Food Deserts: Evaluating Grocery Stores and Bus Accessibility using GIS in Madison, Wisconsin

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Abstract

A major challenge facing low-income neighborhoods is the growing presence of food deserts. Food deserts are caused by lack of availability of healthy food and poor public transit systems. In order to assess food deserts in Madison, Wisconsin, the authors developed a scoring system to rate supermarkets and bus services. The scoring system contains two components. Supermarket scoring is based on the NEMS-S, and looks at price, availability, and quality of healthy food. Bus scoring is a new development and takes into account the number of routes, numbers of routes in a food desert, frequency, and number of food deserts served. The scoring system helps assess how low income and food desert areas are serviced in regards to healthy food access. The authors used GIS technology to assess and examine differences in the food desert definitions.

TABLE OF CONTENTS

INTRODUCTION

Food deserts have become an important area of research across multiple fields of social science. Public and private groups (Ghirardelli 2011, S104), and governments (Walker et al 2010, 877) at all levels have studied food deserts in an effort to understand where they occur and how they are formed. The hope is this research leads to a better understanding of the ways to provide affordable, healthy foods to areas that lack access to them. The relationship between diet and health is an important one, and the people studying food access hope that their research can lead to improved health for the residents of food deserts (Smoyer-Tomic et al 2008, 741).

Academic research often focuses on how, why, and where food deserts occur. The focus of our study will be on availability of healthy foods, specifically how public transportation provides access to supermarkets and other stores that provide healthier alternatives for people to eat. Additionally, we will develop a scoring system of stores that not only rates them on what types of healthy food they carry, but how well public transportation brings residents of food deserts to those. The stores that we are evaluating are Copps at S. Park St., Copps at Whitney Way, Copps at Junction Rd, Metcalfe's at Mineral Point Rd, and Woodman's at South Gammon Rd (see Figure 2 on page 20). We have divided the research into three groups: food deserts themselves, public transportation, and the development of a scoring system to rate specific bus routes and their ability to get riders to stores with healthy food. Our study will specifically target the urban definition of food desert, using south and western suburbs of Madison, Wisconsin as our study area, and we will follow these three areas of research to answer our question.

<center>**LITERATURE REVIEW**</center>

Food Deserts

Food deserts, despite the amount of research done on them, remain without a precise definition. The term supposedly was coined "by a resident of a public-sector housing scheme in the west of Scotland in the early 1990s'" (Shaw 2006, 201). The concept of a food desert consists of two key components: low income and low access to healthy foods. The United States Department of Agriculture's (USDA) definition is an urban census tract where the poverty rate is greater than or equal to 20 percent or median family income does not exceed 80 percent of the metro-area median family income, and at least 500 people or 33 percent of the population is located more than 1 mile from the nearest supermarket or large grocery store (Dutko et al 2012, 6). Rural census tracts have a different definition reflecting their less densely populated nature. It should be noted that there is "controversy and criticism aimed at the food desert concept for its lack of definitional and methodological consistency" (Bedore 2013, 134), but there seems to be no disagreement that economics and location are the two main components of a food desert.

Food deserts are an important concept, as diet influences health. A lack of access to a healthy diet could lead to health issues later on. Obesity is a major factor in many diseases, from heart disease to diabetes, and research has shown that "physical inactivity and food consumption are two major behavioral factors in obesity" (Smoyer-Tomic et al 2008, 740). Some studies are looking at availability and "suggest that factors within the built environment play a critical role in a person's diet" (Walker et al 2010, 878). That is, a diet is not just an individual choice, but is influenced by environmental factors (Walker et al 2010, 879).

Urban food deserts display certain commonalities. They tend to be "areas with higher levels of poverty" (Dutko et al 2012, iii). The single most important economic factor for food deserts is the poverty level. "Areas with higher poverty rates are more likely to be food deserts regardless of urban or rural designation" (Dutko et al 2012, iii) and those low-income urban areas tend to be "inner-city, and predominantly African American or Hispanic neighborhoods within US urban areas" (Smoyer-Tomic et al 2007, 741). Race tends to be another important factor. In fact, "[h]ealthy food is also typically less available in minority, rural, and poor neighborhoods" (Moore et al 2012, 1037). Low education tends to be the third demographic factor of food deserts. When asked about their accessibility to healthy foods, "minority race, lower education, and lower income [people] reported lower availability of healthier foods and lived in areas with lower direct measured availability than did white, more highly educated, and higher income [people]" (Moore et al 2012, 1042).

These factors paint a picture of food deserts as urban, and specifically inner city areas with higher poor, minority and undereducated residents. The literature has answered the question of who suffers from lack of availability of healthy foods, which raises the question why healthy food is not available in these areas. The answer lies in the type of stores that are found in these areas. Evidence shows that larger sized food stores and chain supermarkets are "more likely to stock healthful foods and to offer foods at lower cost" (Powell et al 2006, 189). While our study will get into what constitutes a store with healthy food, the research does suggest that such stores are far less likely to be found in food deserts. The biggest reason these larger stores are not found in the urban setting is because of the automobile (Larsen et al 2008, 2). As the automobile became the center of

traffic infrastructure planning, and people who were predominantly white and rich moved out to the suburbs, the large grocery stores followed them. "By the 1970's many businesses and retailers (including grocery stores) were moving closer to their predominantly suburban customer base" (Larsen et al 2008, 2).

Another factor was the consolidation of grocery stores into chains. By the early 1990s, "the top four chains controlled 73 % of the stores...as compared to 43% in 1963" (Gottlieb et al 1996, 10) in Southern California, a trend that was mirrored nationally. Also, "inner city stores tend to have higher operating costs than suburban stores" due to "security costs, greater 'shrink' (loss of product due to employee theft, shoplifting, etc.), greater numbers of bad checks, and high labor costs" (Gottlieb et al 1996, 10). Add the price of obtaining a piece of real estate in the city, and what you have is the perfect mix of economic forces for large chains to move their stores to more affluent suburban communities. "It is believed that the lowest income neighborhoods had nearly 30% less supermarkets that the highest income neighborhoods" (Walker et al 2010, 878) across the country. The result is a "lack of availability of chain supermarkets in low-income neighborhoods" (Powell et al 2006, 193).

Since there is a measured lack of chain supermarkets in poorer areas, the need to identify what types of stores are available in these areas arises. "The majority of smaller stores located in urban areas are in low-income areas" (Walker et al 2010, 890), and these stores have already been shown to have less selection and higher prices than chain supermarkets. The likelihood of getting smaller and corner stores to stock healthier foods is a subject of some research. These stores could be a place where fresh fruits and veggies are sold, but there would need to be extensive changes to the supply system to make this

feasible (O'Malley 2013, 747). In addition to smaller stores, restaurants, fast food locations and convenience stores are likely to be found in poorer areas. Research "has shown a positive association between the number and density of restaurants, including fast food outlets and state-level obesity rates in the United States" (Smoyer-Tomic 2008, 741). When fast food and convenience stores are an option, "residents are more likely to purchase food items at these locations, although they lack healthier options when compared to grocery stores" (Smith et al 2013, 5). The lack of healthy food outlets has a demonstrable effect on people's diets, and can lead to unhealthy lifestyles.

Food deserts have been shown to be the product of two main factors: income and location. The residents of food deserts lack the resources to get to healthy food options, which are not located near where they live. In fact "the cost of providing consumers with healthy and culturally appropriate food extends far beyond the purchase price of individual food items. Travel costs to reach food stores is an obvious additional cost" (Hallett and McDermott 2011, 1215). Our discussion continues with a look at how public transportation allows people living in food deserts to travel to stores that stock healthy food options. It is the purpose of our study to reveal how important public transportation is by including transit access data into our store scoring system.

Public Transit

The issues of food security are often associated with the availability of public transits and the degree of automobile ownership in a particular region. Since not everyone could afford to own a personal vehicle, public transportation certainly eases people to go to supermarkets and grocery stores to purchase their food. Majority of studies agree that

vehicle ownership and low median income come hand in hand. "Automobile ownership is less common among the poor than among the non-poor. Most food stamp recipients don't drive their own car – only 22 percent of them do own an automobile (Gottlieb et al 1996, 11)". A study by University of Connecticut's Food Policy Marketing Center shows that areas that have the fewest supermarkets are also areas that have lowest vehicle ownership. Similarly, the study conducted by Junfeng et al (2010, e33) in King County, Washington, found out that most of the vulnerable populations lived within a 10-minute drive or bus ride of a low- or medium-cost supermarket.

One study mentions about the flaw in USDA's food desert classification. Bader et al (2010) argues that the use of census track as study unit will affect the accuracy of the data. "Studies that take only census tract into account do reflect a basic de facto adjustment – census tracts are larger than lower-density environments where vehicle ownership tends to be higher" (Bader et al 2010, 413). They suggest that more systematic adjustment for vehicle ownership would make measures of spatial accessibility more comparable across areas.

Since people with low-income cannot afford to own a vehicle, the availability of public transit service may be crucial in accessing food resources. Among studies of the food environment, the most comprehensive research that takes public transportation into account is the research conducted by Larsen and Gilliland (2008). Their study focuses in the food environment of the town of London, ON, Canada; they systematically categorized points within a 500-meter walk and a 10-minute bus ride to a supermarket as being accessible by bus. They found out that 35.1 percent of the urban residents of London, ON lived within 1 kilometer of a supermarket, while 86.5 percent had accessibility by bus

(Larsen & Gilliland 2008, 8). These results in some way suggest that public transit can greatly increase access to food resources.

However, while we agree that public transportation might be useful for these people, there are a lot of shortcomings that need to be noted. A large amount of studies regarding food access and public transportation chiefly discuss about the limitation of public transit, and address little about the advantages it imposes on a particular community. Majority of studies share one commonality regarding the use of public transit: the concern about its efficiency and effectiveness. The study conducted by Clifton (2004, 402) aims on how to solve transportation issues for food access purposes, specifically on low-income family in Austin, Texas and the result shows that although public transit is self-reliant and inexpensive, it is subjected to spatial restrictions. These restrictions include the degree of accessibility of a particular public transit service, which concerns about the number of bus stops and transfers available. The insufficiency of bus stops and transfers decreases commuters' walkability, as the distance that the commuters need to walk between their homes and the bus stops is considerably great.

When commuters are forced to walk for quite a distance from the nearest bus stop to their house, the problem of carrying the goods emerges. This issue is illustrated in the studies directed by Gottlieb et al (1996, 11) and Coveney & O'Dwyer (2007, 48). Both studies confer about how the use of public transportation causes many people to have difficulties in carrying groceries from the bus stop back to their houses. "In one low income neighborhood in South Central Los Angeles, one third of the residents surveyed reported difficulties carrying their groceries home; roughly the same number of persons without access to a vehicle" (Gottlieb 1996, 11).

This difficulty always leads to some other sub-issues such as the need to limit the amount of groceries purchased. "Shopping choices became constrained… (for example) a woman had to choose between purchasing a gallon of milk and a jug of laundry detergent, given her inability to carry both home" (Gottlieb 1996, 11). The hassle in hauling groceries back home also leads to the increase in the frequency of shopping. "Because the amount that can be carried is limited, those that ride the bus to shop for food tend to shop more frequently, making trips every few days" (Clifton 2004, 409). These problems augment the amount of time dedicated to provisioning activities and travel.

Another disadvantage of public transportation is the temporal restriction it places on its commuters. "Accessibility by bus was reduced in comparison with travel by car and was further decreased depending on whether bus travel was in peak time or off peak (Burns & Inglis 2007, 881). Some study addresses commuters' dissatisfaction with bus frequency (Coveney & O'Dwyer 2009, 50). In city centers, grocery stores are usually served by multiple bus lines, and thus the frequency of bus service is fairly high. But at the edge of the city or in the suburbs, the service is usually limited to a few bus lines only, hence the low bus frequency. In addition to that, some bus lines do not begin until late in the morning, and some others do not even serve during the night, and this might conflict with commuters' daily schedules.

Oftentimes commuters have to face inconvenience such as delays, detours and service cancellations which indirectly causes more trouble than before. Commuters also have to plan ahead of time since public transit service is subject to change (Clifton 2004, 407). Gottlieb et al (1996, 11) listed down long waits, multiple transfers and long walks to bus stops as examples of inconvenience. Coveney and O'Dwyer (2009, 50) addresses the

insufficient seats and bus shelters issues as different types of inconvenience experienced by public transportation users.

Nevertheless, even if the transit system is efficient, if the fares are considered high enough by the low-income people, the service does not really benefit these people. Low income residents may have difficulty affording transportation costs to the supermarket outside of their neighborhoods. Walker et al (2010, 877) found out that many low-income households do not have access to a car and cannot afford the costs associated with getting to a supermarket outside of their immediate neighborhood. Although bus services cost significantly lower than personal vehicles or taxis, it can still be expensive to them, especially when they have to shop frequently.

A few studies mention about safety issues in using the public transportation. There is some evidence that fear of crime and other safety-related matters discourage people from walking in the neighborhood at a particular time of the day. (Shaw 2006, 242) comes up with a non-spatial factor in determining food deserts: attitude. 'Attitude' problems may be defined as any state of mind that prevents the consumer from accessing foods they can otherwise physically bring into their home and have the necessary assets to procure. Public transportation commuters are more likely exposed to street crimes than those who use their own vehicles, especially when they get down the bus and walk back home. The study conducted by Shaw (2006, 244) shows that 30 percent of the respondents put fear of crime or reluctance to venture to unfamiliar places as the most important. High crime rates near a supermarket could also lead to a vicious cycle in which crime deters customers and reduces sales revenues, making it more difficult to stock perishable foods such as fresh produce.

Since most of these studies were conducted in various places worldwide, such as London, (Canada), Cardiff (Wales) and Melbourne (Australia), some cross-cultural differences certainly exist. For instance, Larsen & Gilliland (2008, 3) elucidates the difference in commuting culture in the United States and Canada. They explain that Canadians use public transportation more frequently than Americans, while Americans tend to drive more often than Canadians. However, since our study incorporates both walking and bus service together, we opt to look at cultures as more dynamic and interconnected, which is one of a few practical approaches in studying different cultures as suggested by Clifford et al (2010, 159). Clifford et al also mentions that globalization may have erased the differences between cultures in the culturally and technologically interconnected "global village" which consents us to see 'other' cultures 'just like us.'

Scoring System

In order to thoroughly assess the presence of food deserts, research has to go beyond just counting and recording the number supermarkets and other stores and fast food restaurant areas and then comparing those numbers of low income areas to those of more affluent areas. In our research we are creating and conducting a scoring system for food retail stores in USDA indicated food desert areas throughout Madison, WI. After rating the stores themselves, we will rate bus routes in these areas in relation to the number of higher or lower scoring stores that each route services, number of transfers, and duration of the route. There is currently little to no literature about rating bus stops. From these ratings we hope to gauge a better understanding of the impact public transportation has on healthful food access. In past literature, evaluating healthfulness of stores has been various

methods including shopper surveys and store ratings. Consumer surveys help indicate what is important to shoppers, and in turn influences the creation of scoring systems.

Because the "presence of food stores, and the availability of healthful products in those stores, appear[s] to be important contributors to healthy eating patterns among neighborhood residents," (Glanz et al 2007, 282) it is important to determine what type of products stores are providing to consumers. The first criterion in developing a rating system is identification and classification of stores (Glanz et al 2007, 282) and "site selection for nutritional food environment assessment" (Smith et al 2013, 2). Retail food outlets must be "identified, enumerated, classified, and mapped using multiple data sources" (Glanz et al 2007, 282). Outlets include stores that have the primary focus of providing foodstuffs, including "independent, franchise, and chain groceries; a limited assortment store; a retail food cooperative; delicatessens, butchers, and seasonal produce markets; and a large general merchandise store that carried canned and boxed food items" (Webber et al 2010, 298), and convenience stores that provide food selections as well as other goods (Glanz et al 2007, 283). In "economically underserved communities, grocery store locations are fewer and more dispersed, which makes the reliance on convenience stores for obtaining food greater in these areas" (Smith et al 2013, 2). The definition we are using comes from Smith et al., stating, "[a] convenience store was defined as a small, higher- margin store offering a limited selection of staple groceries, nonfoods, and other convenience food items (e.g., ready- to-eat foods). The store may or may have not sold gasoline." Convenience stores are a common shopping destination in food deserts, and "[a] consequence of poor supermarket access is that residents have increased exposure to

energy-dense food ("empty calorie" food) readily available at convenience stores and fast-food restaurants" (Walker et al 2010, 877).

The next facet to creating scoring systems is choosing what factors to account for when determining positive and negative aspects of a given store. In a study done in 2004 by Glanz and Yaroch, "Four types of grocery store-based environmental, policy, and pricing interventions can be identified: (1) Point-of- Purchase (POP) information; (2) reduced prices and coupons; (3) increased availability, variety, and convenience; and (4) promotion and advertising" (S76). Ghiradelli et al. also notes the importance of advertising in a store's rating (2011, S106). Another very influential part of scoring systems is "nutrition-related variables" (Glanz et al 2007, 283). These measures "focus on availability of more healthful or recommended choices, quality of produce, and prices" (Glanz et al 2007, 283-4).

Point of purchase information in stores "is the use of shelf labels and/or signage that specifies healthy food choices, based on established criteria" (Glanz & Yaroch 2004, S76). POP information can be useful in store evaluations because it can "list specific nutritional values" and can give "[a] fruit and vegetable- specific definition [...] and/or signage specifying that food items are good sources of F&V choices, often along with recipes and/or food demonstrations" (Glanz & Yaroch 2004, S76). POP information is a way to help consumers make more informed and healthy food choices.

Price, or affordability, information can be assessed in various ways. Glanz and Yaroch look at the coupons and discounts stores provide for healthier food options, which they qualify as positively influencing scores (2004, S77). Price cuts for fruits and vegetables act as incentives for low-income consumers to make healthier choices. Price can also account for government programs such as the Women, Infants, and Children Nutrition

Program (WIC) and Supplemental Nutrition Assistance Program (SNAP) (Ghirardelli et al 2011, S106). Stores' application of these programs is more examples of assistance to low-income consumers that will be favored in a rating system. Glanz et al. state, "the prices for most healthy (lower fat, lower calorie, and whole grain) options were not significantly different from the comparable regular items" (2007, 286).

Access to healthy food, especially produce is an important part of developing a scoring system (Guy & David 2004, 229). This can be done simply by making a list of healthy foods and then seeing if and how much of each item a retail store offers (Guy & David 2004, 229), or by grouping foods into categories and then dividing those categories into healthy or unhealthy options (Smith et al 2013, 3), and looking at shelf space devoted to healthier foods (Glanz et al 2007, 284). Some things to look for in stores are:

"Programs to increase availability, variety, and convenience are those that provide more healthy food choices, more or less of certain foods and nutrients in prepared foods, and more variety of healthful foods more often. When applied to fruits and vegetables (F&V), this might mean providing more easy-to-use or -eat F&Vs, and/ or making F&V easier to locate in stores" (Glanz & Yaroch 2004, S77).

On a related noted, the food that people have access to should be of good quality. Quality can be determined by "an accept- able/unacceptable rating based on the majority of a given type of fruits or vegetables being clearly bruised" (Glanz et al 2007, 284). An adapted version of the Nutrition Environment Measures Surveys in Stores (NEMS-S) (see Appendix 1 on page 54) is a useful and commonly used tactic for formulating scoring systems (Moore et al 2012, 1038).

Marketing for healthy goods is something that was researched extensively by Ghirardelli et al:

> "Exterior marketing conditions were assessed by the number, size, and type of posted advertisements in windows and doors; the types of ads displayed on other parts of the property; the types of food products visible from the outside windows; and the presence of produce bins and vending machines in front of the store. Interior marketing was assessed through the presence of ads and products for healthful and less healthful food next to the checkout counter" (2006, S106).

It is assumed that an abundance of advertisements for healthy foods would prove more beneficial in a store, in attempts to encourage healthy eating.

After determining what criteria we want to use to assess Madison stores, the scoring system can be developed either by only awarding points based on the presence of "desired conditions and positive attributes" (Ghirardelli et al 2007, S106). Another method is subtracting points when a store fails to meet predetermined requirements (Glanz et al 2007, 284).

The creation of scoring systems can, in part, be aided by qualitative survey data that assess what individuals living within food deserts find important and/or desirable in stores and shopping experiences. "People tend to make food choices based on the food outlets that are available in their immediate neighborhood […] This can pose problems since many low-income, urban areas have a higher density of fast-food restaurants and corner stores that offer prepared foods compared to higher income areas" (Walker et al 2010, 877). In the study performed by Webber et al in 2010, primary shoppers were asked to keep a written log of food purchases and then partook in reflective interviews (298-9). Interviews revealed that "qualities of importance to fruit and vegetable shoppers that emerged from data analysis were organized around five themes: (1) store venue; (2) the internal store

environment; (3) product quality; (4) product price; (5) informants' relationships with stores" (Webber et al 2010, 299). Another study performed by O'Malley et al looked at consumers in New Orleans to determine "purchasing and consumption patterns of neighborhood residents" (2013, 742). Moore et al. conducted a similar study with participants agreeing or disagreeing with three statements about stores near them: "(1) A large selection of fruits and vegetables is available in my neighborhood. (2) The fresh fruits and vegetables in my neighborhood are of high quality. (3) A large selection of low-fat products is available in my neighborhood "(2012, 1038). Reviewing this qualitative data can be beneficial in ascertaining what aspects to include in scoring systems because it is real world, primary data.

The last piece we hope to implement in a comprehensive scoring system is rating bus stops that service the food deserts within Madison, WI. Lack of reliable access to a car can be very inconvenient in accessing healthy food (Coveney & O'Dwyer 2009, 45). In this study participants were interviewed and stated their satisfactions and dissatisfactions with alternative public transportation methods. This can prove useful in creating a system to score bus routes. The notion that "income, mobility, and time constraints together limit the range of destinations within reach of low-income households and, thus, the choices available to them as consumers. A greater dependence upon local options emerges, but [...] local retailers tend to be in short supply in those areas where residents need them most," (Clifton 2004, 403) also serves as a starting point to develop a bus rating system. The bus system rating that we plan to develop will rely heavily on secondary data. Because of the lack of research of its kind, we will use literature that addresses people's dissatisfaction

with public transport as a means of grocery shopping to formulate what would make a route more or less desirable.

Because we will be formulating our own scoring systems, it is critical that we use secondary data to understand what will be beneficial in our analysis and creation of rating the stores and routes. We will be looking at a large area and number of stores, so secondary data can help provide supplementary data. Secondary data of past studies that have included similar scoring components can be used to compare what will or will not prove useful for our research and to put our research into a wider context. Data from other studies that use personal interviews give good indications for what to take into account when scoring (Clifford et al 2010, 62).

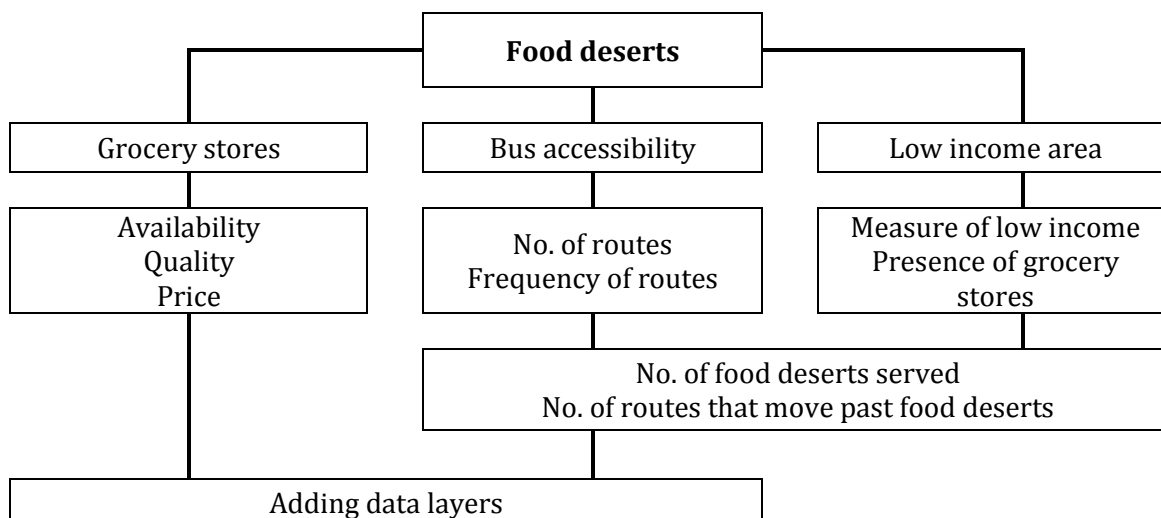## METHODOLOGY

Conceptualization

Figure 1 Conceptualization of the research.

Observing grocery stores

Five different grocery stores were chosen in south and west Madison based on their proximity to the food deserts (see Figure 2 on page 20). Two were located in food deserts, two were located outside food deserts and the final store was located adjacent to a food desert. Those stores are Metcalfe's at Mineral Point Rd, Woodman's at South Gammon Rd, and Copps across the southern city and western suburbs – South Park St, Whitney Way and Junction Rd. Each of the Copps stores fell into a separate category of location with respect to food deserts. The Park Street store is in a food desert, the Whitney Way store is next to a food desert and the Junction Road store is outside a food desert. Woodman's is outside a food desert and Metcalfe's is in a food desert. Items observed in store included various categories of food such as fresh fruit and vegetables, milk, prepackaged bread, ground beef, hot dogs, frozen dinners, beverages, baked goods, chips and cereals. These food items were decided based on different literatures. The observation was focused on the availability of options, quality of items and price.

Redefining food desert

We decided to use GIS (geographic information systems) application to incorporate Metro Madison with food desert and low income area. The definition of food desert described by USDA does not include public transit so we attempt to redefine this by including bus services. The goal is to reformulate the definition of food desert as described by USDA and perhaps see if there is any difference in the extent of food desert if bus service is taken into consideration.
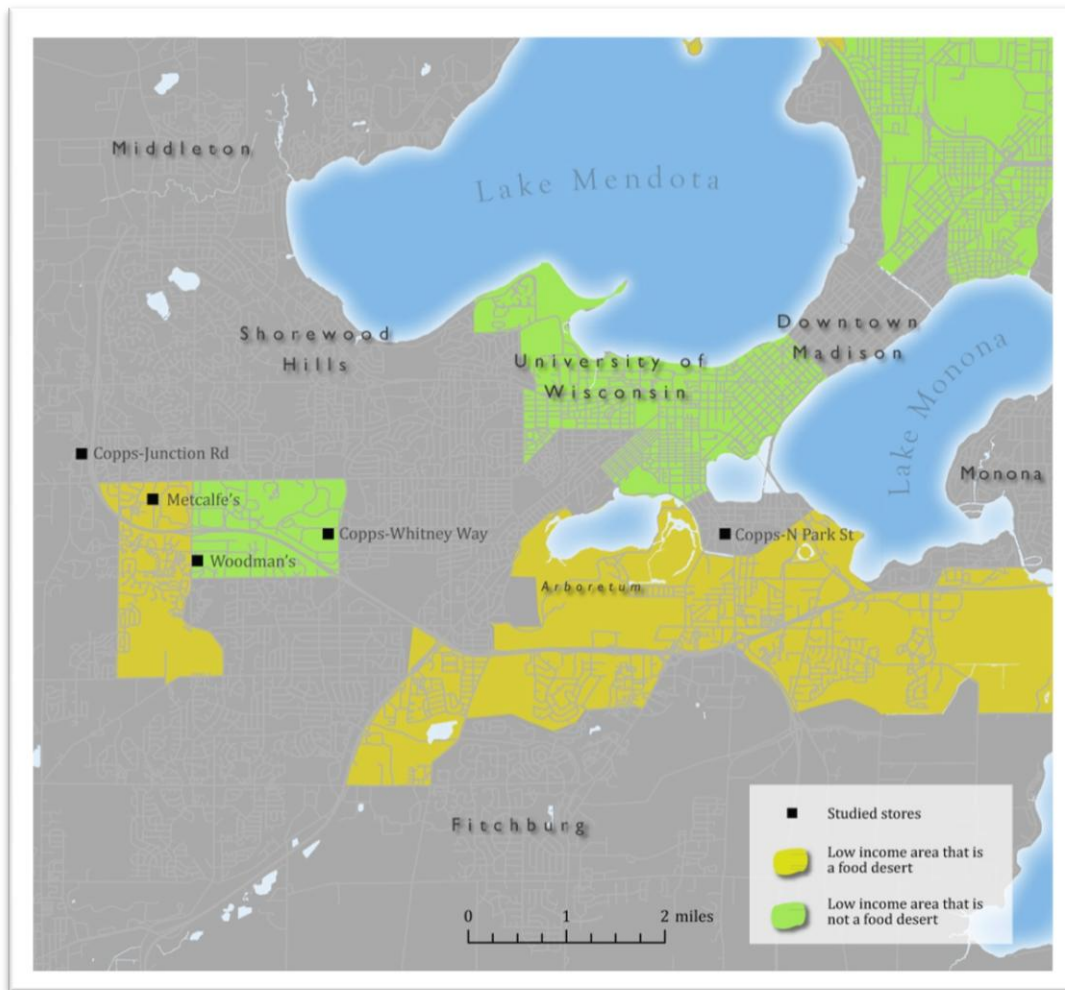
Figure 2 Original extent of food desert and low income area as described by USDA. This map also shows the location of our surveyed grocery stores. Cartographer: Masrudy Omri

According to USDA website, these food desert polygons are census tracts that are both low income and low access, as measured by the different distance demarcations. The low income area polygons are census tracts where the tract's poverty rate is 20 percent or greater; or the tract's median family income is less than or equal to 80 percent of the State-wide median family income; or the tract is in a metropolitan area and has a median family income less than or equal to 80 percent of the metropolitan area's median family income.. From this map (Figure 2) we found out that all food deserts are actually part of low income

area. In other words, food deserts in our study area consist of people that have low income, but not all people that have low income live in these food deserts. We intend to use GIS to shorten the actual distance between the houses of those who live in food deserts and the surveyed grocery stores to at most 0.5 miles, i.e. 0.25 miles from the house to the bus stop, and 0.25 miles from the bus stop to the grocery stores (see Figure 3).
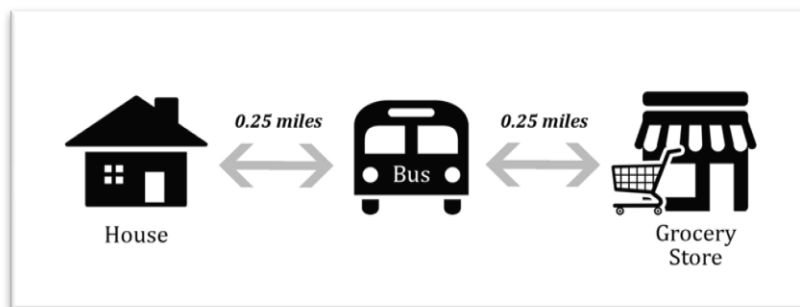

Figure 3

In this GIS analysis, we used three different layers: (1) Metro Madison routes (2) food desert polygons and (3) low income polygons. Original spatial data of Madison metro routes and bus stops are taken from Madison Area Transportation Planning Board (MATPB). GIS layers of food desert and low income areas are derived from the United States Census Bureau. We also generated spatial data of the grocery stores using GPS points. The first step is to use the "select by location" tool on ArcGIS to select the routes that are located within 0.25 miles buffer from each grocery store as this is considered the acceptable maximum walking distance. Larsen & Gilliland (2008) writes that the acceptable walking distance is 500 meters which is equivalent to 0.311 miles. We opted to use 0.25 miles as instead as to make calculation easier, i.e. rounding up to 0.5 miles (see Figure 3).

This step narrows down the routes to only those that go to any of our surveyed grocery stores, which are accessible by walking.

The second step is to make sure that the routes are single routes with no transfers. We exclude transfers in our research because transfers usually take longer travel time due to the long waiting time. Transfers can also cause a hassle to the commuters as they have to get on and off the bus multiple times. Larsen & Gilliland (2008) also writes that on average bus commuters usually travel 10-15 minutes to go the grocery store. By excluding transfers we are able to keep the travel time less than average. To ensure the routes that are chosen are single rides, we used the "select by attribute" tool on ArcGIS to select routes that have "1" in their attribute column for "transfers." "1" means there are transfers available in the routes and "0" means there are no transfers. The routes that have transfers should be deleted. By the end of this step, all the routes that we have in the dataset are only those that go to at least one of our surveyed grocery stores and these routes do not have any transfers.

After the bus routes are filtered, we created a 0.25 mile buffer around these routes. The goal is to look at the area that is within walking distance from the bus stop to the commuter's houses. The buffer represents area that is within 0.25 miles from the bus routes that go to at least one of our surveyed grocery stores (see Figure 4). We then edited this buffer to exclude any spatial restrictions such as highways like the Beltline Highway and impassable physical features like the arboretum, rivers and lakes into account. This can be done by overlaying spatial layers of highways, forests and waterbodies on the buffer and delete the buffer area that is overlapping with these additional layers.
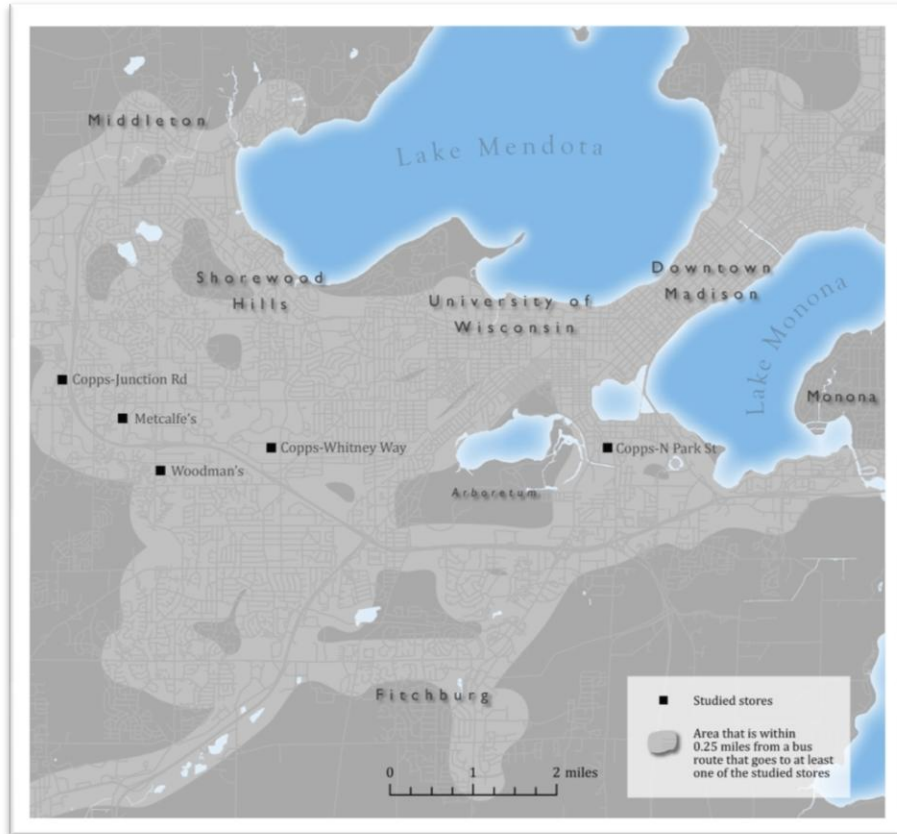
Figure 4 The area in lighter grey is the area that is within 0.25 miles from the single bus routes that go to at least one of our surveyed grocery stores.
Cartographer: Masrudy Omri

The last step is to overlay this buffer on the original food desert extent, and delete the area where these two layers overlap. The area of food deserts that overlap with the buffer stands for food desert areas that are within 0.25 miles from the nearest bus stop that have single routes that go to any of our studied grocery stores, and the ones that do not overlap mean otherwise. The outcome of this GIS application is the final map that shows the potential extent of food desert after bus service is taken into consideration. This map can be found in the results section on page 31 and will be further discussed in the discussion section on page 35. Figure 5 on the next page shows the summary of our GIS analysis to create this map.
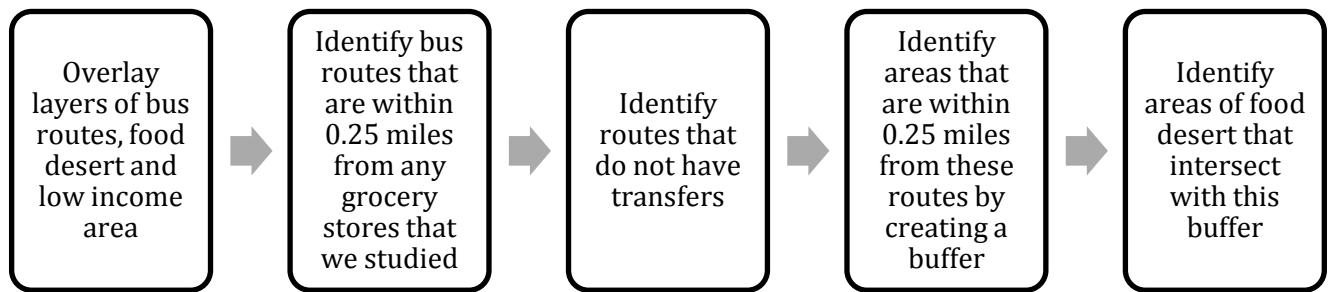
| Overlay layers of bus routes, food desert and low income area | → | Identify bus routes that are within 0.25 miles from any grocery stores that we studied | → | Identify routes that do not have transfers | → | Identify areas that are within 0.25 miles from these routes by creating a buffer | → | Identify areas of food desert that intersect with this buffer |

Figure 5 Summary of GIS analysis in redefining the extent of food desert.

Developing a scoring system

The results from grocery store observation and bus routes analysis are integrated and analyzed through a scoring system. This scoring system is developed so that each grocery store will be evaluated in respect to the overall condition of the store and its connection to Madison public transit. The scoring system for the grocery stores evaluation is developed based on samples of scoring framework from Nutrition Environment Measures Survey in Stores (NEMS-S) by Glantz et al (2007) (see Appendix 1 on page 54). Meanwhile the scoring system for the bus accessibility is a new idea that we developed based on our observations of the bus transit system in Madison. Our observations of the five grocery stores were conducted in a four hour session on a Saturday morning. The goal was to observe the stores in similar situations with regard to time and day of week, so that the store observation score would have less bias due to customer demand. The observations were made by each of the three team members, and the score given for each item was agreed upon by all three. We allocate 60 percent of the scores to grocery stores evaluation and the rest of 40 percent to the bus services. The reason why grocery stores

24

have higher weightage is because we see availability, price and quality of food as the key elements in solving food access problems.

Availability

In terms of the overall condition of the store, three different aspects were taken into consideration: (1) availability, (2) quality, and (3) price. The availability aspect concentrates on the availability of alternative options. For example, instead of just selling regular, 2% and skim milk, each grocery store is expected to provide other selections as well, such as soy, low fat, organic 2%, and organic skim. For hotdogs, each grocery store is expected to offer varied types of hotdogs such as turkey, less fat, organic sausages and vegetarian hotdogs such as Tofurkey®, along with regular beef hotdogs. In addition to that, each grocery store is supposed to provide organic fruits and vegetables, wholemeal bread options, baked chips, lower sodium snacks and natural frozen dinners.

Figure 6 A section dedicated for certified organic produce at Woodman's.
Photographer: Masrudy Omri

2 points are awarded to stores that offer wide availability of alternative options along with the essential items. Food item categories that were given 2 points are labeled with "high availability." 1 point is awarded to stores that offer sufficient availability of essential food items but with limited availability of alternative options. Food item categories that were given 1 point are labeled with "moderate availability." 0 points are awarded to stores that offer neither satisfactory availability of essential items nor broad selections of alternative options. Food item categories that were given 0 points are labeled with "low availability."

Quality

The quality aspect focuses on the freshness of produce such as vegetables, fruits, baked goods and ground beef. 2 points are awarded to stores that offer fresh and high quality products. Fresh fruits and vegetables are green. Ground beef looks new and fresh.

Figure 7 Poor quality eggplants at Copps, Whitney Way.
Photographer: Masrudy Omri

Food item categories that were given 2 points are labeled with "high quality." 1 point is awarded to stores that offer products of mixed quality and freshness. Fresh and high quality produce are available, but there are some products that are rotten or of low quality. Food item categories that were given 1 point are labeled with "mixed quality." 0 points are awarded to stores that offer products that in which its level of freshness and quality is very poor. Food item categories that were given 0 point are labeled with "low quality." However, the limitation of this evaluation is that it was rather difficult to evaluate the quality of prepackaged goods such as cereals, juices and chips. Hence, these prepackaged food items receive an automatic 2 points.

Price

2 points are awarded to food items that are sold at lower price than county average. 1 point is awarded to food items that are sold at county average price. 0 points are awarded to food items that are sold at higher price than county average.

Figure 8 The price of a gallon of whole milk at Woodman's
which is lower than county average ($4.14). Photographer: Masrudy Omri

The data for county average price is taken from C2ER retail price survey. Table 1 lists down the average price of a few key food items in Dane County.

Food items	Average price
Fresh fruits & vegetable	
Bananas (1 lb)	$0.56
Peaches (29 oz)	$2.55
Potatoes (5 lb)	$2.60
Lettuce (1 head)	$1.69
Frozen corn (16 oz)	$1.81
Sweet peas (15 oz)	$1.31
Milk & dairy	
Whole milk (0.5 gal)	$2.07
Skim milk (1 gal)	$2.79
Parmesan cheese (8 oz)	$3.53
Pre-packaged bread	
White bread (24 oz)	$1.45
Whole wheat bread (24 oz)	$2.99
Beef	
Ground beef (1 lb)	$3.49
T-bone steak (1 lb)	$10.59
Hot dogs	
Sausages (1 lb)	$4.02
Frozen dinners	
Frozen chicken dinner (8-10 oz)	$2.61
Beverages	
Fresh orange juice (59 oz)	$3.64
Snacks & chips	
Potato chips (12 oz)	$4.13
Cereal	
Cereal (18 oz)	$3.90

Table 1 List of average price of some food items in Dane County.

Bus accessibility

The bus accessibility is evaluated based on four considerations: (1) number of routes available, (2) number of routes that move past food desert, (3) number of food deserts serve (4) and the frequency of routes. For number of routes available, 1 point is awarded for each route available, and each store could score 10 points maximum. For

number of routes that move past food desert, 1 point is awarded for each route available, and each store could score 10 points maximum. For number of food deserts served, no point is awarded to routes that do not serve any food desert. 5 points are awarded to routes that serve one food desert and 10 points are awarded to routes that serve more than two food deserts. The frequency of routes aspect is evaluated based on the most frequent bus route available. If any of the routes that serve a food desert has hourly transit, the grocery store will receive 3 points. If the grocery store is also accessible by routes that arrive every half an hour, an extra 4 points will be awarded. Additional 3 points will be given to grocery stores that are accessible by routes that have transits less than every 30 minutes, such as 15 minutes or 20 minutes.

The routes that were generated earlier are used again in scoring the grocery stores based on bus accessibility. Figure 9 shows a simple method to find the number of routes that serve a particular grocery store based on the routes that have been narrowed down to those that are within 0.25 mile proximity to the store. In this example, the result shows that there are four routes that serve Copps at Junction Road. Figure 10 shows a method used to verify whether each route moves past any food desert, and subsequently determine the number of food deserts this route serves. In this example, the result shows that route #15 moves past a food desert and it only serves one food desert. Figure 11 shows another example using route #68. This figure illustrates that route #68 does not move past, hence it does not serve any food desert. These steps are then repeated for all grocery stores.
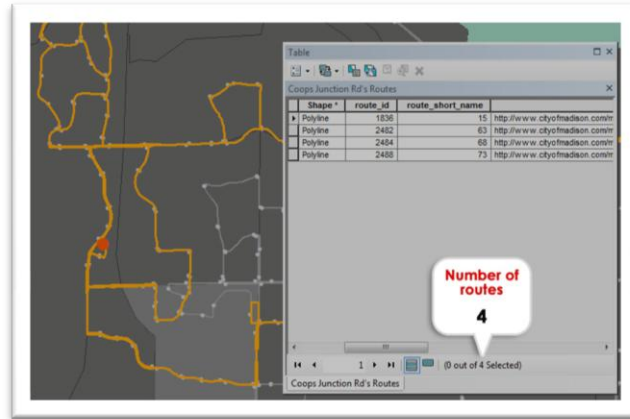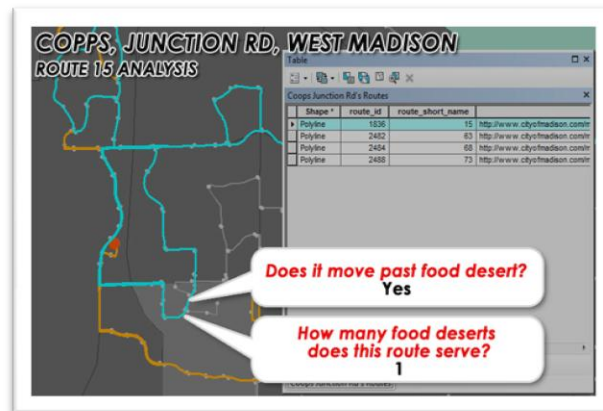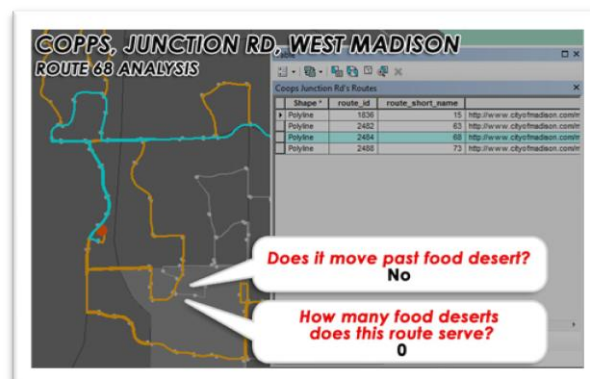
Figure 9

Figure 10

Figure 11

Redefining food desert

Figure 12 is the map that shows the outcome of our GIS analysis in integrating bus services with food desert in Madison. This map displays the redefined extent of food desert after taking bus services into account. The original map that illustrates the original extent of food desert as described by USDA can be found on page 19 (Figure 2). Further discussion of these two maps can be found on the discussion section on page 35.
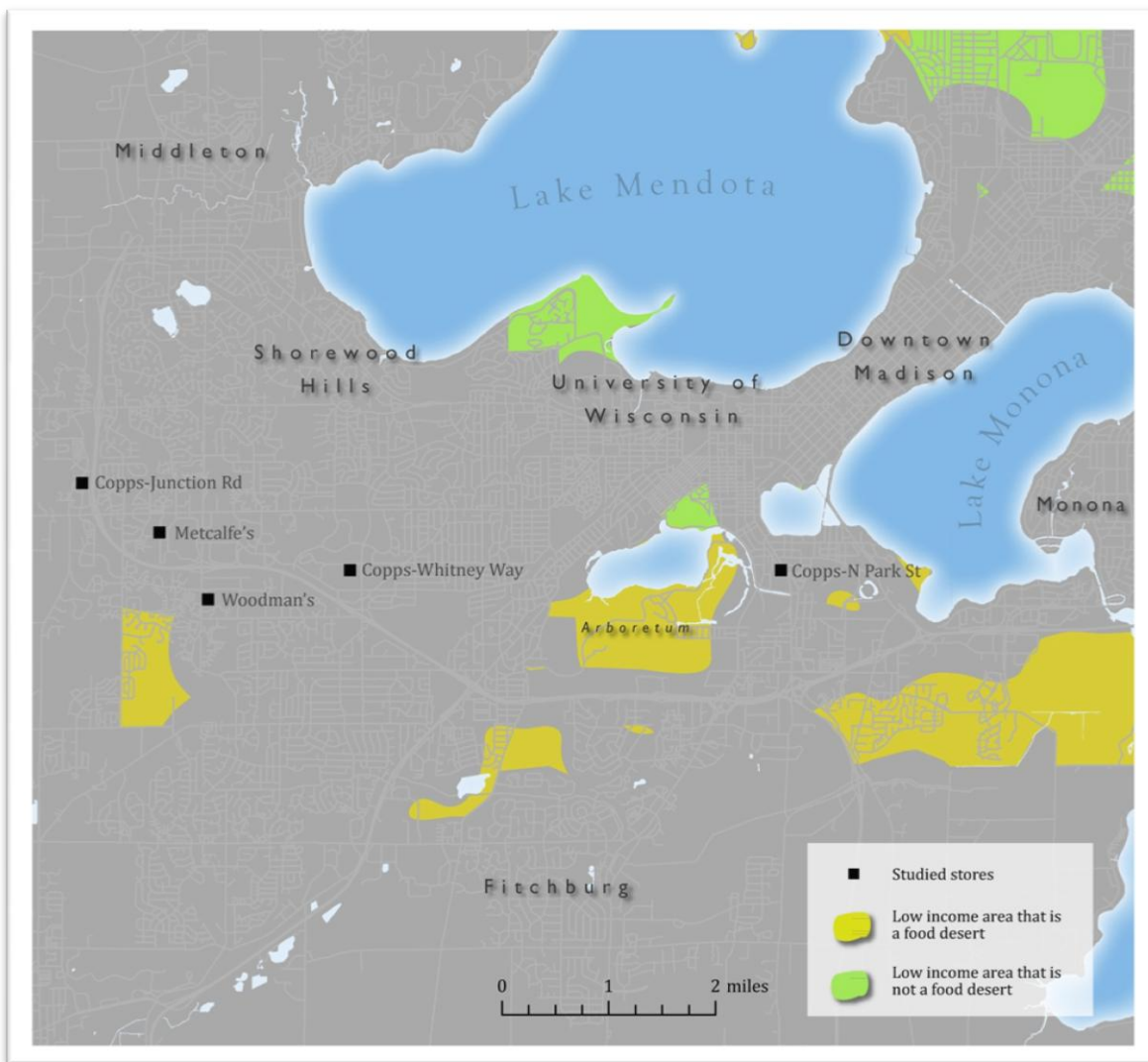

Figure 12 Redefined extent of food desert after taking bus services into account.
Cartographer: Masrudy Omri

Scoring grocery stores

Availability

	Copps, S. Park St.	Copps, Whitney Way	Copps, Junction Rd	Metcalfe's, Mineral Point Rd	Woodman's, S Gammon Rd
Fresh fruits & vegetable	1	0	0	2	2
Milk & dairy	2	2	2	2	1
Pre-packaged bread	2	2	2	2	2
Ground beef	1	1	1	2	2
Hot dogs	2	2	1	1	2
Frozen dinners	1	1	1	2	1
Beverages	1	1	0	1	2
Baked goods & pastries	0	1	1	2	1
Snacks & chips	2	2	1	2	2
Cereal	2	2	2	2	2
Total Score (max. 20)	**14**	**14**	**11**	**18**	**17**

Table 2

Quality

	Copps, S. Park St.	Copps, Whitney Way	Copps, Junction Rd	Metcalfe's, Mineral Point Rd	Woodman's, S Gammon Rd
Fresh fruits & vegetable	1	1	1	2	2
Milk & dairy	2	2	2	2	2
Pre-packaged bread	2	2	2	2	2
Ground beef	0	0	0	2	2
Hot dogs	2	2	2	2	2
Frozen dinners	2	2	2	2	2
Beverages	2	2	2	2	2
Baked goods & pastries	1	1	1	2	2
Snacks & chips	2	2	2	2	2
Cereal	2	2	2	2	2
Total Score (max. 20)	**16**	**16**	**16**	**20**	**20**

Table 3

Price

	Copps, S. Park St.	Copps, Whitney Way	Copps, Junction Rd	Metcalfe's, Mineral Point Rd	Woodman's, S Gammon Rd
Fresh fruits & vegetable	1	1	1	0	2
Milk & dairy	1	1	1	1	2
Pre-packaged bread	1	1	1	0	2
Ground beef	1	1	1	0	2
Hot dogs	1	1	1	1	2
Frozen dinners	1	1	1	0	2
Beverages	1	1	1	0	2
Baked goods & pastries	1	1	1	0	2
Snacks & chips	1	1	1	0	2
Cereal	1	1	1	0	2
Total Score (max. 20)	**10**	**10**	**10**	**2**	**20**

Table 4

Bus Accessibility

	Copps, S. Park St.	Copps, Whitney Way	Copps, Junction Rd	Metcalfe's, Mineral Point Rd	Woodman's, S Gammon Rd
Number of routes available	7	10	4	3	4
Number of routes that move past food desert	7	10	3	3	3
Number of food deserts served	5	10	5	5	10
Frequency of routes	7	10	10	10	7
Total Score (max. 40)	**26**	**40**	**22**	**21**	**24**

Table 5

Total score

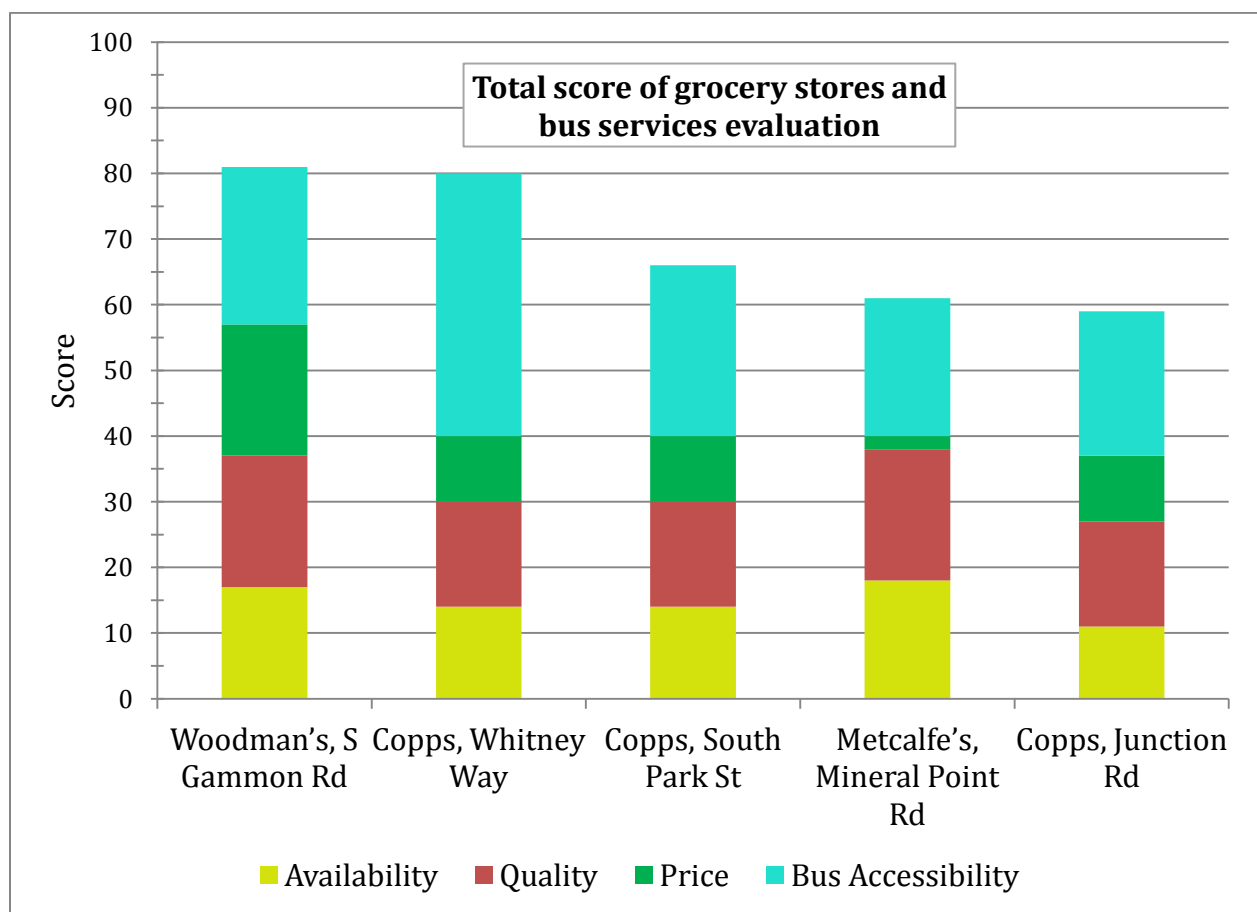|	Copps, S. Park St.	Copps, Whitney Way	Copps, Junction Rd	Metcalfe's, Mineral Point Rd	Woodman's, S Gammon Rd
Grocery stores evaluation	40	40	37	40	57
Bus accessibility evaluation	26	40	22	21	24
Total Score (max. 100)	66	80	59	61	81

Table 6

Figure 13 Total score of grocery stores and bus services evaluation.
Bar chart created by Masrudy Omri.

DISCUSSION

Redefining food desert

Our GIS analysis shows that there is a significant difference in the extent of food desert if bus service is taken into consideration. The original extent of the studied low income area that is within food desert is 36.149 square miles. After incorporating Metro Madison service, this extent shrinks to only 19.326 square miles. Our analysis shows that the food desert gets 45.5 percent smaller if bus service is used as an element in defining food desert. These changes show that public transportation should be an important consideration in defining the extent of food desert. We believe that if we are able to extend our research further in the east and north sides of Madison with more grocery stores surveyed, the actual extent of food desert will most likely be greatly minimized.

Scoring grocery stores

The first category that we rated was the availability of food items in the store. Both Metcalfe's (18/20) and Woodman's (17/20) had high scores for item availability. Metcalfe's missed out on a perfect score because of a smaller range of hot dog and beverage options, while Woodman's missed out because of fewer choices in baked goods, frozen foods and milk options. The Copps stores scored lower, with the Junction Road store coming in last at 11/20. Generally, the Copps stores had very small selections of fresh fruit and vegetables, ground beef and frozen dinners. The Whitney Way store is by far the largest. The Junction Road store is about 2/3 the size and the Park Street store is around 1/4 the size of Whitney Way. What was surprising was that given the size difference of the three stores, the selection at each was very comparable.

The next category evaluated was quality of food items. Both Metcalfe's and Woodman's had perfect scores of 20/20. All three Copps scored 16/20, with marks coming off for lack of quality ground beef, fresh fruit and veggies which were wilting in the display and baked goods. It should be noted that evaluating the quality of prepackaged food is difficult, as the observations had to be made of the packaging and the expiration dates instead of the actual products.

The third category observed for the store scores was price. The Copps stores came in with prices that are at the Dane County average. Metcalfe's scored higher in every category except milk and hot dogs. Woodman's was the clear winner in price, beating each of the other stores in every category that was evaluated. An interesting note is that although Woodman's and Metcalfe's both scored 20/20 in food quality, the price difference between the two stores is quite noticeable.

These three categories were combined to give the overall store score for each location. Woodman's scored highest (57/60), as they had an overall wide selection, high quality and lower prices. Metcalfe's had high overall quality and availability. However, they were the highest priced location, and their score suffered because of this (40/60). The Copps were all within three points of each other, and they mostly equaled the score of Metcalfe's (Park Street and Whitney Way received 40/60 while Junction Road scored 37/60). However, the quality and availability at Metcalfe's far exceeded that of the three Copps, and only the high prices kept them from finishing much higher than the Copps stores. One again we note that both Woodman's and Metcalfe's scored especially high in quality, but Woodman's prices were all much lower than Metcalfe's. The price difference may be accounted for by the overall aesthetic differences in the ambiance of both stores.

Woodman's has the appearance of a food warehouse, while Metcalfe's has decided to emphasize the décor and appearance of their store. The Metcalfe's has the appearance of, for lack of a better term, a nicer store to visit than Woodman's, which emphasizes quantity and lower costs at the expense of ambiance. It is once again noted that Woodman's is located adjacent to a food desert while Metcalfe's is located inside one.

The bus service portion of the store scores was based on routes that serviced the stores and food deserts. Copps on Junction Road and Metcalfe's are both located in Madison's suburban west side, and thus had fewer buses which run past their locations. Although Woodman's is also located on the suburban west side, it is closer to residential neighborhoods and has more bus routes running past its location. The Copps on Park Street is located just south of downtown Madison, and scored second highest of the five stores. The Copps on Whitney Way is adjacent to a transfer point for the bus system, and thus has multiple routes running at quarter hour intervals around the city. It was the only store to receive a perfect score for the transit portion of its evaluation. It should be noted that only the Copps on Whitney Way and Woodman's were serviced by bus routes that went past more than one food desert.

Overall, Woodman's scored highest, gaining 81/100 points. The Copps on Whitney Way was a close second, finishing with 80/100 points. Copps on Whitney Way gained half its points by its perfect bus score, a benefit of its location next to a transfer point. Woodman's gained more of its points from its store score, with a total of 57/60. In general, most of the stores scored much higher in the store portion of their observations. All five stores gained at least two thirds of their store score potential. However, most of the stores scored much lower in the bus system score. Three stores, Woodman's, the Copps on

Junction Road, and Metcalfe's, all failed to receive at least 60 percent of their possible bus system score.

CONCLUSION

The scoring system we developed was able to rank stores based on how well they served residents of food deserts. The dual emphasis on both healthy food and access was reflected in the scores. By examining the food selection and price, as well as the number and frequency of buses that serviced these stores, we developed scores that reflect how well those stores provide healthy food to those who would otherwise have lower access to it. The limitations in the scoring system, such as the lack of modeling for transfers, are not a death knell for the scoring system. They are simply a warning that the system needs to be fine tuned to better reflect the real world situations that people find themselves in when riding the bus.

Our research raised as many questions as it answered. We have found that the method people use to get to the grocery store is an extremely important aspect of the quantity, quality and price of healthy food they have access to. Our main discovery from this research is that transportation is something that should not be ignored when discussing the nature and identity of food deserts. By focusing on the stores themselves we were able to identify which locations could best help the underserved. We hope that our scoring system, with its public transportation element, will serve as a basis for future research that examines not only healthy food, but how people can get to the stores that have healthy options.

FUTURE RESEARCH

There are limitations to the scoring system. If a resident of a food desert wishes to travel to Woodman's, the store with the highest score, and they do not live in one of the two food deserts directly serviced by bus routes moving past the store, they must transfer. A ride that makes transfers would take longer than a ride does not. Such limitations inhibit our scoring system, but it can be improved upon to better model the way people travel to the grocery store by bus. Future research would create a better model of the way people may travel to the stores with higher scores, based on transferring buses as well as how long they must wait for a bus.

This leads to the next idea we would like to further explore: how many people travel to the grocery store by bus? Although a person without an automobile would certainly benefit more from riding a bus to a grocery store rather than walking to whatever store is close, the issue of whether people actually ride the bus to the store is one that must be addressed. Due to the sometimes crowded nature of buses, it is difficult to imagine someone traveling with several bags of groceries in such confined quarters. Future research may explore not only whether people ride the bus to the grocery store, but whether the buses themselves may be improved to allow people to better transport a mass of groceries from the store to their home.

We would also like to expand both the scale of our research as well as the extent covered by our rubric. A full examination of the grocery stores in Madison would give us a better idea of how well our scoring system reflects the reality of shopping in these stores. Also, we would like to expand the rubric to cover other elements of the grocery store score. As noted in the analysis section, shopping at Metcalfe's is a much different experience than

shopping at Woodman's. Even the Copps stores displayed a great variety in store type. The store on Whitney Way is spacious and softly lit, while the store on Park Street has the appearance of a place whose décor has not been updated in thirty years, with tight aisles and very bright lighting. Elements of the shopping experience such as ambiance and safety may play a factor in which stores people choose to shop in, and thus must be considered for our scoring system.

APPENDIX

Table 1. Food store nutrition environment measures and variables assessed by direct observation

	Availability	Quality	Price[a] Absolute	Price[a] Comparative
Type of Food				
Fruit (fresh): 10 types	X	X	X	
Vegetables (fresh): 10 types	X	X	X	
Milk: skim/low-fat versus whole	X			X
Ground beef: lean versus regular	X			X
Hot dogs: low-fat versus regular	X			X
Frozen dinners: Reduced-calorie versus regular	X			X
Beverages				X
Soda: diet/low-calorie versus regular	X			
Fruit juice: 100% juice versus juice drinks	X			X
Baked goods: lower fat versus regular	X			X
Bread: 100% whole grain versus refined	X			X
Snack chips: baked/low-fat versus regular	X			X

[a]Comparative price applies when there is price information for a healthier food option and the equivalent "regular" comparison (e.g., skim milk vs whole milk), while absolute price applies when the item is compared across store type and neighborhood characteristics.

Appendix 1 NEMS-S scoring system developed by Glantz et al (2007).

Photo 1 Locally grown produce available at Copps, S. Park St.
Photographer: Masrudy Omri

Photo 2 Baked chips aisle at Copps, S. Park St. Photographer: Masrudy Omri

Photo 3 Natural foods aisle at Copps, S. Park St. Photographer: Masrudy Omri

Photo 4 Example of a grocery store that accepts SNAP.
Photographer: Masrudy Omri

Photo 5 Example of a grocery store that accepts WIC.
Photographer: Masrudy Omri

Photo 6 Organic produce section at Copps, Whitney Way
Photographer: Masrudy Omri

Photo 7 A taxi waiting for carless customers in front of Copps, S. Park St.
Photographer: Masrudy Omri

Photo 8 Tomatoes found at Copps, Junction Road.
Photographer: Masrudy Omri

Photo 9 An aisle that is dedicated for only natural and organic frozen dinners.
Photographer: Masrudy Omri

Photo 10 Fresh, green vegetables at Metcalfe's.
Photographer: Masrudy Omri

Photo 11 An aisle dedicated for organic and vegetarian
frozen dinners at Woodman's. Photographer: Masrudy Omri

Photo 12 An aisle dedicated for natural frozen
at Metcalfe's. Photographer: Masrudy Omri

Photo 13 An aisle dedicated for variety of alternative/healthy
food options at Woodman's. Photographer: Masrudy Omri

Scoring Rubric
Copps, South Park St.

GROCERY STORE EVALUATION				
Criteria	**AVAILABILITY** Low = 0 point Moderate = 1 point High = 2 points	**QUALITY** Poor = 0 point Mixed = 1 point Good = 2 points	**PRICE** (relative to county average) Lower = 0 point Equivalent = 1 point Higher = 2 points	**TOTAL**
Fresh fruits & vegetable	1 Takes up smaller % of the whole store.	1 Potatoes are rotten. Peppers are in bad quality.	1	3
Milk & dairy	2	2	1	5
Pre-packaged bread	2	2	1	5
Ground beef	1 Limited availability	0 The beef looks old and not so fresh.	1	2
Hot dogs	2	2	1	5
Frozen dinners	1 Limited availability.	2	1	4
Beverages	1 Aisle for juices is too small. Lack of healthy options.	2	1	4
Baked goods & pastries	0 Too much sweet pastries. Lack of breads.	1 Freshly baked breads are not available.	1	2
Snacks & chips	2	2	1	5
Cereal	2	2	1	5

BUS ROUTES EVALUATION		
	Criteria	**Scores**
Number of routes available	1 point for each route available. Maximum: 10 points	7
No. of routes that move past food desert/low income area	1 point for each route that moves past food desert. Maximum: 10 points	7
No. of food deserts/low income area served	0 food desert = 0 point 1 food desert = 5 points 2 and more food deserts = 10 points	5
Frequency of routes	Availability of hourly transit = + 3 points Availability of every 30 minutes transit = +4 points Availability of less than every 30 minutes transit = +3 points	7

Grocery store evaluation accumulated scores	40/60	Bus routes evaluation accumulated scores	26/40	Final score	66/100

Scoring Rubric
Woodman's, South Gammon Road

	GROCERY STORE EVALUATION			
Criteria	**AVAILABILITY** Low = 0 point Moderate = 1 point High = 2 points	**QUALITY** Poor = 0 point Mixed = 1 point Good = 2 points	**PRICE** (relative to county average) Lower = 0 point Equivalent = 1 point Higher = 2 points	**TOTAL**
Fresh fruits & vegetable	2	2	2	6
Milk & dairy	1 Organic milk was not sold in gallons.	2	2	5
Pre-packaged bread	2	2	2	6
Ground beef	2	2	2	6
Hot dogs	2	2	2	6
Frozen dinners	1 Takes up too little space.	2	2	5
Beverages	2	2	2	6
Baked goods & pastries	1 No freshly baked breads available.	2	2	5
Snacks & chips	2	2	2	6
Cereal	2	2	2	6

	BUS ROUTES EVALUATION	
	Criteria	**Scores**
Number of routes available	1 point for each route available. Maximum: 10 points	4
No. of routes that move past food desert/low income area	1 point for each route that moves past food desert. Maximum: 10 points	3
No. of food deserts/low income area served	0 food desert = 0 point 1 food desert = 5 points 2 and more food deserts = 10 points	10
Frequency of routes	Availability of hourly transit = + 3 points Availability of every 30 minutes transit = +4 points Availability of less than every 30 minutes transit = +3 points	7

Grocery store evaluation accumulated scores	**57/60**	**Bus routes evaluation accumulated scores**	**24/40**	**Final score**	**81/100**

Scoring Rubric
Metcalfe's

GROCERY STORE EVALUATION				
Criteria	AVAILABILITY Low = 0 point Moderate = 1 point High = 2 points	QUALITY Poor = 0 point Mixed = 1 point Good = 2 points	PRICE (relative to county average) Lower = 0 point Equivalent = 1 point Higher = 2 points	TOTAL
Fresh fruits & vegetable	2	2	0	4
Milk & dairy	2	2	1	5
Pre-packaged bread	2	2	0	4
Ground beef	2 (freshly packaged)	2	0	4
Hot dogs	1 The aisle for hot dogs is too small compared to the others	2	1	4
Frozen dinners	2	2	0	4
Beverages	1 The aisle for juices is too small compared to others	2	0	3
Baked goods & pastries	2	2	0	4
Snacks & chips	2	2	0	4
Cereal	2	2	0	4

BUS ROUTES EVALUATION		
	Criteria	Scores
Number of routes available	1 point for each route available. Maximum: 10 points	3
No. of routes that move past food desert/low income area	1 point for each route that moves past food desert. Maximum: 10 points	3
No. of food deserts/low income area served	0 food desert = 0 point 1 food desert = 5 points 2 and more food deserts = 10 points	5
Frequency of routes	Availability of hourly transit = + 3 points Availability of every 30 minutes transit = +4 points Availability of less than every 30 minutes transit = +3 points	10

Grocery store evaluation accumulated scores	40/60	Bus routes evaluation accumulated scores	21/40	TOTAL SCORES	61/100

Scoring Rubric
Copps, Junction Road

GROCERY STORE EVALUATION				
Criteria	**AVAILABILITY** Low = 0 point Moderate = 1 point High = 2 points	**QUALITY** Poor = 0 point Mixed = 1 point Good = 2 points	**PRICE** (relative to county average) Lower = 0 point Equivalent = 1 point Higher = 2 points	**TOTAL**
Fresh fruits & vegetable	**0** Takes up smaller %. Smaller organic section.	**1**	**1**	**2**
Milk & dairy	**2**	**2**	**1**	**5**
Pre-packaged bread	**2**	**2**	**1**	**5**
Ground beef	**1**	**0** The beef looks old and lacks freshness.	**1**	**2**
Hot dogs	**1**	**2**	**1**	**4**
Frozen dinners	**1**	**2**	**1**	**4**
Beverages	**0** Smaller section	**2**	**1**	**3**
Baked goods & pastries	**1**	**1**	**1**	**3**
Snacks & chips	**1**	**2**	**1**	**4**
Cereal	**2**	**2**	**1**	**5**

BUS ROUTES EVALUATION		
	Criteria	**Scores**
Number of routes available	1 point for each route available. Maximum: 10 points	**4**
No. of routes that move past food desert/low income area	1 point for each route that moves past food desert. Maximum: 10 points	**3**
No. of food deserts/low income area served	0 food desert = 0 point 1 food desert = 5 points 2 and more food deserts = 10 points	**5**
Frequency of routes	Availability of hourly transit = + 3 points Availability of every 30 minutes transit = +4 points Availability of less than every 30 minutes transit = +3 points	**10**

Grocery store evaluation accumulated scores	**37/60**	Bus routes evaluation accumulated scores	**22/40**	**TOTAL SCORES**	**59/100**

Scoring Rubric
Copps, Whitney Way

	GROCERY STORE EVALUATION			
Criteria	**AVAILABILITY** Low = 0 point Moderate = 1 point High = 2 points	**QUALITY** Poor = 0 point Mixed = 1 point Good = 2 points	**PRICE** (relative to county average) Lower = 0 point Equivalent = 1 point Higher = 2 points	**TOTAL**
Fresh fruits & vegetable	**0** Takes up smaller %. Smaller organic section	**1**	**1**	**2**
Milk & dairy	**2**	**2**	**1**	**5**
Pre-packaged bread	**2**	**2**	**1**	**5**
Ground beef	**1**	**0** The beef looks old and lacks freshness.	**1**	**2**
Hot dogs	**2**	**2**	**1**	**5**
Frozen dinners	**1**	**2**	**1**	**4**
Beverages	**1**	**2**	**1**	**4**
Baked goods & pastries	**1**	**1**	**1**	**3**
Snacks & chips	**2**	**2**	**1**	**5**
Cereal	**2**	**2**	**1**	**5**

	BUS ROUTES EVALUATION	
	Criteria	**Scores**
Number of routes available	1 point for each route available. Maximum: 10 points	**10**
No. of routes that move past food desert/low income area	1 point for each route that moves past food desert. Maximum: 10 points	**10**
No. of food deserts/low income area served	0 food desert = 0 point 1 food desert = 5 points 2 and more food deserts = 10 points	**10**
Frequency of routes	Availability of hourly transit = + 3 points Availability of every 30 minutes transit = +4 points Availability of less than every 30 minutes transit = +3 points	**10**

Grocery store evaluation accumulated scores	**40/60**	Bus routes evaluation accumulated scores	**40/40**	**TOTAL SCORES**	**80/100**

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