 1999 poverty level</b>	<b>% no vehicle</b>	<b>% over 65</b>	<b>Population density (per sq. Mi)</b>	<b>Median household income</b>
501; 6	Coos Bay	1934	788	36	26	4	16	187	Low
7; 6	Coos Bay	1293	493	31	21	6	14	673	Low
502; 2	Coos Bay	779	416	29	13	6	35	3	Low
11; 7	Powers	1027	449	29	19	3	21	3	Low
950302; 3	Brookings	1108	532	57	13	0	39	577	Low
9504; 3	Brookings	1681	789	21	14	2	31	291	Low
9504; 2	Brookings	848	491	21	15	9	43	1102	Low
9504; 1	Brookings	1124	535	18	12	10	38	975	Low
4; 1	North Bend	1038	478	48	21	5	20	173	Medium
4; 2	North Bend	882	254	32	3	0	18	126	Medium
3; 1	North Bend	992	403	49	23	3	31	496	Medium
3; 2	North Bend	720	300	33	7	8	13	720	Medium
8; 1	Coos Bay	540	212	37	11	1	17	90	Medium
502; 1	Coos Bay	1981	842	29	22	1	22	34	Medium
9504; 4	Brookings	1180	540	22	12	4	37	1	Medium
950301; 2	Brookings	720	300	21	9	0	27	6	Medium
950301; 3	Brookings	1331	537	49	20	3	14	266	Medium
950302; 1	Brookings	1211	483	51	5	1	20	606	Medium
501; 1	Coos Bay	1383	508	34	19	4	11	173	High
4; 4	North Bend	804	290	20	1	2	11	402	High
6; 1	Coos Bay	1008	362	23	0	0	18	504	High
7; 1	Coos Bay	506	259	31	27	0	28	506	High
6; 3	Coos Bay	1080	413	33	7	0	14	98	High
8; 1	Coos Bay	540	212	37	11	1	17	90	High
8; 2	Coos Bay	1227	517	26	7	1	18	136	High
7; 7	Coos Bay	1123	458	22	17	5	16	24	High
8; 3	Coos Bay	1200	467	15	8	2	15	29	High
7; 8	Coos Bay	1335	520	24	16	8	15	121	High
950301; 1	Brookings	2053	894	14	9	0	25	1	High
950301; 2	Brookings	720	300	21	9	0	27	6	High
950302; 2	Brookings	2072	862	26	7	1	24	188	High