AN ABSTRACT OF THE THESIS OF

Dianna Marie Smith for the degree of Master of Science in Geography presented on October 10, 2003.

Title: Food Deserts in the Willamette: A Study of Food Access in Lane County, Oregon.

Abstract approved:

According to USDA research, Oregon in 2002 had the highest rate of hunger and one of the highest rates of food insecurity in the United States. Although the margin of error involved with these statistics indicates that the state may not actually be at the top of the list, a state with only moderate poverty is not expected to be first in hunger. A possible explanation for this high incidence of food insecurity and hunger is the geographic disadvantage of low-income Oregonians.

My research, performed in cooperation with a local food security coalition (the Lane County Food Coalition), focused on a cross-section from urban areas to small towns. Specifically, this study evaluated access to food in order to determine if geographic disadvantage exists in Eugene-Springfield and its surrounding communities. The analysis uses a Geographic Information System (GIS) to identify the location of large retail food stores in relation to residential areas in order to compare 1) food prices and availability, and 2) socioeconomic variables across the study area.

Several results emerged from this study. Rural residents had few low-priced food choices compared to urban residents in the study area, and higher food prices were not concentrated in low-income urban areas. Low-income urban residents did experience poor access to stores in some areas, but the presence of bus routes improved this access. While these results do not categorically demonstrate that geographic disadvantage leads to food insecurity and hunger, they suggest that further
research to clarify how residents travel to buy their food and select stores they visit will prove significant.
Food Deserts in the Willamette: A Study of Food Access in Lane County, Oregon.

by
Dianna Marie Smith

A THESIS
submitted to
Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

Presented October 10, 2003
Commencement June 2004

APPROVED:

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Dean of the Graduate School

I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

[Signature]

Dianna Marie Smith, Author
ACKNOWLEDGEMENTS

I would like to thank my committee for many hours of assistance, advice, and patience in this process. Ronald E. Doel has proved invaluable every step of the way, and has served as an excellent advisor. Laurence Becker, Garry Stephenson, and Larry Lev have all contributed wonderful comments and guidance, and their work is greatly appreciated. Additionally, the help and support of the Lane County Food Coalition made this project worthwhile.

My parents, David and Claire Smith, along with Chris Bromley have offered unyielding support during my entire thesis experience. Their patience and care enabled me to reach this goal.

My many friends here at Oregon State University have contributed to an outstanding two years. I would especially like to thank Jeremiah Knoche, Michele Punke and Chris Zanger for their help with the GIS for this project.

Finally, my love of geography and path to graduate school were inspired in large part by classes with Ian Manners. His passion for geography and encouragement to pursue a greater understanding of this discipline are the best motivation.
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Food Deserts in the Willamette: A Study of Food Access in Lane County, Oregon

Introduction

Involuntary lack of food is not a problem faced by many residents of the United States, but for some hunger is a harsh reality. Nine million people living in the United States experienced hunger in 2001 (United States Department of Agriculture 2002). The highest rate of hunger in this nation is not in the high-poverty states, but in a state where poverty is only moderate. This state is Oregon.

Actual hunger--people going without food because there is none and no money available for food--is more prevalent in Oregon than anywhere else in the United States (USDA 2002). While the national average for hunger is around 3% of the population, Oregon residents are hungry at a rate nearly twice that, 5.8% (USDA 2002). What is the cause of this startling statistic? The aim of this research is to understand potential causes of these hunger statistics, and to consider the possibility of geographic disadvantage (peoples’ inability to access food based on where they live) as a reason for hunger among low-income Oregonians.

This research takes a new approach to the issue of hunger and food by considering the challenges faced by people in both rural and urban areas of Oregon. Rather than isolate one aspect of food security, this study explores the cost of food in various areas, the availability of a variety of food items and the locations of large grocery stores across four communities in Lane County, Oregon. Additionally, the use of public transportation (where available) is considered as a way to improve food access for people without a vehicle. The result is a study specific to one geographic area, but with an approach easily replicated elsewhere in the United States to gain further understanding of why some people in this country do not have enough to eat.

Throughout this paper, the terms food security, food insecurity, and hunger describe various levels of food access. All terms are used extensively in this area of research with the understanding of the following definitions (Table 1).
Table 1. Terms used in this research

<table>
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<th><strong>Food security</strong>: Access by all people at all times to enough food for an active, healthy life. Food security includes at a minimum: (1) the ready availability of nutritionally adequate and safe foods, and (2) an assured ability to acquire acceptable foods in socially acceptable ways...</th>
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<td><strong>Food insecurity</strong>: Limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways.</td>
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<td><strong>Hunger</strong>: the painful sensation caused by a lack of food. The recurrent and involuntary lack of access to food.</td>
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(Anderson 1990, reproduced from Nord et al. 1999)

The above definitions describe three conditions of food access in United States households with the understanding that hunger due to dieting or inadequate time to eat is not the type of hunger USDA researchers are concerned with measuring. Instead, the purpose of United States hunger statistics is to capture the occurrence of hunger in households where food is unavailable for those who want and need it.

Since hunger in Oregon is best learned about from those experiencing it, the Oregon Food Bank regularly collects information from clients to better understand their needs and challenges. Over the past few years, this need has been growing: between 1997 to 2002, the demand for emergency food in Oregon increased by 42%. Surveys from Linn and Benton County food banks show that 42% of clients come from a household where at least one person works, but this statistic shows that working a low-wage job cannot always support a family (Community Services Consortium, http://www.csc.gen.or.us/survey.htm, accessed on 7/15/03).

The working poor are likely one of the groups reporting high rates of hunger in Oregon. From the mid 1980s to the mid 1990s, the income gap between the wealthiest fifth and poorest fifth of Oregon’s population grew substantially. During that time, the average income of the poorest fifth decreased by 6.5%, while the average income of richest fifth increased 33.9% (Economic Policy Institute/Center on Budget and Policy
Priorities 2002). Additionally, the cost of living in Oregon has climbed over the same time as many people moved into the state, increasing demand for housing and driving up prices (Oregon Center for Public Policy 2002). A recent survey of emergency food providers in Linn and Benton counties indicated that 47% of households receiving emergency food were spending over half of their income on housing (Oregon Food Bank 2002).

Rural areas are suffering economically, and in 2000, reports indicated that many of Oregon’s rural counties had unemployment rates more than 20% above the national average (OCPP 2000). The problems faced by people living in the rural United States are poorly addressed in hunger research compared to their urban counterparts; many researchers have focused on typically low-income inner-city urban core areas. However, many rural regions are also low-income, including large areas of Oregon. This lack of previous research, coupled with the high rates of food insecurity and hunger in Oregon, underscores the importance of the current study.

The United States hunger statistics, with Oregon’s place at the top, inspires many questions: What are the causes of food insecurity and hunger in the United States and Oregon? Are lower income Oregonians at a geographic disadvantage when it comes to purchasing healthy, affordable food? Could this disadvantage translate into increased food insecurity?

This study begins with a comprehensive literature review discussing the methods used to measure hunger in both the United States and abroad. The review begins with a comparison of USDA food security and hunger measures to the hunger measures used in lesser-developed countries. This provides a perspective for United States hunger statistics, clarifying their significance when compared to hunger statistics of other countries.

The review then continues to include United States research focusing on food access, to determine appropriate methods for measuring food access in this research. Since little peer-reviewed literature exists on this topic, it was necessary to include studies completed by a variety of organizations.
Retail models, historical and current, are reviewed to consider possible reasons for geographic disparity in food security, and economic inequality measures are included to place the United States hunger statistics in a larger context. The use of retail models is rare in food access studies, but these models are important in understanding retail flows and the impact of consumer demands and location. Research from the United Kingdom demonstrates this importance.

The results of this study show that people with lower incomes are sometimes geographically disadvantaged. Residents of rural towns (with lower incomes on average) have fewer stores locally than urban residents do, which leaves them with little choice of price. While the urban areas have a variety of stores (and price ranges) to choose from, rural residents sometimes have only one grocery store. In the case of this study, unless rural (Oakridge) residents drive 30 miles to a larger city, they will spend over $30 more for the same week’s worth of food than some urban residents. This finding begins to uncover the possible causes of Oregonians’ problems with hunger.

Completion of the literature review led to the formulation of a research plan and hypotheses. The research process for this paper included two steps. First, a Geographic Information System (GIS) provided an overview of Oregon’s socioeconomic status at the county level. The GIS allowed for comparisons between counties in a visual format that quickly showed differences between the primarily rural counties in the east and the more heavily populated areas in the Willamette Valley (Fig 1). The goal in developing this GIS was to determine if socioeconomic differences caused rural Oregonians to have higher rates of food insecurity and hunger. A focused case study with three major hypotheses to test local-level food security completed the research.
Location choice for the case study considered a few factors. Limited funds restricted extensive travel, so the area needed to be near Oregon State University. Interaction with a food security organization was desirable because an active advocacy group can use the research results to address any problems or replicate the work elsewhere.

Lane County, Oregon was a logical choice. Home to the University of Oregon, Lane County is immediately south of the researcher’s university. The county was not familiar to the researcher, so there was no prior knowledge or expectations of possible research outcomes. The Lane County Food Coalition (LCFC) is an active advocacy group based in Eugene, Oregon and was receptive to meeting with the researcher regarding this work. After meeting with members of the LCFC’s research committee,
we decided that four communities in Lane County would be included: two small cities and two rural towns.

The three hypotheses investigated in this case study sought to determine causes of food insecurity.

1. Low-income and rural Oregonians are at a geographic disadvantage for retail food store access.
2. There is less availability of food in low-income and rural locations.
3. Food is more expensive in low-income and rural areas.

The four communities varied by population and income, with the two cities located next to each other and the rural towns further away (Fig 2). Eugene and Springfield are two moderately sized cities, with populations of 137,893 and 52,864 respectively (Census 2000). The two rural towns included are Florence and Oakridge. Florence is a coastal town with a population of 7,263 and Oakridge is a small town south of Springfield with 3,148 residents (Census 2000) (Fig 3).

Figure 2. Location of the four communities used as study areas in Lane County
Figure 3. Population of each community included in the study

In each community, the variables of median household income, rate of individual poverty, and incidence of rented households without access to vehicles are recorded at the census tract level to indicate socioeconomic status. Twenty-seven stores were surveyed in the study area, and analysis of grocery store location and price comparisons provide information about food price and availability. The survey includes a list of sixty-eight items on the USDA's Thrifty Food Plan list, and the total cost of the list at each store is compared to all other surveyed stores.

The above information is compiled in a GIS encompassing the Eugene-Springfield metro area to effectively test the stated hypotheses. For an additional level of detail and understanding of economic diversity within the study area, the income distribution of each city or town's population was gathered from census data and graphed below (Fig 4).
The graph shows that income distribution varies widely in these communities. Eugene has a higher percentage of the population reporting incomes over $75,000 a year, while Oakridge residents record a higher percentage of incomes below $50,000 per year.

From my literature review, I believe this to be one of very few food access studies in the United States to include both urban and rural communities. The inclusion of rural areas was necessary to evaluate the food access, availability, and affordability in these areas compared to urban regions. Rural towns are important because much of Oregon's land area is rural, so an indication of food access in these areas was a necessary research objective.

These research results provide greater insight into food insecurity and hunger in Oregon: the role of social inequity and the importance of geographic location are clearer as the debate over hunger in Oregon continues. As new studies emerge that address hunger in the United States, this work adds to a growing base of knowledge. The research presented here contributes a case study that examines geographic disadvantage as an explanation for hunger in the Lane County study area.
Literature Review

A number of topics are relevant to the research of food insecurity and hunger, resulting in an extensive and varied literature review. The differing ways that the United States and other countries define hunger influence the entire research: understanding the methods of different organizations and ideas of relative wealth before launching into a discussion of United States food access is necessary. The study of food access measures in this country’s research is essential, as it influences the methodology used in this work extensively. Retail geography and food access studies in the United Kingdom provide an overview of potential methods and possible policy implications for this and similar United States-based work, as well as contributing results from a country further along in this area of research.

One goal of this literature review is to address the following questions: Is hunger in the United States similar hunger as defined in other countries? How exactly do researchers measure and describe hunger in the United States? Understanding the way hunger is measured in the United States appropriately begins with an overview of hunger measures around the world.

Approaches to defining hunger vary based on size of study area and geographic location; some areas use surveys to generate hunger statistics while other regions use physical measures. Organizations such as the Food and Agriculture Organization (FAO) do not usually distinguish hunger as a separate region along the continuum of food security as done in the United States. Instead, research focuses on measurable health problems. A 2002 publication by the FAO addressed food deprivation and undernutrition, two clearly quantifiable problems. This represents a significant departure from the focus of studies in the United States. The FAO (2002) discusses the United States Food Security Module (the survey-based methodology) as it may be relevant to other regions of the world. The conclusion is that although the USDA survey may produce useful results in the United States, it might not be appropriate for measuring hunger and food insecurity elsewhere. Additionally, the document concludes that the United States food security measure should not be used in place of quantitative measures already in use around the world (FAO 2002).
Developing countries are often concerned with either micronutrient or protein-calorie malnutrition (Foster and Leathers 1999). Micronutrient malnutrition includes but is not limited to a lack of Vitamin A, iron, or iodine in the diet. None of these deficiencies are as common in the United States as they are in less developed countries, due in part to the nutritional programs and fortified foods available in the United States. Calorie deficiency is the largest worldwide problem, as most people worldwide obtain sufficient levels of protein. As with the FAO, methods discussed in this book for measuring malnutrition are a series of quantitative evaluations including clinical, biochemical, dietary, and anthropometric assessments.

Foster and Leathers (1999) provide an excellent description of the four assessments. A study-specific example of each assessment illustrates the advantages and disadvantages associated with each method. For instance, they show that biochemical assessment successfully measured dietary deficiencies in the Philippines, although problems arose with the collection and subsequent transportation of body fluids to a lab for testing. Foster and Leathers describe this method of assessment as being useful for measuring short term nutritional problems, but point out that it is costly and time consuming to complete (1999).

In contrast to the clearly quantitative methods utilized by researchers in many countries, the United States arrives at statistics for hunger and food insecurity through more qualitative methods. Here, results from surveys mailed out to selected households are statistically evaluated. No biochemical assessments are used and dietary records are not obtained. Instead, the United States Department of Agriculture releases its statistics for hunger based on respondents’ answers to carefully developed questions. This method is far removed from the dietary analysis and medical tests used to measure severe malnutrition in other countries.

The United States’ established methodology for measuring or estimating hunger is an eighteen-question survey, the Food Security Supplement (FSS), sent out to approximately 600,000 households with the Current Population Survey (CPS). The FSS survey accounts for incidences of hunger and/or food insecurity due to inadequate finances during the previous twelve months. The answer to each question provides
information on the presence and extent of food insecurity for that household. For instance, if the response to the statement, “We couldn’t afford to eat balanced meals” is “sometimes”, then the household is closer to food insecure than food secure. The number of affirmative answers provided by a household classify each household as food secure, food insecure, or food insecure with hunger.

One problem identified with the survey approach is the lack of information gathered about how often households experience hunger. With the December 2001 CPS survey, the USDA began to consider this aspect of hunger by asking about the frequency of food insecurity and hunger in. Past surveys classified a household as hungry based on a single hunger incident occurring during the prior year. Now, some questions are more specialized, with yes/no answers requiring respondents who mark “yes” to indicate how often the situation is true for that household. This additional information is an important step in improving food security measures in the United States.

Even with these improvements underway, survey results are hard to interpret accurately. A publication available along with the 2001 report states “small differences in estimated prevalence rates between States may be due to sampling variation and statistics are not sufficiently reliable to support precise state rankings” (http://www.ers.usda.gov/publications/fanrr29/Q&Asecurity.pdf , accessed on 7/10/03). Nord and other USDA researchers provide contemporary research suggesting that on any day, the rate of hunger is not affecting 3% of the United States population, as statistics indicate. The researchers found that, “The monthly prevalence of hunger is about 60% of the annual prevalence, and the daily prevalence is about 13% to 18% of the annual prevalence” (Nord, Andrews and Winicki 2002: 194).

Simply put, if the statistics indicate that three in every 100 people are hungry during the year, less than one person (13% to 18% of these three people) is hungry each day. These numbers provide a more realistic idea of food insecurity and hunger in the United States, and are important to consider when discussing similar figures for Oregon.
Research outside of the USDA has confirmed the validity of these food security measures. Edward Frongillo, Jr. at Cornell University found that the survey used to measure food insecurity and hunger was appropriate and accurate. He concludes that “This approach...has the direct potential to be important in providing a common means for assessing food security in other countries.” (Frongillo 2002:510). While his work indicates that the survey can be appropriate for identification of hunger and food insecurity, a distinction needs to be drawn between hunger in the United States and malnutrition in India.

Although independent research validates the survey methodology, the consideration of a household as hungry based on the answers to a survey is less than ideal when there are more quantitative methods available. The label of hunger is open to criticism by skeptics if there is a paucity of physical evidence. What constitutes hunger according to the USDA survey is reflective of the United States society, and perceptions of people living here. The FAO addresses this idea when comparing various measures of hunger, pointing out that people living in wealthy countries have different social norms than someone living in a poorer country.

Even if energy intake is adequate, and people do not feel pangs of hunger, they may still suffer from an acute sense of food deprivation if what they eat is considerably inferior in quality and quantity to the average standard prevailing in the society in which they live (FAO 2002:25).

The FAO is not alone in discussing how location influences the definition of deprivation (or perception of deprivation). Amartya Sen is an economist whose work on welfare economics and economic inequality provides some assistance at placing United States hunger statistics in a larger global context. People suffering from severe malnutrition in poorer countries may not agree that hunger is identifiable through the answers to a survey, but one point made by Sen (1997) is that capability deprivation through income deprivation can define poverty. When discussing inequality, he states that, “…relative deprivation in terms of incomes can yield absolute deprivation in
terms of capabilities. Being relatively poor in a rich country can be a great capability handicap, even when one’s absolute income is high in world standards” (Sen 1997: 212-213). This concept of relative deprivation validates the use of different methods for measuring hunger, as long as the results are also interpreted with each region’s economic situation in mind.

Hunger research methods clearly vary by country, as the above review indicates. This is appropriate, as culture influences the hunger measures. Calorie and nutrient deficiency are not a widespread problem in the United States, but these deficiencies are problems in many other countries. To address these differences, some countries such as the United States and the United Kingdom focus on understanding the reasons behind hunger and food insecurity. The following section includes a review of food security and hunger research in these two countries that was most influential in developing this study’s methodology.

Most people in the United States take for granted the ability to eat when and what they want, but not everyone in this country enjoys complete food security. As discussed before, some Americans do not have sufficient food without emergency assistance. Lang and Caraher (1998) discuss how the inability to obtain food usually happens in one of three ways. Food must be physically accessible, affordable, and available for consumers in order for them to be food secure (Lang and Caraher 1998).

Lack of food access, both physical and financial, can be a barrier to food security (Furey, Strugnell and McIlveen 2001). Food accessibility can vary by location, with accessibility influenced largely by the presence of food stores within an attainable distance; there must be a store with food in order for individuals to access to the food. Because reaching a store to buy food is necessary, people without private transportation are at a disadvantage if there is no store within walking distance. Transportation is not an issue to many Americans, as 89.7% live in households with cars (Census 2000). However, for people without access to a car, reaching a grocer can be a daunting task.

Previous research shows that fewer large chain grocery stores locate in low-income, inner-city areas (Andrews et al. 2001, Chung and Meyer 1999, Morland et al.
2002). Each of these studies shows a concentration of chain grocery stores in areas outside of the inner city. Chung and Meyer focused their research on inner-city and suburban Minneapolis-St. Paul in Minnesota, where they compared the locations of over 500 food stores. The research concludes that, “Chain stores were disproportionately located outside inner-city areas. Only 22% of the chains in the 526 sample stores are located in inner St. Paul or Minneapolis; nearly half of the nonchains were located there” (Chung and Meyer 1999:284).

Morland et al. completed research based in four separate cities within the US and found that in these areas stores are also disproportionately located outside of low-income areas; “there are over 3 times as many supermarkets in the wealthier neighborhoods compared to the lowest-wealth areas” (2002:26). Because of the large sample size (n=3341) and diverse locations (Maryland, Mississippi, Minnesota and North Carolina), this study provides strong evidence that large chain stores are less likely to locate in poorer urban neighborhoods.

Research by Andrews et al. used the Washington, DC region as a study site and concluded that stores are less likely to locate in poor areas of the study area. The authors concluded, “Supermarkets are more sparsely located in the southeast area, where some of the city’s highest poverty neighborhoods are located” (Andrews et al. 2001:50). This non-peer reviewed study had a relatively small sample size of 34 food retailers. Additionally, the results show that discount food retailers are more likely to locate in poorer neighborhoods.

Additional studies completed by private organizations found similar results; the problem of fewer large stores in lower-income neighborhoods is widespread. “Access Denied” by the Sustainable Food Center in Austin, Texas (1995) and “The Persistence of L.A.’s Grocery Gap” from the Center for Food and Justice (2002) both provide evidence of large chain grocery stores failing to locate in higher poverty areas. “Access Denied” found that the poor, predominantly black neighborhood of East Austin have only two grocery stores, many fewer than wealthier neighborhoods (Sustainable Food Center 1995). The study in Los Angeles found that in 2002, there
was a supermarket for every 18,649 Los Angeles County residents, but in the area identified as low income, each supermarket served 27,986 people.

The process of selecting a new supermarket location is one that must consider potential profits, suggesting a potential reason for fewer stores in poorer neighborhoods. Most grocery chains operate on a very low profit margin; Albertsons reported net earnings of 1.79% for the July 31, 2003 quarter. (http://www.albertsons.com/abs_news/latest/default.asp?id=4151#pdf, accessed on 10/15/03). Fred Meyer, a large chain store in Oregon, cited poor sales as the reason for closing a store location in a low-income Portland neighborhood. “The company (Kroger) says it is closing the 45-year-old store because it has been unprofitable for several years, despite a 1999 multimillion-dollar remodel” (Trevision 12/02/02). Industry evidence such as this statement and the noticeably low profit margin give weight to the argument that grocery stores are concerned with locating in profitable areas.

There is less rural research on food access, as access is approached as a problem largely confined to urban areas. However, some research is available to indicate that rural families also face problems with food access. Mark Nord (2002) published an overview of rural food insecurity and hunger, showing that these problems have remained steady in rural areas while decreasing in urban areas from 1998 to 2000. Additionally, the rates of food insecurity and hunger were highest in the nonmetro Western region, with 15.5% of all households classified as food insecure in 2000, a figure that backs up the statistics showing Oregon to have high rates of hunger (Nord 2002). As with the national hunger statistics, the sources of these statistics are answers to the CPS FSS survey.

Phil Kaufman, an agricultural economist with the USDA, completed rural research that closely resembles the urban locational research discussed above. Kaufman (1999) studied the locations of larger grocery stores and supermarkets in the lower Mississippi Delta region and concluded that the access to these types of stores was poorer in rural areas. Similar to urban areas the prices are lower in supermarkets, so people without access to supermarkets and large grocery stores pay higher prices.
when they buy groceries at smaller stores. This study concluded that food access was poor for low-income rural households, and that residents in a large area of the study region had to travel more than 30 miles to reach a large grocery store or supermarket (Kaufman 1999).

Comparison of urban and rural areas is not unique to this study. However, the idea is not widespread; a recent example comes from another state where there is a significant rural population. Researchers in Iowa recently completed a study comparing prices at stores (n=8) in four communities, using interviews to identify areas considered food deserts, areas where healthy, affordable food is unavailable (Low Income Project Team 1996). Here, food prices were higher in the rural food deserts than urban food deserts, although all prices were lower than the national average for the same time (Iowa State University Family Nutrition Program 2002).

As well as having fewer stores in their neighborhoods, some low-income and inner-city residents also face higher food prices in the stores that are present. Some groups suggest that food prices in lower-income, inner-city areas tend to be higher, placing poorer residents at a disadvantage due to geographic location (Sustainable Food Center 1995, Center for Food and Justice 2002). Price comparison is a way to address this idea through research. Past studies have used the USDA’s Thrifty Food Plan (TFP) as a standardized list of items (Andrews et al. 2001, Chung and Meyer 1999).

The USDA developed the TFP list to provide a minimal-cost diet meeting all nutritional guidelines for a set family size over one week (Fig 5). This plan is the lowest cost of four plans developed by the USDA, intended to represent purchases by a family on a low budget or food stamps. The list includes ingredients to make recipes developed and tested by USDA researchers. The cost of the TFP list is used in part to determine the value of food stamp allocations to people, by assuming that they will follow a similar meal plan. The list used in these studies suggests a menu for a family of four, two adults ages 20 to 50 and two school-aged children ages 6 to 8 and 9 to 11 (CNPP 1999).
## Food for a Family of Four

### Fruits and vegetables

**Fresh:**
- Apples: (5 small) 1 lb 4 oz
- Bananas: (11 medium) 2 lb 12 oz
- Grapes: 1 lb 8 oz
- Melon: 1 lb
- Oranges: (22 small) 4 lb 12 oz
- Carrots: 1 lb
- Celery: 5 oz
- Green pepper: 4 oz
- Lettuce, leaf: 9 oz
- Onions: 1 lb 4 oz
- Potatoes: 10 lb 6 oz
- Tomatoes: 6 oz

**Canned:**
- Oranges: 13 oz
- Peaches, light-syrup: 1 lb 10 oz
- Mushrooms: 4 oz
- Spaghetti sauce: 26 oz
- Tomato sauce: 8 oz

**Frozen:**
- Orange juice, concentrate: 7 12-oz cans
- Broccoli: 6 oz
- French fries: 11 oz
- Green beans: 1 lb 7 oz
- Peas: 15 oz

### Breads, cereals, and other grain products

- Bagels, plain, enriched: (4) 5 oz
- Bread crumbs: 3 oz
- Bread, French: 4 oz
- Bread, white, enriched: 2 lb
- Bread, whole-wheat: 1 lb
- Hamburger buns: 8
- Rolls, dinner: 4
- Corn flakes: 1 oz
- Toasted cereals: 10 oz
- Flour, white: 1 lb 2 oz
- Maccaroni: 1 lb 5 oz
- Noodles, whole: 1 lb 2 oz
- Popcorn, microwave: 3 oz
- Rice: 3 lb 2 oz
- Spaghetti: 11 oz

### Milk and cheese

- Evaporated milk: 4 oz
- Milk, 1 percent: 9 qt
- Milk, whole: 4 qt
- Cheese, cheddar: 2 oz
- Cheese, cottage: 1 oz
- Cheese, mozzarella: 1 oz

### Meat and meat alternatives

- Beef, ground, lean: 3 lb 15 oz
- Chicken, fryer: 1 lb 13 oz
- Chicken, thighs: 2 lb 12 oz
- Fish, frozen: 2 lb
- Tuna fish, canned: 12 oz
- Pork, ground: 1 lb 7 oz
- Turkey, ground: 1 lb
- Turkey ham: 11 oz
- Beans, garbanzo (chickpeas): 15 oz
- Beans, kidney: 15 oz
- Beans, vegetarian, baked: 1 lb 9 oz
- Eggs, large: 17

### Fats and oils

- Margarine, stick: 16 oz
- Shortening: 4 oz
- Salad dressing, mayonnaise-type: 6 fl oz
- Vegetable oil: 9 fl oz

### Sugars and sweets

- Sugar, brown: 1 oz
- Sugar, powdered: 3 oz
- Sugar, granulated: 9 oz
- Jelly: 8 oz
- Molasses: 1 fl oz
- Pancake syrup: 2 oz
- Chocolate chips, semi-sweet: 2 oz
- Fruit drink: 1 gal
- Fudge mix: 4

---

1 Provide food for a family of four. Amounts of food shown are for foods actually needed to prepare the Week 2 recipes in Preparing Meals at Minimal Cost, CNPP-78, September 1990.

Figure 5. Thrifty Food Plan list for one week, reproduced from Andrews et al. 2001
Chung and Meyer (1999) used the 1983 TFP list (week 1) for price comparisons along with a few additional items (baby formula, toothpaste, tampons, and carbonated soft drinks). The items priced at each of 55 locations across Minneapolis-St. Paul were chosen based on the following parameters:

To maximize homogeneity of each product, the most popular brand and package size for each product was chosen. For this purpose, a pilot survey was conducted at five stores before implementing the full-scale survey. If the particular brand and package size were not available, the least expensive brand (e.g., store brand) and package size (e.g., the largest package size) of the product in the store were included in the survey (Chung and Meyer 1999:282).

In contrast, the study completed by Andrews et al. simply chose the lowest priced item, whether generic, name or store brand that fulfilled the package size included on the 1999 TFP list.

USDA researchers considered the same hypothesis—that prices for food were higher in low-income areas—but used a different methodology. Kaufman and Lutz (1997) took existing data including food stamp redemption data, Census of Retailing data, and consumer surveys to piece together a picture of food choice and spending in the United States. One of the main conclusions reached by Kaufman and Lutz (1997), as well as Andrews et al. (2001) and Chung and Meyer (1999), is that food prices are lower in large chain grocery stores than in independent markets or small stores. Food stamp redemption data found that most food stamps are used in supermarkets, reflecting the desire for lower prices among food stamp recipients.

In the previous section, research indicated that large chain stores are less likely to locate in lower income areas. The literature on food price research indicates the consequences of this location disparity. If prices are lower in large chain stores, and these stores are less likely to locate in lower-income and inner-city areas, then it would follow that prices paid by residents in these areas are higher (Chung and Meyer 1999, Kaufman and Lutz 1997). Both of these studies concluded that prices were slightly higher in low-income and inner-city areas, but these price differences were due to
store type (small or independent). Some research suggests that prices are lower in large chains stores because they have higher overall sales and the availability of store brand items (Kaufman and Lutz 1997). Chung and Meyer (1999) also noted that the higher prices paid by inner city residents on some items could be offset by the lower prices on other items, and that the higher prices in poorer neighborhoods were not statistically significant.

Food availability is the underlying issue when researching store access, especially store type, as large chain stores can carry more variety of food than small or nonchain stores. The focus in this study is food that meets USDA recommendations, represented by the TFP list. Previous research indicates that not all of the items are found at small stores or at every large chain store. This portion of the literature review helped to develop the hypothesis dealing with food availability, that lower-income and rural areas would have lower availability of TFP items.

It is again important to note that fewer large chain stores are located in inner city and poor neighborhoods. Andrews et al. (2001) found that inner-city residents had access to inexpensive food with discount stores; unfortunately, these stores were missing an average of eighteen items from the list. Compared to large chain stores, which were missing an average of one item at each location, the people shopping at discount stores were experiencing lower food availability (Andrews et al. 2001).

Research in the Washington, D.C. area used the 1999 Thrifty Food Plan list to compare the availability of food items across different neighborhoods (Andrews et al. 2001). As the researchers completed surveys of each store they noted if items were not available, and then used this information to compare the selection of food available in every area (Andrews et al. 2001). The study completed in Austin was concerned primarily with the availability of produce and meat at stores in a low-income neighborhood (Sustainable Food Center 1995).

The Sustainable Food Center (1995) found that after surveying stores in East Austin, only five of thirty-eight convenience stores carried items needed for a balanced meal. Only eighteen of the convenience stores carried milk, but all of them carried alcohol. Supermarkets included in the study also showed lower availability;
the two large grocery stores located in East Austin carried fewer varieties of apples and other produce than similar stores in wealthier Austin neighborhoods.

The United States food security literature provides good examples of how to measure access, affordability, and availability of food. Ongoing research from the United Kingdom utilizes different methods of measuring food access, including retail models and GIS. Since these methods are incorporated into this study to evaluate food access, understanding how they were developed is important.

Retail models are not new to the field of geography. Walter Christaller introduced a retail model of central place theory in the 1930s, which described the interactions between size and the resulting number of retail businesses in a given place. His study area was southern Germany, where he devised his theory based on the placement of established settlements (Christaller 1966). Much weight was given in his model to the size of a place as indicating what its area of influence would be, inappropriately weighting some cities and ignoring places located between cities of origin and destination (Beguin 1992, Christaller 1966). Christaller’s theory is open to criticism today because of its simplistic nature, but continues to inspire further work (Beguin 1992).

A recent paper by Mushinski and Weiler (2002) built on Christaller’s concepts by focusing on geographic interdependencies in retail markets. The researchers state:

We would expect the number of retail establishments in a place is affected by both the population in neighboring areas, as potential sources of demand, and the number of establishments in those areas, as potential competing sources of supply (2002:76).

They go on to discuss the dependency of certain retail establishments on the presence of other establishments. Interestingly, the grouping of stores that included food stores was found to have no geographic interdependence, with the reasoning that food stores are necessary and will exist because people need them (Mushinski and Weiler 2002). This interaction between establishments (competition) influences spatial interaction models, discussed below in British research dealing with food deserts.
The notion of food security involving access, affordability, and availability to food is found in United Kingdom literature as far back as 1986 (Cole-Hamilton and Lang, in Mooney 1990). As a result, there is a wealth of information available on various methods of measuring food access. The history of food access studies in Britain and the implications of these studies are important to include in this work, as it leads to a better understanding of the potential for this type of research in America.

Retail models have been used in the United Kingdom in attempts to understand causes of food insecurity. While these models provide a basis for further US research, some modifications must be made. Although the United Kingdom is similar to the United States in terms of wealth, large differences are present in transportation methods. The most recent British statistics indicate that 72% of British households had a car or van in 2001 (National Statistics 2001). In contrast, as we have seen, the United States reported that 89.7% of households had access to a vehicle in 2000 (Census 2000). The method of access used by a person influences food access, so differences in transportation methods and availability are important and prevent direct comparisons between United Kingdom and United States research.

The Social Exclusion Unit (1998) in the United Kingdom defined a 500 meter boundary for the limit of easy food access, based on the distance an average person could walk in 6-7 minutes (cited in Furey, Strugnell and McIlveen 2001). The idea of defining an area of easy access was important after British food retailers began to move from city centers to suburban areas (Guy 1996). The result was that urban residents did not have grocery stores within walking distance, placing residents without vehicles or otherwise limited mobility at a disadvantage. The Low-Income Task Force (1996) began to consider areas where there was no fresh and healthy food available ‘food deserts’, introducing an emotive term to describe the lack of retail food stores in urban core areas.

The interest in the United Kingdom to address food access gained momentum with the publication of small-scale studies throughout the 1990s. These studies concluded that residents in poorer areas paid higher prices for healthy food (Soonman, Macintyre and Anderson 1993). Within the literature, a study that took place in
London gained early consideration. Cathy Mooney captured attention with a 1990 publication comparing food cost and availability in supermarkets in London’s Hampstead health district.

This growing body of literature resulted in two divergent courses followed by academics: the call for a change in policy that would equalize food access for lower-income people, and the concern that there was insufficient evidence for policy change to occur.

Two papers published in the Health Education Journal considered the problems of healthy food access by evaluating reasons for poor access and ended with policy recommendations (Caraher et al. 1998, Lang and Caraher 1998). These recommendations were echoed in a later publication by other researchers seeking answers to problems of food access (Furey, Strugnell and McIlveen 2001). And so the idea of increasing food access through governmental policy gained attention.

Not all researchers felt that governmental policy change was the answer to food access problems. Some researchers expressed concern that the basis of these policy recommendations was a small body of research lacking strong evidence of widespread food deserts (Cummins and Macintyre 2002). A publication by Cummins and Macintyre (2002) in the British Medical Journal brought up two of the studies (Mooney 1990 and Soonman, Macintyre and Anderson 1993) and showed how there could be problems with data interpretation and small sample size. After their report, it seemed reasonable to question the validity of using these studies as the basis for policy recommendation.

After the publication of Cummins and Macintyre’s critique, a special section of the journal *Urban Studies* was published that focused on food deserts. Neil Wrigley, a well-known retail geographer, authored an introductory article outlining the debate, policy response and research in the area of food deserts. His paper called for further quantitative research and “before and after studies of diet (and potentially health)” (Wrigley 2002: 2035). Clarke, Eyre and Guy (2002) provided quantification of food deserts in the same issue, with a continuation of the research since the publication.
Donkin et al. accomplished the quantitative identification of food deserts to some extent in 1999 with a Geographic Information System (GIS). While the Donkin study was limited because it primarily evaluated distance to a food store, Clarke, Eyre and Guy's (2002) use of a spatial interaction model allowed for the consideration of additional parameters (such as consumer preference). The usefulness of the spatial interaction model in mapping food deserts is that it allows more indicators of access to be included, as well as factoring in competition and customer flows (Clarke, Eyre and Guy 2002).

The model identified areas as potential food deserts in Leeds and modeled the potential impact of introducing a large retail food store in one of those areas, Seacroft. After areas with poor access were identified, the social composition of each area was studied to locate areas with both poor provision (as predicted by the model) and disadvantaged residents, defined by social indicators (Clarke, Eyre and Guy 2002).

One area identified as a food desert in Leeds, England became the focus of a before-and-after diet study. Tesco, a major British food retailer, opened a store in the Seacroft area of Leeds. Researchers found that store proximity does influence diet, providing "evidence for the first time in the UK of a positive but modest impact of a retail intervention on diet, associated with significant shifts in access" (Wrigley, Warm, and Margetts 2003: 182). This study provides important evidence that retail provision does influence diet, also shown in the United States by Morland et al. in 2002. However, differences between the United States and the United Kingdom cannot be understated; because of the difference in transportation use and availability, it is inappropriate to extrapolate research results from one country to the other.

Spatial interaction models are useful in mapping potential food deserts, and were a consideration in mapping for this project as well. The program necessary to calibrate the models for Lane County was unavailable at the time of research, so GIS-based mapping was used instead. The following section elaborates on the methodologies used in an attempt to quantify food access in Lane County.
Methods

The methods used in this research are based on methodology described in previous food access publications, adjusted to fit the needs of this project. The design of this research is to approach the issues of hunger and food insecurity in Oregon with quantitative methods, exploring the possible causes of these problems at both the state and local level. Several hypotheses were mentioned earlier, including widening income gaps, high unemployment, and the rising cost of living (OCPP 2002). The isolation of people in rural areas may also contribute to higher food insecurity and hunger, with some rural areas poorly served by emergency food sources or even grocery stores.

This research acknowledges that Oregon does not have many urban core areas so the focus was on rural areas and the ways these regions differ from urban areas socially and economically. What are the socioeconomic differences between primarily rural and primarily urban counties? Do these differences contribute to greater economic disparity in rural populations and possibly lead to food insecurity, causing the state to report relatively high percentages of the population as hungry? These questions are addressed at a statewide level with GIS-based analysis.

A GIS was created using ArcView GIS 3.2 to evaluate selected economic variables statewide to allow these questions to be addressed. In this situation GIS allows for comparison between all counties of Oregon based on income, poverty and housing costs. These variables gave an overview of the socioeconomic conditions in each county, providing indicators of social and economic disparity that may be present between the urban and rural regions of Oregon.

The statewide GIS contains county-level data including population, median household income, individual poverty, median home value, and gross monthly rent (average). One hypothesis proposed for the high rate of hunger in Oregon is the high cost of living (OCPP 2002), so the home value and gross rent are included. Gross rent is the amount paid for rent that includes some utilities to provide a more complete total of what households are spending on housing each month.
Store location is not included in detail at the statewide level, but showing the number of grocery stores per county provides a measure of access. The 2001 County Business Pattern data provided all of the store location information. All stores included were reported under the North American Industry Classification System (NAICS) code of 44511 which indicates “supermarkets and other grocery (except convenience) stores.”

Rural towns often do not have public transportation, so residents without vehicles in these areas are at a further disadvantage than urban residents without vehicles. The case study addresses this lack of access, where two of the cities included had public transportation while the remaining two towns did not. Public transportation is not included in the statewide GIS due to the scale of the data.

The specific measures of food access, availability, and affordability are addressed in a case study. This case study includes four communities, Eugene, Springfield, Florence, and Oakridge, in Lane County that vary in both population and income.

The purpose of a focused case study in Lane County was to test the following hypotheses:

1. Low-income and rural Oregonians are at a geographic disadvantage for retail food store access.
2. There is less availability of food in low-income and rural locations.
3. Food is more expensive in low-income and rural areas.

A local level GIS analysis was completed that focused on the two urban study communities, Eugene and Springfield. All information included was from the 2000 Census at the census tract level (Census 2000). USDA and other researchers (Andrews et al. 2001, Morland et al., 2002) have used census tract level data in previous food access studies. Census tracts each have populations of approximately 4000, so these tracts can indicate possible neighborhoods. Potential difficulties in analyzing access arise because residents of one census tract may easily shop in another
census tract, if transportation is available. At present, this methodology is the best available.

Oakridge and Florence are fully contained in one and two census tracts respectively, so there is not much basis for demographic comparison in those communities. Both stores in Florence are located along the border (Highway 101) of census tracts 7.03 and 7.04, so it is arguable that the demographic characteristics of both tracts influence the stores. The number of residents per grocery store is calculated for each community to provide a measure of access across the entire study area.

The case study GIS analysis includes three major socioeconomic variables: (1) median household income, (2) percent of individuals below the poverty level, (3) rented households without cars are included. Median household income provides a realistic measure of income in an area, more so than average household income or the median income of families or individuals because extreme high or low values can skew the mean.

Past researchers defined low-income areas by ZIP code areas having rates of poverty at either 10% or 15% (Andrews et al. 2001, Chung and Meyer 1999). Low-income areas in this study are census tracts where 15% or more of the population falls below the federal poverty guidelines; 24 of the 52 census tracts in the Eugene-Springfield metro area are considered low-income.

Households without cars are more limited in the ability to travel further for food stores, so this provides an indicator of limited access. Households that rent are typically lower income than those that own their housing, so the rented households without cars are the final variable that indicates lower income households without private transportation. Using this information, a collection of fourteen census tracts were selected that had 15% or more of the population living below the poverty level and 15% or more of rented households having no access to a vehicle. This final collection was adjusted for student populations, as described later, resulting in twelve tracts that represent low-income and low-mobility areas.

Households without vehicles can use public transportation to access stores, but only two of the cities included, Eugene and Springfield, have public transportation
easily available. The GIS includes these bus routes. The remaining towns, Florence and Oakridge, lack public transportation, leaving their residents who do not have access to vehicles at a further disadvantage. People living without private transportation might be able to rely on family or friends to go grocery shopping, but because no interviews were included in this case study the number of people using this method of access cannot be determined.

All chain grocers and large supermarkets over 20,000 square feet in store size were located in the Eugene-Springfield metropolitan area GIS (Fig 6). Large stores are the study focus because statistics show that food stamps are most often redeemed at either chain or other large grocery stores (Andrews et al. 2001, Kaufman and Lutz, 1997). The research was designed to measure food access for lower income groups, so it was most appropriate to use large stores. Limited availability of TFP items excluded specialty and ethnic food stores from this study.

A listing of all stores in each of these communities was compiled from First Search online yellow pages for each area. During the data collection, if additional stores were located they were included as well. After visiting the websites of major grocery chains to ensure the inclusion of all large stores the LCFC was contacted to confirm store selection. If a store did not carry sufficient produce from the Thrifty Food Plan list, it was not included in this study. These criteria caused many health or natural food stores to be omitted from the study, as well as outlet type stores that carried little or no produce. The omitted stores did not have enough items on the TFP list to provide meaningful comparisons.
Figure 6. Locations of stores surveyed in the Eugene-Springfield metropolitan area
Store location was compared to surrounding socioeconomic characteristics including the factors listed above (median household income, poverty, car ownership). A lack of stores combined with a higher incidence of poverty and rented households without cars, identifies areas of relative deprivation. Research in the United Kingdom indicated that households located more than 500 meters from a grocer are in a potential food desert (Social Exclusion Unit 1998). Recent work in the United States suggests extending this area to one mile as a reflection of the car-oriented American society (Tetty-Fio 1999 in Frazier et al. 2003). The access analysis included both measures, as the focus of the research is the measure the access for lower-income households, which may or may not have access to a vehicle. The low-income and mobility area comprised of twelve census tracts described above is evaluated for access primarily using the 500-meter boundary.

One hypothesis formulated for this study is that prices for TFP items are higher in low-income and rural areas. Food affordability was evaluated using the Thrifty Food Plan week 2 list (Fig 5). This included sixty-eight items (excluding condiments) with specific quantities to provide a straightforward comparison between stores. All prices were gathered during the week of February 2-8, 2003 to prevent seasonal fluctuations in the price of produce. At the time of data collection, the TFP list's average nationwide cost was $107.70 (http://www.usda.gov/cnpp/FoodPlans/Updates/foodfeb03.pdf, accessed on 7/13/03). This is based on a weighted average of prices collected around the US, including brand name items.

Up to two prices were recorded for each item on the list:

1. The lowest regular price of the item.
2. The lowest priced item at the time of data collection. This includes both sale prices and prices requiring a store membership card, which often vary from week to week.

By using this method, the lowest price at that time was captured as well as the lowest regular price that more accurately reflects what consumers would normally pay was recorded as well. One of the difficulties in this part of the research was the
quantity required for each item. The prices recorded reflect the smallest package size available that fulfills the list requirement. For example, the list calls for 3 pounds and 2 ounces of rice. Often, the cheapest option is to buy two 2-pound bags, keeping the leftovers for future use. The formula used to calculate each unit price in Microsoft Excel is shown below (Fig 7).

When calculating the price of an item for the list total, the following equation determined the cost of only the amount called for on the list:

Rice: 3 pounds, 2 oz = 50 oz. Purchased in 64 oz for $2.00 so

\[
\begin{align*}
X &= \text{purchase price} \\
Y &= \text{purchase size (oz)} \\
Z &= \text{size needed (oz)} \\
(X/Y) * Z &= \text{price} \\
($2.00/64) * 50 &= $1.56
\end{align*}
\]

Figure 7. Price calculation for the TFP list totals

Meat and produce prices were recorded by the price per pound, and then multiplied by the amount needed for the TFP list. When the type of item, for instance melon, was unspecified, we recorded the lowest priced type (watermelon, cantaloupe) was recorded.

The availability hypothesis for this study states that there is lower availability in low-income and rural areas. Availability is defined in this study as the variety and availability of various food items. To evaluate this hypothesis in the study area, the sixty-eight item Thrifty Food Plan list provided a means for evaluating availability at each store.

If an item was not available at a location, we recorded the item as unavailable at the time of data collection. When calculating the price totals for that location, we replaced the missing price with the mean price of that item at all other stores. We assumed that the average price would reflect the probable price paid at the location had the item been available, though this may result in an underestimation of the list
price at that location. We totaled the number of items available at each store to provide a measure of food availability.

Work published in the United Kingdom indicates that food security in North America is primarily a function of the ability to pay for food, whereas in the United Kingdom the issue is largely physical access to food stores (Furey, Strugnell and McIlveen 2001). This part of the study tests the hypothesis that low-income and rural Oregonians are at a geographic disadvantage for retail food access by using a GIS of the Eugene-Springfield metropolitan area for spatial analysis of store location and various socioeconomic variables. Store locations were placed in the GIS using address matching or visual placement. The resulting GIS provides a base map showing census tract boundaries, streets, and the locations of all large stores (greater than 20,000 square feet) included in the price analysis. Ethnic food and specialty stores were excluded, as were stores with insufficient amounts of produce for meaningful comparison.

Because GIS provides a visual representation of store location and surrounding area easily accessible on foot (500 meters), it allowed for the quick identification of neighborhoods or census tracts without a large store nearby. A 500 meter radius buffer around each store represents this local access. Census data identified neighborhoods with higher rates of poverty (low-income), as well as areas with low rates of car ownership (low-mobility), for which the 500 meter distance was most appropriate. Remaining low-income areas with greater car ownership rates were evaluated using the one mile buffer, reflecting the higher mobility. After the inclusion of public transportation routes, areas with the greatest geographic disadvantage were easily identified.

The inclusion of the area surrounding the University of Oregon does complicate the analysis; reported incomes of students are often quite low and can artificially inflate the poverty rate, while causing the median household income in an area to be unrealistically low. Because this GIS and census data is divided into census tracts, tracts with known high student populations are termed “student tracts” and are not considered to have the same limitations on income as other low-income areas with
fewer students. The tracts identified in this study as having high student populations were tracts 37 and 38 in Eugene, in which over half of the tracts’ populations are enrolled as college students (Census 2000). This adjustment resulted in the low-income areas being limited to twenty-two tracts (Fig 8), and the low-income and mobility areas to twelve tracts (Fig 9).
Figure 8. Census tracts classified as low-income in the Eugene-Springfield metro area
Figure 9. Low-income and low-mobility areas in the Eugene-Springfield metro area
Results

This section reports the results of this research, with the caveat that all reported findings are appropriate only for the area studied. Data analysis showed that availability was high across the study area, with varied affordability and access. The statewide GIS introduces the variables considered in the study area, as well as demonstrating the value of GIS in representing data patterns.

A GIS of county-level data compared socioeconomic variables statewide. The intention was to spot significant correlations between rural areas and higher poverty. Specifically, the following questions were considered: What are the socioeconomic differences between primarily rural and primarily urban counties? Do these differences contribute to greater economic disparity in rural populations and possibly lead to food insecurity, causing the state to report relatively high percentages of the population as hungry?

The average statistics for the state of Oregon provided a starting point for comparing the counties. The following table gives socioeconomic information relevant to this work (Table 2). All of this information gathered for each county used 2000 Census data from the Census Bureau. The number of grocery stores per county is included to indicate potential food access (http://censtats.census.gov/cgi-bin/cbpnaic/cbpcomp.pl, accessed on 7/13/03).

Table 2. State demographics

<table>
<thead>
<tr>
<th>Census statistic</th>
<th>Oregon average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median household income (1999)</td>
<td>$40,916</td>
</tr>
<tr>
<td>Median home value (2000)</td>
<td>$152,100</td>
</tr>
<tr>
<td>Median gross rent (2000)</td>
<td>$620</td>
</tr>
<tr>
<td>Poverty, percent of population below (2000)</td>
<td>11.6%</td>
</tr>
</tbody>
</table>

Most of Oregon’s population lives in the western half of the state, particularly in the Willamette valley. This population concentration was quickly evident when comparing populations of all counties (Fig 10). A group eastern of counties following a north-south axis all had populations below 15,000.
The median household income followed similar patterns around the state, with the highest levels concentrated in the inland northwestern corner of the state. Deschutes County in central Oregon, including the prosperous city of Bend, is an exception to this grouping (Fig 11).

Poverty seemed to follow no distinct pattern, with high and low poverty areas close together (Fig 12). Benton County showed relatively high levels of both poverty and median household income.

Median gross rent was highest in the higher-income northwestern corner, reflecting the relatively high income of this region (Fig 13). Median home value was similarly high in this area of Oregon (Fig. 14).

Grocery stores were concentrated in the more prosperous and populous regions of the state, with very few stores located in the sparsely populated counties (Fig 15). Wheeler County had only one grocery store, and Sherman County had only two.

Further discussion of these results will be included later in this paper, but the GIS shows that counties with lower populations also have lower incomes and availability of grocery stores when compared to more populated counties.
Figure 10. 2000 Population distribution in Oregon, by county
Figure 11. Median household income in 1999, by county
Figure 12. Percent of the population below the poverty level, by county (2000)
Figure 13. Median gross rent, by county (2000)
Figure 14. Average median home value by county, 2000
This research began with the understanding that the results found in this area cannot with any confidence be extrapolated to a larger region. Several variables were specific to the area, including income, poverty, and the location of bus routes. To replicate this study in a new area, census and transportation data for the region should be gathered and the same methods of analysis followed.

The case study included three hypotheses, with an explanation of the results is in the following section. Table 3 below provides an overview of results.
Table 3. Major results of the case study

<table>
<thead>
<tr>
<th>City</th>
<th>Average TFP Cost</th>
<th>Number of Stores</th>
<th>Average number of items missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eugene</td>
<td>$102.62</td>
<td>17</td>
<td>1.5</td>
</tr>
<tr>
<td>Springfield</td>
<td>$101.30</td>
<td>7</td>
<td>1.7</td>
</tr>
<tr>
<td>Florence</td>
<td>$104.48</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Oakridge</td>
<td>$102.10</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total sample</strong></td>
<td><strong>$102.40</strong></td>
<td><strong>27</strong></td>
<td><strong>1.6</strong></td>
</tr>
</tbody>
</table>

The food access hypothesis states that low-income and rural Oregonians are at a geographic disadvantage for retail food access, the assumption following that poor access could account for higher rates of food insecurity and hunger. A GIS of the Eugene-Springfield metro area tested this statement by comparing the location of all large grocery stores with three socioeconomic variables divided by census tracts. One area of difficulty with this GIS is that many of the roads were also census tract boundaries, and the available ArcView GIS shapefile for roads was incomplete due to these boundaries. The locations of stores were partially geocoded with the majority placed visually in the GIS.

All of the large grocery stores were located in the GIS and buffers with one mile radii placed around them to represent the surrounding areas easily accessible by car. Buffers of 500 meters were also included to indicate the distance easily walked to the store, which are of particular interest in the tracts classified as both low income and mobility (Fig. 16).
Figure 16. Grocery store locations (Eugene-Springfield metro area) with buffers of one mile and 500 meters
The map with mile-radius buffers shows that under these conditions, only a few low-income areas in the metro region have poor access to a large grocery store; fifteen of the 24 stores in the Eugene-Springfield metro area were located in census tracts previously defined as low-income (15% or more of the population having incomes below the federal poverty guidelines)(Fig 17). Most of the areas with lower access are in the outer portions of the metro area or outside the city limits, which have a higher median income and a lower incidence of households without vehicles. Areas that have poorer access and mobility are well served by public transportation, which included lines nearby most stores (Fig 18).
Figure 17. Low-income census tracts highlighted with one-mile buffers
Figure 18. 1999 Bus routes showing access to Eugene-Springfield grocery stores
The 500 meter buffers were placed around stores in the GIS with a focus on the twelve tracts having both high poverty and lower mobility (Fig 19). The result showed that some of these tracts had poor pedestrian access, with tract 32.02 having no store available at all. This tract is well inside the city limits, and has a higher population (4,066). Additionally, there are few bus routes in this tract, leaving many residents without this travel option.

One of the low income and low mobility tracts (21.01) includes areas close to and outside of the city limits, and has a relatively low population of 2,777 residents, but many of the low-income and low-mobility tracts are inside the city limits and more heavily populated. As with the above buffers, once the bus routes were included, access to stores was improved.

Another area that appears to have lower access to grocers is inside the city of Eugene. Parts of census tracts 29.01, 41, 42, and 43 are outside of the buffered store location areas. Only tract 42 was included in the low-income and mobility group, with a median household income of $22,025 and 36% of its 4,066 residents falling below the poverty level.

Based on previous definitions, the above areas are food deserts and are of importance for future research. Lower access in a low-income and especially low-mobility area can indicate that residents are at a higher risk for food insecurity. Residents living in these areas can use public transportation to reach grocery stores, but interviews with residents are necessary before this is transportation method is considered to provide access equal to a privately-owned vehicle.
500 meter buffer stores roads

Figure 19. Eugene-Springfield stores buffered at 500 meters, with low-income and low-mobility tracts highlighted
Although rural areas were not included in the GIS, the level of access in these towns was a consideration. After evaluating the number of residents for each grocery store in each community, this measure of access was better in Oakridge than all other communities (Table 4). As expected, the rural stores serve a smaller population, with the one store in Oakridge serving the entire town of 3,148 people. Although Eugene has many stores, seventeen, the high population causes the number of residents served by each store to be the highest.

<table>
<thead>
<tr>
<th>City</th>
<th>Population in 2000</th>
<th>Residents served by each store</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eugene</td>
<td>137,893</td>
<td>8,111</td>
</tr>
<tr>
<td>Springfield</td>
<td>52,864</td>
<td>7,552</td>
</tr>
<tr>
<td>Florence</td>
<td>7,263</td>
<td>3,631</td>
</tr>
<tr>
<td>Oakridge</td>
<td>3,148</td>
<td>3,148</td>
</tr>
</tbody>
</table>

The affordability of food was measured by comparing the cost of items on the TFP list for week two at all large grocery stores in the study area. The stated hypothesis for food affordability is that food is more expensive in low income and rural areas. Two prices were gathered for each item. The prices used in the following analysis were the non-sale lowest price, intended to reflect normal prices paid.

The average cost of the TFP list for the entire study area (n=27) was $102.40, with a range in prices from $67.86 to $113.89 (Table 5). The average price per community was highest in Florence, where there were only two stores. At the more expensive store, the TFP list cost $13.54 more with a total price of $111.25, forty-three cents higher than the most expensive store of the same chain in the Eugene-Springfield metro area. Similarly, the other store in Florence was seventy-two cents higher for the total list price than the most expensive store of that particular chain in Eugene and Springfield.

The next highest community average list cost was for Eugene, with a range in price totals from $70.03 to $113.49 (Table 5). Springfield, with the lowest TFP average list price among the communities, had a similar variation in price with totals
from $67.86 to $110.09. Oakridge had only one store with a TFP list price of $102.10.

Table 5. Store price totals and availability for the entire study area

<table>
<thead>
<tr>
<th>Store Name</th>
<th>Location</th>
<th>TFP total</th>
<th>Items missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albertsons</td>
<td>55 Division Ave, Eugene</td>
<td>$113.49</td>
<td>1</td>
</tr>
<tr>
<td>Albertsons</td>
<td>3075 Hilyard St, Eugene</td>
<td>$112.72</td>
<td>1</td>
</tr>
<tr>
<td>Safeway</td>
<td>700 Hwy 101, Florence</td>
<td>$111.25</td>
<td>1</td>
</tr>
<tr>
<td>Safeway</td>
<td>350 E. 40th, Eugene</td>
<td>$110.82</td>
<td>1</td>
</tr>
<tr>
<td>Albertsons</td>
<td>2000 Marcola Rd, Springfield</td>
<td>$110.09</td>
<td>1</td>
</tr>
<tr>
<td>Safeway</td>
<td>5415 Main St, Springfield</td>
<td>$110.08</td>
<td>0</td>
</tr>
<tr>
<td>Main Street Market</td>
<td>4215 Main St, Springfield</td>
<td>$109.92</td>
<td>5</td>
</tr>
<tr>
<td>Safeway</td>
<td>945 Bailey Hill Rd, Eugene</td>
<td>$109.4</td>
<td>0</td>
</tr>
<tr>
<td>Albertsons</td>
<td>1675 W. 18th Ave, Eugene</td>
<td>$108.73</td>
<td>1</td>
</tr>
<tr>
<td>Safeway</td>
<td>1500 Coburg Rd, Eugene</td>
<td>$107.76</td>
<td>1</td>
</tr>
<tr>
<td>Safeway</td>
<td>1891 Pioneer Pkwy E, Springfield</td>
<td>$107.59</td>
<td>1</td>
</tr>
<tr>
<td>Safeway</td>
<td>2060 River Rd, Eugene</td>
<td>$107.42</td>
<td>3</td>
</tr>
<tr>
<td>Albertsons</td>
<td>5755 Main St, Springfield</td>
<td>$106.6</td>
<td>1</td>
</tr>
<tr>
<td>Safeway</td>
<td>145 E. 18th Ave, Eugene</td>
<td>$106.49</td>
<td>0</td>
</tr>
<tr>
<td>Albertsons</td>
<td>4740 Royal Ave, Eugene</td>
<td>$103.59</td>
<td>3</td>
</tr>
<tr>
<td>Albertsons</td>
<td>311 Coburg Rd, Eugene</td>
<td>$103.48</td>
<td>1</td>
</tr>
<tr>
<td>PC Market of Choice</td>
<td>1960 Franklin Blvd, Eugene</td>
<td>$102.87</td>
<td>1</td>
</tr>
<tr>
<td>Rays Food Place</td>
<td>48067 Hwy 58, Oakridge</td>
<td>$102.1</td>
<td>3</td>
</tr>
<tr>
<td>Red Apple on 6th</td>
<td>849 W. 6th Ave, Eugene</td>
<td>$99.14</td>
<td>4</td>
</tr>
<tr>
<td>PC Market of Choice</td>
<td>1060 Green Acres Rd, Eugene</td>
<td>$99.02</td>
<td>3</td>
</tr>
<tr>
<td>Fred Meyer</td>
<td>4701 Hwy 101, Florence</td>
<td>$97.71</td>
<td>1</td>
</tr>
<tr>
<td>Fred Meyer</td>
<td>650 Q St, Springfield</td>
<td>$96.99</td>
<td>2</td>
</tr>
<tr>
<td>Fred Meyer</td>
<td>60 Division St, Eugene</td>
<td>$96.97</td>
<td>1</td>
</tr>
<tr>
<td>Fred Meyer</td>
<td>3333 W 11th Ave, Eugene</td>
<td>$96.46</td>
<td>0</td>
</tr>
<tr>
<td>PC Market of Choice</td>
<td>2858 Willamette St, Eugene</td>
<td>$96.17</td>
<td>2</td>
</tr>
<tr>
<td>Winco</td>
<td>4275 Barger Dr, Eugene</td>
<td>$70.03</td>
<td>3</td>
</tr>
<tr>
<td>Winco</td>
<td>1920 Olympic St, Springfield</td>
<td>$67.86</td>
<td>2</td>
</tr>
</tbody>
</table>

When comparing store totals in the Eugene-Springfield GIS, the most expensive 25% of stores were located equally in low-income and wealthier areas. Of the six stores that had prices at or above $109.92, three were located in low-income census tracts and three were not (Fig 20). Eight stores in the GIS recorded a list price at or below $102.40 (average cost), and four of those were located in the low-income
areas, with one additional store bordering a low-income census tract. The cheapest 25% of stores in the GIS were located slightly more often in low-income areas with four of the six stores located in or on the boundary of low-income census tracts (Fig 21).

As a final step, the selection of census tracts having both individual poverty levels and percent of rented households without vehicles above 15% indicated areas at highest risk for poor food access. Eight of the 24 stores in the Eugene-Springfield area were located on the border of or in these low-income and -mobility census tracts. Again, selecting the most expensive 25% of stores allowed for identification of areas with poor access, higher poverty, and higher prices. The result was that one store with a higher price total was located on the border of one census tract having both high poverty rates and lower vehicle availability (Fig 22).
Figure 20. Distribution of most expensive urban stores (shown larger in blue)
Figure 21. The least expensive urban stores (shown larger in red)
Figure 22. Low-income and low-mobility areas (shown in blue) with the most expensive urban stores shown larger in blue.
A surprising result surfaced when calculating the annual expenses for food in each town or city, using the average TFP list price as a guideline. When the total annual price was calculated and compared with the corresponding community’s median household income, results showed that the price paid for food on the TFP list (expressed as a percentage of income) had an inverse relationship with the median household income in each community (Fig 23).

![Comparison of median income with TFP cost](image)

Figure 23. Median household income shown with annual expenditure on TFP list, expressed as a percentage of income

This result indicates that on average, residents pay a higher percentage of their income on food as their income decreases. This finding provides strong evidence of inequality: residents of Eugene will spend an average 14.9% of their income on food while residents of Oakridge will spend 19.9% on average of their income on food. Low-income households spending a higher percentage of their overall income on food is logical, but choices of stores (and as a result, the choice of lower prices) are poor in the rural areas when compared to the urban areas.

Eugene has one store where the TFP list costs only $70.03, equal to 10.2% of the median household income for this city. Even at the most expensive store in Eugene, the total price translates to an annual cost equal to 16.5% of the annual median income. A key difference between the wealthiest city, Eugene, and the
lowest-income town, Oakridge, is that Eugene residents have the availability of choice with a range of prices and stores while Oakridge has only one large store and only one set of prices.

This problem of few low-priced options in the rural communities is clear when comparing the cost of food to the 2003 federal poverty guidelines (Table 6). The cheapest possible annual price in each community was calculated by selecting the lowest-priced TFP total in each community and multiplying it by fifty-two to represent an annual cost. The 2003 federal poverty guidelines for a family of four is $18,400 (http://aspe.hhs.gov/poverty/03poverty.htm, accessed on 10/15/03). Table 6 shows the percent of this income required to purchase food at the cheapest store and using the average price in each community. When the cheapest local store prices are used to calculate annual cost, urban residents living at this income level spend a much lower percentage of their income (19.2 or 19.8%) than rural residents also living on this income (27.6 or 28.9%).

<table>
<thead>
<tr>
<th>Community</th>
<th>Cost at average price</th>
<th>Average cost, percent of poverty income</th>
<th>Cost at cheapest store</th>
<th>Cheapest cost, percent of poverty income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eugene</td>
<td>$5336.24</td>
<td>29%</td>
<td>$3641.56</td>
<td>19.8%</td>
</tr>
<tr>
<td>Springfield</td>
<td>$5267.60</td>
<td>28.6%</td>
<td>$3528.72</td>
<td>19.2%</td>
</tr>
<tr>
<td>Florence</td>
<td>$5432.96</td>
<td>29.5%</td>
<td>$5080.92</td>
<td>27.6%</td>
</tr>
<tr>
<td>Oakridge</td>
<td>$5309.20</td>
<td>28.9%</td>
<td>$5309.20</td>
<td>28.9%</td>
</tr>
</tbody>
</table>

These rural residents living on a low income are not able to purchase the lowest-priced foods in their own communities, and even driving to Eugene or Springfield each week would increase transportation costs. Food costs consume a much larger portion of rural residents' incomes than that of urban residents living below the poverty level, again providing evidence of geographic disadvantage.

The number of TFP items available at each store at the time of the survey indicated food availability. There were sixty-eight items counted, excluding
condiments. Twenty-seven stores were surveyed for this study, three of which were located in rural towns.

Overall, food availability was high in the study area. The result of the study was that four stores carried all of the items, and less than half of the stores surveyed were missing two or more items (Fig 24). An average of 1.6 items were missing at each store (Table 3). Only nine of the sixty-eight items were missing from any of the surveyed stores. The most common item missing was frozen fish (2 lb), which was not available at 23 stores. Ground pork and yolk-free noodles were each unavailable at five stores.

![Chart showing items missing at stores](chart)

Figure 24. Analysis of item availability at all stores

The anticipated result for this portion of the research was that the availability of food would be lower in the rural and low-income areas. Oakridge, one of the rural areas, had only one large grocery store that was missing three items on the list. Florence, another rural town, was missing one item at each of its two stores. These results do not prove the rural hypothesis, especially due to the small rural sample size.
The comparison of availability in areas of differing incomes was more appropriately completed using the Eugene and Springfield metropolitan area.

Indeed, the Eugene and Springfield metropolitan area had the lowest food availability in varying areas. When the area of low income was isolated, three stores missing three or more items from the list were located in or on the border of low-income census tracts (Fig 25). Six stores were missing three or more items, only one of which was located in Springfield. The large independent stores in Springfield and Eugene were missing four and five items respectively.

Stores missing fewer items are similarly dispersed. Stores that had all but one item on the list were located in all areas of the metro region. Contrary to the hypothesis, three of the four stores in the study that had all items on the list were located in or in the boundary of a low-income census tract with the fourth store located right outside of a low-income area (Fig 26).

The results of this research supported some hypotheses while disproving others. A complete discussion of these results follows, and includes suggestions for further work to gain a better understanding of food security in this study area.
Figure 25. Urban stores missing three or more items from the TFP list (shown larger in green)
Figure 26. Urban stores stocking all of the items on the TFP list (shown larger in purple)
Discussion

The purpose of this research was to investigate poor access (geographic disadvantage) as a cause for food insecurity and hunger in Oregon through two steps. The study began with statewide overview of socioeconomic conditions, followed by a case study in Lane County. The results provided in the previous section were reached after careful data analysis and consideration so as not to overstate the outcomes, with the impact and limitations of this work discussed below.

The statewide GIS gave quantitative confirmation that the rural, less populated areas of Oregon are less wealthy than the more heavily populated Willamette Valley. Poverty was spread across the state, with relatively high percentages recorded in both rural and urban areas. Median gross rent was lower in the poorer counties, and fewer grocery stores were located in the lower population and lower income counties. All of this supports data from previous surveys.

Residents in counties with very few grocery stores experience similar disadvantages to those of Oakridge residents. Wheeler County, with only one grocery store, has fewer than 2,000 residents, but these people have very limited choice for grocery stores compared to the over 660,000 residents of Multnomah County with 156 grocery stores. Although the residents of Wheeler County have one store for less than 2,000 residents, these residents have only one choice of prices for their food they buy.

Klamath and Coos counties had similar socioeconomic characteristics, including population, poverty and median household income. However, when comparing the number of grocery stores per county, Klamath had only nineteen stores while Coos County had twenty-six. The grocery stores are probably more heavily concentrated in Coos County because it is located on the coast, and therefore more likely to have a high number of travelers vacation or drive through annually. This would provide more business to grocery stores, and encourage stores to locate there more often than Klamath County.

The GIS shows differences that are expected between rural and more urban counties, but whether or not these differences translate into higher rates of food
insecurity and hunger in the rural areas cannot be determined without further research and interviews with rural residents.

Within the study area, evaluation of access to food was divided into urban and rural areas, with a GIS showing the access in the urban areas based on a distance from stores, bus transportation, and car ownership rates. Census tract boundaries defined neighborhoods, and access was defined as areas within 500 meters or one mile of a store, depending on vehicle availability. The inclusion of bus routes in the GIS provided an indication of potential access for households lacking a vehicle, by showing that low-income and low-mobility areas were linked to stores by bus routes.

Areas of poor access (food deserts) were identified; however, the impact of this poor access on residents’ food security is uncertain. No data was available or gathered to find out what transportation methods low-income residents use when traveling to grocery stores. Additionally, the assumption that census tract boundaries represent a physical boundary is questionable. This assumption is important in considering the locations of stores outside of low-income census tracts, as some stores were located only slightly outside of a census tract and are easily accessible by nearby residents. A method of correcting for this assumption would improve the accuracy of future results; using a spatial interaction model that incorporates consumer preferences based on demographic information can achieve this.

These problems complicate the access analysis. Additionally, the methods used here are rarely combined in one study. In the past, census tracts determined boundaries for access (Chung and Meyer 1999, Morland et al. 2002) or a distance buffer was placed around the store location to suggest access by walking or driving (Donkin et al. 1999, Tetty-Fio et al. 1999). This research blended both methods by defining areas of low income and poor access based on census-tract level socioeconomic data, and including bus routes as a potential means of access. This methodology attempted to gain full understanding of who may be disadvantaged in accessing stores and what options are available to reach a store. Interviews of
residents in these various areas would have provided insight into these issues, but were not part of the research design.

The access hypothesis assumed that stores had moved out of inner-city areas and into suburban regions surrounding the urban core. This is not accurate for the Eugene-Springfield metro area, with a population of slightly over 200,000. While Guy (1996) found that in Cardiff, Wales (with a population a little over 300,000) stores had begun to move from the inner-city to outer areas, it has yet to noticeably occur in this study area. United States cities show similar results, with fewer chain stores locating in inner city urban areas (Andrews et al. 2001, Chung and Meyer 1999). There is likely a certain population threshold to be surpassed before this out-of-town movement occurs, which has yet to be reached in the study area. This point is significant for future studies.

Rural stores presented a less equitable distribution of low prices compared to their urban counterparts. The lowest-cost food was not available in the rural communities, as it was for residents of Eugene and Springfield. In Oakridge there was only one large grocer in town, eliminating the possibility of same-area comparison. The store was part of a chain, but there was not another member of that chain present in the study area with which to compare prices. Florence had only two stores, both of which also had locations in the Eugene-Springfield metro area. In this instance, both of the Florence stores had higher prices than any urban location of that chain surveyed. The average cost for Florence was the highest of the four communities.

The most obvious inequality in food cost was between the rural and urban areas. Although the affordability hypothesis was incorrect in stating that prices would be higher in low-income areas, prices were higher in the rural areas, as in the Iowa food deserts study. Some stores were still more expensive in Eugene and Springfield, but there were also much cheaper stores. The difference between a week’s worth of groceries in the lowest-priced store in the urban area and the lowest-priced rural store (Oakridge and Florence together) was $29.85. The significance in this price difference is that the income distribution is also shifted toward lower incomes in rural
towns compared to urban areas (Fig 3). In the towns where a higher percentage of residents have lower incomes, no local store is present with prices as low as those seen in Eugene and Springfield. This finding is the most significant of this research.

The Thrifty Food Plan provided the shopping list used for comparison in this study. However, there are some problems in interpreting the results when compared to the mean national price as published on the USDA website each month. As discussed in earlier work (Andrews et al. 2001), there is regional variation in what is available for food. The stores in this study stocked the majority of the items on the list. However, unbreaded frozen fish was difficult to find, with only four stores carrying it. Additionally, the gallon-sized fruit juice drink was priced using a twelve ounce concentrate that makes a gallon of fruit juice, rather than the pre-made type of fruit juice sometimes carried by grocers. This substitution was made after several of the early stores failed to stock the pre-made fruit drink. As a result, the comparison between stores in this case study remains meaningful, as the items priced were consistent at each store. However, prices may not be as meaningful when compared to the national price averages.

When comparing the prices found in this study area to the national average for that same time, it is important to note that the prices are gathered using different methods. The national price average uses national price averages that include name brand, store brand and generic items of different sizes, whereas this research took only the lowest priced item. As a result, the national average ($107.70) was 5% higher than the average in this study area ($102.40).

Aside from these research differences, further difficulty arises in interpreting the usefulness of this food list as a realistic representation of what low-income families or households purchase. The list of recipes prepared from the ingredients required that all meals on the list be made from scratch; no preprepared items such as biscuits were included. This condition on the food list assumes a basic knowledge of cooking, as well as available time to prepare each meal.
Meals included in the TFP plan also fail to provide low-salt options or vegetarian plans, which exclude people with special dietary needs or value/religious differences that prohibit the consumption of meat.

Availability was high for the overall study, measured by the number of items available from a list of sixty-eight. Only five items (7%) were missing in the store with the lowest availability. This availability is much higher than that reported by Andrews et al. (2001) where the least expensive stores were missing an average of 18.3 items. Independent stores in Eugene and Springfield were missing more items than any chain stores, consistent with the findings of Andrews et al. (2001). Chain stores had high rates of availability; only five of twenty-five chain stores were missing three or more items.

When selecting the urban stores missing three or more items, three stores were in or on the boundary of low-income areas, and three were not. This result proved that the availability hypothesis was partially incorrect; stores in low-income areas were no more likely than those in wealthier areas to have lower availability. The rural stores provided mixed results, with two missing only one item and the third store missing three items. The store with three items missing was part of a small chain, and the two stores with better availability were part of larger chains. The rural results on availability indicate that there is no consistent pattern, except that stores belonging to larger chains have better availability.
Conclusion

This research leads to a number of conclusions and identifies important gaps in the data. This research identified and tested variables (access, affordability, availability) that may contribute to high rates of food insecurity and hunger. The results do not provide an absolute answer to all hypotheses, and so following are suggestions of further research to fill voids in the data.

At the state level, it seems likely that many rural residents have access similar to that of Oakridge residents; that is, there may only be one grocery store available for a large, sparsely populated area. While one store is better than none, it does not allow these rural residents to have a variety of choice in store or price paid for food.

Before reaching further conclusions about the effect of this access on food insecurity and hunger, completing interviews with the residents of rural counties will help to identify transportation capabilities and store choices; the inclusion of small stores in the GIS can also provide a more complete view of food access. Additional interviews concerning the barriers to food access including unemployment and lack of emergency food sources would provide needed information for understanding food insecurity and hunger as well.

The case study in Lane County provided some clear conclusions in terms of availability with less obvious results in affordability and access. Availability was higher than reported in previous studies, and highest in chain stores. Availability did not vary significantly by income area, although both independent stores with more items missing were located in low-income areas. Availability in rural areas was mixed, with high availability in Florence and lower availability in Oakridge.

Affordability was consistent in the urban area, with the low-income region being no more expensive than the rest of Eugene and Springfield. A comparison of the entire study area showed that the rural residents of Florence and Oakridge faced higher prices than urban residents. These towns had few choices (Oakridge has only one) for residents' grocery stores, unlike the urban areas where prices for the TFP list at each store varied by over $40.00.
Access was difficult to measure in the urban region, but the inclusion of public transportation routes indicated that most areas were well served by grocery stores, if this method of access is utilized. In the rural areas, store access may also be limited for residents without access to vehicles, as there was no public transportation available.

Subsequent researchers can use this work as a basis for further research, with the following suggestions. Pricing the TFP list at smaller stores would provide valuable information about prices paid by residents unable to reach a large store. Addition of interviews would improve the data, to ascertain where residents of lower income and mobility areas shop for groceries. Personal interviews with residents of these same areas may provide indications of barriers to food access not yet considered, along with more insight into food items typically purchased. Additionally, it would be useful to find out how many people without vehicles use public transportation for grocery shopping; that information would validate the assumption that availability of public transportation improves food access in households without vehicles.

The primary significance of this research was its inclusion of rural areas alongside smaller urban areas in the analysis. Statistics show that rural food insecurity and hunger is high; these problems are likely contributors to Oregon's identification as the nation's hungriest state. Also significant in this research was the inclusion of public transportation as a method of access to stores. Previous studies rarely include this method of transportation when discussing access to stores, but as mentioned above further research is necessary before definite conclusions link public transportation and food access.

Although this research was unable to identify the reason behind the high rates of hunger, results did not support geographic disadvantage as cause within most of the study area. This study will serve well as a model that can be improved on and replicated across the United States until we meet the goal of ending food insecurity and hunger.
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