EVALUATING AND DESIGNING URBAN FOOD SYSTEMS:
THE ROLE OF LOCAL INITIATIVES

By

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EVALUATING AND DESIGNING URBAN FOOD SYSTEMS:

THE ROLE OF LOCAL INITIATIVES

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By

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Abstract

In the search for solutions to environmental and human health problems linked to the dominant global food system, too much attention has been given to the scale of food systems and too little attention given to the specific practices and outcomes of various food system components and initiatives. The community of Fairbanks, Alaska is used to examine whether local-food system initiatives can improve an urban food system's social equity and environmental sustainability. Three studies of the current food system and nascent local-food system were conducted. The first study examines community-wide physical and economic access to fresh foods in general and locally grown foods in particular using surveys of local stores and spatial analysis of food-outlet locations. The second study examines local-food production at an individual scale at a community garden. Gardeners' reasons for participation, practices used, and amount of food produced are examined. A regionally scaled study speculates about the region's ability to meet the community's food and nutritional needs using only local resources and develops a tool, the local-food system footprint, to conduct such an assessment.

The studies found that locally grown foods purchased at local outlets are less physically and economically accessible than comparable imports. However, local foods tend to be grown using sustainable practices and travel shorter distances than imports. Gardeners tend to participate in the activity for personal enjoyment with food production as an added benefit. On average, gardeners in the study offset the costs of gardening with the value of food produced, if labor costs are not included. The Fairbanks region could grow enough food to feed the current population, but the diet might be limited. The local food system footprint method could be a valuable tool to help communities identify needs, resources, and food-production priorities. Vulnerabilities in the food systems of urban areas must be addressed to ensure long-term, positive environmental and human-health outcomes. If local-food system initiatives are to be used in this capacity, more rigorous evaluation of local-food system components and practices as well as tools and frameworks appropriate to the task are required.

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1 Introduction: The Question of Scale in Food-System Design

1.1 Global and Local Food Systems

North American cities, Fairbanks, Alaska included, are part of what is often referred to as a global food system (GFS) that stretches across miles, continents, and cultures. The GFS largely relies on industrial food-production techniques intended to increase food production, which many proponents of the system claim will end hunger and ensure food security across the world. Unfortunately, as has become apparent over the past 50 years of consistently increasing agricultural yields, simply making more food does not make it more accessible to all people everywhere (see for example: Manning 2000; Patel 2007). Not only has the industrial food-production system failed to provide food security, particularly for the world's most vulnerable people, the practices used are detrimental to the environment in ways that harm wildlife, water sources, and human health. These practices also degrade agricultural and other natural resources in such a way as to erode long-term food-production potential that could lead to increased food insecurity for a growing sector of the world's population (Abate, et al. 2008). The environmental and social problems in the GFS are well documented and more people are becoming aware of the negative effects of these practices.

Awareness of the multitude and magnitude of problems in the GFS has lagged behind the actual effects on certain regions and people. The lag in awareness is partially due to the distance between food-production regions and food-consumption regions (Kloppenburg Jr., et al. 1996; Sundkvist, et al. 2005). More affluent consumers, those Patel (2007) refers to as the "global north" are less directly exposed to the environmental and human-health effects of industrial-food production than are those in the "global south", making those negative effects easier to ignore while the affluent nations reap the benefits of low food prices and expanded food choices.

However, despite this distancing of production and consumption, some consumers have long been aware of abuses related to food production and distribution and have worked to force changes in the GFS. By choosing to purchase organically grown foods, some consumers may force changes through market decisions and market-based solutions. Protests against genetically modified (GMO) foods in the late 1990s and early 2000s were instrumental in raising public awareness about the environmental, health, and social issues surrounding their use, leading to bans on their use in Europe and Africa as well as reduction in demand for GMO products worldwide. Targeted boycotts of particular products are another approach to influencing the GFS. For example, I was raised during the era when boycotting Californian grapes and lettuce to support the United Farm Workers; Chilean grapes because of that country's dictatorial and oppressive government; and Nestlé products because of that corporation's practice of marketing infant formula to poor African women where it was often mixed with unsafe water resulting in infant illness and death, were common undertaking – at least among the socially conscious middle-class members of my family and community. While these relatively small acts of protest against practices in the GFS might not have succeeded in changing the system as a whole, they demonstrate that people have long been aware of abuses in the system and have been willing to act upon their awareness, despite "distancing." Direct challenges to the dominant food system in the form of boycotts or protests are what Hinrichs, et al. label "warrior work" (1998).

A more recent response to the problems of the GFS has been the call for food system localization. Localization is a different approach than the boycotts of my childhood – it is a shift away or secession from the dominant food system, rather than a direct challenge to it, albeit with the long-term goal of large-scale reform (Kloppenburg Jr., et al. 1996). Hinrichs, et al. (1998) refer to these initiatives that create new productive structures as "builder work." Food-system localization is intended to improve food access, create a stable base of family farms using sustainable practices, create direct links between farmers and consumers, improve working conditions on farms, create local jobs, and boost local economies (Feenstra 2002). Given the uncertain future of the GFS in the face of complex political and economic changes (see for example: Patel 2007) as well as the potentially devastating effect of global warming on world wide food production (Battisti and Naylor 2008), we must work in earnest to redesign our food systems to ensure long-term food security and environmental protection. We must develop solutions that directly address the most serious weaknesses in our food systems today and that are capable of sustaining us into the future.

It is with the goal of practical and effective food-system solutions in mind that I undertook my studies of various aspects of the current and nascent local-food systems in Fairbanks, Alaska. A central question in my work is to determine the extent to which current local or alternative food-system initiatives address the gaps in food, environmental, and social security created by the dominant GFS. My goal was to explore methods to assess food systems and food-system initiatives in order to aid in the design of better food systems that will meet the wide range of community needs.

1.2 Food System Localization

1.2.1 Defining the Terms

What precisely is meant by food-system localization remains the topic of much discussion between and among academics, food security advocates, agricultural organizations, and grassroots groups. The desire to create food systems that work to counterbalance the negative aspects of the currently dominant, globally scaled food system is a unifying theme in these discussions. But no definitions or even a set of criteria have yet emerged. Kloppenburg, et al. (1996) introduced the idea of a foodshed that, conceptually, mirrors a watershed with its boundaries defined by the ecological and cultural features of the area in question. Feenstra (2002) uses the term "community food system" to mean a more locally based, self-reliant food economy. Allen (1999; 2004) refers to the broad spectrum of anti-GFS efforts as alternative food systems. "Sustainable" or "alternative" are the terms developed by a group of food-system researchers to refer to food systems associated with greater democratic participation and control, shared decision-making, and furtherance of community priorities and goals (Hinrichs, et al. 1998).

What these terms share is an attempt to define a food system that ensures food security, promotes greater participation by consumers, and reduces or eliminates environmental degradation from, for example, greenhouse-gas emissions and agricultural chemicals. Although most academic researchers agree that the spatial boundaries of a food system matter less than the social relations within it (Hinrichs, et al. 1998), proximity of food production and consumption remain a key component in many discussions of food-system reform. And while, admittedly, the spatial aspect of food system reform may be overstated and over critiqued by some (see for example: Born and Purcell 2006), the reification of "local" is present and common in vernacular discussions of food-system reform. So it is incumbent upon researchers and advocates in this area to continue the process of defining our terms, evaluating our assumptions, and sharing our discussions with the general public to both clarify misconceptions and include them in effective food-system reform.

Throughout these papers, I tend to use the terms local food system and food-system localization for two reasons. First, my studies are of specific locally based food-system initiatives. Secondly, despite the academic discussions of the issue, both academics and others still use "local" as a shorthand way to refer to the movements away from the dominant GFS. However, I would prefer to see a more general term applied to the kind of food systems that produce long-term food security, environmental security, and social well-being. For the time being, "alternative" food-system initiatives might best capture the spirit of these initiatives as attempting to provide options to the way most of us currently procure our food. However, in the long-term, if we succeed in developing viable solutions, we will need to stop thinking of them as "alternatives," and consider them the mainstream or dominant food-system forms.

1.2.2 Food-System Change and Reform

Food-system localization, it is hoped, will address the range of environmental, economic, and social problems associated with the functioning of the GFS. One of the most common arguments in favor of local food production is reduction of food miles – or the miles food must travel from point of production to point of consumption. Current estimates are that fresh food in the United States travels an average of 1,500 miles from farm gate to table (Pirog and Benjamin 2003). In 2001, 39% of fruit, 12% of vegetables, and 78% of fish consumed in the U.S. were produced in other countries (Pirog and Benjamin 2003). The energy use and emissions associated with long-distance shipping have raised significant concerns about the contribution of the GFS to climate change, air pollution, and over reliance on non-renewable energy sources. Shortening the distance food must travel, it is argued, will ameliorate these excesses. However, more recent analyses, particularly life-cycle assessment of energy use in food production stress the importance of a more holistic assessment of energy use in the food system (Eshel and Martin 2006; Mila i Conals, et al. 2007; Weber and Matthews 2008). The concept of food miles is helpful in laying the groundwork for such an analysis. If all production processes are equal, then reduction of food miles will help reduce energy use and related pollution.

Food, particularly fresh produce, that travels 1,500 or more miles, must be durable – which comes at the expense of palatability and nutritional content (Kloppenburg Jr., et al. 1996). Local food production drastically shortens the time between harvest and consumption – often resulting in a higher-quality product. The short social distance between producer and consumer in a LFS is one of the hallmarks of the approach. The development of face-to-face relationships between and among farmers, small-scale processers, and consumers in which people re-connect and strengthen their communities is, perhaps, one of the most appealing aspects of food-system localization in this increasingly fast-paced, electronically linked society.

Integration of food production into urban areas brings other benefits as well. The presence of open spaces, such as farms, ranches, and large gardens close to urban areas can have a positive effect on the environment. Urban areas are often subject to the urban-heat-island effect in which the impervious building materials that make up their built-environment absorb heat, making urban areas warmer than surrounding rural areas. Incorporation of greenspace in and around urban developments reduces the amount of impervious surfaces, allowing for greater evapo-transpiration. This then causes a cooling effect and can restore or maintain hydrological functions, such as groundwater recharge and stream flow, which are often disrupted by urban development (Gómez, et al. 2004; Randolph 2004). Gardens, in particular, appear to have a positive effect on urban-wildlife populations – replacing habitat previously lost to urban development (Colding, et al. 2006; Matteson 2007).

The conventional GFS continues to promote and reward corporate consolidation. Five seed companies dominate the world market and have extended their influence through supply-chain consolidation all the way through the processing stage (Hendrickson and Heffernan 2002). Consolidation in retailing has followed a similar path with five supermarket chains accounting for 40% of food-retail sales in the U.S. (Hendrickson and Heffernan 2002). Kloppenburg, et al. (1996) estimate that 75 cents of every dollar spent on food in the U.S. goes to processors, packagers, shippers, advertisers, and retailers – with falling farm incomes as the consequence. Food-system localization promises to link farmers directly with consumers, eliminating the middle-man, helping farmers out of the "spiraling cycle of debt and corporate dependency inherent in capital-intensive industrial production" (Macias 2008), and making farming a viable occupation again.

Local food systems are often assumed to be more environmentally sustainable due to the production methods used. A strong argument can be made that, if food production occurs within a community, that community will be more active in promoting sustainable and environmentally sound practices. "A consequence of proximate self-reliance is that social welfare, soil and water conservation, and energy efficiency become issues of immediate practical concern" (Kloppenburg Jr., et al. 1996). But, it should be recognized that simply scaling down a food system does not immediately lead to environmentally sound practices. Small-scale farmers may have some opportunities to use alternative production techniques, but small, or local, scale is not inherently environmentally sound (Bellows and Hamm 2001; Born and Purcell 2006; Hinrichs 2003). In addition, proximity does not necessarily equate with political power or influence. There are many communities around the world that are proximate to where their (and other's) food is produced who lack the ability to challenge the practices in use despite their detrimental effects on human and environmental health.

1.3 Characteristics of Urban Food Systems

While food-system localization could potentially occur in any community, urban communities pose a challenge for any scale of food system because of the need to feed large, diverse populations. Cities developed as centers of trade, education, economic development, and culture. They attract people to work, study, and live in ethnically, culturally, and socioeconomically diverse communities. But these characteristics also mean that urban communities have food-system needs that are specifically related to their large, dense, and diverse populations.

The U.S. Census Bureau defines an urbanized area as consisting of a large central place and adjacent densely settled census blocks that together have a total population of at least 2,500 for urban clusters, or at least 50,000 for urbanized areas. Given the population density and land required to house the population, urban areas are less likely than rural to have large quantities of open space available for food production. In fact, current urban-development trends are using a larger proportion of land than is required simply for population growth – much of that land is prime farmland immediately surrounding urban areas (American Farmland Trust 2008). Cities, currently and historically, tend to rely on their hinterlands to supply their food.

Most people in urban centers do not produce food as their primary activity. They engage in wage labor and purchase their food through what Sen (1981) refers to as an exchange entitlement. While some urban residents do produce at least some of their own food (see for example: Altieri, et al. 1999; Blair, et al. 1991; Brown and Carter 2003; Hynes 1996; Sanyal 1984), this is not necessarily an option for people with work and family responsibilities that reduce their available time or who lack the skills and knowledge required to engage in food production.

Finally, the diverse nature of urban populations, which includes both socioeconomic diversity and ethnic and cultural diversity, means that food needs are also diverse. The food-system needs in urban areas are different, in this respect, from the needs of smaller, rural, or culturally homogenous communities. These smaller communities are likely to have more land available and fewer people to feed with the land. In addition, they may be concerned with reviving or maintaining culturally rooted food traditions common to most or all community members (see for example: Loring and Gerlach 2008). In an urban setting, food must be available at a range of costs accessible to residents with the lowest income (a characteristic they likely share with more rural communities). Currently, those urban residents least capable of earning or producing food often rely on the charitable food stream (Pothukuchi 2004), which should not be considered a long-term solution to food security. Food that is culturally appropriate (conforming to religious requirements, for example) and preferred (meeting cultural standards and traditions, for example) is also required in an urban food system in order to meet the needs of a diverse population.

1.4 Rethinking and Redesigning Food Systems

Given the needs of our communities, particularly our diverse, dense, and labor-specialized urban areas, creating food systems that meet the needs of all people at all times is challenging. Responding to the deficiencies of the GFS by creating a whole new local food system is appealing on some levels. Advocates promote the promise of a food system that prioritizes people over profits, focuses on producing healthful foods, produces foods without damaging the land, and addresses inequity in how food is distributed and accessed. Bringing food production into a community, and people into direct contact with food production, it is hoped, will make "social welfare, soil and water conservation, and energy efficiency . . . issues of immediate practical concern" (Kloppenburg Jr., et al. 1996). If distancing and lack of control over their food sources are the causes of food and environmental insecurity in the GFS, then localizing the system is the solution, so the argument goes (Allen 1999).

However, is retreating or seceding from the GFS (Kloppenburg Jr., et al. 1996) the best option? What happens to those dependent on the GFS: food producers (some of whom are still family farmers), those employed in production and processing (including low-wage workers), shippers (including independent truckers) if we simply leave? Do we have a responsibility to take part in reform of a system that damages, not just those within our own communities, but those thousands of miles from us – to take on the "warrior work"? Are we simply practicing "defensive localism" - protecting ourselves from a perceived harm at the expense of those without the means to do so (Allen 2004; Szasz 2007)? Finally, can food-system localization adequately address the gaps in food, environmental, and social security the GFS cannot?

We do not yet know enough about the costs and benefits of food-system localization and its potential role in larger food-system reform to answer these questions (Grey 2000; Hinrichs, et al. 1998). However, the answers to these questions can be found by giving greater attention to and research on food systems organized at all scales and including a wide range of practices. In addition to the quantitative and qualitative data we can collect and analyze about the effects of food-system practices, the attention we can bring to bear on these issues will help consumers become better informed.

Public interest in food and food systems has piqued in recent years, judging by the number of trade books published on the topic (see for example: Kingsolver, et al. 2007; Nabhan 2002; Pollan 2006). Let us continue the process of raising awareness through rigorous scientific study that elucidates the benefits, as well as the costs, of our decisions about food systems at all scales and in all forms. My research contributes to this effort by examining LFS initiatives, understanding their strengths and weaknesses, and seeking ways to design food systems that rely on a set of best practices (which will likely be somewhat different for different communities) to meet the needs of people and the environment upon which we all rely. We owe it to the members of our own communities, as well as communities at a great distance from us, to ensure that our solutions to the problems in the GFS are practical, well planned and effective.

1.5 Current Research on Local Food Systems

Although interest in local food systems is growing, there are relatively few studies that assess their effectiveness in meeting the goals of food security, environmental security, and social welfare. However, such work has begun and important lessons are being learned about the strengths and limitations of LFS initiatives. Despite the relatively few studies, the authors agree, to a large extent, and that increases my confidence in their findings. One common finding is that many of these initiatives have so far failed to address critical social-equity issues. These early findings are not an indictment of the goals or actions of food-system localization, but a call for better assessment, planning, and design of LFS initiatives in order to ensure that we meet the needs of all people for healthful food, the means to access that food, and a safe environment now and into the future.

Hinrichs and Kremer (2002) conducted one of the earliest analyses of social inclusion and access in LFS initiatives. They found that members of a community-supported agriculture (CSA) farm in the midwest tended to have higher incomes, were more likely to have professional or managerial occupations, and had higher rates of post-graduate education than the regional reference population. Macias (2008) compared CSAs, community gardening, and an organic farmers' market in Vermont and found that none of the strategies were particularly successful in achieving food equity. Like Hinrichs and Kremer, Macias found that the CSAs tended to attract and serve higher-income households. In California, Guthman, et al. (2006) also found that the up-front costs and lack of subsidies available from CSAs tended to exclude lower-income participants. However, larger well-established CSA farms were in a better position, and were more likely, to take direct steps (like providing subsidies or alternative payment plans) to improve food access.

One of the two farmers' markets in Macias' study was targeted at low-income households through siting in a particular neighborhood and participation in a state food-subsidy program that made the organic, local produce more affordable. Such targeted marketing was, according to Macias, the most effective approach to ensuring food equity in his sample. Like Macias, Guthman, et al. (2006) found that farmers' markets that can accept federal entitlement-program payments helped increase low-income participation.

Labor time seems to be the key factor in determining the accessibility of direct food-entitlement activities like community gardening. Gardening requires a significant time commitment that may put it out of reach of those with family obligations or someone already working multiple jobs simply to earn sufficient income to meet basic family needs (Macias 2008). In one of the few specific analyses of participation in community gardens, Blair, et al. (1991) found that community gardeners in Philadelphia tended to be older, have lower education levels, and were more likely to be retired than the control group surveyed. In their survey, Blair, et al. calculated the net economic value of the participating plots to be $113 per year, but do not discuss the labor required to achieve that value. However, they conclude that the food produced in the gardens made a positive contribution to nutritional and health outcomes for participants. Similarly, Gladwin and Butler (1984) found that family farmers in Florida who engaged in gardening as a method to supplement their family's food sources were successful in offsetting their food costs. However, they note that if labor were included in the calculation, the economic benefit may be lost (Gladwin and Butler 1984).

These few analyses of local, small-scale food production conducted thus far have produced mixed findings about the ability of local production to meet the goals of improved food security and improved social welfare. An additional concern is the lack of comparable data – or even standardized protocols for data collection and analysis. Some of the best-developed research on local food systems is focused on the social goals of the movement. Hinrichs and Kremer (2002) and Hinrichs (2003), for example, are explicitly concerned with social inclusion in LFS initiatives. Guthman, et al. (2006) and Guthman (2008) probe both racial and social exclusion in local-food-system initiatives. And, while Macias (2008) addresses food equity in his study of 3 local-food-system initiatives, his focus tends toward a sociological analysis of the community and human-environment interaction aspects of participation in local-food production. Blair, et al. (1991) and Gladwin and Butler (1984) stand almost alone in their attempts to quantify the economic and nutritional benefits of gardening.

Food systems are incredibly complex with multiple inputs and outputs, multiple scales and levels of organization, and multiple potential forms. If we wish to design urban food systems that meet community needs potentially through the incorporation of more local production, we must begin the task of conducting more systematic research focused on specific outcomes related to food security, environmental effects, and the economic impact of local production on local regions, including the effects shifting the location of food production on the distant regions that currently produce our food.

Several new models of food systems have been developed that can aid in this assessment process. Only one of the available models, however, focuses specifically on the human and environmental effects of food-system localization. Bellows and Hamm (2001) suggest using the framework of import substitution to examine both the positive (such as local employment, fresher foods, or reduced energy use) and negative (such as importation of agricultural pollutants or magnification of existing inequities in access to food) outcomes that might be imported into a community when it increases local food production for local consumption.

Two other models have been developed specifically to deal with the potential effects of large-scale environmental changes, such as climate change, on food systems. However, because they address ways to assess the resilience and sustainability of existing food systems, they can also be used to design systems with these attributes. Fraser (2006) suggests a framework in which food systems are assessed at four levels: field, farm, community, and institution. At the field level, the health of the agro-ecosystem should be considered to ensure that long-term food production is possible. Indicators of agro-ecosystem health include crop diversity and amount of soil organic matter. At the farm level, farmers should have a range of management options available to them and be able to shift practices in response to changing circumstances. The community should have assets, including both social and natural capital, available to survive an environmental crisis. For example, can community members rely on friends and family for support if a drought, or another event, significantly disrupts their usual food sources. And institutions at the regional, national, and international level should have policies in place to protect people in times of need. As an example, Fraser uses ensuring that markets continue to function and roads remain in good repair during times of crisis.

Erickson (2008) stresses the importance of studying the outcomes of food systems to measure the system's resilience or vulnerability to global-environmental change. She identifies food security, which relies on food availability, food access, and the ability to use food, as the primary function of a food system. But she also includes environmental security, which ensures long-term food production; and social welfare, which refers to the food system's ability to contribute to the economy and well being of a community as a whole as key outcomes. I rely heavily throughout this study on Ericksen's outcome-based approach to food-system assessment. I was also influenced by the concept behind Bellows and Hamm's framework: that shifting the location of food production might import negative unintended consequences as well as the intended, positive outcomes. Ericksen's framework allows us to evaluate whether the food system is producing those positive outcomes, particularly food security, and if we detect other, unintended outcomes, we can trace back through the processes within the system, using Fraser's model, for example, to determine where the system breaks down. Such a process evaluation determines whether each component of the food system, in Fraser's model the field, farm, community, and institutions are functioning in the manner in which they are intended or whether one or more component is causing a disruption or breakdown in the food system. If the system is producing the desired outcomes of food security, environmental security, and social welfare, a process evaluation is still valuable in order to understand why it works so we might replicate its successes elsewhere.

This focus on specific outcomes should not eliminate additional inquiries into other, less tangible outcomes of local-food-system initiatives such as social inclusion, community relationships, or cultural health – but could act to help researchers develop baseline information for any region, allowing for cross-regional and cross-community comparisons, and a stronger, more rigorous basis for decision making. I also suggest, in the papers that follow, that more focus in local-food-systems research should come to bear on the food and nutritional security produced by the current food system and nascent local food systems. Ensuring that all community members are food secure, without degrading the natural resources that permit food production, should be at the heart of food-system analysis and reform.

1.6 Summary of Papers

The following three papers examine the current and nascent alternative food systems at work in Fairbanks, Alaska during the years 2006-2008. The first paper assesses the state of food access in the community by comparing the number and type of stores in higher- and lower-income census tracts in the community. I focus, in particular, on physical and economic access to locally grown foods. I found that access to imported foods (those produced through the global food system) is relatively equitable across income groups in the community – with the caveat that suburbanization of supermarkets may significantly change this situation in the near future. However, locally grown foods, purchased through community-supported agriculture farms or the farmers' market, are less physically accessible, on average, across the community. The generally higher prices for locally grown foods may also make them less economically accessible to lower-income households. I conclude the study with several suggestions about how locally grown foods can be made more accessible to community members through siting of farmstands or markets and through increasing funding for programs that help low-income households buy local foods.

The second paper is a case study of participants and the environment at the Fairbanks Community Garden. This study allowed me to explore the reasons people participate directly in food production, the practices they use in food production, and their ability to supplement household food provisions through the activity. I found that the community garden allows participants to engage in an activity most find enjoyable, above all else. Gardeners, on average, appear able to offset the costs of gardening with the amount of food produced, if labor time is not included. The garden seems to be most successful in building community relationships, providing a resource (a garden plot) for people without access to such a resource at their homes, and in allowing people to pursue a fulfilling hobby.

The final paper in this set moves away from the current state of the food system in Fairbanks and poses questions about what might be possible for the community to produce using only local resources. I propose the use of a local food system footprint, in which the food and nutritional needs are calculated for the community, the type and amount of crops necessary to meet those needs identified, and the amount of land required to produce those crops mapped onto the local region. I determined that the

Fairbanks region might be capable of meeting the food and nutritional needs of the current population. But the amount and location of land required for such a large-scale food-system localization effort may significantly change the character of the region. In addition, projections of the effects of climate change on the subarctic region indicate a more limited future for agriculture in the area. However, the local food system footprint can be used by community members, elected officials, and other stakeholders in the region to begin important discussions about community needs and preferences, available resources, the consequences of allocating those resources to one use or another, and what their vision of a food system suitable for the community, local or not, looks like, acts like, and provides the community.

2 Food Access and Food-System Resilience in a High-Latitude City

2.1 Introduction

Access to food is an essential component of food security (Ericksen 2008). Access to food requires that food be physically accessible, affordable, and culturally or personally acceptable. Long-term food access and food security depends, to a large extent, on the source or sources of food (Fraser 2006; Fraser 2007; Fraser, et al. 2005). A diversity of food sources helps to ensure that a community, or individuals, can have an uninterrupted supply of food despite the failure or disruption of one or more existing food sources. I consider whether food-system localization, the process of producing more of a community's food within that community, can help address the vulnerabilities in an urban food system related to food access and diversity of food sources and, therefore, contributes to the resilience of the food system.

Most local-food-system development and research has been undertaken in regions with high potential for local food production (Feenstra 2002; Hinrichs 2003; Hinrichs and Kremer 2002; Pirog and Benjamin 2003; Pirog, et al. 2001). However, I consider the role of local production in a more challenging agricultural climate – a place with a short growing season and cold, wet soils – which, so far, have limited the extent of local food production.

Fairbanks, Alaska is the urban center of the interior region of the state. Like many North American communities, I show that food production in Fairbanks has not reached the stage where it is capable of making a significant contribution to the food system or to community food security. However, I propose several ways that local food production could be better targeted toward reaching the goal of food-system resilience. Some of the general lessons regarding the role of agricultural production for local consumption in challenging agricultural climates can be applied to other communities with challenges due to, for example, limited water or limited land, as well as having direct applications to northern communities within and outside of Alaska that are searching for effective methods to increase their food self-reliance.

2.2 Food Access and Food Security

Access to food involves affordability of the food, how the food is allocated in the community and to residents, and food preferences. In urban centers, lower-income residents often find themselves living in areas of the city with little access to full-service food stores (stores stocking a wide range of fruits, vegetables, low-fat dairy, and other healthful foods). Low-income neighborhoods often have more small, or convenience stores, and fewer large grocery stores than do higher-income areas (Algert, et al. 2006; Alwitt and Donley 1997; Morland, et al. 2002; Whelan, et al. 2002). Because large stores can take advantage of economies of scale in their purchasing, prices at large retailers are often lower than at small retailers. Alwitt and Donley (1997) also note the importance of geographic isolation on prices; poor neighborhoods that are several miles removed from higher-income areas are relatively isolated, so stores in those areas often charge more due to lack of competition.

Areas or neighborhoods that lack adequate food resources are often referred to as "food deserts" (Hendrickson, et al. 2006; Whelan, et al. 2002; Wrigley 2002). Food deserts, or other forms of low food access, have implications for residents' health and well-being. Lack of access to nutritious foods in developed countries (as opposed to regions in which access to calories creates hunger-related health problems) has been linked to health outcomes such as overweight, obesity, cardiovascular disease, diabetes, and low-birth weights (Inagami, et al. 2006; Lane, et al. 2008; Wang, et al. 2007; Winson 2004).

2.3 Food-System Resilience

When the concepts of food access and food security are applied to a long temporal scale, we intersect the idea of a resilient food system. A resilient food system is one that is capable of maintaining structure and function – in this case the function of providing food security - despite periodic or long-term disturbances or anticipated or unanticipated system shocks (Berkes and Folke 1998; Folke 2006; Walker, et al. 2004). Diversity of food sources is one important component of food-system resilience. On an individual scale, people should have access to enough food options to provide them with the nutrition they need to maintain good health. Neighborhoods, ethnic groups, or socio-economic groups should have equitable access to this range of food options across the entire community. And the community as a whole should have enough food sources available to them to ensure a continual flow of food even if one source is disrupted or fails due to, for example, crop disease, drought, or transportation failures. Over reliance on any one source whether local, regional, or global could lead to food insecurity if the source fails outright, or if it fails to provide adequate nutrition to community members (Fraser 2006; Fraser, et al. 2005; Sundkvist, et al. 2005).

2.4 Food-System Scales and Choices

A food system encompasses all activities related to providing food to a community: production, processing, distribution, consumption, and waste (Pothukuchi and Kaufman 2000; Sundkvist, et al. 2005). Today, most urban areas do not produce enough food to feed their residents and, therefore, rely on the global food system (GFS) to provide food. The GFS links the entire world through food production and transportation. While the GFS has provided new foods and new economic opportunities to communities around the world, concerns have begun to grow about the consequences of relying on a food system that stretches tens of thousands of miles and uses industrial-scale production techniques. The ability of the GFS to maintain healthy stocks of natural capital or protect ecosystems is in question (Altieri 1995; Foley, et al. 2005; Fraser 2006), as is its precise role in creating and maintaining food security (Abate, et al. 2008; Manning 2000).

Concern about the environmental and social costs of the GFS have lead some individuals and communities to advocate and practice food-system localization (Hendrickson and Heffernan 2002; Sundkvist, et al. 2005). Localizing a food system refers to the process of meeting a community's nutritional needs by shifting at least some food production to within the community. The goals of food-system localization generally include: reduced environmental impacts and ecosystem degradation from industrial agricultural practices, reduced "food miles," reduced community vulnerability to supply-line disruptions or shortages, improved conditions for small farmers, and improved community relationships. Common forms of food-system localization initiatives are small-scale farms, community-supported agriculture (CSA) enterprises, farmers' markets, and community gardens.

While the popularity and viability of local-food-system initiatives have increased in recent years, their specific role in building resilient food systems has yet to be examined. Local food systems (LFS) are not inherently sustainable, environmentally sound, or socially equitable – although they may make contributions to one or more of these objectives. LFSs have strengths and weaknesses, just at the GFS does (Hendrickson and Heffernan 2002), including susceptibility to local disease, climate, and disturbance patterns (Sundkvist, et al. 2005); over-stressing of local resources (ibid); and lack of social equity (Allen 1999; Guthman 2008; Guthman, et al. 2006; Hinrichs 2003; Macias 2008).

Building a resilient food system capable of meeting the needs of the community now and into the future will require thinking outside of the boxes "global" and "local" to examine what benefits and challenges each food system brings to a community (Hinrichs, et al. 1998). A system shock, such as drought or frost, can place a local food system in a very vulnerable position, as can an external shock like rising fuel prices or transportation disruption. Fraser (2006) notes the benefits of diverse sources of food and Hendrickson and Heffernan (2002) propose that communities not abandon the GFS entirely, but rather identify the vulnerabilities or "gaps" in that system and develop local food-production capacity in ways that fill the gaps and increase community resilience. Fairbanks is engaged in the process of building local capacity and it is important, early in the process, to identify existing community needs and the role of nascent LFS initiatives in addressing those vulnerabilities.

2.5 The Fairbanks Foodscape

This research took place in Fairbanks during the summers of 2006 and 2007 and describes the community foodscape and food system, as it existed at that time. Both the foodscape and food system are likely to change in the future in response to rising energy costs, which affect both food production and transportation; climate change, which will affect (although in uncertain ways) the region's agricultural capabilities; and population movements, as people move into and out of the community from both rural Alaska and outside of the state.

The foodscape of Fairbanks, the multiple places where food is available, reflects its blend of modern, U.S. city and historic frontier town. Fairbanks largely relies on the GFS to supply its food. Fairbanks' geographic isolation relative to of the U.S., combined with its subarctic climate and location mean that the vast majority of the community's food is imported from great distances outside the state. However, the community's history and culture, combined with current interests, have kept an LFS component alive for more than 100 years. The foodscape includes modern full-service grocery stores; convenience-gas stores; small markets; local farms and a farmers' market; and food acquired directly through subsistence hunting or fishing, gathering, or home-gardening. While we focus on retail-food access, all of these food sources contribute to the foodscape of Fairbanks and most other Alaskan communities.

Fairbanks, located at 64˚ north latitude is the urban hub of Interior Alaska (see Fig. 2.1). The region is subarctic with average temperatures that range from -9.7˚ F in January to + 62.4˚ F in July. Fairbanks averages 10 days per year below -40˚ F and 13 days above +80˚F (Alaska Climate Research Center 2008a). There are less than 4 hours of daylight at the winter solstice in December and more than 22 hours at the summer solstice in June (Alaska Climate Research Center 2008b). Fairbanks receives an average of 10.56 inches of precipitation annually (National Agricultural Statistics Service - Alaska Field Office 2006). The average growing season for Fairbanks is 115 days (Alaska Climate Research Center 2008c). In the agricultural region of the Tanana Valley, the scale at which the USDA keeps records, which includes the FNSB, 16,337 acres were planted in crops in 2005 – however the majority (10,000 acres) was planted in grasses (National Agricultural Statistics Service - Alaska Field Office 2006).

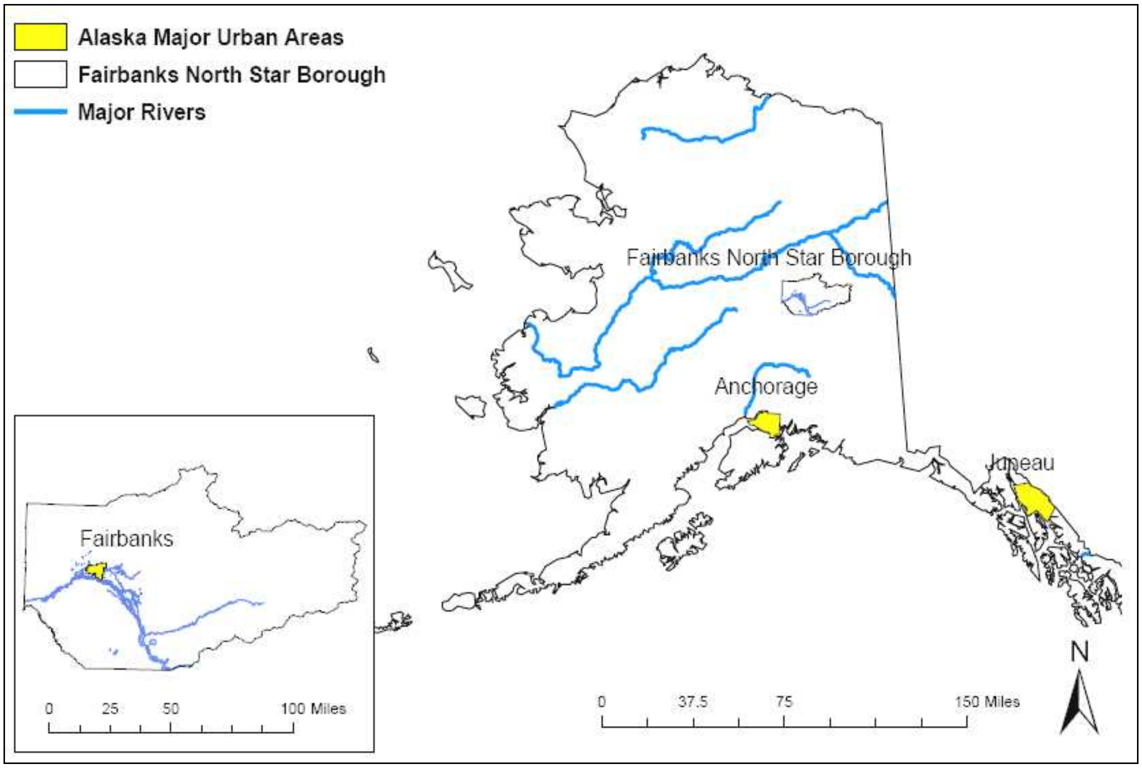

Figure 2.1 The State of Alaska and the Fairbanks North Star Borough

The Fairbanks North Star Borough encompasses the City of Fairbanks, the City of North Pole, and several smaller towns and had a 2007 population of 97,484 people in 7,444 square miles (U.S. Census Bureau 2008). Because almost all residents rely on a common set of resources for shopping, education, and entertainment located within or near the city limits I treat the Fairbanks North Star Borough (FNSB) as one large community. I use FNSB and Fairbanks interchangeably, unless City of Fairbanks is specified.

Fairbanks' geographic isolation has given it a long history of self-reliance. Gardening and small-scale farming has a rich history in the region (see for example: Lewis 1998; Logsdon 1983; Papp and Phillips 2007). A growing interest in small-scale local food production, combined with this historic interest in self-sufficiency, has helped several small farms, a farmers' market, and a large community garden develop over the past 30 years. In addition, many avid home gardeners provide food for themselves, friends, and relatives. A unique attribute of Fairbanks, when compared to other urban areas outside of Alaska, is the level of participation in subsistence hunting and fishing. Due to the manner in which subsistence resources are legally managed within the State, detailed statistics are not kept on urban hunters in Alaska, however it is estimated that Fairbanks residents, on average, harvest and consume 16 lbs of wild foods per person per year (Wolfe 2000). Although rural Interior Alaska residents harvest far more subsistence foods annually (up to 613 lbs per person), subsistence hunting and fishing remain important parts of the diet and culture of at least some urban residents.

Despite geographic separation from the contiguous U.S., Fairbanks has developed along a similar path as other western U.S. cities – a growing suburban and ex-urban population which has left lower-income neighborhoods in the urban core (Fishman 2000; Frank, et al. 2003; Squires 2002). The city began to develop outward from the urban core when it experienced a population boom related to the building of the Trans-Alaska Oil Pipeline in the 1970s (Dixon 1978). Today, the government is the largest employment sector in the FNSB. The University of Alaska Fairbanks is the single largest employer in the community, followed by the military, and the FNSB School District. The three national supermarket chains represented in the area are each in the top 12 employers in the region and combined to employ 1452 people in 2006 (FNSB Community Research Center 2007), making them, as a sector, the fifth largest employer in the FNSB.

The first chain supermarket entered the community in 1961 (Burgett 1967). In 2007, the FNSB had 9 supermarkets. Three stores were from one national chain, 2 stores from another major chain. Two other stores – one "club" store with an annual membership fee and one discount grocer – were both owned by a third major-retail chain. The discount grocer did not stock fresh foods in 2007, but added a full grocery section in 2008. Finally, there was 1 independent grocer and 1 store operated by the U.S. Army, which is not available to the general public.

Fairbanks has several points of vulnerability in its current food system that are common to many North American cities: reliance on foods produced outside of the region (less than 5% of the State's food is produced within the state (UAF Cooperative

Extension Service 2006)) and shipped an average of 1,500 miles into the community; socio-economic inequities in access to certain foods; diminishing diversity in food suppliers; and drift of supermarkets out of urban-core areas and into wealthier suburbs. Some of Fairbanks' vulnerabilities are more unique to high-latitude communities or those in marginal agricultural climates, particularly a short growing season and cold soils that limit local production.

The similarities between Fairbanks and other U.S. cities allow me to use Fairbanks to test hypotheses about the current food system and the potential role of local production within that system. The unique aspects of Fairbanks: its geographic isolation and challenging climate make this study imperative for the region as it manages the challenges of rising energy costs, climate change, and population shifts – all of which pose challenges and create opportunities to develop a more resilient food system and community.

2.6 Research Questions

This study poses several questions about the resilience of the current food system of the FNSB as it relates to diversity of food options, equity of food options, and the current and future role of locally grown foods in the food system.

- Do census tracts in the FNSB with below the FNSB median household income (BMHI) have the same number of food stores as tracts above the median household income (AMHI)?
- Do BMHI tracts have the same proportion of convenience stores and local-food outlets as AMHI tracts?
- Is the distance residents must travel to food stores the same in BMHI and AMHI tracts?
- Are local foods as physically accessible as non-local foods?
- Do locally grown vegetables cost more than those grown outside the region?

2.7 Methods

The approach used here is similar to a Community Food Assessment (Pothukuchi 2004). Retail-food outlets in the FNSB are indentified and their relationship to the population of the region examined. I use geographic information system (GIS) technology to analyze spatial relationships that might affect food access and affordability in the FNSB. I obtained TIGER/Line data from the Geography Network (ESRI 2000) and the U.S. Census Bureau (2000), created a geographic information system with ArcGIS software, and produced a detailed map of the FNSB. Additional information on census tract median household income was obtained from the Fairbanks Community Research Quarterly (FNSB Community Research Quarterly 2007). The methods I used to gather and analyze specific data are discussed below.

2.7.1 Store Type and Availability

To compare locally grown and imported foods, I use a sample of 7 vegetables. Five vegetables in the sample (broccoli, cabbage, carrots, lettuce, and potatoes) represent the top 5 vegetables by acres harvested in Alaska (National Agricultural Statistics Service - Alaska Field Office 2006) and are assumed to be the most readily available vegetables locally. Two vegetables (tomatoes and zucchini) were the 2 most commonly grown vegetables in a survey of community gardeners in Fairbanks in 2006 and were, therefore, considered to be popular and common vegetables in the area.

During the summer of 2007, I compiled a list of all stores selling food in the FNSB using online search engines and the local phonebook. I initially identified 48 stores. I visited and surveyed each store to record the number of fresh items, number and type of vegetable in other forms (canned, frozen) and, where possible, the point of origin of each vegetable. Later searches of outlets accepting Farmers' Market Nutrition Plan coupons uncovered 7 additional farm outlets, bringing the total to 55, but these additional farm outlets were not directly surveyed in 2007. I assume that all local farm outlets have similar selections of produce at the same time of year.

I categorize stores based on the amount and type of vegetables available. Stores are classified as "convenience" if they have less than 5 fresh items and/or none from the sample list. Convenience stores also tend to have gas stations and to be owned by fuel companies. Stores are classified as “small” if they stock 5-12 fresh items, although the items are not necessarily represented on my list. These stores include ethnic-specialty stores and tend to be independently owned and operated. “Supermarkets” stock a full-range of vegetables including most on the survey list. “Farm-outlets” stock mostly or exclusively fresh vegetables, grown locally. Farm-outlets include the Tanana Valley Farmer’s Market and all pick-up sites for CSA enterprises in the FNSB. For the purposes of this paper, only fresh vegetables are included in the analysis.

Stores are geocoded by address and sorted by store type, availability of Alaska-grown vegetables, and availability of Fairbanks-grown vegetables. Several addresses could not be geocoded because the road layer available for the FNSB has incomplete information for addresses on some, mostly rural, roads. Nine stores had to be digitized individually and then added to the goeocoded database. To ensure proper placement of these 9 stores, I consulted with online map services Mapquest and Google Maps. The location of the Ft. Wainwright Commissary in Tract 11 is approximate and based on my memory of the site visit because maps are not readily available for the military base.

FNSB census tracts were divided between Above Median Household Income and Below Median Household Income. Nine tracts’ median household income fall below the FNSB 2000 median household income of \$ 49,076.00 and 10 tracts fall above the median. Tracts were further divided into quartiles based on median household income (see Fig.1). The location of the population centroid for each tract was obtained from the U.S. Census Bureau and plotted onto the map for use during distance analysis.

ArcGIS was used to calculate the number of stores of each type in each census tract. A test for proportion was used to determine whether BMHI tracts have a greater proportion of convenience stores.

2.7.2 Distance to Food Outlets

Because presence or absence of a store in a census tract does not guarantee its accessibility to residents, I also consider the distance to each store. Distance to stores was calculated using the Point Distance tool in ArcGIS to measure from each population centroid to all stores and to each type of store. I used the Point Distance instead of the more accurate Network Distance tool because even the most up-to-date GIS maps of the region do not include all roads or addresses so distance calculations could not be considered entirely accurate using a road-network measure. The mean distance between each population centroid and the 55 stores was calculated for each census tract and T-tests used to compare mean distances to the various store types. The Ft. Wainwright Commissary was excluded from the distance measures for all tracts except 11, which encompasses the base, because it is not open to the public. However, base residents are free to shop off base so distance to all stores was calculated for Tract 11.

2.7.3 Food Costs

Cost for each type of vegetable included in the survey list was gathered during the store survey. Costs for vegetables at the Tanana Valley Farmer's Market and the Calypso farmstand are also included in this assessment. Costs for vegetables obtained through a CSA subscription are not included; this is because of the difficulty of determining costs for individual vegetables in the CSA system. Cost per ounce for each vegetable is the unit of measurement. Lettuce is the only item not calculated in this manner as all lettuce (not packaged) in the survey was sold per head. The costs for vegetables grown in Fairbanks, in Alaska (but not Fairbanks), and outside of Alaska were then calculated for each vegetable and for the sample group of vegetables. One-way ANOVA was used to compare vegetable costs between the three points of origin.

2.8 Results

Median household income in the Fairbanks North Star Borough in 2000 was $49,076 and ranged from a high of $69,688 in Tract 12 to a low of $25,901 in Tract 1(U.S. Census Bureau 2000). Tracts 1-7 encompass the urban core of the community. From the map in Figure 1, it is possible to see that lower-income census tracts tend to be clustered in the center of the city with higher income tracts surrounding them (see Fig. 2.2). Exceptions are tracts 17 and 18, which are both rural areas to the southeast of the City of Fairbanks.

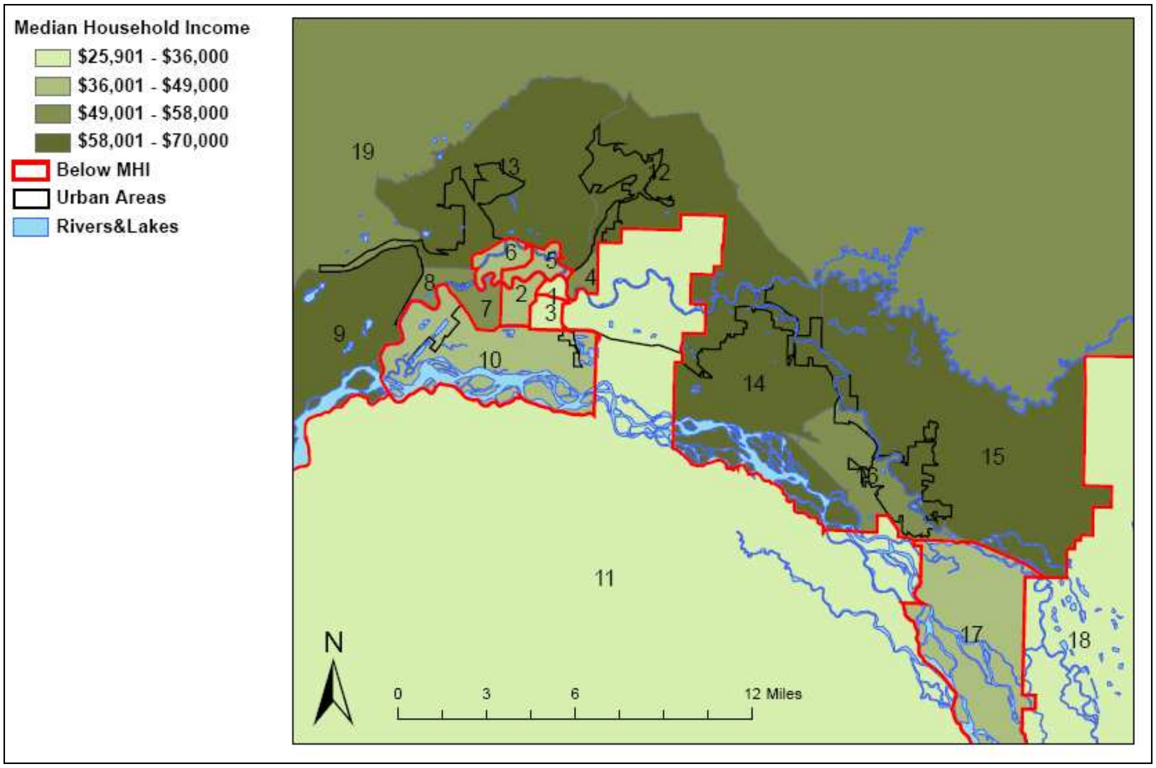

Figure 2.2 FNSB Census tracts and 2000 median household incomes

2.8.1 Allocation of Stores by Census Tract

A total of 55 stores and farm outlets were identified in the FNSB and categorized according to availability of fresh produce. Twenty-four of the stores are convenience or convenience-gas stores. Four stores are classified as "small." I also found 18 farm outlets and 9 full-services grocery stores in the FNSB. Figure 2.3 illustrates the number of stores in each census tract.

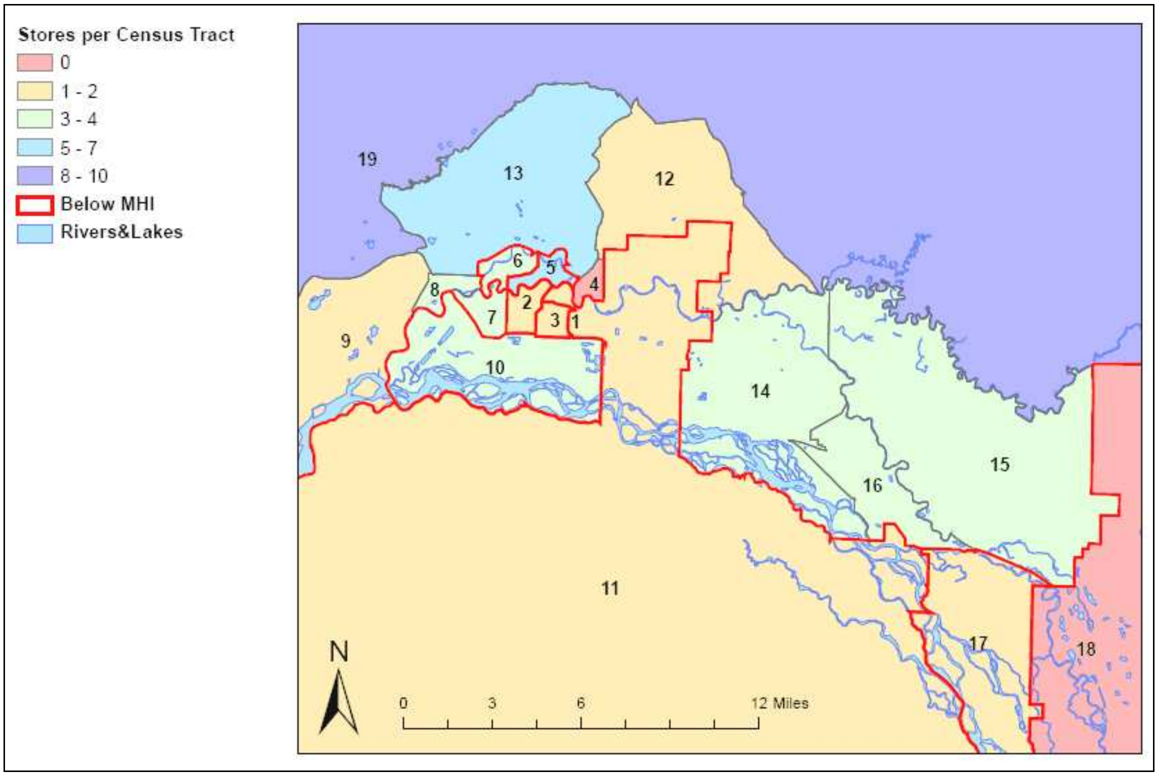

Figure 2.3 Stores per census tract in the FNSB

Table 2.1 summarizes the different kinds of stores in each tract type.

Table 2.1 Stores and Store Types by Census Tract Type

Tract Type	Total Stores	Convenience	Small	Supermarket	Farm Outlets
BMHI	19	11	3	3	2
AMHI	36	13	1	6	16
FNSB	55	24	4	9	18

A test for difference between proportion was used to determine whether BMHI tract have a statistically greater proportion of convenience stores than AMHI tracts; no significant difference was found (z= 1.564, P= .059). However, higher income tracts have a greater proportion of farm outlets, indicating that higher-income residents may have greater exposure and access to locally grown foods than do lower-income residents (z= -2.48, P= .0066).

2.8.2 Distance to Food Resources

I did not find a statistically significant difference between the overall numbers of stores by census tract type (t= .948; P= .357), which may be attributable to the small sample size. However, simple presence or absence in a tract neither guarantees nor eliminates access to food resources. An important aspect of access to food is the distance one must travel to reach food resources, and whether or not someone has the means to travel that distance. To further examine the issue of access, I test average distance to supermarkets and convenience stores for each tract type. The mean distance from BMHI population centroids to all supermarkets in the FNSB is 8.83 miles; the mean for AMHI tracts is 7.10 miles. No significance is discernable between average distances (t= -.521; P= .609).

The mean distances to convenience stores are 10.76 miles for BMHI tracts and 9.10 miles for AMHI, an apparent reversal of the pattern showing better access to convenience stores in lower-income neighborhoods. In addition, mean distances are farther to convenience stores than to supermarkets for both tract types. However, this pattern is likely due to the large number of convenience stores and to the location of several stores on the outskirts of the populated areas, making them convenient for rural residents, but adding to larger mean distances. There is no statistically significant difference between AMHI tract and BMHI tracts in terms of average distance to convenience stores (t= -.582; P= .569).

Census tracts were further broken down into quartiles by median household income. However, no statistically significant difference was found for average supermarket distance (f= .135; P= .938) or convenience stores (f= .147; P= .930).

The population of the FNSB, like many western US cities, is dispersed well beyond the city center, making distances to stores high when all stores are considered as a group. I tested the difference in distance to the closest store by census tract. For BMHI tracts, the mean distance to the closest supermarket is 4.47 miles and 2.26 miles for AMHI tracts. The mean for BMHI is likely skewed by 2 BMHI tracts (17 and 18), which are rural, with the closest stores approximately 20 and 12 miles away respectively. Given the range of distances in BMHI tracts, it is not entirely surprising to find that there is no statistically significant difference between BMHI and AMHI tracts despite clear differences in means (t= -.999; P= .332). If tracts 17 and 18 are removed, the average distance to the closest grocery store in the remaining BMHI tracts drops to 1.2 miles. However, there is still no significant difference in distance to the closest supermarket between BMHI and AMHI tracts (P= .12). Similar results were found for convenience stores (BMHI mean 1.33 miles; AMHI mean 1.51 miles). No statistical difference in distance to closest convenience store was found (t= .250; P= .806). No difference by quartile is statistically discernable for supermarkets (f= .468; P= .709) or for convenience stores (f= 1.562; P= .240). Table 2.2 summarizes all store-distance findings.

Table 2.2 Distance to Stores (in miles) by Census Tract Population Centroid

Distance	BMHI	AMHI	All FNSB
All supermarkets	8.83	7.10	7.9*
All convenience	10.76	9.10	
Closest supermarket	4.47	2.26	3.31
Closest supermarket (excluding tracts 17 & 18)	1.20	2.26	
Closest convenience	1.33	1.51	
All local-food outlets	13.40	10.89	12.08*
Closest local-food outlet	3.93	1.94	2.89

*distance to supermarket*local outlet p = .000

2.8.3 Local-Food Access

Distance to full-service supermarkets is fairly equitable across the FNSB. When the two most rural tracts are excluded, residents of lower-income census tracts may even have shorter distances to supermarkets than higher-income areas. I look now at locally grown foods to determine whether these foods are equitably accessible across the community.

Although some stores stock locally grown foods occasionally, my survey found that they rarely had more than 1-3 items at a time, and that these items are not regularly available even during the local growing season. For these reasons, I measure distance only to farm outlets when calculating distance to local foods. The farm outlets are generally open only 1 or 2 days each week, but when open the selection of locally grown foods is extensive. The mean distance to outlets for locally grown foods in BMHI tracts is 13.40 miles and 10.89 miles for AMHI tracts – but there is no statistically significant difference between the two groups (t= .833; P= .417). Nor are there differences by income quartile (F= .223; P= .879).

The closest farm outlets range from .21 miles for Tract 1 to 17.23 miles for Tract 17. The average distance for BMHI tracts is 3.93 miles and average distance for AMHI tracts is 1.94 miles. No statistical difference is discernable by tract type (t= 1.047; P= .310) in the aggregate; however, it is clear that some neighborhoods have much shorter distances to travel to reach locally grown foods.

Where differences are discernable is when distances to all farm outlets and all supermarkets were compared for the FNSB as a whole. Supermarkets are an average of 7.9 miles from tract population centroids, while local-food outlets are an average of 12.08 miles. This difference is significant (t= -13.775; P= .000).

However, the average distance to the closest supermarket is 3.31 miles. Assuming people shop at the closest supermarket to their homes, the average roundtrip to the supermarket is 6.62 miles. Pimentel and Pimentel (1996) estimate that the average American family shops 3 times per week. By this estimate, Fairbanks residents may drive as much as 19.86 miles per week to grocery shop – or almost 5 miles per week more than the national average. I discuss the changing location of supermarkets in Fairbanks, and the affects on food access, below (p. 38-39)

While the average distance to all farm outlets is 12.08 miles, the average distance to the closest farm outlet is 2.89 miles, which is not significantly different from the closest supermarket. This finding is a good indicator of local-food access for Fairbanks because it appears that local farmers appear to be able to locate their CSA pick-up sites close to their customers. However, the local-food outlets are not necessarily close to supermarkets, which mean that an additional trip is required to access locally grown foods and add 5.78 consumer miles per week.

The finding that farm outlets are potentially closer to consumers than supermarkets assumes that people generally access local foods at the closest outlet. But, this is not necessarily a fair assumption. The majority of farm outlets mapped (10) are CSA pick-up sites, which require consumers to be members in order to access the available food. Since only approximately 350 households are currently served by CSAs in Fairbanks, the vast majority of residents would need to purchase locally grown foods at a farmstand or the Tanana Valley Farmers' Market (TVFM). Given these constraints, it is fair to consider the average distance to the TVFM, 7.59 miles (15.18 miles round-trip), as an accurate estimate of distance to local foods, which is significantly farther than to the closest supermarket ($t= -3.338$, $p=.004$). These results indicate that Fairbanks residents can access non-local foods by exceeding average travel distance slightly, while accessing locally grown foods requires additional effort and additional travel distance.

The issue of scheduling and availability – when these outlets are open – is yet another matter that should be considered when promoting locally grown foods to consumers. The Tanana Valley Farmer's Market is open 2 days per week during the summer months (roughly June through September). CSA farms tend to give members 2-3 choices of days and locations to pick up produce shares. The additional distance necessary to reach local-food outlets and the limited schedule means that consumers may need to make a separate trip or special arrangements to access local foods. While for many consumers of local foods, these are minor inconveniences in comparison to the perceived benefits of locally grown foods, they can be barriers to increasing the consumer base for local foods to include lower-income people or for those with work, family, or childcare responsibilities that hinder their movement throughout the day (Allen 1999; Bellows and Hamm 2001).

An additional access issue in small communities, like Fairbanks, is the quality of roads. Farm access roads can be rough and unmaintained, requiring appropriate vehicles to safely navigate them. The farmers in Fairbanks have largely addressed this issue by selecting pick-up sites that are on well-maintained roads in locations that are accessible to all vehicles. CSA farms in other communities often deliver their goods directly to members, but the rural, sprawling nature of Fairbanks makes this option more challenging for Fairbanks farmers.

2.8.4 Distance and Access

Although distance to various food outlets appears, on the surface, equitable across census-tract type, these results do not necessarily equate to equal physical access to food. While miles to a store may be similar for two different households, if access to transportation is not equal in the households, such distances may mean two entirely different things. Information on personal transportation ownership by census tract is not available for the FNSB. However previous studies show that lower-income households tend to have lower rates of car ownership meaning that travel to shopping must be accomplished by foot, public transportation, or commercial taxi (Algert, et al. 2006; Whelan, et al. 2002; Wrigley 2002).

To determine whether any stores in the FNSB are within walking distance of census tract population-centers, I placed half-mile buffers around each centroid using the buffer tool in ArcGIS (see Fig. 2.4). One-half mile was chosen as reasonable walking-distance based on existing literature (Algert, et al. 2006). However, the physical structure of a city and its climate must be considered when analyzing walking distance. In many Western U.S. cities, sidewalks are not common, forcing residents to walk in roadways or drive to their destinations. Additionally, in Fairbanks the impact of climate and geography cannot be ignored. Although my study focuses on summer months, in winter, temperatures can drop below -40º F with less than 4 hours of daylight – both of which hinder residents' ability to walk to destinations.

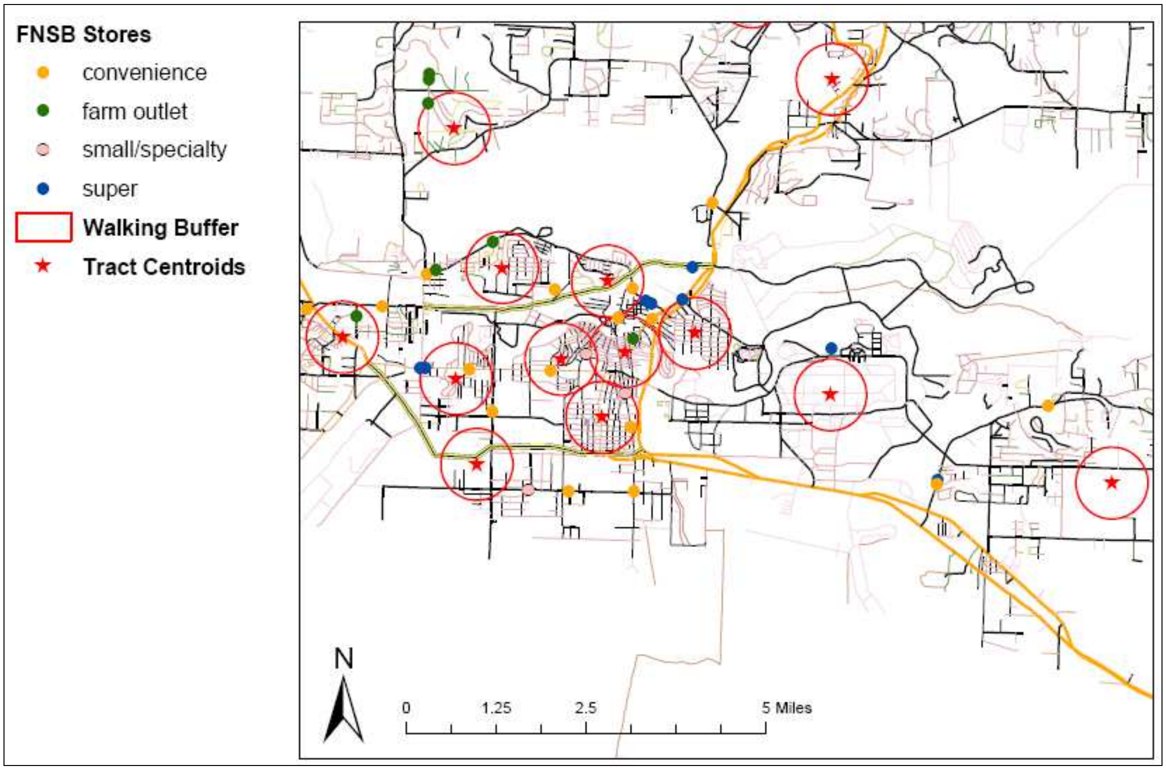

Figure 2.4 Half-mile walking buffers around census-tract population centroids

I found that 10 of the 19 tracts had at least one store within the half-mile buffer. However, only 2 tract centroids are within this estimated walking distance of a supermarket (tracts 4 and 7) and only 1 is within walking distance of the Tanana Valley Farmers' Market (tract 6). Table 2.3 summarizes stores within the estimated walking distance buffer.

Table 2.3 Stores within half-mile walking distance of census centroids

Tract Type	Total Stores	Convenience	Small	Supermarket	Farm Outlet
BMHI	9	4	3	0	2
AMHI	7	1	0	2	4
FNSB	16	5	3	2	6

The FNSB operates a public transportation system consisting of 7 different bus routes. Each of the seven lines stops at one of the major grocery stores and two of the routes stop near the farmers' market. The availability of public transportation can ease food-access issues, but doesn't eliminate them. Doing grocery shopping by bus can be challenging because of the need to walk to and from the closest bus stop, carry grocery bags from the stop, and coordinate shopping trips with bus schedules (Whelan, et al. 2002; Wrigley 2002).

Taxis are another possible transportation choice for shopping. Residents without personal transportation can take a taxi directly to the grocery store without having to wait for public transportation schedules or to walk to and from public transportation stops with full grocery bags. Anecdotal information indicates that some residents even rely on trusted taxi drivers to do their shopping for them and to deliver the food to their home, particularly the elderly or those with physical limitations. Taxi fares in Fairbanks change slightly depending on the season (price per mile is higher in the summer months when fuel costs tend to be higher), but average $3.00 per mile plus a $1.00 flag drop in 2007. Without access to information on rates of personal transportation ownership, or more detailed surveys or ethnographic study, it is not possible at this time to determine how many people use taxis to facilitate food shopping although one local taxi driver volunteered the information that it is a "common" practice. Approximate taxi fares from the census-tract centroids to and from the closest supermarket range from $4.70 to $32.84. Taxi fares from census centroids to the farmers' market range from $4.34 to $55.00 and up for tracts outside the urban center.

2.8.5 Affordability

One important dimension of access to food is the affordability of that food. I hypothesize that locally grown vegetables from our sample would be more expensive than are vegetables from points of origin outside the FNSB.

Calculating the costs of locally grown foods proved somewhat difficult because much of the local food in Fairbanks is distributed through CSA enterprises (many of the identified farm outlets in the FNSB are CSA pick-up spots). CSAs function by asking members to pay an up-front fee prior to the farming season and receive, in exchange, a share of all foods produced each week during the farming season. This system makes calculating the price of individual vegetables impossible. I limit my analysis of food prices to outlets selling vegetables on a per item basis: The Tanana Valley Farmers'

Market, one farmstand, and the supermarkets. I recognize that this limits my data, somewhat, and therefore consider my price analysis as preliminary and encourage further work in this area. Table 2.4 summarizes the average price of the 7 vegetables by point of origin.

Mean prices by origin are calculated, with the exception of lettuce because lettuce is sold per head, not by the pound. For other vegetables sold per item during the survey period, the item or an equivalent was weighed to estimate per ounce costs. There were significant differences between vegetable prices by point of origin (f= 5.050; P= .009). A Bonnferoni post hoc test indicates that FNSB-grown vegetables are more expensive than are comparable vegetables from each of Alaska-grown and nonlocal sources (see Table 2.5).

Table 2.4 Vegetable Costs (per ounce) June-July 2007 in the FNSB

Vegetable	Nonlocal	Alaska-grown	Fairbanks-grown
broccoli	$0.12	$0.09	$0.19
cabbage	$0.07	$0.05	$0.10
carrots	$0.06	n/a	$0.35
lettuce	$1.62/ea	$.99/ea	$1.94/ea
potatoes	$0.02	$0.02	$0.10
tomatoes	$0.19	$0.19	$0.26
zucchini	$0.13	n/a	$0.11

Table 2.5 Price comparison by point-of-origin

Origin	Average price	items
Nonlocal	$.1044[1]	48
Alaska-grown	$.0708[2]	12
Fairbanks-grown	$.1818[12]	17

[1] p = .026
[2] p = .015

These statistical differences may also be affected by seasonal variations in food availability. For example, local potatoes and carrots were not widely available at the time of the survey because they are late-season crops. Given that both vegetables are relatively inexpensive, they are likely to bring down mean prices for locally grown vegetables. However, the lack of availability of two common vegetables throughout most of the summer in Fairbanks raises issues of access, at least in terms of seasonality and availability of common foods. But the survey indicates that despite shorter transportation distances, locally grown vegetables tend to be more expensive for at least some vegetables and times of year.

2.9 Discussion

2.9.1 Access: Allocation

Access to food – locally grown or otherwise – is the ability of a person or household to obtain the type, quality, and quantity of food they require (Ericksen 2008). Access includes allocation of food, affordability of that food, and food preferences (ibid). When I looked at the pattern of geographic allocation of food outlets across the FNSB, I initially saw few differences between low and high-income census tracts in terms of their physical distance to food. However, statistical differences are not the same as discernable differences for the people who confront their food-access issues regularly. Lack of access to personal transportation can make the 1.2-mile average distance to supermarkets in BMHI tracts a barrier for some households. And the average distance to locally grown foods for the FNSB as a whole is significantly higher than to supermarkets, indicating that additional effort and time is often required to access locally grown foods – another potential barrier for some households.

Despite the potential for transportation to act as a barrier to food access, the equitable distance to full-service stores is a positive indicator of food access for Fairbanks at this time. However, by tracking the history of grocery stores in the region, we can discern a directional shift over time that could change this indicator in the future. Early Fairbanks grocery stores were clustered in the downtown area, allowing most residents to live within 2 miles of 1 of the 7 grocery stores in 1965 (Burgett 1967). Today, that average is 7.9 miles. Part of this shift can be attributed to the type of development common in modern U.S. cities whereby residential development increasingly occurs farther and farther from traditional urban centers. A recent trend in U.S. cities is for supermarkets to move toward the newer suburbs and abandon the urban core (Morland and Wing 2007; Morland, et al. 2002). This trend appears to be occurring in Fairbanks as well. There are no longer any grocery stores in the traditional urban-core area and the newest stores are in a newly developed suburban area in the northeast section of the city – distinctly farther away from the majority of lower-income census tracts in the southern part of the city. This pattern of larger stores moving to suburban areas has been linked to the increase of "food deserts," reduced food access, and higher food prices for low-income residents in other U.S. cities (Hendrickson, et al. 2006). Figure 2.5 illustrates the drift of supermarkets in the FNSB out of the urban core over the past 40 years. Data for 1965 was taken from Burgett (1967). Data for 1985 and 2005 were gleaned from census records and regional telephone directories. Data for 2007 comes directly from my study.

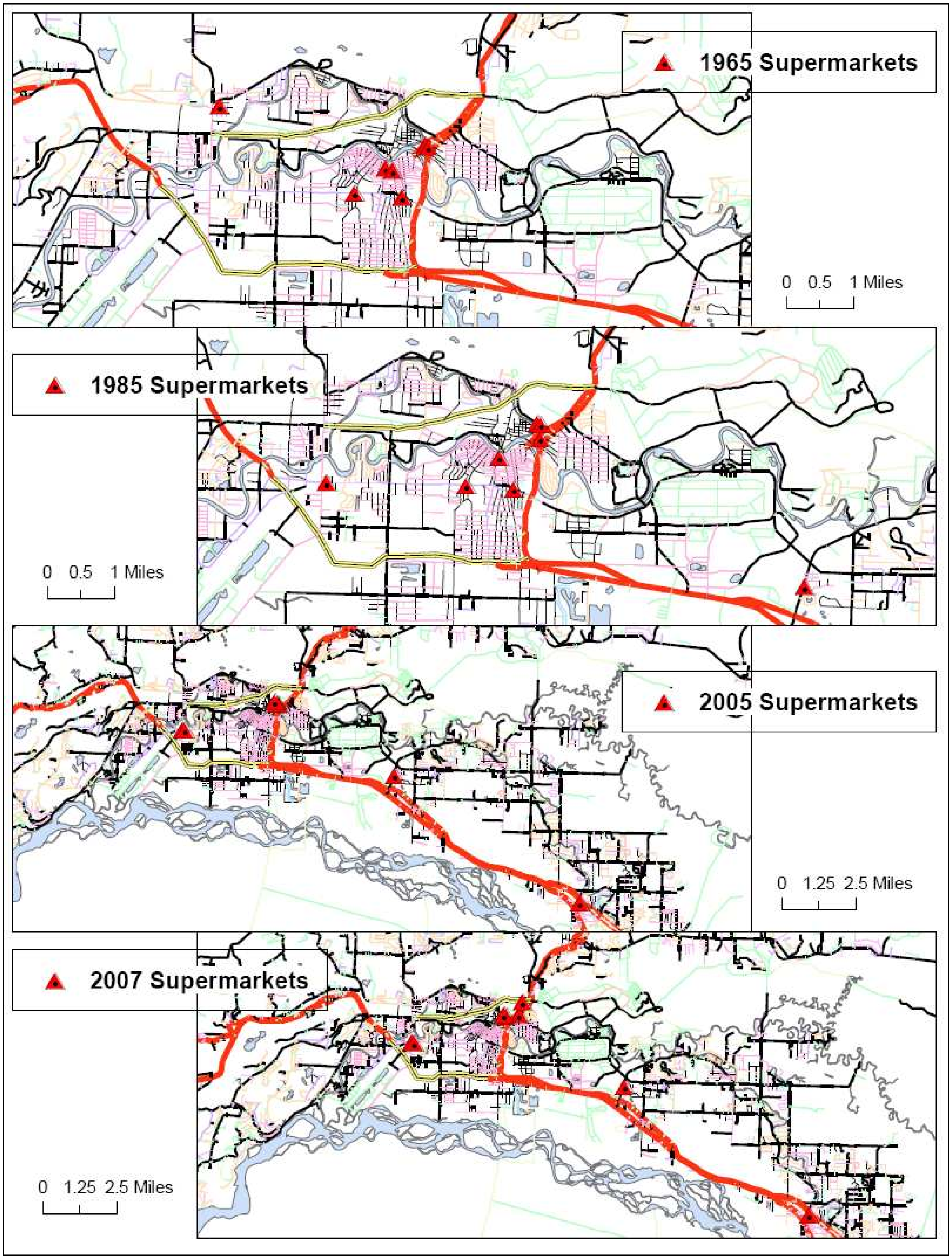

Figure 2.5 Supermarket “drift” in the FNSB 1965 – 2007

The number and type of stores in a community help to determine the allocation of food within the community. The FNSB, as well as the U.S. in general, has seen a steady decline in the number of full-service grocery stores in recent years. Individual stores have grown in size and now accommodate more people than before, but the diversity of stores is shrinking. In the U.S., 5 supermarket chains account for more than 40% of food-retail sales (Hendrickson and Heffernan 2002; Stanton 1999). The trend toward consolidation of the national food system into fewer hands is clear in Fairbanks where only 1 independent grocer is in business and the remaining 7 stores (excluding the military commissary) are owned by 3 of the top-5 supermarket corporations: Kroeger, Safeway, and Wal-Mart. Table 2.6 summarizes the change in persons per supermarkets in the FNSB since 1965. While national statistics are not directly comparable due to the manner in which the Economic Census is conducted, nationally, stores classified as "Supermarkets or Grocery stores" have declined from 73,357 in 1992 to 66,150 in 2002. The population grew from approximately 249 million to 281 million people during the same time period (U.S. Census Bureau 1997; 2002)

Table 2.6 Supermarkets per person in the FNSB

Year	Supermarkets	Population	Persons/Supermarket
1965	7[1]		2,200[1]
1975	10	n/a	n/a
1985	9	72,474[2]	8,053
1995	11	84,380[3]	7,671
2005	8	87,555[3]	10,944
2007	9*	97,484[3]	10,832

[1] Burgett (1967)
[2] Alaska Department of Labor (1987)
[3] U.S. Census Bureau (2000; 2008)
* Data from this study

In addition to where stores are located, allocation can be thought of as including the kinds of food that are carried within those stores – in other words, how certain types of food are allocated within the community foodscape. My survey found that little to no locally grown foods is available in the large chain grocery stores that supply the majority of food to the Fairbanks population. The increasing consolidation of business within the GFS has been linked to a reduction in the diversity of crops grown by farmers and the diversity of foods available to consumers (Sundkvist, et al. 2005). Nationwide chains now dominate the foodscape of Fairbanks, with these enterprises more likely to maintain product and purchasing control in a central location ensuring standard practices throughout the chain. Retail consolidation also allows these large enterprises to set prices for producers – with fewer choices of places to sell their produce, food producers are forced to accept the prices offered by the large chains (Hendrickson and Heffernan 2002; Stanton 1999).

The desire for standard products and procedures leaves locally grown foods out of major chains. In the FNSB, only Safeway stores stocked any Fairbanks-grown foods – and only tomatoes grown by one local producer were observed during my survey. All stores but one sourced at least some Alaska-grown produce from the more southern Matanuska-Susitna region of Alaska where food crops can be grown on exponentially larger scales than in the interior or northern parts of the state[1]. While produce managers at each of the large chain stores reported ordering Alaska-grown foods as soon as they became available each year, they did not report having discretion about most purchasing decisions. Most foods come from a central warehouse and managers place orders through the company, not individual farmers.

Consolidation of food retailing and sourcing of food largely outside the state has implications for Fairbanks' food security in the event of a system shock that disrupts transportation. Safeway has one warehouse in Anchorage that must supply the entire state and Fred Meyer's has no warehouse in Alaska and must re-stock all its food from Portland, Oregon. Estimates place the amount of fresh food on-hand in the state's grocery stores at 2-3 days at any given time. A shutdown of the transportation system that brings food into the state by truck, barge, or air could have serious impacts in Fairbanks.

[1] The Matanuska-Susitna agricultural region produced 128,500 cwt of potatoes and 20,000 cwt of carrots in 2005, compared to the Tanana Valley region's (location of FNSB) 37,000 cwt and 500 cwt of the same vegetables, respectively.

How food is allocated within the retail sector – where stores source their produce, where they store it, and how they transport it – all play an important role in who has access to different kinds of food and whether a community will have access to food in an emergency.

The other side of the "vulnerabilities to external forces" equation is the potential for vulnerabilities within the region. An unseasonable frost, or a regional crop disease, could have a severe impact on local-food production. If local foods are the primary source of nutrition for a community, the results of a shock within the local system could be devastating. However, vulnerabilities can be reduced through agricultural practices that focus on diversity within the agro-ecosystem. Fraser (2006) found that common features in communities affected by past famines included over-dependence on a fragile and specialized agricultural system and a lack of connections (physical, financial, and political) to other sources of food. How much reliance the community has on any one source of food – how much food is "allocated" within each source – is a source of vulnerability or resilience.

2.9.2 Access: Affordability

Affordability of food has several components: production methods, location of production, and consumers' ability to pay (Ericksen 2008). Industrial agricultural-production techniques were intended to make food production more cost effective and reduce food prices (Fraser 2006; Grey 2000; Hendrickson and Heffernan 2002). Much of industrial agriculture is also subsidized by governments, which helps to keep food prices, particularly commodities like corn, wheat, and soy, low and more competitive on the global market. The environmental and human-health costs of these methods are often borne outside of the agricultural marketplace in the form of externalities unaccounted for in costs. While changing from industrial scale production methods to a more ecologically sensitive method may improve environmental and human-health outcomes, it can be financially difficult for farmers who lose the benefits of economies of scale and government subsidies (Fraser, et al. 2005). Farmers must pass those costs along to consumers in order to stay financially solvent and continue producing food into the future. There is evidence that the costs of sustainable agricultural practices, while initially high, do fall over time (Horrigan, et al. 2002) which may help farmers recoup costs in the long term. While the costs of small-scale, organic, or sustainably grown foods may better reflect actual production costs, they can still be more expensive and out of reach for consumers with limited food budgets.

Location of production can also contribute to food costs. Food miles are commonly used as a measure of the energy required to ship food from point of production to point of consumption – with clear implications for consumer costs because of the cost of transportation. Between 6 and 12% of food costs are estimated to be transportation-related expenses (Pirog, et al. 2001). Grocery-store food in Fairbanks is, on average, 30% higher than national averages (FNSB Community Research Center 2005) largely due to the community's geographic isolation, resulting to lower competition in the retail sector and higher transportation costs, which, in combination, contribute to higher prices. As fuel and energy prices rise, the costs of production and transportation of food will both increase, pushing consumer costs even higher. Communities that depend heavily on outside sources for their food may see even higher food prices than national averages. While food miles are not the sole indicator of energy use and energy costs in the global food system (see for example: Mila i Conals, et al. 2007; Weber and Matthews 2008), they are still a helpful tool in understanding the impact of energy costs on food costs. The food miles for the selection of vegetables in this study are calculated using weighted average source distance (Carlsson-Kanyama 1997; Pirog and Benjamin 2003) to demonstrate the distance food must travel to reach Fairbanks. Table 2.7 summarizes my findings.

Table 2.7 Food miles for sample vegetables in the FNSB

Point-of-Origin	broccoli	cabbage	carrots	lettuce	potatoes	tomatoes	zucchini
Palmer, AK	329	329			329	329	
Vancouver, BC						1659	
Fresno, CA	2445		2445				2445
Pocatello, ID					2257		
Saginaw, MI			2356				
Portland, OR			1691		1691		
Moses Lake, WA		1696		1696	1696		1696
FNSB-region	8 - 95	8 - 95	8 - 95	8 - 95	8 - 95	8 - 95	8 - 95
Average	819	606	1021	747	1353	1099	773

Food miles and transportation costs are not the only factor in the location-affordability equation. The resources available in a location can also determine the cost of producing certain foods there. If inputs such as fertilizers must be purchased because a region's soil lacks necessary nutrients, these expenses can contribute to higher farm costs and higher food costs. The amount of land available locally, the amount of land required to produce certain levels of food, and the cost of that land may also affect food prices. If a farmer is able to make efficient use of locally available resources at low costs, consumers may see lower food prices.

Finally, consumer ability to pay significantly affects affordability of foods. My study finds that locally grown vegetables are more expensive than their non-local counterparts when per-item costs are compared. Membership in a community-supported agriculture enterprise is another popular method for buying locally grown foods throughout the country and in Fairbanks, which may help reduce the per-item cost of vegetables. Local CSAs charge approximately \$30-\$40 per week of harvest for a full-share (enough to feed an entire family) in the enterprise. However, the structure of a CSA requires that the payment be made in a lump sum of between \$360-\$500 for 12 to 20 weeks (depending on the farm) and this requirement can be a barrier to lower-income households (Guthman, et al. 2006; Hinrichs and Kremer 2002; Macias 2008)

The practice of CSA farming has been widely credited with reviving many small farms across the country – ensuring income for farmers and allowing the risks of farming to be shared across a community (Ashiabi 2000; Henderson and Van En 1999).

Most consumers and farmers feel that the prices charged fairly reflect the amount of food produced. The accessibility of CSA membership for lower-income households is an illustration of the challenges of spreading locally grown foods equitably across the community. Farmers deserve a fair price and fair income for the work they do and services they provide, and CSA has proven an effective strategy for them. However, the same strategy that allows small farmers to survive can be a challenge for potential consumers who may struggle, or be unable, to pay a lump sum of several hundred dollars or the higher prices often charged at other local-food outlets. Some larger CSA farms are in a position to subsidize lower-income members, allow monthly or weekly payments, or accept farm work or "sweat equity" in payment (Guthman, et al. 2006). However, expecting a small farmer to be capable of such adjustments may be unfair to the farmer.

The tension between higher prices for locally grown foods and lower food access due to the cost highlights one of the most challenging aspects of alternative food systems. Guthman, et al. (2006) discuss the difficulty of supporting small farmers while ensure equitable food access as "squaring farm security and food security". In addition to farmers deserving a decent income, farm security also means that farmers having the economic security to continue to produce food on a consistent basis. If farmers cannot afford to farm, food security will suffer.

Affordability at the consumer level is an issue of equity and inclusiveness in the LFS debate. While a food system that excludes a segment of the population cannot be considered socially equitable or sustainable, at least some of the high costs and social exclusion we currently see reflected in LFS participation may be related to the relative newness of the movement and may be resolved if the movement progresses. Diffusion of Innovation Theory (DIT) can help us understand the needs and perspectives of a range of people within a community developing a locally based food system, which can be considered the innovation in question. DIT divides adopters of an innovation into 5 categories: innovators, early adopters, early majority, late majority, and laggards (Rogers

1995)[2]. An important characteristic separating innovators and early adopters from the late majority and laggards is availability of capital (social and financial) and the related ability to cope with uncertainty and risk. A person with greater expendable income can afford to participate in a new local-food economy, despite higher prices, without placing family finances at risk. A person with lower income may find that the higher prices are too great a risk if it means sacrificing other necessary family expenses. As more people adopt a new innovation – such as a new source of food – the social and, sometimes financial, risk diminishes allowing late majority and laggards to more comfortably adopt the innovation. If production of local foods rises (for example if farmers' risk is lowered because of greater customer base), costs may fall, allowing more low-income people into the local-foods market. In other words, the higher-income consumers – the innovators and early adopters – may be necessary to make the wider adoption process possible.

But, this diffusion of innovation process should simply be seen as an illustration – not as a given. DIT, which was largely developed among extension agents working with farmers, encompasses the need for additional work on the part of practitioners, community members, or advocates, to make the late majority and laggards comfortable with the innovation and reduce their risk in adopting a new innovation. This is often accomplished through education as well as peer-to-peer communication.

One example of lowering the financial risk of LFS initiatives is the Farmers' Market Nutrition Plan (FMNP), operated by The U.S. Department of Agriculture, which provides farmers' market coupons to low-income families. Participants in the Women, Infants, and Children (WIC) nutrition program and eligible seniors aged 60 and older can receive $25 worth of coupons per year to be used only at participating local markets or farmstands for Alaska-grown fresh, unprocessed fruits, vegetables, and herbs.

[2] Rogers explains the use of the relatively pejorative term "laggard" in this way: "'Laggard' might sound like a bad name. This title of the adopter category carries and invidious distinction in much the same way that 'lower class' is a negative nomenclature. Laggard is a bad name because most nonlaggards have a strong pro-innovation bias. Diffusion scholars who use adopter categories in their research do not mean any particular disrespect by the term 'laggard.' Indeed, if they use any other term instead of laggards, such as 'late adopters,' it would soon have a similar negative connotations. *But it is a mistake to imply that laggards are somehow at fault for being relatively late to adopt*. System-blame may more accurately describe the reality of the laggards' situation" (1995: 266; italics mine).

Nutritional and preparation information is available to participants through the agencies granting the coupons. The Alaska Department of Health and Social Services (DHSS) estimates that the FMNP generated $250,500 for participating farmers in 2006 (State of Alaska 2007). DHSS also reports that many participants continued to shop at the local markets after using all of their coupons.

While the FMNP appears to be a successful step toward linking low-income families with local producers, the amount of coupons provided to each family is a fraction of average household expenses for fresh vegetables. In 2000, Americans spent, on average $1.45 per person per week for fresh vegetables (Blisard, et al. 2004) . A household of four could be expected to spend $5.80 per week on fresh vegetables. The $25 book of coupons per year is equivalent to approximately 1 month of vegetables per household.

The illustration of DIT points to the importance of community-wide initiatives to help food-system localization become a successful adaptation for a wide-range of people. Expecting individual adaptations, particularly on the part of low-income, working, or otherwise constrained households, may weaken the local food system because it might not be the most viable option for a large percent of the population. However, adaptations made on a community-scale, such as placement of local-food outlets in low-income neighborhoods; increased funding for FMNP; and broader community support for CSAs, which might then allow for more subsidized shares, can contribute to the development of a more resilient food system.

2.9.3 Access: Preference and Seasonality

While it is not within the scope of this paper to address the issue of individual preference for fresh vegetables in general, or locally grown vegetables in particular, personal tastes, dietary requirements, and cultural preferences are important issues when considering the design and development of resilient food systems. As the GFS developed over the last 50 years, we have become accustomed to choosing from a wide variety of foods, from around the world, regardless of season. Changing back to a reduced number of choices, depending on the season will require significant adaptation on the part of most Americans – particularly Alaskans who rely on external sources for 95% of their food. For example, Alaska-grown fruit (with the exception of berries) is not widely available and its absence would mean a significant shift in eating habits for many people.

Availability of culturally appropriate foods is an issue that cannot be ignored in our increasingly multicultural communities. At present, religious or cultural food requirements can be met in a great number of communities around the world, including Fairbanks. There are 3 stores in the FNSB that specialize in Asian foods including fresh and canned vegetables, fish, herbs, and processed foods. An entirely locally based food system could eliminate or severely restrict the availability of these foods (DuPuis and Goodmand 2005; Sundkvist, et al. 2005). However, a commitment to local production may also encourage experimentation and innovation among farmers and gardeners seeking culturally appropriate foods.

Seasonality and seasonal availability are particular challenges to a locally based food system in Fairbanks. The average growing season for Fairbanks is 115 days (Alaska Climate Research Center 2008c) – although much of that time has 20+ hours of daylight which encourages quick growth. Most locally grown foods are not widely available until July and August – as the food-outlet survey from 2007 indicated (Lewis, et al. 2004). While most consumers of locally grown foods enthusiastically await the availability of fresh vegetables each year, their willingness and ability to subsist solely on the locally available foods has yet to be studied. When I surveyed gardeners at the Fairbanks Community Garden in 2006, I found that 88% of gardeners supplement their homegrown foods by shopping at supermarkets – even during the gardening season (see Chapter 3, p. 54).

Willingness to subsist solely on locally grown foods in a high latitude region, like Fairbanks, involves the ability to grow adequate food to last year-round in a short growing season; the skills, knowledge, and time to preserve the food properly; and appropriate facilities to store the food year-round. The time and resources necessary are formidable; however, educational programs in the region aim to address the skill-development challenges[3]

Time is an element that affects accessibility of locally grown foods. Ericksen (2008) places "time" within the preference category – but it can also be considered a part of cost particularly for lower-income households or in households in which overtime or multiple jobs are required to meet family expenses. Time can become an opportunity cost for those households – time spent not working may not be a worthwhile investment.

While statistics are not available on the specific amount of time required to prepare unprocessed foods at home, it is a concern often raised in discussions of local food productions (Kingsolver, et al. 2007). Gladwin and Butler (1984) found that farmers using gardening to feed their families, as a supplement to farming income, spent an average of between 87.2 (men) and 115.6 (women) hours per year in the garden on top of other work and family responsibilities. When gardening hours were multiplied by the minimum wage and compared to the cost of comparable foods in local stores, Gladwin and Butler found that the presumed financial benefits disappeared.

Time spent gardening is clearly more extensive than that spent processing foods at home. However, the study illustrates that for some families the extra time required to prepare foods available through CSA or farmers' markets may present a barrier or a perceived barrier to their full participation in a locally based food system. Whether one believes that the time issue is a real or perceived barrier, approaches must be developed that alleviate the barrier and bring people into the local system – not exclude some segments of the community whose household circumstances do not permit adequate time flexibility to take on food production and processing responsibilities.

2.10 Conclusions: Filling Gaps to Create a Sustainable Food System

Hendrickson and Heffernan (2002) propose that the best use of local-food-system resources are to fill gaps in what the GFS brings to a community. I take a similar approach to the development of a resilient food system for Fairbanks – identify the gaps

[3] University of Alaska's Cooperative Extension Service provides a range of programs to local residents. See: http://www.alaska.edu/uaf/ces/

in the way food is currently allocated and accessed in the community and examine whether local resources could fill those gaps in the service of reducing community vulnerabilities. I have identified several gaps in the current food system in Fairbanks: affordability, preference, and allocation. Capacity – biological and social - for increased production in the region is an area in need of further research, but we touch briefly on it here.

2.10.1 Gaps in Affordability

Food in Fairbanks, even conventionally grown and commercially available, is more expensive than national averages, due to transportation costs and geographic isolation, which lowers competition. Local production has the potential to address the transportation issue – and the energy use and pollution related to it. Food miles for foods grown within the Fairbanks region are substantially lower than conventional foods, and consumer miles, while higher, do not offset the difference. However, my study found that locally grown foods are more expensive than vegetables available in supermarkets. These higher prices can be attributed to farming methods (most local farmers choose organic or other sustainable agriculture methods) and the climate and geography of the region, which limit the growing season and the overall production levels. Switching to more conventional farming methods may lower food prices (conventional Alaska-grown vegetables are less expensive), but pose potential harm to the local environment and may reduce the interest of local consumers who value the environmentally sensitive growing techniques.

2.10.2 Gaps in Allocation

Food allocation, in general, in Fairbanks is relatively equitable on a community-wide scale. Low- and high-income residents must drive approximately similar distances to reach full-service grocery stores and distances to local-food outlets are comparable by census tract type; although longer than to supermarkets at a community-wide scale. However, I note potential access barriers at a household scale for those without personal transportation, as well as the trend of “supermarket drift” away from the urban core – both of which put lower-income residents at a distinct disadvantage. Local food production has not yet filled the allocation gap – but this is an area with great promise. One local farm has already started a weekly farmstand in the urban core and more may follow.

Small farmstands have some advantages over large grocery stores – they need little space, are mobile, and don't need as many daily customers to be financially viable. Other communities use produce-delivery vans that target low-income neighborhoods (Algert, et al. 2006). Siting farmers' markets in low-income neighborhoods may also ease access for low-income and minority people (Alkon 2008; Macias 2008). If the affordability gap can be closed, the potential for the local food system to fill the allocation gap by bringing food closer to low-income and other underserved areas is high.

2.10.3 Gaps in Preference

Consumers of locally grown vegetables in Fairbanks say that the foods are fresher, taste better, and offer more diversity than those available in the supermarkets. More research is needed, however, to identify the reasons why people do not buy local foods. Are the varieties unfamiliar to them? Do they prefer foods that can't be grown locally? Is the cost too high for some households? Some of these issues may be resolved through more outreach, education, and exposure to locally grown foods. The issue of seasonality is critical in Fairbanks. With a short growing season, the foods that are available at the beginning and end of the season are limited, and many local foods are completely unavailable for most of the year. Are consumers willing and able to make a commitment to eating what is available locally, even when it is extremely limited? Some local-food-system advocates believe that we all should make that commitment, but even they admit it is neither easy nor perhaps even possible everywhere in the country (Kingsolver, et al. 2007).

2.10.4 Gaps in Capacity

The underlying question in local-food-system development is whether the region has the capacity to support itself. If all of the above mentioned gaps could be addressed through local production – if all residents showed a preference for locally grown foods, the foods were accessible and affordable to all residents – could the FNSB grow enough food to meet the new demand?

Capacity has several dimensions. Availability and suitability of land is one dimension. Can large amounts of food be grown locally without resorting to the industrial-agriculture techniques, like use of chemical inputs, that are detrimental to the long-term sustainability of a food system (Abate, et al. 2008)?

A second dimension of capacity is human capital. Are there enough skilled people willing and able to become farmers or gardeners in the region? How many people in the region have the skills, knowledge, land, and opportunity to grow their own food? The number of small farmers and farms has been growing in recent years – but none of the farmers make their entire living from farming which raises questions about the long-term sustainability of the individuals and the profession in the region. More food production may make the profession more stable or may simply spread the relatively small customer base out among more farmers.

A resilient food system requires, in part, diverse food sources and the ability of residents to access, use, and shift between those sources to achieve food security. Local food production can be an important component in building food-system resilience through diversity; communities add an additional food source over which they have more control than distant sources. However, to avoid creating unintended new vulnerabilities through large-scale shifts from one food source to another, we argue that communities should carefully assess the strengths and weaknesses of their current food system and determine where additional food sources (both production and retail) can best be used to fill gaps and reduce vulnerabilities.

Food-system localization is not a panacea for all vulnerabilities in urban food systems. Local crops can fail, farming practices can be environmentally detrimental, and low-income residents can be underserved by a local food system as well as the global system. Most urban areas have grown beyond the ability of a LFS to meet all their needs; but that does not mean that resources for local production are entirely lacking. These resources can, and should, be identified and developed in ways that make important contributions to food-system resilience by providing individuals, neig-hborhoods, and the community as a whole with additional food sources and choices and making those foods more accessible and affordable. Local food production has a promising role in combination with existing food-system infrastructure, in the development of food systems that sustain healthy environments, healthy people, and healthy communities.

3 Food-System Localization at Ground Level: A Case Study of the Fairbanks Community Garden

3.1 Introduction

The structure and organization of a community's food system affects our personal health and well being and the health and well being of our ecosystems. This paper explores the effects local-food-system initiatives have on individuals, communities, and the environment. The focus is on urban communities where space for food production competes directly with the built-environment and where a range of socio-economic needs must be met. Specifically, one example of a local-food-system initiative is examined in detail: the Fairbanks Community Garden in Fairbanks, Alaska. I consider the role the Fairbanks Community Garden plays, or might play, in developing a stronger local food system in Fairbanks and highlight gardeners' reasons for participating in the Garden – which are not necessarily linked to food-system localization. I hope that this study will contribute to the development of a robust literature examining and assessing food-system-localization practices and their place in food-system reform.

A food system encompasses the production, processing, distribution, consumption, and waste involved with providing food to a community (Feenstra 2002; Pothukuchi and Kaufman 2000; Sundkvist, et al. 2005). Through these activities, a food system should provide food security, environmental security, and social welfare (Ericksen 2008). Most, if not all, North Americans participate in the dominant global food system (GFS) in which they consume foods that are produced and processed anywhere in the world. While the GFS has provided new foods and new economic opportunities to communities around the world, concerns have begun to grow about the long-term sustainability of a food system that stretches tens of thousands of miles and relies upon industrial agricultural-production practices, which have been linked to the degradation of natural resources necessary for human and other species' health, yet still fails to ensure food security for all peoples.

3.2 The Global Food System

Sundkvist, et al. (2005) identify 4 characteristics of the GFS that have raised environmental and social concerns: specialization, intensification, concentration and homogenization, and distancing. Specialization refers to the tendency for industrial-scale farms to produce only one crop. Specialization can make production a much simpler process – for example allowing the use of dedicated equipment to plant and harvest crops. However, specialization also leads to lower biodiversity – both genetic, because uniformity within crops is prized and selected for, and with respect to species and varieties – because fewer crops can be adapted to the industrial model. The U.N. Food and Agriculture Organization estimates that of the 7,000 food crops that have been cultivated by humans at one time or another, we now rely on only 30 for 95% of our dietary energy or protein (United Nations Food and Agriculture Organization 1996).

Intensification refers to practices related to growing more crops on smaller pieces of land through the use of technological advances such as chemical inputs. Intensification can lead to soil loss due to erosion, lower soil fertility, over-reliance on chemical inputs including developing pesticide resistance, pollution, and loss of biodiversity due to pollution and the use of pesticides and herbicides (Foley, et al. 2005; Horrigan, et al. 2002; Jackson 1985; Matson, et al. 1997).

Concentration and homogenization within the GFS refers to the horizontal and vertical integration of agrifood corporations. A significant portion of food production, processing, transportation, and retailing is in the hands of a small handful of corporations. Five seed companies control the majority of that food-system sector (Hendrickson and Heffernan 2002). Through consolidation and joint ventures, several of these seed companies have extended their reach all the way through food processing and distribution (ibid). Five corporations account for 40% of food-retail sales in the U.S. (Grey 2000; Hendrickson and Heffernan 2002; Stanton 1999).

Finally, distancing means that food production takes places far away from consumption. Travel distance, or food miles, for the average food consumed in North America is 1,500 miles (Pirog and Benjamin 2003). Greater food miles require more energy for transportation, which contributes to greenhouse gas emissions (Pretty, et al.

2005). Food production, including processing and distribution, accounts for 17% of all fossil-fuel use in the United States and 10.5% of total energy used (Horrigan, et al. 2002). However, more recent analyses, particularly life-cycle assessment of energy use in food production stress the importance of a more holistic assessment of energy use in the food system (Eshel and Martin 2006; Mila i Conals, et al. 2007; Weber and Matthews 2008). The concept of food miles is helpful in laying the groundwork for such an analysis. If all production processes are equal, then reduction of food miles will help reduce energy use and related pollution.

In addition to the use of fossil fuels for production and transportation, distancing also contributes to the lowering of food quality and nutrition as foods are picked earlier and then stored for long periods before reaching consumers. Separation of production and consumption insulates those consumers, who are distanced from production sites, from the environmental and social consequences of food-production practices. This insulation due to distancing, it is argued, reduces consumers' ability or interest in responding to poor environmental or labor practices involved in producing their food (Kloppenburg Jr., et al. 1996; Sundkvist, et al. 2005).

The social costs of the GFS are also serious. Food production in the GFS often occurs in places with weak environmental and worker protections, meaning that the negative effects of industrial agricultural practices are borne by people who may lack the political influence to change them (Grey 2000; Sundkvist, et al. 2005). Concentration of retailing has helped to reduce the number, and change the locations, of full-service grocery stores creating "food deserts" in which residents cannot easily access affordable, healthy foods and this trend disproportionately affects low-income neighborhoods (Hinrichs 2003; Larsen and Gilliland 2008; Whelan, et al. 2002).

In response to increasing awareness of the negative environmental health, human health, and social-welfare impacts resulting from practices used in the GFS, some individuals and communities advocate and practice food-system localization (Hendrickson and Heffernan 2002; Sundkvist, et al. 2005). Localizing a food system refers to the process of shifting at least some food production to within a community.

Common forms of food-system-localization initiatives are small-scale farms, community-supported agriculture (CSA) enterprises, farmers' markets, and community gardens. The goals of food-system localization are generally:

- To improve physical and economic food accessibility
- To increase community self-reliance and reduce vulnerabilities related to reliance on external food sources
- To strengthen relationships between farmers and consumers
- To reduce the environmental harm of industrial agriculture and long-distance shipping

3.3 Local Food Systems

A local food system is one in which all or most food required by a community is produced within or nearby the community. It is more accurate to think of this movement as food-system localization – the process of shifting at least some food production, int-ended for local consumption, into the community or the region. Given the long history of trade among human societies, particularly in urban settings (Blouet 1972), and sea-sonal migration among many non-urban societies, entirely local food systems are likely to have never existed.

Food-system localization is intended to address the range of environmental, economic, and social problems associated with the functioning of the GFS. One of the most common arguments in favor of local food production is reduction of food miles – or the miles food must travel from point of production to point of consumption. Current estimates are that fresh food in the United States travels an average of 1,500 miles from farm gate to table (Pirog and Benjamin 2003). In 2001, 39% of fruit, 12% of vegetables, and 78% of fish consumed in the U.S. were produced in other countries (Pirog and Benjamin 2003). The energy use and emissions associated with long-distance shipping have raised significant concerns about the contribution of the GFS to climate change, air pollution, and over-reliance on non-renewable energy sources.

Long distance shipping also affects the palatability and nutritional content of food (Kloppenburg Jr., et al. 1996). Local food production shortens the time between harvest and consumption – often resulting in a higher-quality product. The short social distance between producer and consumer in a LFS is one of the hallmarks of the LFS approach. The development of face-to-face relationships between and among farmers, small-scale processors, and consumers in which people reconnect and strengthen their communities is, perhaps, one of the most appealing aspects of food-system localization.

Kloppenburg, et al. (1996) estimate that 75 cents of every dollar spent on food in the U.S. goes to processors, packagers, shippers, advertisers, and retailers – with falling farm incomes the consequence. Food-system localization promises to link farmers directly with consumers, eliminating the middle-man, helping farmers out of the "spiraling cycle of debt and corporate dependency inherent in capital-intensive industrial production" (Macias 2008), making farming a viable occupation again.

Integration of food production into urban areas brings other benefits as well. The presence of open spaces, such as farms, ranches, and large gardens close to urban areas can have a positive effect on the environment. Urban areas are often subject to the urban-heat-island effect in which the impervious building materials that make up their built-environment absorb heat, making urban areas warmer than surrounding rural areas. Incorporation of greenspace in and around urban developments reduces the amount of impervious surfaces, allowing for greater evapo-transpiration which has a cooling effect and can restore or maintain hydrological functions, such as groundwater recharge and stream flow, which are often disrupted by urban development (Gómez, et al. 2004; Randolph 2004). Gardens, in particular, appear to have a positive effect on urban wildlife populations – replacing habitat previously lost to urban development (Colding, et al. 2006; Matteson 2007).

While LFS initiatives are intended to counter the negative aspects of the GFS, they have yet to entirely fulfill this promise. One barrier to the universal success of LFS initiatives is inequitable food access due to the generally higher prices in LFS initiatives and, often, greater time required for participation. These two characteristics have led to a tendency for LFS initiatives to be driven by, and remain the domain of, middle- and upper-income consumers (Alkon 2008; Allen 2004; Hinrichs 2003).

Higher food prices have a flip side: farmers involved in these initiatives need to and deserve to earn income adequate enough to continue their work and support their families. The small-scale farms generally involved in LFS initiatives are less likely than their industrial scale counterparts to benefit from government agricultural subsidies or economies of scale, which would subsidize their activities, reduce farm costs, and allow farmers to charge lower prices for their goods. The need to support local farmers and ensure them a fair wage while also keeping food economically accessible to lower-income residents is, perhaps, one of the greatest challenges facing LFS development (Alkon 2008; Allen 1999; Allen 2004; Guthman, et al. 2006).

While much of the LFS movement has been tied to the organic or sustainable-agriculture movements, the potential for environmental damage from increased local production cannot be ignored. If undesirable agricultural practices are simply transferred to a local scale, pollution may be introduced to the region and local resources may be overstressed (Bellows and Hamm 2001; Sundkvist, et al. 2005). Finally, entirely local food systems are susceptible to local disease, climate, and disturbance patterns (Sundkvist, et al. 2005). However, some of the vulnerabilities related to disease and climate patterns can be addressed through choice of farming practices and plant varieties – ensuring that both are suitable to the local region. Relying on a single source of food can make a community more vulnerable, in case of environmental, economic, or political disruption that affects food production, than a community that receives food from a variety of sources (Bellows and Hamm 2001; Fraser 2006).

3.4 Local-Food-System Research

Most scholars critiquing food-system localization do not advocate against the practice, they simply suggest that more research is required to explore the strengths and weaknesses of the movement in order to design food systems that best meet the needs of all residents and the environment (Bellows and Hamm 2001; Hendrickson and Heffernan 2002; Hinrichs, et al. 1998; Sundkvist, et al. 2005).

The effort to develop food systems that are democratic, healthy, and sustainable (DuPuis and Goodmand 2005) requires analysis of the costs and benefits of all food sources, production practices, and distribution practices. While interest in LFS initiatives is rising, relatively little research has been done to assess the specific contributions these alternative food initiatives currently make, or could make in the future, to meeting the goals of creating a more healthful food system capable of providing food security, reducing environmental damage, and contributing to community well-being (Grey 2000).

Blair, et al. (1991) found that community gardeners in Philadelphia consume fruits and vegetables more often than do their non-gardening peers and that they consume sweet drinks and foods less often than do non-gardeners. They conclude that gardening in the inner city is an empowering strategy that overcomes many of the barriers to increasing vegetable consumption. Baker (2004) found that community gardens in Toronto produced food at a rate up to 5 times the national standard for mixed vegetable consumption and that the gardens were sources of culturally appropriate foods for the many new immigrants who participated in the activity. Gladwin and Butler (1984) assessed the role of gardening as an adaptive strategy to provide additional food and supplement farm incomes for family farmers in Florida. Gardening, for these farmers, provides a steady supply of vegetables and saves the family money, as long as the labor inputs provided by family members are not considered.

Both Baker (2004) and Blair, et al. (1991) found that gardening acted to pull gardeners into other community activities. Gardeners in Toronto tended to be active in community food security efforts. In Philadelphia, gardeners tended to be more active in community projects than non-gardeners and they provided additional benefits to their neighborhoods by sharing vegetables with friends and family. Armstrong (2000) found that community gardeners in upstate New York seem to facilitate improved social networks and organizational capacities in their communities.

While within-initiative community building is a common theme, some studies have found that LFS initiatives are somewhat socially exclusive – catering more to upper-income, well-educated, white households. Hinrichs and Kremer (2002) surveyed members of a Midwestern CSA and found them to have higher incomes and higher education rates than regional reference populations. Reasons for participating in the CSA also varied with income, occupation, and education with the least advantaged participants citing access to food as a reason more often than did more educated members. It is worth noting that the CSA in question offered subsidized shares for lower-income households, which may have been a factor in the improved food access they reported. Guthman (2008) surveyed managers of CSAs and farmers' markets in California and found them to be largely "white" spaces. Although farmers' markets had greater African-American participation, CSAs in the study had almost completely white shareholders. Study participants attributed the exclusivity at least partially to income, noting that upper-income households (who tended to be white) were able to afford the produce. Macias (2008) found a similar pattern in a Vermont CSA – a greater percent of CSA members have college degrees than the community average. He also attributes such a difference to the higher, and up-front, costs of CSA membership, when compared to conventional foods.

One explanation for higher participation rates in farmers' markets for lower-income and minority people is the ability to use food stamps and other government food-entitlement programs to purchase foods there (Guthman, et al. 2006). CSAs are not allowed to accept food stamps because of fee the structure, which requires up-front payments. Macias (2008) and Alkon (2008) both found somewhat greater rates of participation of minorities and low-income people when farmers' markets were sited, with that goal in mind, in targeted neighborhoods.

Fewer studies still have examined the environmental impacts of LFS initiatives. Armstrong's (2000) survey of community garden managers in upstate New York found that 60% of the gardens prohibit the use of any chemicals, or allowed the use of only chemical fertilizers. However, 60% of rural community gardens in her study allowed the use of chemical herbicides and insecticides, compared with only 33% of urban gardens that allowed the use of such substances.

Colding, et al. (2006) found high rates of biodiversity and the potential for pollinator habitat in urban allotment gardens in Stockholm. Matteson (2007) studied the role community gardens in New York City play in providing insect habitat. He found that insect richness (total number of species present) was influenced by garden area, floral area, and proportion of greenspace in the surrounding landscape. Studies of urban greenspaces in general point to their role in moderating urban climates by reducing the urban-heat-island effect (Colding, et al. 2006; Gómez, et al. 2004). Urban greenspaces can also play a role in preserving hydrological function and filtration of runoff pollutants, in part because of their pervious surfaces (Colding, et al. 2006).

Although the economic benefits of LFS initiatives for individual participants are not well-documented, studies of urban greenspace in general (Gobster 2001; Tajima 2003) and community gardens in particular (Voicu and Been 2008) point to the potential for higher property values in areas adjacent to greenspaces.

This study of the Fairbanks Community Garden seeks to contribute to the development of a robust literature that assesses the efficacy of LFS initiatives in creating a healthful food system capable of providing food security, environmental security, and community well being. I ask specific questions about the effects of localizing food systems including: whether an LFS can reduce greenhouse gas emissions, the use (or lack of) environmentally sustainable production methods, the ability of a LFS to improve food access, and the ability of a LFS to be resilient in the face of environmental, economic, or social system shocks and disturbances.

We must better assess current LFS initiatives in order to understand their contributions, or gaps in contributions, to these goals so that better food systems, whether local, global, or cross-scalar can be designed and built for the benefit of all people.

3.5 Study Site: Fairbanks, Alaska

The city of Fairbanks, Alaska provides an excellent site for the study of the potential for food-system localization. Although most U.S. cities are at a great distance from their food sources, Fairbanks, at 64˚ north latitude and 1,500 miles from the major port of Seattle (meaning food must be transported to Seattle then on to Fairbanks), is a more extreme example of distance from food sources. The State of Alaska produces only approximately 5% of its own food (University of Alaska Fairbanks Cooperative

Extension Service 2006), suggesting that there may be opportunities to shift the balance of imported and locally grown foods.

Fairbanks is the urban hub of Interior Alaska (see Fig. 3.1). The region is south of the Arctic Circle with a continental climate. Average temperatures range from -9.7˚ F in January to +62.4˚ F in July. Fairbanks averages 10 days per year below -40˚ F and 13 days above +80˚F (Alaska Climate Research Center 2008a). There are less than 4 hours of daylight at the winter solstice in December and more than 22 hours at the summer solstice in June (Alaska Climate Research Center 2008b). Fairbanks receives an average of 10.56 inches of precipitation annually (National Agricultural Statistics Service - Alaska Field Office 2006). The average growing season for Fairbanks is 115 days (Alaska Climate Research Center 2008c).

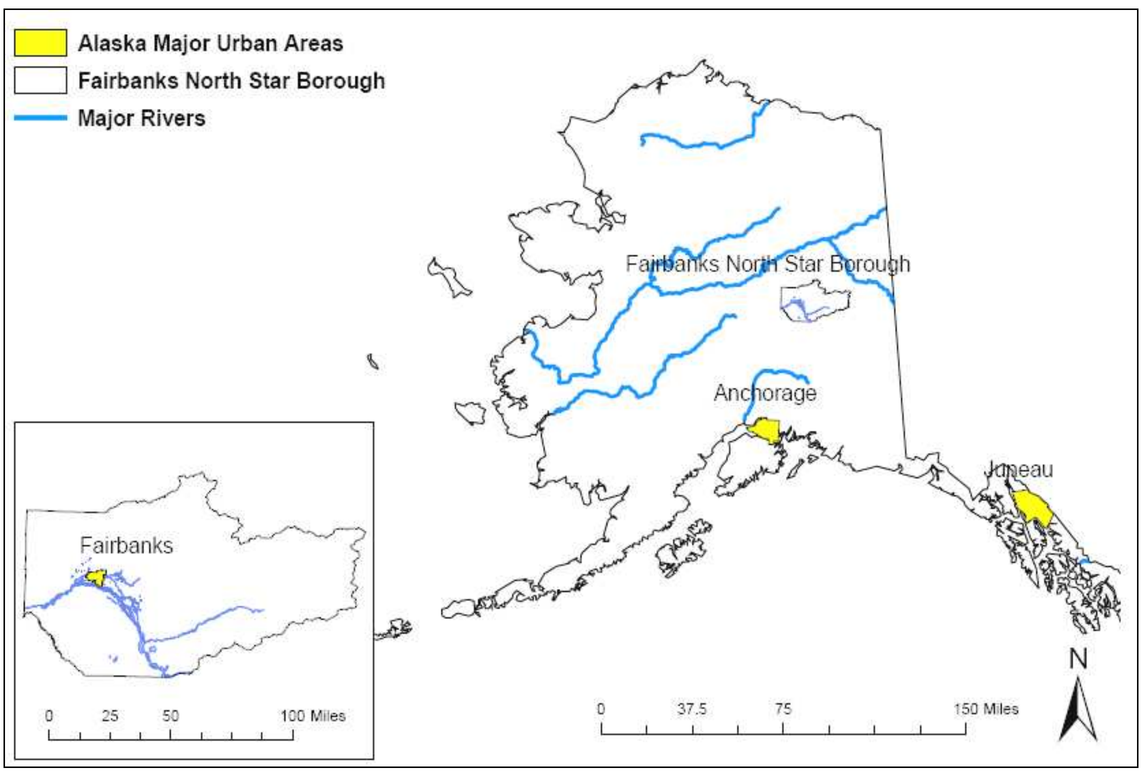

Figure 3.1 The State of Alaska and the Fairbanks North Star Borough

The Fairbanks North Star Borough (FNSB) encompasses the City of Fairbanks, the City of North Pole, and several smaller towns. In 2007, the borough population was

97,484 people in 7,444 square miles (U.S. Census Bureau 2008). Because almost all residents rely on a common set of resources for shopping, education, and entertainment that are located within or near the city limits of Fairbanks, we treat the FNSB as one large community. We use FNSB and Fairbanks interchangeably, unless the City of Fairbanks is specified.

Fairbanks has a food system similar to that of other urban areas in North America with most food being transported long distances into the community and most consumers accessing food through major chain supermarkets. The majority of food consumed in the FNSB comes from between 1,500 and 3,000 miles away. High transportation costs contribute to food prices approximately 30% higher than national averages (Fairbanks North Star Borough Community Research Center 2005).

Most residents purchase their food at 1 of the 9 full-service grocery stores in the region. The community also has 24 convenience stores (usually connected to gas stations), 4 small stores that specialize in ethnic foods, a farmers' market that operates from June-September, and several community-supported agriculture enterprises that all together serve approximately 350 households.

As a frontier community, Fairbanks has struggled with issues of food self-reliance since its founding more than 100 years ago (Papp and Phillips 2007). Only rarely, for a few years in the 1920s, did the community come close to supplying all its necessary food from local sources (Lewis 1998; Papp and Phillips 2007). The issue has regained local attention recently and several localization efforts have begun in the Fairbanks region in the last 30 years including small local farms, a farmers' market, CSAs, and a large community garden.

The Fairbanks Community Garden (FCG), in particular, provides an opportunity to explore the issues of food-system localization at an individual level. The Garden was first created in 1979 and moved to its present location in the early 1980s (see Fig. 3.2) where it has been in constant use ever since. The plots are much larger than those found in many community gardens at 600 ft^2 - a size calculated at the garden's inception to be able to provide vegetables for a family of four for one year (personal communication:

Farris 2006). With 84 plots, the total size of the Fairbanks Community Garden is approximately 3 acres – again significantly larger than most other community gardens which are often created on vacant lots in densely developed urban areas (Hynes 1996; von Hassell 2002). The size and number of gardeners involved (59 in the 2006 season) provide ample opportunities to measure the effects of the garden on individuals, families, and the local ecosystem.

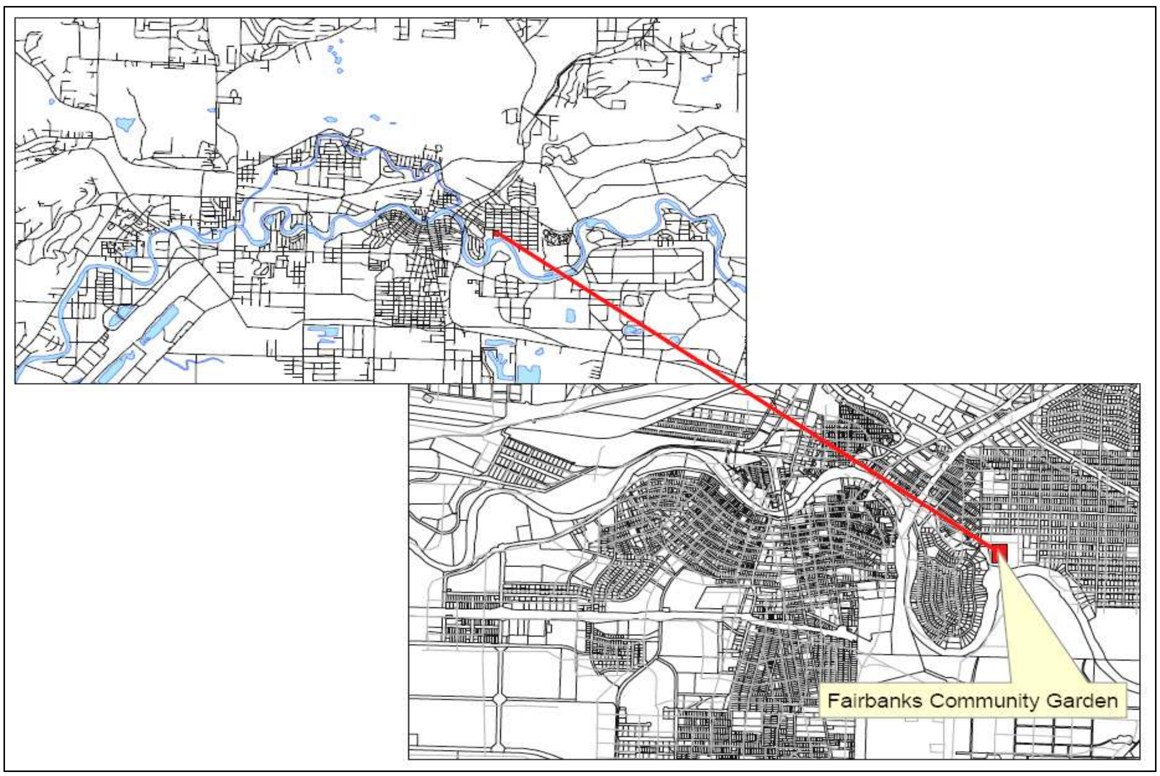

Figure 3.2 City of Fairbanks and the location of the Fairbanks Community Garden

The nature of community gardens means that a variety of people are involved for a variety of reasons, each with their own goals and aspirations. Although we have chosen to examine the FCG through the lens of food-system localization, it may not be a goal identified by all participants. I do not mean to imply in this study that members of the FCG have these specific food-system localization goals in mind. This framework and set of questions about how the garden works in a local food system are mine, not the gardeners'. However, the history of the garden indicates that local food production was a consideration in the founding of the garden and the framework of local food systems research provides an effective way of exploring the role of community gardening in local food systems – just not the only way.

3.6 Methods

Research in the summer of 2006 focused on the extent to which the garden met the goals of food-system localization. I returned to the garden in the summer of 2008 to complete a study of the economic value of garden harvests and to include the FCG in a study of bird-species diversity and abundance on agricultural lands in the region.

Surveys were distributed to each of the members of the Fairbanks Community Garden beginning in early June 2006. Most gardeners were given the survey in person at the annual garden clean-up day in June. They were given the option of filling out the survey on-site or taking it home to complete – in which case, they were given an addressed, stamped envelope in order to return it to the researchers. Copies of the survey were also left in a file box in the communal garden shed along with a sealed box for returning surveys. A second round of survey distribution consisted of leaving a copy of the survey, in a watertight bag, at the garden plots of gardeners who had not returned a survey as of mid-June. Surveys were also mailed to gardeners who had not been contacted in person, along with an addressed return envelope. Finally, an electronic version of the survey was made available to those gardeners who preferred to complete such a version at home. The electronic version of the survey was the least successful approach resulting in only 4 responses. Of the 59 gardeners who started the 2006 garden season, 29 returned completed surveys – a response rate of 49%.

In addition to surveys, semi-structured interviews were conducted with 8 members of the community garden, 2 of the people involved in founding the garden (a third founder has moved away and was unreachable, despite several attempts), and a former member who was extremely influential at the garden during her tenure. Interviews with the gardeners often took place at the garden while the gardener worked or took a break. Each interview lasted between 30 and 60 minutes and focused on how the gardeners learned to garden, why they joined the community garden, and what benefits they perceive from gardening.

While I was not able to calculate the amount of produce each garden plot yielded during the 2006 season, I returned to the garden in 2008 to complete this portion of the study. Volunteers were solicited through signs at the garden, personal contact, and e-mail sent to all gardeners. In this case, e-mail contact had the best response rate, but unlike completing an entire survey, response only involved a return e-mail or a phone call to set up an appointment. Volunteers were given $30 at the completion of the study – an amount equal to the fees to rent one plot for one year.

I met with 11 gardeners at least 3 times during the gardening season to weigh their weekly harvest. I attempted to schedule harvest weigh-ins at regular intervals of 1-2 weeks, depending on each gardener's harvesting schedules. However, as gardener's schedules changed, I had to become more flexible in my intervals and meet with them whenever they were available and harvesting. Because I was not able to record each item harvested every week, I averaged recorded amounts and extrapolated across the 9-week harvest period. This approach may underestimate total harvest amounts because data collection was slightly skewed to earlier in the season, before crops like potatoes – which tend to be the last harvested – were ripe. The 2008 gardening season began and ended with unusually cold, rainy weather that delayed the beginning of harvests until late July. The first hard frost in Fairbanks occurred during the third week of September for a total of approximately 9 weeks of possible garden harvest. I surveyed as late into the season as possible, but recognize that undercounting remains a strong possibility.

Three gardeners in the harvest survey maintained more than 1 garden plot. In these cases, I divided their total harvest amount by the number of plots in order to calculate all harvests on a per-plot basis. If a gardener maintains multiple plots, they could expect their harvest's economic value to be at least twice the calculations below – but additional plots require both additional time and plot fees.

I collected data from supermarkets and the local farmers' market on prices for comparable fruits and vegetables in order to estimate the economic value of harvests from the FCG. Economic values were calculated in 2 ways: a Lowest Cost option, which selects the lowest cost option (usually the supermarket choice) first and supplements the list with farmers' market produce price if a supermarket option was not available; and a Local Priority option which selects a locally grown (farmers' market) option first and substitutes a supermarket option if local was not available.

In addition to collecting data on food costs, I used supermarket survey to collect data on food miles. In order to compare local and imported food miles, I selected a sample of 7 of the most commonly grown vegetables in the Fairbanks region, based on the Alaska Agricultural Census (National Agricultural Statistics Service - Alaska Field Office 2006) and interviews with gardeners. I selected only the fresh form of my sample vegetables because fresh is the most common form of locally grown vegetables and I wanted to ensure comparability between foods of different origins. During supermarket surveys, I recorded the point of origin of all fresh vegetables from my sample list. I divided all the vegetables surveyed into 3 groups: locally (FNSB) grown, Alaska-grown (but not FNSB), and imported foods. Using the weighed average source distance method (Carlsson-Kanyama 1997; Pirog and Benjamin 2003), which averages the distances from all known food sources (including amount of food from each source, if known) I calculated the food miles for each vegetable in my sample from each of the 3 origin groups. Transportation methods vary – and have differential environmental impacts (Pretty, et al. 2005) – however, I calculated these food miles based on road distance for the sake of comparison with local and Alaska-grown foods that are transported by road.

Bird species diversity and bird abundance were recorded in the FCG as part of a larger project to compile baseline data on bird-species' use of agricultural lands in the FNSB. These data will be used to better understand the role of agricultural lands in providing, or reducing, wildlife habitat and overall biodiversity in the region. A wildlife biologist was hired as a research assistant to conduct all the bird surveys. The FCG was divided into 4 unique habitat types, based on land use and plant species present. A 20-minute area search was conducted in each habitat type. An area search census is a common method used to inventory species presence (Ralph, et al. 1993). This method was used as opposed to more rigorous survey methods; such as a point count survey, because of the small size of areas being surveyed.

Three private farms; the Fairbanks Experimental Farm on the University of Alaska Fairbanks (UAF) campus; the Georgeson Botanical Gardens, also on the UAF campus; and the FCG were included in the study. One farm was surveyed per day, June 11 through 27, 2008. All surveys were conducted in June, which is the peak of the songbird breeding season for Interior Alaska (Peyton 1996). Surveys began close to sunrise (0400) and were completed within 3 hours. The order in which farms were surveyed and habitats sampled was randomly selected. All farms were sampled twice.

Within each habitat type, bird diversity and abundance was assessed by recording birds detected by sight or sound. Selected behaviors were also recorded, including: foraging, flocking, and signs of breeding behaviors. Flyovers were also recorded at each habitat site. Each survey was conducted by one observer.[4]

3.7 Results

3.7.1 Food Production Methods

Local-food-system initiatives are often advocated for as a response to the environmental harm done by industrial agricultural practices. I asked FCG gardeners about their gardening practices in order to understand how their food production might impact the local environment. The FCG does not allow the use of chemical herbicides because they do not break down well in the cold soils of the area and, therefore, will persist in the soils and continue to affect a plot long after initial application or plot abandonment. All gardeners in the survey reported that they rely on natural weed-control methods in their plots. Most simply pull or hoe the weeds.

Maintaining soil fertility is a challenge in high-latitude regions like Fairbanks because of cold soils; but food production using only natural methods, like compost and organic soil amendments, to boost fertility is still possible and several local commercial

[4] Methods for bird surveys were described by Anna Maguire in her report to the researcher and the partnering organization, the Alaska Bird Observatory.

farmers use only these methods. Although the FCG does not ban chemical fertilizers, 85% of respondents report using some natural soil-fertility methods such as applying compost in their plots. However, 36% also report using a chemical fertilizer occasionally.

Pest-control methods are another common source of environmental pollution from agriculture. However, 39% of garden respondents report using only natural pest-control methods like applying neem oil, an oil from the Neem tree often used as a pesticide in organic farming, or a mixture of soap and water to control aphids. Thirty-six percent of respondents do not use any pest-control methods at all or report no issues with pests in their plots. One possible explanation for the lack of pests is the high level of plant diversity in the garden, which can help manage pests by attracting beneficial insects who feed on damaging insects (Buchmann and Nabhan 1996). Some gardeners report that voles were a problem in the garden in 2005 and several report that they trapped the rodents that year in an effort to protect their gardens. Some attempted to use humane (live) traps. As of mid-summer in 2006, voles were not reported as a problem by any gardeners.

The environmental effects of the Fairbanks Community Garden are currently benign, on the whole. A majority of gardeners rely solely on natural methods of fertilization and pest or weed control and, therefore, the pollutants tied to agricultural inputs are minimal.

3.7.2 Food Miles and Energy Use

One of the early arguments for food-system localization was to reduce the food miles, energy-use, and pollution associated with long-distance shipping (Pirog and Benjamin 2003; Pirog, et al. 2001). While food miles are one tool to estimate the environmental impact of the global food system, recent research stresses the importance of measuring energy use in the food system in a more holistic manner to include production and processing as well as transportation. A rapidly developing tool for this approach is life-cycle assessment (see for example: Eshel and Martin 2006; Mila i Conals, et al. 2007; Weber and Matthews 2008). However, if all production and processing methods were equal at global and local scales (a large assumption), reducing food miles could lower GHG emissions and, possibly, food costs.

I compare distance traveled for 7 fresh vegetables from 3 different sources: imported (from outside of Alaska), Alaska-grown (not FNSB) and locally grown (FNSB). Food miles for the sample vegetables are displayed in Table 3.1. Locally grown or Alaska-grown foods have far fewer food miles than their imported counterparts, which come from as far as Michigan and central California.

Table 3.1 Food miles for sample vegetables in the FNSB

Point-of-Origin	broccoli	cabbage	carrots	lettuce	potatoes	tomatoes	zucchini
Alaska-grown	329	329			329	329	
Imported	2445	1696	2164	1696	1881	1659	2071
FNSB-grown	8 - 95	8 - 95	8 - 95	8 - 95	8 - 95	8 - 95	8 - 95

I propose that another measure of food distance and energy use, consumer miles, be added to the food miles measurement. Consumer miles refer to the distance people must travel to access their own food. Physical access to food is a critical component of food security. The abundance of food available in a community is meaningless if that food cannot be equitably accessed, physically and economically, by all sectors of society. A measure of consumer miles can be used to ensure that food does not become less accessible when its food miles are reduced through food-system localization. Additionally, consumer miles can be used to ensure that energy use in the food system is not simply shifted from one source (food transportation) to another (consumers).

Pimentel and Pimentel (1996) estimate that the average American family drives a total of 15 miles per week to do grocery shopping. In the previous chapter, I demonstrate that consumer miles in Fairbanks are significantly higher for local foods than for imported foods (see p.30). The estimated average distance residents must drive to a supermarket is 15.8 miles roundtrip and to local-food outlets is 24.16 miles roundtrip (Meadow in review).

The Fairbanks Community Garden is located in the central core of the city, just east of the downtown. Gardeners report roundtrips to the Fairbanks garden ranging from

2 miles (4 gardeners) to more than 25 miles (6 gardeners) with an average roundtrip of approximately 12 miles, which is shorter than the average roundtrip to the supermarket or commercial local-food outlets. However, several weekly roundtrips are required to tend a garden plot. Gardeners reported spending an average of 8 hours per week in the garden for an average of 12 weeks per year. The average number of trips to the garden each week, based on survey and interview responses, is estimated to be 4. Ninety-three percent of gardeners report driving to the garden while only 10% reported biking (some people said they use both methods of transportation). Several gardeners comment that although they live a great distance from the garden, their workplaces are closer so they try to combine trips by going to the garden before or after work. Based on these self-reports, the average number of miles gardeners drive to and from the garden is estimated to be 56 each week and 672 miles per year. While the annual distance traveled to the garden is higher than once per week trips to the grocery store in the same period, the distance is far shorter than even 1 trip to the community by imported vegetables.

Food miles are an incomplete measure of energy use in a food system (Eshel and Martin 2006; Mila i Conals, et al. 2007; Weber and Matthews 2008). However, when the concept is applied to consumers, miles traveled to reach food sources can be an effective (although still incomplete) measure of food access. Physical access to the FCG is good given the diffuse population distribution of the community. Gardeners reported driving shorter distances to reach the garden than the average distance to other local-food outlets in the community.

However, if we consider access in terms of time commitment, including time required to travel to and from the garden; the apparent need for a car for transportation; and the number of hours required to tend the garden, we see potential barriers to participation for those with limited leisure time or many household responsibilities. Siting a community garden in an area close to its intended participants and in a place accessible by foot or public transportation is a more conventional community garden model (Hynes 1996). The FCG is unconventional in the plot size, as well. The large 600 ft^2 plots may not be available at other sites in the community and there is, therefore, a trade-off of food miles, accessibility, and plots large enough to produce a significant quantity of food. Finding a balance between these elements will likely be a challenge in any local-food-system initiatives, but is an important consideration in the design of LFS initiatives.

3.7.3 Accessibility of Local Foods

An important consideration when localizing a food system is whether the initiatives will make food physically and economically accessible to a broad cross-section of the community. LFS initiatives such as farmers' markets and community-supported agriculture farms can have higher food prices because they are less likely to be subsidized through national agricultural policies, tend to be more labor-intensive, and the farmers need and deserve to recoup their costs and make a fair living (Alkon 2008; Allen 2004). Physical access can be an issue if farms and farmers' markets are not within walking distance of low-income households or not on public transportation routes. Reduced physical access to fresh foods has been shown to negatively affect the health of low-income populations (Algert, et al. 2006; Lane, et al. 2008; Pearce, et al. 2006; Whelan, et al. 2002).

When considering the role of community gardens in local food systems, some of the same questions apply: is the garden physically accessible to those without personal transportation, what are the costs associated with participating in the garden, and what are the time requirements to produce one's own food?

Since the FCG is not a neighborhood-specific garden, most participants drive to the site. This situation is a marked difference from most community gardens, which are sited to be accessible to residents of the immediate area. Despite the travel distance and time required to access the garden, the FCG provides some distinct economic access advantages. While each gardener must pay a $30 annual fee to be a member of the garden, those funds have allowed the garden to provide running water, a wide assortment of garden tools for members' use, and a large protective fence around the garden that keeps out the largest garden pest in Interior Alaska: moose. Members, therefore, avoid most of the capital costs of gardening by sharing tools and other resources within the garden. In addition to the annual fee, a $20 clean-up fee is required for members. However, this fee is refunded if the gardener participates in the annual garden clean-up day.

Other costs of gardening can add up. Seeds or seedlings as well as any soil amendments must be purchased annually. Sixty-one percent of gardeners reported spending more than $100 each growing season for garden-related expenses with an additional 29% spending between $50 and $100.

The time required for gardening can also present a challenge for those gardeners who work full-time or have full-time childcare or other family responsibilities. Allen (1999) notes that the time required to participate in alternative food-system initiatives such as driving to farms, processing whole foods, and doing more cooking at home have important class-based implications. Additional food processing and preparation responsibilities often fall to women, which points to gender-based concerns about changing food-system forms (Bellows and Hamm 2001). Gladwin and Butler (1984) found that Florida farmers using gardening to feed their families as a supplement to their farm income spent an average of between 87.2 (men) and 115.6 (women) hours per year in the garden on top of other work and family responsibilities. Fairbanks Community Gardeners reported spending between 18 and 252 hours gardening over the course of a gardening season, which, depending on the gardener, lasts between 6 and 16 weeks per year. The average number of hours spent was 103 over a season of 12 weeks – approximately 8 hours each week.

Gladwin and Butler (1984) multiplied hours spent gardening by the minimum wage in place at the time of their study to calculate the actual economic benefits of gardening for family farmers and concluded that gardening was not as effective an economic strategy as wage labor would have been. However, they also note that time spent in the garden could be spent as a family, outside of regular working hours, and was unlikely to require childcare arrangements or costs. The State of Alaska minimum wage is $7.15 per hour, which means that garden hours could have an economic value as high as $57.20 per week or $686.40 per season.

The economic value of harvests from the FCG were calculated by comparing weekly garden harvests to the cost of comparable foods in supermarkets and the local farmers' market. Based on discussions with gardeners, the range of values can most likely be attributed to the level of experience of the gardeners as well as their choice of crops. Some gardeners, for example, planted large quantities of peas – which carried a higher sales price than many other crops, particularly at the farmers' market. Results fr-om the harvest survey are summarized in Table 3.2.

Table 3.2 Economic Value of Harvest from FCG in 2008

	Lowest Cost	**Local Priority**
Per week range	$9.87 - $21.60	$14.68 - $37.18
Per season range	$88.83 - $194.40	$132.12 - $334.62
Per week average	$15.51	$24.56
Per season average	$139.62	$221.03

Applying Gladwin and Butler's (1984) analysis to the harvest data for the FCG would result in poor economic returns from gardening. But, as Gladwin and Butler note, gardening doesn't necessarily take the place of wage labor, so while illustrative, their analysis is not entirely complete. My findings echo Gladwin and Butler's caveat that a purely economic evaluation misses other benefits of gardening. For instance, in surveys, interviews, and discussions with gardeners most reported spending time at the garden after work hours or on weekends and, therefore, gardening is not necessarily taking the place of wage earning.

Based on my survey of garden costs, annual plot fees and other costs can be estimated at up to $130 per plot. The Lowest Cost harvest economic value estimate is $139.62 per plot so even an underestimation of harvests indicates a small economic return, if labor costs are discounted. Additionally, Americans are estimated to spend $1.45 per person per week for fresh vegetables (Blisard, et al. 2004); although most Americans do not eat the recommended daily intake of fruits and vegetables (Reed, et al. 2004). A household of four would spend $5.80 per week for fresh vegetables. Despite just barely recouping estimated garden costs, the economic value of vegetables is much higher than the average household expenditure, which might mean that, like the gardeners in Blair, et al.'s study (1991), Fairbanks Community Gardeners are increasing their vegetable consumption through their gardening activities. Whatever the outcome of an economic evaluation of the Garden, it is important to note that many FCG participants do not consider their time at the garden as "labor." For many gardeners, their primary reason for gardening is enjoyment – food production is a byproduct of their hobby.

Some participants provide direct benefits to others with their garden produce. One gardener in 2008 (who could not participate in the harvest survey, unfortunately) used her garden to supply the soup kitchen at her church. Another long-time member of the garden reported that he usually donates a significant portion of his garden produce to the local foodbank. However, in 2008, the foodbank was forced to cut back its hours which made it impossible for the gardener to reach the foodbank in time to donate, given his work schedule. This situation was frustrating for a food advocate: during a time when demand was increasing for foodbanks, funding cuts resulted in an even further reduction in donations. And, an important outcome of gardening was lost to the gardener in question.

Since the hours required maintaining a successful garden may have excluded low-income people, their experiences are not necessarily reflected in the survey and interviews. It is important to ask whether the hours required for gardening puts the activity out of research for those with work and family responsibilities. For people without 8 hours available each week to garden, the simplicity of buying food at local grocery stores where all the shopping can be accomplished at one time, may be a more expedient choice.

3.7.4 Community Building and Local Foods

LFS advocates often cite strengthened relationships between farmers and consumers as an important outcome of local-food-system initiatives. Consumers get to know local farmers and become more willing to support them. Farmers get to know the community they serve and the concerns and interests of their customers (Hendrickson and Heffernan 2002). However, some researchers have noted that local-food-system initiatives often remain rooted in the white middleclass and do not fully extend their benefits and relationships into low-income or minority populations (Alkon 2008; DuPuis and Goodmand 2005; Hinrichs 2003; Hinrichs and Kremer 2002).

In the context of a community garden, an appropriate measure of community building is the extent to which relationships are formed among people of different incomes, occupations, and political or personal beliefs. The nature of the FCG as a community, but not necessarily a neighborhood-based garden, increases the chances that people from a broad cross-section of the community will be represented in the membership. Results from my survey appear to support this point. Members tend to be well-educated professionals: scientists and educators are two of the most common occupations listed. However, participants also report occupations that include fast-food worker, retired military, and cab driver; two respondents are retired, one from teaching and one from the military (see Table 3.3). The range of incomes represented is large – from households earning less than $25,000 (11%) to those earning over $100,000 (11%) and every category in between (see Figure 3.3).

When the household incomes reported by community gardeners are compared to census data for the FNSB (U.S. Census Bureau 2008), incomes in the FCG skew lower than the community as a whole. While 39% of FCG participants earn more than $50,000 per year, in 2006 56.2% of FNSB residents were in that income category. Of note is that 11.6% of FNSB residents were in the lowest income categories (below $15,000/year) while no gardeners reported household incomes that low. When income data is combined with the information on occupation in the FCG, a similar pattern as discussed above emerges: community-garden participants require a certain level of income and leisure time to participate. But the skewing toward lower-than-average incomes indicates that the activity is accessible to lower, if not the lowest end of the income scale.

The diverse garden membership is seen as a benefit by the current site manager who noted, “I feel like I’ve made some really good friends down there. I’ve met people that I wouldn't have met otherwise. And it's just interesting to get to know people and to chit-chat with people who I otherwise wouldn't have crossed paths with."

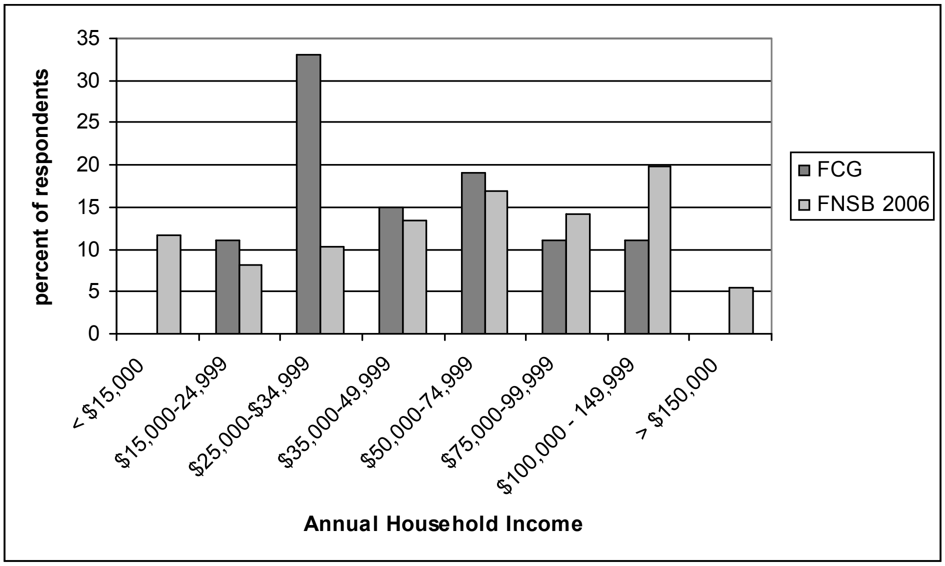

Figure 3.3 Gardener-Household Incomes and FNSB Household Income

Table 3.3 Occupations of Gardeners at FCG

Occupation	Respondents*
Educator	7
Scientist	5
Student	4
Homemaker	2
Retired military	1
Supported living specialist	1
Fast food worker	1
Community planner	1
Federal employee	1
Accountant	1
Healthcare	1
Cab driver	1

* not all respondents provided occupation data

As noted above, time constraints or other factors may have already preselected for those with greater time available or allocated for food production. But, there is still a range of occupations represented, which means that gardeners do have opportunities to meet people they might not normally encounter on a daily basis. Respondents were not asked their political or religious affiliations or beliefs but observational evidence suggests that the garden is a very politically mixed group and that relationships have developed across political and religious lines.

A critical piece of data not discussed here is ethnic diversity of gardeners. Despite several efforts to secure translators to help gardeners with limited English proficiency, I was not able to get survey or interview data from several participants in the FCG during the original 2006 survey. These important missing gardeners were Korean and Japanese and may have provided interesting insights into the immigrant experience in Fairbanks and the role of gardening in their lives and cultures. Although I returned in 2008, the time lag between the original survey and my return made re-surveying gardeners missed in the first study impossible because data could not be considered comparable to surveys from 2 years prior. I was able to contact 1 gardener missed in 2006 for an interview and have integrated his responses into my results where appropriate.

3.7.5 Diversity in and through Gardening

Diversity is important within systems – whether food systems or ecosystems. Diversity in a system means that there is more than one source for a particular resource or system function. Diversity has been linked to greater system resilience – allowing a system to fall back on another component if one fails. For example, a food system that relies entirely on one source of food is vulnerable to a disruption in supply chains that could cause food shortages and put an entire community at risk (Fraser 2006). A system that relies on more than one source (including a diverse range of crops as a food source) can survive a disturbance, such as crop losses, in one area if it can access food from other sources.

Locally grown food can play an important role in diversifying food sources for a community. But a complete reliance on only one source of food, locally grown or otherwise, can place a community in a vulnerable position should that source fail due to a climatic or disease disturbance (Fraser, et al. 2005; Sundkvist, et al. 2005). Diverse crops and crop varieties can mitigate the risk of failure, but may not eliminate it entirely. This point was driven home in Fairbanks in the summer of 2006 when a late frost and snow flurries on June 3 and 4 destroyed many garden plants and local farmers' crops; and again in 2008 when a cold, wet summer slowed garden growth and reduced harvest rates. While most gardeners and farmers were able to recover at least some of their plants, the community could have been at great risk for economic and health problems had no other sources of food been available.

I asked gardeners what percent of their household's vegetables come from their garden during the growing season. While 57% of respondents report that their garden provided between 25 - 75% of their vegetables during the growing season, these numbers are self-reported; based on the results of the 2008 harvest survey the self-reports may overestimate actual garden production. Only 18% of gardeners report relying on their gardens for 75% or more of their vegetables during the garden season.

When gardeners need to supplement their garden produce, they rely largely on the local supermarkets – 89% report purchasing vegetables at a supermarket during the growing season. However, 76% also report buying at least some of their vegetables from the Tanana Valley Farmers' Market. Eleven percent engage in trading or sharing of foods with friends or neighbors to supplement their own garden produce. No gardeners report buying a share in a CSA farm, indicating that there are likely some important differences between those who choose to grow at least some of their own food and those who appreciate locally grown food but are unwilling or unable to participate in the activity themselves. Gardeners appear to have diversified their food sources, balancing between growing their own, buying (or trading) other locally grown foods, and buying imported food.

Hendrickson and Heffernan (2002) suggest that local food systems be designed to fill spaces or vulnerabilities in the dominant GFS rather than try to take over the dominant system. Since fresh vegetable are a weakness of the dominant food system in Fairbanks and other high-latitude communities, due to long shipping distances, produce from the FCG is currently used to reduce, but not eliminate that gap.

In addition to diversifying the food system of Fairbanks, the community garden is a diverse agro-ecosystem in and of itself. The advantages of a biodiverse agricultural plot include improved soil fertility, natural pest management, and wildlife habitat. When asked about plants in their plots, participants generated a list of 50 different species, which include both food crops and inedible flowers or other plants. Some plants are particularly common across all plots. For example, 61% of respondents plant potatoes and 57% plant broccoli. The average number of different plants in each plot is 13. Within-plot diversity helped gardeners survive the June 2006 frost by ensuring that at least some heartier plants survived despite the loss of more fragile species. I did not specifically ask gardeners about the range of plant varieties (as opposed to species) in their gardens, but in interviews and conversations many indicate that they experiment with a range of varieties. The most common plants in the FCG in 2006 are shown in Table 3.4.

Table 3.4 Most Common Plants in FCG Plots

Plant	Percent of Gardens
Potatoes	61
Broccoli	57
Peas	54
Carrots	50
Tomatoes	50
Lettuce	46
Zucchini	39

Greenspaces, like community gardens, in urban areas serve to enhance wildlife habitat (Andersson 2006; Stearns 1972). In a study of allotment gardens in Stockholm, Colding, et al. (2006) found that a 400 m^2-patch of garden contained 447 different plant species. Gardens with a variety of plants, of different sizes and shapes, have been shown to support high numbers of invertebrates (such as pollinating species) whether planted with native or non-native species (Colding, et al. 2006).

I asked gardeners about the wildlife they most often saw in the garden. While not all know the names of species sighted, they are aware of the presence of birds, in particular. Commonly mentioned birds included juncos (*Junco hyemalis*) and robins

(*Turdus migratoris*). Several gardeners report finding nests near or in their plots. In the spring of 2006, a pair of robins nested in debris left over from the previous years' garden, but was apparently frightened away once activity in the garden increased.

In 2008, the garden was included in my survey of bird-species diversity and abundance on agricultural lands in the FNSB region. I found 16 different bird species during the sampling period and 81 total birds (see Table 3.5). Findings from the 6 other sample sites ranged from 46-81 total birds and 11-18 different species, placing the garden on the high end of each measure. While these results are preliminary and based on only 1 year of data, they indicate that the role of small-scale agriculture in providing wildlife habitat merits further study.

Table 3.5 Results of Bird Species Diversity and Abundance Survey in FCG

Species	**Number Reported**
Common Redpoll	20
American Robin	12
White Crowned Sparrow	9
Alder Flycatcher	7
Olive Sided Flycatcher	7
Yellow Warbler	6
Orange Crowned Warbler	5
Dark-eyed Junco	5
Yellow-rumped Warbler	3
Black-capped Chickadee	1
Boreal Chickadee	1
Bohemian Waxwing	1
Common Raven	1
Northern Flicker	1
Ruby Crowned Kinglet	1
Lesser Yellowlegs	1
Total Number of Individuals	**81**
Total Species	**16**

3.7.6 Reasons for Gardening

Although I chose to examine the FCG in the context of LFS initiatives, I recognized early in the study that food production or participation in local food system development was not necessarily the primary motivation for many gardeners, despite the fact that these were the goals of the garden's founders. The Fairbanks Community

Garden was founded in 1979 as a project of the Alaska Federation for Community Self-Reliance. Alex Scala, Dick Farris, and Niilo Koppenen were all involved in the project through the Federation. It was this original group who, with help from the University of Alaska Fairbanks Cooperative Extension Service, designed the garden with plots large enough to supply vegetables for an entire household. Niilo Koppenen says that his motivation for starting the garden was to take a step toward making people independent while encouraging them to work together communally (personal communication: Koppenen 2006)

Gardeners today appear to have a slightly different set of motivations than the founders. Gardeners were asked to rank their 3 most important reasons for gardening from a list of 8 choices, with 1 being the most important reason. I calculated a weighted average score for each given reasons, including the blank "other" choice, which 5 respondents used. Out of a possible 3 total points, reasons for gardening ranged from .11 for "getting exercise" to 1.36 for "enjoyment." Full results are summarized in Table 3.6.

Table 3.6 Reasons for Gardening

Reason	% of respondents	Weighted score	Rank
Save money	14%	.36	5
Better quality food	54%	.96	2
Better nutrition	18%	.46	4
Self-sufficiency	39%	.82	3
Enjoyment	79%	1.36	1
Stress relief	21%	.32	6
Exercise	7%	.11	8
Improve environment	21%	.36	5
Other	18%	.29	7

Enjoyment of gardening is clearly the most important reason people participate in gardening - that option had both the most responses and received the highest rank. Providing better quality food is the second most popular response, pointing to a common issue in high-latitude or otherwise isolated communities – food that is shipped in must travel for several days (or longer) and is not necessarily fresh when it arrives. Increasing self-sufficiency is the third most popular reason for gardening indicating a lingering link to the original goals of the FCG as well as to the "pioneer" ethic of many northern communities in which residents have always taken pride in their ability to care for themselves (see Papp and Phillips 2007).

3.7.7 Community Gardening

Gardeners were asked a separate question about why they chose to join the community garden, as this is an issue separate from gardening as an activity. One thing became clear quickly – given the climate and geography of Fairbanks, many of these gardeners could not have their own gardens if not for the community space. Inner-city gardens or those in larger urban areas are often founded for the same reason – because local residents lack the space or resources to have their own gardens (Armstrong 2000; Hynes 1996).

Seventy-five percent of survey respondents cite lack of adequate space at home as a reason for joining the community garden. Several gardeners specifically state that, although they have space available on their own properties, it was shaded and they are reluctant to cut down grown trees. The second most common reason given for joining the community garden is the 12-foot high "moose" fence that encircles the entire 3-acre space. A fence of the size and quality of the one at the community garden would be extremely expensive for the average homeowner, and moose are a persistent and significant threat to gardens and farms in the local area. Armstrong found that the most common reason for fencing community gardens is to reduce vandalism; 67% of urban gardens in her survey were fenced while no rural gardens used fences. While the fence at the FCG does help to deter human vandals, moose are a more common concern to gardeners.

The chance to talk to other gardeners is the third most common response given (by 43% of respondents). Gardeners report of learning many of their skills simply through conversations with other gardeners. When asked how she learned to garden, one woman responded:

> I learned from my [community garden] neighbors mostly. They'll say, "Well, you might consider putting bone meal or this material in with your

> plants." So we talk to each other about things to make things work better. Last year for instance, my tomato plants were going gonzo and I didn't realize that there are tomato plants that are determinate growers and indeterminate growers. And indeterminate growers will keep growing so they'll keep producing flowers. If you don't keep that in check at the beginning of the season, your plant will continue to produce flowers but won't put any effort into creating the fruits. So you have to start pinching back those new leaflets so your tomatoes will ripen and deplete themselves before the frost. So my friend came by, one of my gardening neighbors, and said, "here's what you need to do."

Exchanging plants back and forth is another common activity in the garden. One woman, who is no longer a member of the garden, but now has her own home garden, proudly points out the raspberry bushes her friend at the community garden gave to her. Several gardeners have an on-going joke about the mint that one woman shared with others that is now “taking over entire plots.”

As with any organization, there are, at times, tensions between participants. Some tensions result from personal differences and some spring from disagreements over garden rules and garden management. However, the clear set of formal rules, which all gardeners agree to upon signing their annual garden contract, as well as an involved and available garden manager who can mediate disagreements, seems to help alleviate, if not eliminate, most serious disagreements.

The *moose fence* and *talking with other gardeners* reverse their rank order when their weighted averages are calculated – but both choices are clearly of significant importance to respondents. There is an emerging a pattern in these responses that indicates that 1) the FCG provides resources to the gardeners that they are not able to access on their own 2) the garden provides space, tools, water, protection from moose and 3) the garden provides a community of people who share a common interest and who are willing and able to share their knowledge with each other. The responses to reasons for joining the community garden are summarized in Table 3.7.

Table 3.7 Reasons for joining the Fairbanks Community Garden

Reason	% of respondents	Weighted score	Ranks
No space at home	75%	2.07	1
Soil at home is poor	14%	.36	6
Meet other gardeners	43%	.86	2
Plots were already set up	29%	.64	4
Protective Fence	50%	.71	3
Other	29%	.50	5

The role of the community garden as a resource that allows people to engage in an activity that brings them something beyond food or other tangible rewards was driven home by the experience of a former gardener who was instrumental in reviving the garden 15 years ago when it had fallen on hard times. This story is only peripherally related to gardening as an activity. But, the role the teller, Lee Wood, played as a key figure in ensuring the success of the garden during several vulnerable periods makes the importance of her initial draw to the garden all the more important to relate.

> Do you want to hear a love story? Way back when, when I was young and frisky and in college, I met this wonderful guy who had moss-green eyes and long legs. And we were together for 7 years, lived together, worked together, played together. And the last 2 years he developed kidney failure and he died. This guy was like all guys; they try to figure out the one thing they can get their woman for birthdays, Christmases, anniversaries. This guy, he was into physics so he was fairly bright, he figured out – "Ah ha! She likes plants!" So, anniversaries, birthdays, and stuff it would be a rose bush or a perennial or some present of some growing thing. After he died, I knew I was going to stay in Fairbanks, but I was in the process of losing our home and everything we had, but I didn't know where I was going to end up: an apartment, a shack, a shed, a doghouse, a tent, a yurt. I had these plants that were more precious to me than anything else I had and I didn't have any ground to put them in. And that's when I heard about the community garden. It would be some place I could take my perennials, my precious plants, and leave them year after

> year after year and tend them no matter where I was in town… It was a mandatory thing for me. I had to find it; I had to do it. Because you can put something like that at a friend's house but friends move, friends die, friends do stupid things, friends have dogs, who knows… I knew if I could get my plot I could keep the things that were most precious to me safe. And that's how I got started in the community garden. And that's a love story.

This touching story highlights an important aspect of sustaining a community project like a garden: leadership. Ms. Wood joined the garden in 1990 when it had severely declined in membership. Her intense desire to have a place for her most precious memories made her a fierce advocate for the garden. Under her management, the garden was revitalized. She began regular membership meetings, sent monthly newsletters to members, and ensured that garden rules were enforced. In the mid-1990s the FNSB assembly considered not renewing the lease for the garden land and resuming its use of the site as a snow-dump. Ms. Wood organized the gardeners to sign a petition and speak at the assembly meeting to convince the assembly members of the value of the garden. Since then, the lease has always been renewed and the garden has retained the support of the local government. In fact, the FNSB has codified its support for urban agriculture in its recent regional comprehensive plan (Fairbanks North Star Borough 2005) .

3.8 Discussion

DuPuis and Goodmand (2005) caution that, without careful planning and evaluation, a local food system risks becoming "an unreflexive, romantic reaction[5] against the global system" instead of a system that contributes to a democratic, healthy, and sustainable food system. The environmental, economic, and social benefits that often spur the creation of local-food initiatives are not guaranteed (Alkon 2008; Allen

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[5] Romance, as became clear through Ms. Wood's story (p. 86), can play a crucial role in maintaining local-food-system initiatives. However, DuPuis and Goodmand refer to the sort of blind love that does not permit reflection or honest assessments of the object of desire.

2004; Born and Purcell 2006; Hendrickson and Heffernan 2002). These are not arguments against localizing food systems – simply cautions that they require a concerted effort and careful design to be inclusive and to ensure that the benefits are equitably shared throughout the community.

When the Fairbanks Community Garden is viewed through the lens of a local food-system initiative, there are moderate successes. The garden does not supply all, or even most, food required by participants; but it does make a contribution to household food supplies during the growing season. The FCG does not produce enough food to greatly reduce the community's reliance on the global food system. In fact, the 2 years I spent at the FCG were fairly "poor" gardening seasons due to cold and wet weather, which limited the amount of food produced. If participants were entirely reliant on their own gardens, these poor seasons could have been disastrous.

Food grown in the garden, when measured simply as economic value minus economic input, is slightly less expensive than purchased comparables, if labor time is not included. But labor time cannot be completely discounted from the equation. Gardening is time-intensive and, therefore, raises the question of whether those with limited time to dedicate can participate in the activity.

Food miles are only one small part of measuring energy use in food systems, but growing even relatively small amounts of food locally does, at least seasonally, reduce food miles for a given selection of food. Gardeners at the FCG tend to use environmentally sensitive gardening practices, so they are also offsetting, to a small degree, the environmental costs of industrial agricultural techniques.

While the environmental and economic successes of this local-food-system initiative are moderate, the FCG has met the goal of building community relationships. Gardeners talk to each other, share information and plants, and some have formed long-term friendships, often across political and social lines, based at the garden.

When the local-food-system lens is removed, the broader set of contributions made by the FCG (and other community gardens) become apparent. Colding, et al. (2006) note a range of ecosystem services provided by community, or other urban, gardens ranging from physical services to cultural and aesthetic benefits. For example, greenspaces aid in urban-climate control. While not as critical to a high-latitude city like Fairbanks (Magee, et al. 1999), the urban-heat-island effect can be ameliorated by placing greenspaces in urban-core areas (Colding, et al. 2006; Gómez, et al. 2004). Gardens contain pervious surfaces and can help cities maintain natural hydrologic processes, reduce storm-water runoff, and filter the pollutants that collect on urban streets (Colding, et al. 2006; Randolph 2004). Urban greenspaces provide wildlife habitat in places where other habitat may be lost to development (Colding, et al. 2006; Matteson 2007). I found that the FCG was home to at least as many birds and bird species as found on other small agricultural patches in the region, indicating that it might act to maintain wildlife habitat in the urban core.

While I did not find average food production in the FCG to be of great economic value, depending on the individual gardener, the economic benefits could be more significant. Two gardeners used their plots to grow vegetables and plants to sell at the local farmers' market – making their plots small economic enterprises. At a community scale, a study in New York City found that property values in the vicinity of community gardens rose beyond comparable properties without gardens and that these rising property values could translate into significant tax revenues for the city (Voicu and Been 2008).

Aesthetics, nature education, and recreational opportunities are all provided by the FCG. Gardeners reported that they found the garden area beautiful, parents brought their children to participate in and learn about gardening and wildlife, and almost all respondents said that the most important thing about gardening was "enjoyment."

While local food systems are not intrinsically sustainable or necessarily environmentally sound, or socially equitable, the FCG makes contributions to all of these goals. Some of these achievements were designed into the garden. Of primary importance is the fact that the garden was ever designed and created at all. The FCG allows people who might not have the land, time, or financial resources to create their own garden to reap the benefits of the activity. The community garden provides the space and resources, including a protective fence, not necessarily available at an individual residence.

Other design elements include the size of plots, the fee structure, and the garden rules. The FCG founders were able to create large plots that allow more food production than most community gardens. The costs of gardening are kept low through sweat-equity opportunities and sharing of infrastructure costs among all garden participants. Garden rules prohibit the use of damaging chemical herbicides and, although chemical fertilizers are currently permitted, few members use them. Some of the benefits of the garden, such as providing urban greenspace and wildlife habitat, were not specifically designed into the FCG, but should be considered in other gardens or local-food-system initiatives.

3.9 Conclusions

The currently dominant global food system has failed to provide food security, environmental security, and social welfare to many people who, willingly or not, are engaged in the system. Solutions must be found to remedy these failures. Food-system localization has become a popular option in the search for new food-system forms. However, there is insufficient research to determine the ability of local production to meet local demand, whether food produced locally can be accessed equitably, and whether a local food system can meet both goals without adverse environmental impacts. Redesigning the system that provides our food and sustains our communities is important and we need to know what works, why it works, and how it could work better.

My findings indicate that, at present, the Fairbanks Community Garden makes only a small contribution to food security or a local food system in Fairbanks. However, it provides the food it does using largely environmentally sound methods. The Garden also provides other important community benefits. It appears to play a role in maintaining biodiversity in the urban core by acting as a wildlife habitat. The Garden has created connections and a sense of community among people of different backgrounds and experiences and is a source of recreation and enjoyment for many people who might not otherwise be able to participate in the activity of gardening.

Rather than gardening to produce food, members of the Fairbanks Community Garden tend to garden for enjoyment and produce food as an added benefit. Few gardeners would be concerned that they are not meeting the goals of food-system localization – they garden for pleasure and they cherish their time in the community garden. The importance of the garden in the lives of its participants has, so far, been enough to sustain it for 30 years. Interest in, and commitment to, the Garden show no signs of lagging.

I suggest that more research attention be paid to how and why small food-production efforts, like the Fairbanks Community Garden, are effective. Understanding what motivates people to participate in food production, whether for food, enjoyment, or other personal reasons, may give us clues as to how to engage more people in redesigning our food systems. Achieving the outcomes of food security, environmental security, and social welfare is likely to require a multitude of approaches – which should be based on rigorous study of current food-system practices and careful design of new and alternative food-system forms. We should remain open to the diversity of options available to us, yet ensure that we select the best options that will meet the needs of all members of our communities now and into the future.

4 Local Food Footprints: A Tool for Food-System Planning

4.1 Introduction

Communities and individuals are working to reform and redesign the food systems upon which we all depend in order to improve food security, reduce environmental degradation, and strengthen social and cultural institutions. Many of these reform efforts center on localizing food systems. In this paper, I propose a method, the local food system footprint, to help communities identify their food and nutritional needs, social and natural resources, and community priorities for food-system reform. I use the community of Fairbanks, Alaska as an example of how the local food system footprint can be applied and suggest ways community members can enhance the methods, through participation and additional data provision, to strengthen the food-system design and, ultimately, the food-system outcomes.

The dominant food system that supplies most North Americans with the food and nutrients they need is both globally scaled and industrially oriented. It is capable of producing vast quantities of food and moving them thousands of miles from points of production and processing to our supermarkets and homes, where it is finally consumed. However, this complex system has proven to have some significant drawbacks and many people have lost faith in the global food system (GFS) as it currently functions. The practices used to produce food at an industrial scale have contributed to significant environmental degradation. Small farmers have been hurt economically because of their integration into capital-intensive-farming practices. The transportation of food over long distances contributes to greenhouse gas emissions and reduces the quality of food available for consumption. People are "distanced" (Kloppenburg Jr., et al. 1996; Sundkvist, et al. 2005) both physically and socially from where and how their food is produced. And, finally, the GFS has yet to succeed in alleviating hunger and food insecurity in many communities in both developed and developing nations.

In response to the weaknesses of the GFS, development of local food systems (LFS) has become an increasingly popular topic of discussion and research in both the popular media and academic venues (Hinrichs 2003; Kingsolver, et al. 2007; Pirog and Benjamin 2003; Pollan 2006; Pothukuchi and Kaufman 2000; Sundkvist, et al. 2005). However, despite more than 30 years of public interest and at least 10 years of academic study, there are few studies that evaluate the ability of LFS initiatives to meet the goals of food-system reform. We do not have enough information on the costs and benefits of food-system localization and its potential role in larger food-system reform to answer questions about the ability of food-system localization to alleviate food insecurity, reduce environmental degradation, improve farmers' economic position, or create a socially equitable food system (Grey 2000; Hinrichs, et al. 1998). However, the answers to these questions can be found with greater attention to and research on food systems of all scales and forms.

In this study, I propose a new method that will contribute to more effective food-system design. The local food system footprint I propose is a coarse assessment of the overall food and nutritional needs and food-production resources available in a community. The LFS footprint approach provides a solid basis for food-system design by determining what is required in the community, whether the community is capable of providing for its own needs, and helping to identify the costs and benefits of food-system localization for a particular community. I envision that the LFS footprint will be used in conjunction with more fine-scaled assessments such as community food assessment (CFA), which focuses on issues of food availability and accessibility, and land evaluation and site assessment (LESA), which focuses on agricultural-land-use issues.

A functional food system should produce 3 outcomes over the short and long-term: food security, environmental security, and social welfare (Ericksen 2008). Food security means that all people have physical and economic access to food that provides adequate calories and nutrients and is culturally preferred. Environmental security means that the ecosystem services and natural capital necessary to produce food are maintained to ensure ongoing food production. Ericksen (2008) defines social welfare as the ability of the food system to provide jobs and income or some other economic benefit to the community. I suggest that the definition of social welfare be broadened to include less-tangible measures of social well being such as the level of interaction between community members and the socially inclusive nature of food-system activities. The goal of food-system design and development should be to ensure that these outcomes are consistently produced for the benefit of all people and all communities, locally, regionally, nationally, and internationally.

4.2 The Global Food System

Creating a food system that meets the goals of food security, environmental security, and social welfare requires planning and design – it does not develop on its own, or from an overemphasis on economic development and gain, as we can see from the weaknesses of the GFS. The GFS is failing different people and communities in different ways. Despite a tripling of grain production, due to technical innovations in production methods, from 1950-1996 (Brown 2004)food was still not necessarily more accessible to those without the means to purchase it. Food availability does not equate with food access: people must be able to physically access food and have the means to acquire it, through direct labor or cash income, in order to achieve food security (Sen 1981). In addition to the barrier of food access, we are now seeing a trend toward lower food availability. Between 1996 and 2003 grain harvest rates have stayed flat and are failing to keep pace with population growth due in part to environmental trends such as soil erosion, desertification, land conversion, falling water tables, and climate change all of which reduce agricultural productivity (Brown 2004).

Corporate consolidation in the GFS has consolidated decision-making power about what is produced and how it is produced, in the hands of a small group of people with largely corporate and business interests. Five seed companies dominate the world market, and have extended their influence, through supply-chain consolidation, all the way through the processing stage (Hendrickson and Heffernan 2002). Consolidation in retailing has followed a similar path with 5 supermarket chains accounting for 40% of food-retail sales in the U.S. (Hendrickson and Heffernan 2002). Consolidation has contributed to a reduced number of full-service grocery stores nationwide, and market pressures often push these stores away from low-income neighborhoods creating whole neighborhoods with low food-access, also know as “food deserts” (Alwitt and Donley 1997; Hendrickson, et al. 2006; Larsen and Gilliland 2008; Whelan, et al. 2002). Inaccessibility of healthful foods like fresh fruits and vegetables has been linked to poor health outcomes, particularly but not exclusively, in low-income communities (Algert, et al. 2006; Lane, et al. 2008; Morland and Wing 2007).

The environmental costs of the practices common to industrial-food production are becoming clear. Agricultural methods used in the GFS are linked to long-term environmental degradation – which harms both the environment in the short term and the agroecosystem’s ability to produce food in the long term (Abate, et al. 2008). The chemical pesticides, herbicides, and fertilizers used in industrial-scale agriculture create soil, water, and air pollution (Foley, et al. 2005; Horrigan, et al. 2002). Extensive and intensive irrigation practices contribute to salinization of the soil and overuse of water resources (Foley, et al. 2005; Horrigan, et al. 2002). Due to tilling methods, topsoil is eroding at rates far faster than it can be replaced (Jackson 1985). Monocultural-cropping practices reduce wildlife habitat, erodes genetic and species biodiversity, and can expose crops to pests and disease outbreaks that are then treated through increased use of pesticides and herbicides (Norberg-Hodge 2002).

Other environmental costs are linked to the ways in which food is transported and processed to ease transport. Transporting food over long distances contributes to greenhouse-gas emissions and global climate change (Pirog, et al. 2001). Food production, which includes processing and distribution, accounts for 17% of all fossil-fuel use and 10.5% of energy use in the United States (Horrigan, et al. 2002). Food processing alone accounts for about one-third of all energy use in the U.S. food system; each calorie of processed food consumes about 1,000 calories of energy (Horrigan, et al. 2002). Processing also tends to reduce the nutritional quality of food, with negative health outcomes the result (Winson 2004).

4.3 Local Food Systems

One response to the set of practices known as the GFS has been to call for a shift away from the global-scale system entirely and toward a food system presumed to offer an antidote – a locally scaled system. A local food system is one in which all or most food required by a community is produced within or nearby the community. It is more accurate to think of this movement as food-system localization – the process of shifting at least some food production, intended for local consumption, into the community or the region. Given the long history of trade among human societies, particularly in urban settings (Blouet 1972), and seasonal migration among many non-urban societies, entirely local food systems are likely to have never existed.

Food-system localization is intended to address the range of environmental, economic, and social problems associated with the functioning of the GFS. One of the most common arguments in favor of local food production is reduction of food miles – or the miles food must travel from point of production to point of consumption. Current estimates are that fresh food in the United States travels an average of 1,500 miles from farm gate to table (Pirog and Benjamin 2003). In 2001, 39% of fruit, 12% of vegetables, and 78% of fish consumed in the U.S. were produced in other countries (Pirog and Benjamin 2003). The energy use and emissions associated with long-distance shipping have raised significant concerns about the contribution of the GFS to climate change, air pollution, and over-reliance on non-renewable energy sources. Shortening the distance food must travel is intended to ameliorate these excesses. Recent analyses, particularly life-cycle assessment of energy use in food production stress the importance of a more holistic assessment of energy use in the food system (see for example: Eshel and Martin 2006; Mila i Conals, et al. 2007; Weber and Matthews 2008). The concept of food miles is helpful in laying the groundwork for such an analysis. If all production processes are equal (a large assumption), then reduction of food miles will help reduce energy use and related pollution.

Food, particularly fresh produce, that travels 1,500 or more miles must be durable – which comes at the expense of palatability and nutritional content (Kloppenburg Jr., et al. 1996). Local food production shortens the time between harvest and consumption – often resulting in a higher-quality product. The short social distance between producer and consumer in a LFS is one of the hallmarks of the approach. The development of face-to-face relationships between and among farmers, small-scale processors, and consumers in which people reconnect and strengthen their communities is, perhaps, one of the most appealing aspects of food-system localization in this increasingly fast-paced, electronically linked society.

Kloppenburg, et al. (1996) estimate that 75 cents of every dollar spent on food in the U.S. goes to processors, packagers, shippers, advertisers, and retailers – with falling farm incomes the consequence. Food-system localization promises to link farmers directly with consumers, eliminating the middle-man, helping farmers out of the "spiraling cycle of debt and corporate dependency inherent in capital-intensive-industrial production" (Macias 2008), making farming a viable occupation again.

Integration of food production into urban areas brings other benefits as well. The presence of open spaces, such as farms, ranches, and large gardens close to urban areas can have a positive effect on the environment. Urban areas are often subject to the urban-heat-island effect in which the impervious building materials that make up their built-environment absorb heat, making urban areas warmer than surrounding rural areas. Incorporation of greenspace in and around urban developments reduces the amount of impervious surfaces, allowing for greater evapo-transpiration which has a cooling effect and can restore or maintain hydrological functions, such as groundwater recharge and stream flow, which are often disrupted by urban development (Gómez, et al. 2004; Randolph 2004). Gardens, in particular, appear to have a positive effect on urban wildlife populations – replacing habitat previously lost to urban development (Colding, et al. 2006; Matteson 2007).

While LFS initiatives are intended to counter the negative aspects of the GFS, they have yet to fulfill this promise. One barrier to the universal success of LFS initiatives is inequitable food access due to the generally higher prices in LFS initiatives and often greater time required for participation. These two characteristics have led to a tendency for LFS initiatives to be driven by, and remain the domain of, middle- and upper-income people because of higher food costs and greater time requirements (Alkon 2008; Allen 2004; Hinrichs 2003).

Higher food prices have a flip side: farmers involved in these initiatives need to and deserve to earn income adequate enough to continue their work. The small-scale farms generally involved in LFS initiatives are less likely than their industrial-scale counterparts to benefit from government agricultural subsidies or economies of scale that would subsidize their activities, reduce farm costs, and allow farmers to charge lower prices for their goods. The need to support local farmers and ensure them a fair wage while also keeping food economically accessible to lower-income residents is, perhaps, one of the greatest challenges facing LFS development (Alkon 2008; Allen 1999; Allen 2004; Guthman, et al. 2006).

While much of the LFS movement has been tied to the organic or sustainable agriculture movements, the potential for environmental damage from increased local production cannot be ignored. If undesirable agricultural practices are simply transferred to a local scale, pollution may be introduced to the region and local resources may be overstressed (Sundkvist, et al. 2005). Finally, entirely local food systems are susceptible to local disease, climate, and disturbance patterns (Sundkvist, et al. 2005). Relying on a single source of food can make a community more vulnerable than a community that receives food from a variety of sources (Fraser 2006). Agricultural practices such as developing biodiverse agroecosystems can, however, alleviate some of these threats at all scales of agriculture production.

4.4 Assessing Food Systems

In order to design food systems that are capable of meeting the food-system goals of food security, environmental security, and social welfare, we need tools capable of helping us structure our inquiries regarding community needs as well as ways to accurately assess current food-system forms and practices. In particular, given the interest in substituting local production for global resources, we need to develop robust methods to assess the viability of LFS initiatives and evaluate their potential contribution to community and global food-system reform.

Most existing studies of LFS initiatives focus on the social equity dimensions of the movement. Hinrichs and Kremer (2002) and Hinrichs (2003) are explicitly concerned with social inclusion in local-food-system initiatives. Guthman, et al. (2006) and Guthman (2008) probe both racial and social exclusion in local-food-system initiatives. And, while Macias (2008) addresses food equity in 3 local-food-system initiatives, his focus tends toward a sociological analysis of the community and human-environment interaction aspects of participation in local food production. Blair, et al. (1991) and Gladwin and Butler (1984) stand almost alone in their attempts to quantify the economic and nutritional benefits of gardening.

One existing tool, a community food assessment (CFA), is often used as a first step to identify the needs and assets related to community food security (Pothukuchi 2004). CFAs address many of the issues identified above including food access in low-income neighborhoods, food quality, and local food production. However, we propose that prior to focusing on any one particular GFS or LFS activity, a precursor step will help communities and food system advocates understand both the needs of their community and the capacity in their local environment to meet those needs. Such an assessment will answer questions about whether a community is capable of providing for its own food and nutritional needs and identify the costs and benefits of food-system localization for that community.

At least 4 major questions may be answered through a preliminary assessment of community needs and capacity: how much food is required in the community; how much land is required to grow the food; where is that land located; and whether the community have the human capital, or the set of skills, education, and knowledge (Macias 2008), in the form of farmers and interested consumers, required for such an initiative. We consider the first 3 questions through development of a local food system footprint – a physical representation of the amount of local land capable of and suitable for supporting the nutritional needs of the local population.

Footprints have been used to demonstrate resource-use in a tangible manner. Ecological footprints, developed by Wackernagel and Rees (1996), are defined as “the area of biologically productive land and water required to produce the resources consumed and to assimilate the wastes generated by humanity, under the predominant management and production practices in any given year" (Wackernagel, et al. 2002). Ecological footprints use a universal acre calculation that permits international and cross-cultural comparisons.

The concept has also been applied to measure the use of specific resources, such through the calculation of a carbon footprint. Luck, et al. (2001) further developed the footprint concept to create spatially explicit footprints that are based on locally available resources and which are mapped onto the local region. I follow this lead by refining and creating a LFS footprint based on the specific lands capable of food production, local agricultural yields, and the nutritional needs of the community. It is important to note that I differentiate a LFS footprint from a commercial-agricultural assessment. The LFS footprint demonstrates how local needs are expressed on the landscape while an agricultural assessment identifies all lands capable of agricultural production, but without necessarily considering the suitability of those lands for meeting specific community needs.

4.5 Creating a LFS Footprint to Drive Food-System Design

In this paper, I consider the use of a LFS footprint to identify needs and resources related to developing a local food system. As discussed above, a fully localized food system is not necessarily a realistic goal. However, the LFS footprint can help communities to decide how to best allocate their resources in the quest for food-system reform. We assess the nutritional needs and land resources available to develop a fully local food system below. I create a series of LFS footprints for the Fairbanks North Star Borough in Interior Alaska, each of which illustrates a different nutritional and crop scenario capable of feeding the entire population of the FNSB based on the soil resources available and current best estimates for crop yields in the region.

While commercial agricultural-crop production forms the basis of most foods in the GFS, from crops to feed animals to crops to directly feed people, it is not the sole form of food production or procurement currently in use by people globally. I am aware of the important role subsistence harvesting plays in the lives of many people – particularly in the state of Alaska. However, for the purposes of this study I focus on, and refer almost exclusively to, agricultural-crop production because of its dominant role in the GFS.

The scenarios I develop, through this test of the LFS footprint approach, are hypothetical. The scenarios are not intended as actual proposals for a local food system in Fairbanks – but rather to provoke discussion in the community and among those interested in local-food-system development about the costs, benefits, strengths, and weaknesses of local and other types of food systems.

The LFS footprints focus on development of a local food system, not simply of development of agricultural production. The difference lies in the selection of suitable lands. Based on the assumptions outlined below I have identified more than enough land to feed the current population of Fairbanks using only agricultural production. However, I select, as suitable, those capable lands (according to the USDA land-capability ratings) that are closest to population centers. This is done in order to maximize other LFS benefits such as accessibility and environmental improvements in the urban context.

Previous research in the FNSB found that locally grown foods are less physically accessible than comparable foods in the dominant food system (Meadow in review). Local-food outlets are up to 5 miles farther away from population centers than supermarkets. The outlets, particularly the CSA pick-up locations, are often sited somewhere in between farms and population centers, sharing the burden of transportation between farmer and consumer. We suggest that keeping farms as close to population centers as possible will keep this burden to a minimum for both parties – and ensure that accessibility is not further reduced for consumers.

One noteworthy exception to the local-food accessibility problem is the Fairbanks Community Garden, which is located within the urban core. Although many LFS initiatives have focused on small-scale commercial agriculture, the history of the use of LFS initiatives to address community vulnerabilities also includes the use of home gardens such as Liberty and Victory gardens during both World Wars, allotment gardens in European cities during World War II, and community gardens which gained popularity in economically distressed inner cities in North America. Locating community gardens, or other forms of individual food-production opportunities, close to population centers increases their accessibility and value to a community.

Peri-urban agriculture can bring other benefits to a community. Maintaining open spaces near urban centers can, depending on farming methods, provide wildlife habitat and reduce the urban-heat-island effect (Colding, et al. 2006; Gómez, et al. 2004). The summer-time urban-heat-island effect is not currently an issue for Fairbanks because of climatic and weather conditions in Interior Alaska (Magee, et al. 1999); although, in applying a LFS footprint analysis to other urban areas, the role of greenspaces in urban-climate control must be considered.

Open space near population centers also promotes social welfare by providing aesthetic and recreational benefits. In addition, living near greenspace is often highly prized in urban areas, resulting in higher home values for those sited near parks, gardens, and agricultural lands (Tajima 2003; Voicu and Been 2008; Wu and Plantinga 2003).

4.6 Study Site: The Food Systems of Fairbanks, Alaska

We test the LFS footprint method using the community of Fairbanks, Alaska as an example. Fairbanks' location in a high-latitude region places it in a unique position when compared to other urban centers – it shares the vulnerabilities embedded in the GFS, of which it is a part, but, unlike many urban centers, still has ample open space surrounding it, which may contribute to development of a stronger local food system.

Fairbanks, located at 64˚ north latitude is the urban hub of Interior Alaska (see Fig. 1). The region is subarctic with average temperatures that range from -9.7˚ F in January to +62.4˚ F in July. Fairbanks averages 10 days per year below -40˚ F and 13 days above +80˚F (Alaska Climate Research Center 2008a). There are less than 4 hours of daylight at the winter solstice in December and more than 22 hours at the summer solstice in June (Alaska Climate Research Center 2008b). Fairbanks receives an average of 10.56 inches of precipitation annually (National Agricultural Statistics Service - Alaska Field Office 2006). The average growing season for Fairbanks is 115 days (Alaska Climate Research Center 2008c). In the agricultural region of the Tanana Valley, the regional scale for which the USDA keeps records, and which includes the

FNSB, 16,337 acres were planted in crops in 2005; however the majority (10,000 acres) was planted in grasses which are used as hay and forage crops (National Agricultural Statistics Service - Alaska Field Office 2006).

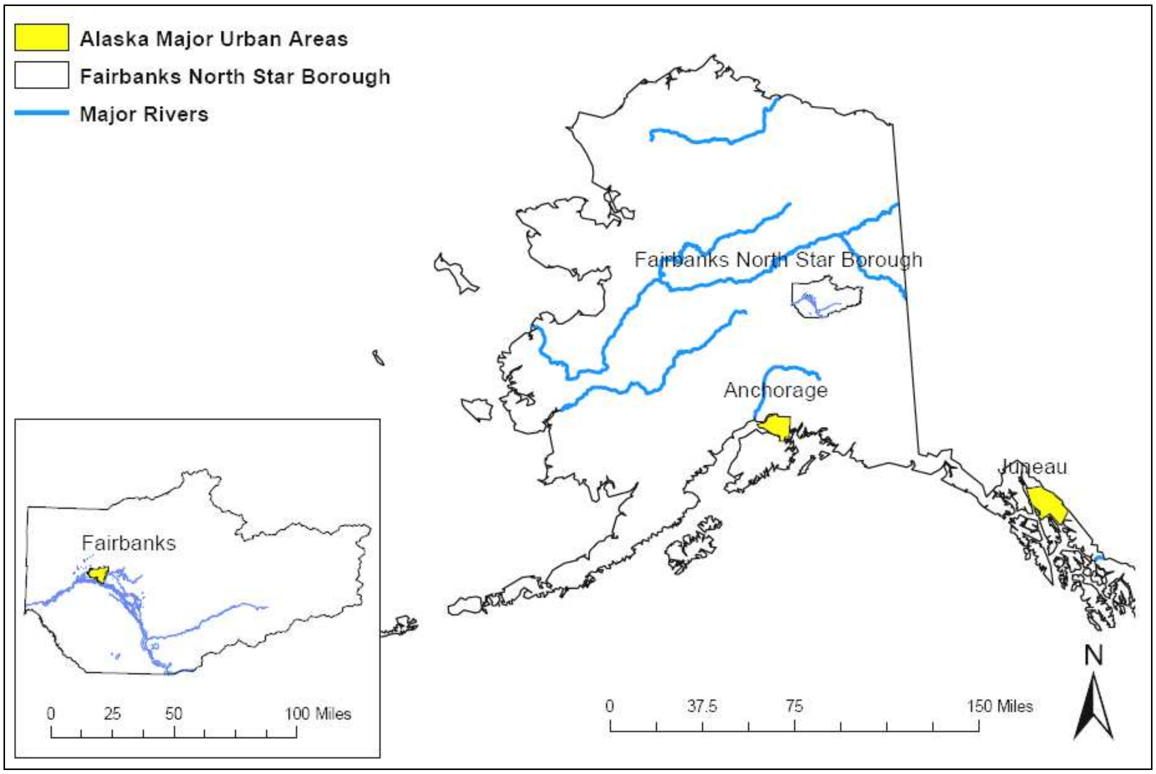

Figure 4.1 The State of Alaska and the Fairbanks North Star Borough

The Fairbanks North Star Borough (FNSB) encompasses the City of Fairbanks, the City of North Pole, and several smaller towns. In 2007, the borough population was 97,484 people in 7,444 square miles (U.S. Census Bureau 2008). Because almost all residents rely on a common set of resources for shopping, education, and entertainment that are located within or near the city limits of Fairbanks, we treat the FNSB as one large community. We use FNSB and Fairbanks interchangeably, unless City of Fairbanks is specified.

Fairbanks has a food system similar to that of other urban areas in North America. The majority of food consumed in Fairbanks comes from between 1,500 and 3,000 miles away. Perhaps 5% of food consumed in Alaska is grown in the state

(University of Alaska Fairbanks Cooperative Extension Service 2006). Most food is purchased at one of the 9 full-service grocery stores in the region. The community also has 24 convenience stores (often connected to gas stations), 4 small stores that tend to specialize in ethnic foods, a farmers' market that operates from June-September, and several community-supported agriculture enterprises that all together serve approximately 350 shareholders.

A unique attribute of Fairbanks, when compared to other urban areas outside of Alaska, is the level of participation in subsistence hunting, fishing, and gathering. Due to the manner in which subsistence resources are legally managed within the State, subsistence harvests are recorded based on location of the harvest, not residence of the hunter. Therefore, it is difficult to assess the rate of subsistence participation among urban hunters who travel to other regions of the state to hunt and fish. However, the Alaska Department of Fish and Game (ADF&G) estimates that Fairbanks residents, on average, harvest and consume 16 lbs of wild foods per person per year (Wolfe 2000). These wild foods include fish, moose, caribou, and a variety of berries. Although rural Interior Alaska residents harvest far more subsistence foods annually (up to 613 lbs per person), subsistence hunting and fishing remain important parts of the diet and culture of at least some urban residents.

Like many urban areas, Fairbanks has food-system vulnerabilities based both within and outside of the community. We refer to vulnerabilities that relate to distance from food sources as extra-urban vulnerabilities to differentiate them from intra-urban vulnerabilities that occur once food has reached the community but is not equitably accessible to all residents.

Fairbanks is almost completely reliant on external food sources and the transportation system required to transport that food into the community. Food availability in the community could be reduced significantly if the transportation system slows or fails due to political or economic factors or a natural disaster. Local supermarkets are estimated to stock only 2-5 days worth of food at any given time. Only 1 of the 2 major supermarket chains in the community (the chain owns 3 of 9 supermarkets in the area) maintains a warehouse in the state, but it is in Anchorage – 350 road miles from Fairbanks. The other chain stores food for Alaska in Oregon warehouses.

While the extra-urban vulnerability related to distance from food source is more pronounced in geographically isolated communities like Fairbanks, the community shares intra-urban food access vulnerabilities with many urban areas. Personal transportation is required for many residents to reach the full-service grocery stores and those stores have been drifting away from the urban core (and lower-income neighborhoods) over the past 40 years (Meadow in review), reducing food access for lower-income households. Local-food outlets are even less physically accessible than supermarkets – they are an average of 5 miles farther away from population centers than are supermarkets and, unlike supermarkets, are not necessarily located on public transportation routes (Meadow in review). Locally grown foods are also more expensive than comparable foods in supermarkets and are currently widely available only during a very limited season (ibid).

One of the social vulnerabilities of Fairbanks' current food system is rooted in employment-sector imbalances. The census data for the region reports that there are only 45 people in the community employed in agriculture, forestry, fishing and hunting combined, while 970 people are employed by the two largest supermarket chains in the region (Fairbanks North Star Borough Community Research Center 2008). The two supermarkets combined are the 6th largest employer in the region. With so many community members dependent on the GFS, and its local manifestations, for their livelihoods, the community is particularly vulnerable to a disruption or change in the current food system.

The similarities between Fairbanks and other U.S. cities allow us to use Fairbanks to test the LFS footprint approach and to evaluate the potential role of local food production in the community. The unique aspects of Fairbanks: its geographic isolation and challenging climate make food-system reform an imperative for the region as it manages the challenges of rising energy costs, climate change, and population shifts

– all of which pose challenges and create opportunities to develop a more resilient food system and community. We also hope to contribute to the relatively small collection of specific community-based studies of LFS development and design. We encourage the development of comparable studies from a variety of communities, in a range of geographic, economic, and cultural contexts, in order to develop a set of tools that will help us, then, identify a set of best practices in LFS design.

4.7 Methods

4.7.1 Nutritional Needs

Food security can refer solely to having access to adequate calories or should, more appropriately, include adequate nutrition as well as caloric intake. I use the latter, more inclusive, definition as it recognizes that calories alone are not sufficient to sustain a healthy person or community. Therefore, while my nutritional assessment begins with caloric needs, I include a range of selected major nutrients in this analysis of food needs for the FNSB. The basic nutritional needs of the average person in the FNSB are estimated on the basis of the U.S. Department of Agriculture's Daily Recommended Intake (DRI) calculations. This approach recognizes that the primary function of any food system is to meet these most basic needs of the people who rely upon it (Amede, et al. 2004; Robinson, et al. 2003).

In order to estimate nutritional needs for all the people in the FNSB, we averaged the recommended DRIs for all adult, sex, and activity-level categories. This approach probably overestimates slightly the caloric and nutrient requirements for the region but I feel that overestimation is preferable to underestimation because overestimation ensures that community needs are met. I limited my range of selected nutrients to: calories, carbohydrates, protein, vitamin A, vitamin C, calcium, and iron. Table 4.1 provides the estimated DRIs for our selected nutrients.

Table 4.1 Average Adult Daily Recommended Intake for Major Nutrients

	Calories	**Carbohydrates**	**Protein**	**Vit. A**	**Vit. C**	**Calcium**	**Iron**
DRI	2435	130g	50g	540mcg	62mg	1167mg	10.5mg

The most common crops grown in the Fairbanks region are barley, cabbage, carrots, oats, and potatoes as well as an aggregate category of "other vegetables (National Agricultural Statistics Service - Alaska Field Office 2006). I selected beets, broccoli, green beans, peas, and zucchini to represent the category of other vegetables, based on surveys of common vegetables available at the local farmers' market and those grown in the Fairbanks Community Garden.

Using the USDA's "What's in the Foods You Eat" Search Tool, I determined the calories and major nutrients in 1 kilogram of each of my selected foods. I use the raw version of all foods, except barley, a crop for which no raw entry is available. Estimating calories and nutrients using raw forms of each food may overestimate the useable calories in each kilogram of each food, however using cooked or processed versions introduced too many variables due to different cooking, preservation, or processing methods and any additives used. I calculated the weight of each crop required to generate 2,435 calories; then calculated the amount of each nutrient in the required kilograms.

The number of acres needed to produce the kilograms necessary to feed the population was calculated based on 2005 crop yields in the region. Specific crop-yields are available for barley, cabbage, carrots, oats, and potatoes (National Agricultural Statistics Service - Alaska Field Office 2006). I use the yield of the aggregate "other vegetables" category for each of our selected additional vegetables.

I created several scenarios in order to determine whether it is possible to meet the DRIs using only crops common to the region. It is important to note that, although I am aware that some Fairbanks residents include wild foods in the regular diet, I did not include them in this initial modeling experiment. Wild foods should be included in a more detailed and specific assessment of the potential for local-food-system development in the region.

I began scenario building by using potatoes, the crop with the highest yield of calories per acre. Employing an iterative process based on nutrients available in other crops, I constructed various crop combinations that might best balance nutritional and land use needs in the region. I recommend that this process be repeated in the future using nutritional optimization modeling to produce more accurate nutritional scenarios (Amede, et al. 2004). This process is currently underway for regional crops, but was not complete at the time of writing (personal communication: Luick 2008).

The weight in kilograms required to meet the daily nutritional needs of one person was multiplied by 365 days and then divided by the established crop-yield to determine the land, in acres, required to feed 1 person. Then, the per capita land requirement was multiplied by 95,000, the rounded current population of the FNSB. By adding together the land required for each crop, I determine the amount of land required for each crop scenario.

4.7.2 Land Suitability Analysis

In order to determine whether the amount of land required to produce adequate crop-yields and capable of agricultural production is available in Fairbanks, I relied on the soil maps developed by the Natural Resources Conservation Service of the USDA.

The USDA classifies lands based on the soil's capability to produce crops without deterioration (Randolph 2004). Class 1 soils have few limitations for crop production and are considered prime agricultural lands. Class 2 soils have moderate limitations that limit crop-choice and Class 3 soils have severe limitations that reduce crop-choice – but are still capable of agricultural production (ibid). There are no Class 1, or prime agricultural lands, in the Fairbanks region.

Table 4.2 USDA Land Capability Classifications

Land Capability Classes and Subclasses*	Description
Class 1 soils	slight limitations that restrict their use
Class 2 soils	moderate limitations that reduce the choice of plants or require moderate conservation practices
Class 3 soils	severe limitations that reduce the choice of plants or require special conservation practices, or both
Class 4 soils	very severe limitations that restrict the choice of plants or require very careful management, or both
Class 5 soils	little or no hazard of erosion but have other limitations, impractical to remove, that limit their use mainly to pasture, range, forestland, or wildlife food and cover
Class 6 soils	severe limitations that make them generally unsuited to cultivation and that limit their use mainly to pasture, range, forestland, or wildlife food and cover
Class 7 soils	very severe limitations that make them unsuited to cultivation and that restrict their use mainly to grazing, forestland, or wildlife
Class 8 soils	limitations that preclude their use for commercial plant production and limit their use to recreation, wildlife, or water supply or for esthetic purposes
Subclass e	soils for which the susceptibility to erosion is the dominant problem or hazard affecting their use
Subclass w	soils for which excess water is the dominant hazard or limitation affecting their use
Subclass s	soils that have soil limitations within the rooting zone, such as shallowness of the rooting zone, stones, low moisture-holding capacity, low fertility that is difficult to correct, and salinity or sodium content
Subclass c	soils for which the climate (the temperature or lack of moisture) is the major hazard or limitation affecting their use

*The subclass represents the dominant limitation that determines the capability class

I used 4 contiguous soil maps available for the FNSB region: the Greater Fairbanks Area, North Star Area, Greater Nenana Area, and Ft. Wainwright area. Using ArcGIS, I merged all 4 maps to create 1 dataset. Based on the non-irrigated land capability classifications for all 4 areas, I selected all polygons with a capability rating of 3 or better.

Most soil polygons in the NRCS maps contain multiple soil types with different capability ratings. If less than 90% of the soils in 1 polygon have different capability ratings, I use a weighted average of all land-capability ratings, which resulted in ratings in our study area of 2, 2.6, 2.8, and 3. This weighting eliminates some lands from my analysis the USDA might consider capable and which may, indeed, be capable of agricultural production. Given that Class 3 soils have severe limitations, my conservative analysis ensures that only the most capable lands in the region are included in the analysis. I identified 96,147 acres of agriculturally capable soils in the soil survey areas adjacent to the cities of Fairbanks and North Pole and the town of Nenana.

As noted above, one of the current vulnerabilities in the food system of the FNSB is reduced physical and economic access to local foods. Local-food outlets are currently an average of 12 miles from census tract population centers while conventional supermarkets are an average of 7.9 miles from population centers. Because food security relies, in part, on food access, I assert that local-foods should be as accessible as imported foods. If local farms are located close to urban population centers, neither farmers nor consumers will need to travel very far to access or distribute locally grown foods. Farms close to urban centers may also be able to rely on existing roads (or minimal new roads will need to be built), which can also improve food access. For the purposes of this study, we did not consider whether the land is currently accessible by road. However, in designing a LFS, the issue of road access would be critical. Based on the 12-mile current average to local-food outlets, we created buffers of 12, 24, and 36 miles around all urban areas in order to give greater weight to capable soils closer to urban areas.

I converted the original vector GIS dataset into a raster dataset with cells equal to 1 acre. Using the Euclidean Distance tool in ArcGIS I created the 12-mile buffers around all urban cells. I determined the distance from each agriculturally capable cell to an urban area using the Times tool. By converting the rasters to integers, I was able to compute the number of acres in each buffer.

The lands most suitable for LFS production were determined by selecting the most capable soils and those closest to population centers (fewest miles). Land suitability, for the purposes of this study, can be expressed as: LandCap + Buffer Miles; for example: LandCap 2 + Buffer 12 = Suitability 14. Lands were then selected beginning with the lowest Suitability scores and moving to a higher score only when lands at a lower score were exhausted.

4.8 Results

A total of 96,147 acres were identified as being capable of agriculture production, according to the USDA ratings system, within the study area. Fifty-six thousand eight hundred seventy-four (56,874) acres of agriculturally capable land fall within the first-ring (12 mile) buffer zone. Thirty-four thousand two hundred ninety five (34,295) acres fall within the second-ring buffer and 4,193 acres is in the third-ring buffer. Table 4.3 displays the acreage by LandCap rating.

Table 4.3 Agriculturally Capable Lands in the FNSB

Buffer	Land Capability Rating	Acres
12-mile buffer	LandCap 2	8,527
	LandCap 2.6	398
	LandCap 2.8	26,528
	LandCap 3	21,421
	TOTAL	**56,874**
24-mile buffer	LandCap 2	4,684
	LandCap 2.6	0
	LandCap 2.8	0
	LandCap 3	29,611
	TOTAL	**34,295**
36-mile buffer	LandCap 2	0
	LandCap 2.6	0
	LandCap 2.8	0
	LandCap 3	4,193
	TOTAL	**4,193**
	Study Area Total	**96,147**

Although I did not exclude developed land from this initial assessment of lands with agricultural potential in the region, I overlaid a map of current land parcels on the agricultural-soils map of the FNSB (see Fig. 4.2). I found that much of the agriculturally capable land close to urban areas is already used for residential or commercial purposes.

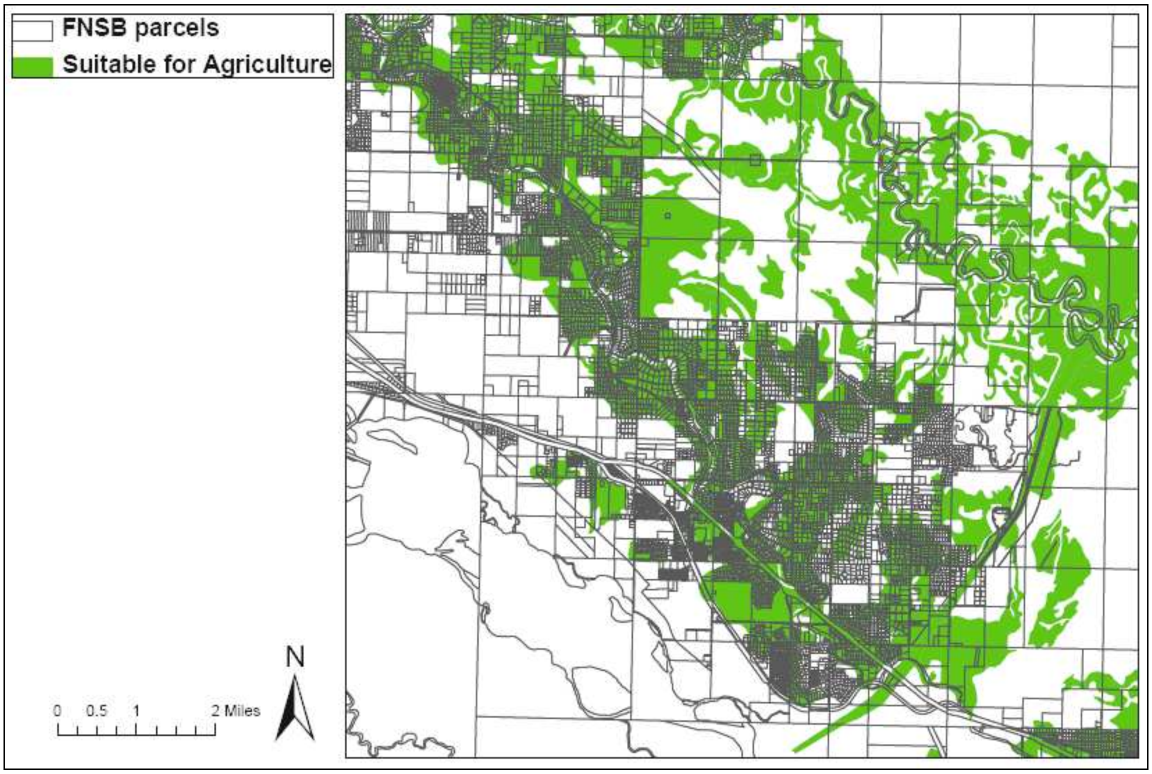

Figure 4.2 Current Land Use on Potential LFS Lands

The six crop scenarios resulted in land-use requirements ranging from 20,198 for potatoes alone, and up to 81,557 for an equal distribution of all 10 selected crops. Table 4.4 summarizes the 6 scenarios.

Table 4.4 Crop Scenarios and Acres

Scenario	Crops	%	Calories	Carbohydrates	Protein	Vit. A	Vit. C	Calcium	Iron	Total Acres/95,000 people
DRI			2435	130g	50g	540mcg	62mg	1167mg	10.5mg	
A	Potatoes	100.00		553g	64g	0*	623mg	379mg*	25mg	**20,198**
B	Potatoes	50.00								
	Barley	50.00		557g	54g	0*	311mg	300mg*	26g	**44,094**
C	Potatoes	33.00								
	Oats	33.00								
	Carrots	33.00		517g	68g	16.53mg	324mg	891mg*	23mg	**30,770**
D	Potatoes	50.00								
	Barley	12.50								
	Broccoli	12.50								
	Carrots	25.00		548g	77g	12.68mg	1197mg	1128mg*	26mg	**39,033**
E	Potatoes	50.00								
	Barley	12.50								
	Broccoli	12.50								
	Cabbage	12.50								
	Carrots	12.50		547g	85g	6.54mg	1599mg	1288mg	30mg	**43,381**
F	Barley	10.00								
	Beets	10.00								
	Broccoli	10.00								
	Cabbage	10.00								
	Carrots	10.00								
	Green beans	10.00								
	Oats	10.00								
	Peas	10.00								
	Potatoes	10.00								
	Zucchini	10.00		520mg	116mg	5.78mg	1627mg	1635mg	42mg	**81,557**

* does not meet DRI

Scenario A (see Table 4.4) uses the least amount of land, 20,198 acres, all of which can be found within the 12-mile accessibility buffer. However, the scenario includes only one crop – potatoes. In addition to failing to provide adequate Vitamin A or calcium, relying on a 1-crop food system makes the community extremely vulnerable to crop disease, weather, and climatic changes (Fraser 2007). In subsequent scenarios, I attempted to address these nutrient deficiencies through introduction and reallocation of crops. Scenario B splits the total required calories between potatoes and barley – a crop that is often suggested as the basis for an agricultural economy in the region, although it is most typically useful only as livestock feed (Pearson and Lewis 1989; Taylor 1983). Within the context of a food system, barley has some weaknesses. It does not provide Vitamin A and has less calcium than potatoes, which makes Scenario B even less nutritionally adequate than Scenario A. Inclusion of barley also more than doubles the land requirements to 44,094 acres, although all the necessary acres fall within the 12-mile accessibility buffer.

Scenario C further diversifies the dietary portfolio to include carrots and oats. The large quantity of carrots required to meet daily caloric intake (1.98kg/person/day) over-provides Vitamin A, which can be toxic at levels over 3000 mcg per day (Higdon and Drake 2007). This scenario also over-provides Vitamin C, but still does not provide adequate calcium.

Scenario D removes oats, which have a low yield per acre, and introduces broccoli, which is high in calcium. The scenario still over-provides Vitamins A and C, but comes within a few milligrams of meeting the calcium requirements and, therefore, is the first I consider to have crossed the threshold into sufficient nutrition for the population. At 39,033 acres, Scenario D can be accomplished within the 12-mile accessibility buffer.

Scenario E adds additional land (4,348 more acres than Scenario D). Despite the addition of cabbage to the crop list, Scenario E does not result in any particular nutritional benefits over Scenario D, although, the reduction of the carrot quantities improves the problem of the over-provision of Vitamin A. Scenario F includes all 10 crops for which yield data is available. There are no nutritional benefits, based on our selected nutrients, over Scenario D except for reducing Vitamin A over-provision. The land requirements for this scenario are more than double those of Scenario D because it includes many crops with relatively low calorie per acre yields. Lands required for Scenario F reach well into the 24-mile buffer, meaning the food could become less accessible to local residents. Maps of all 6 scenarios are included below in Figs. 4.3 – 4.8.

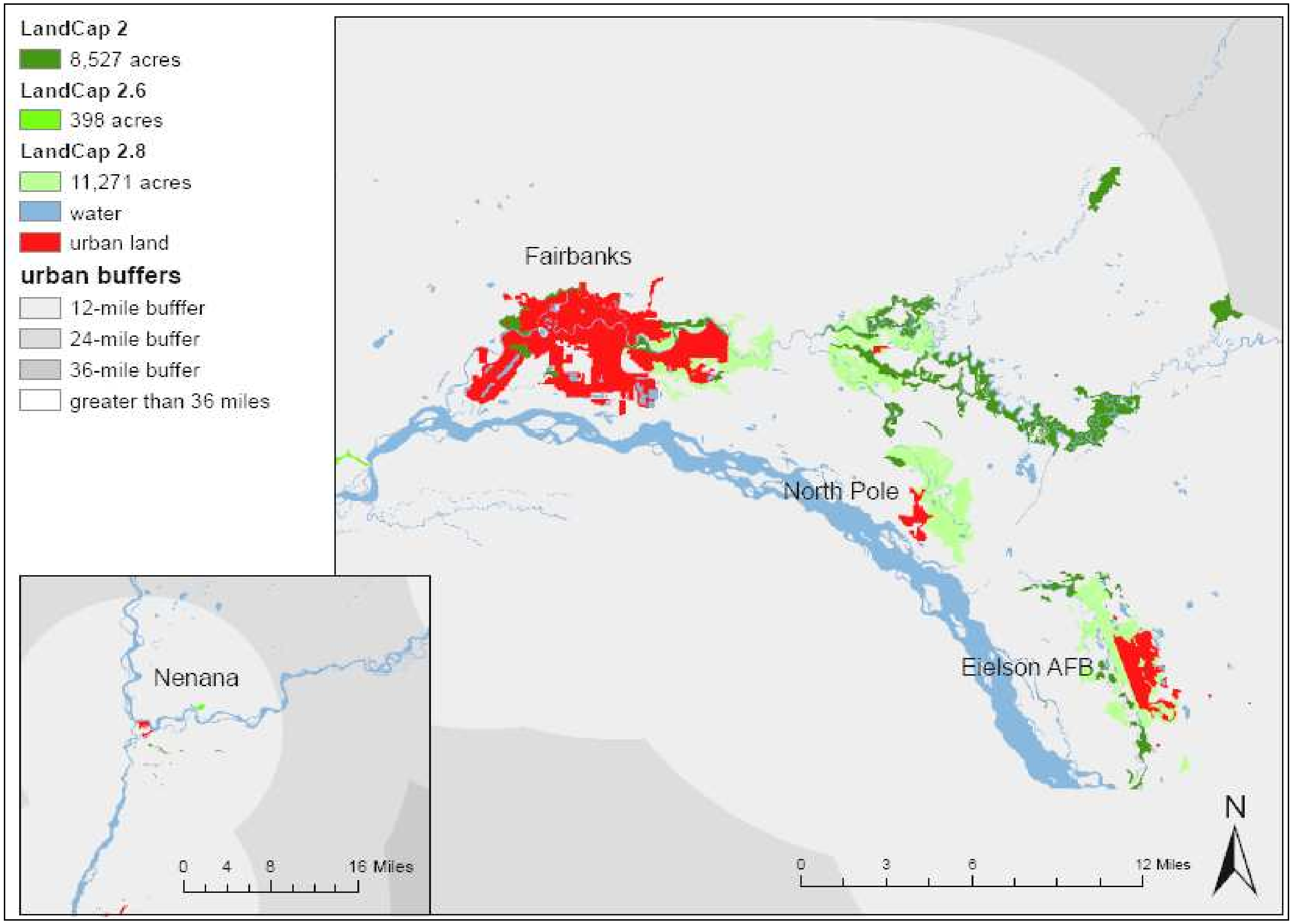

Figure 4.3 Local Food Production Scenario A – 20, 198 acres

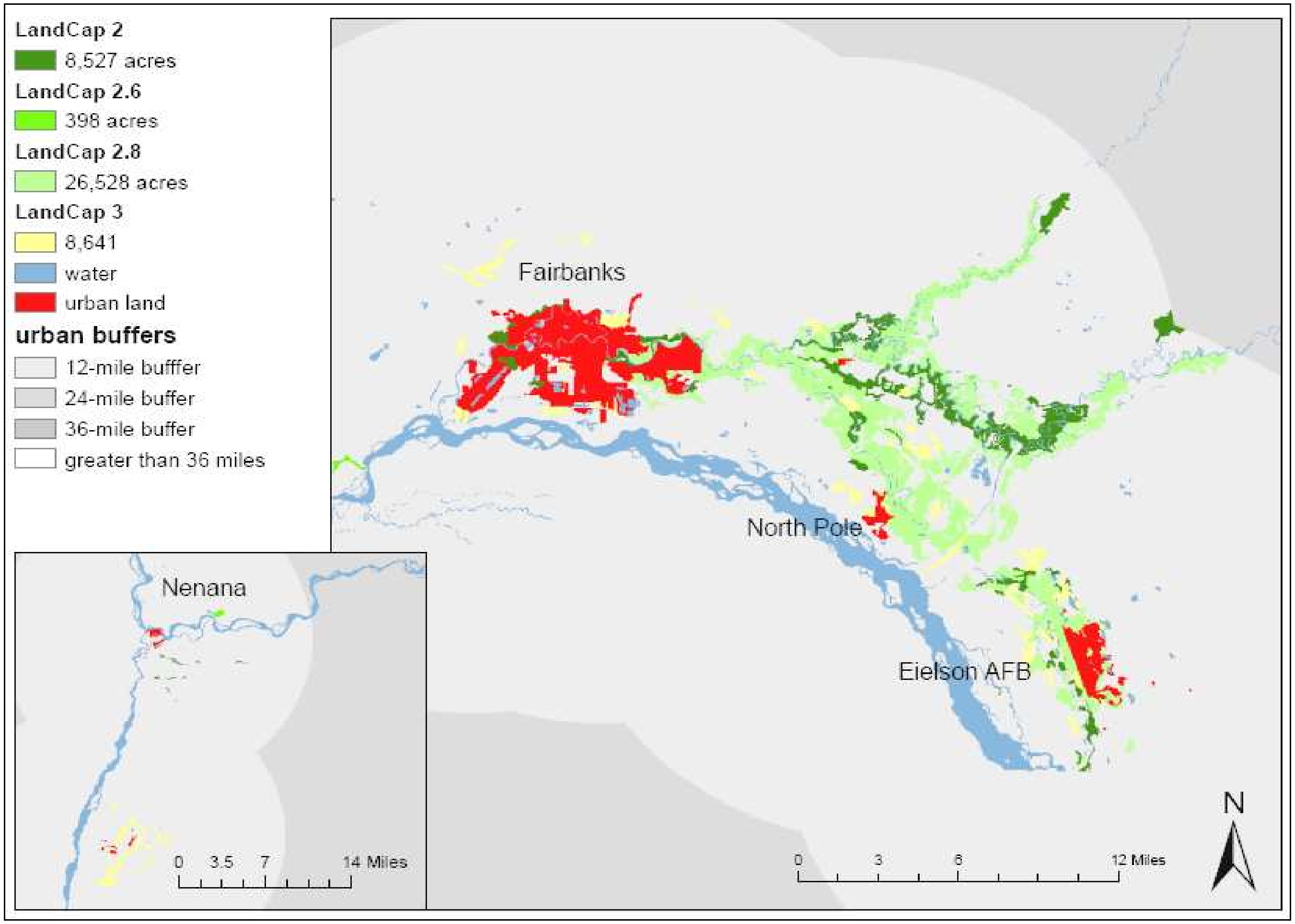

Figure 4.4 Local Food Production Scenario B – 44,094 acres

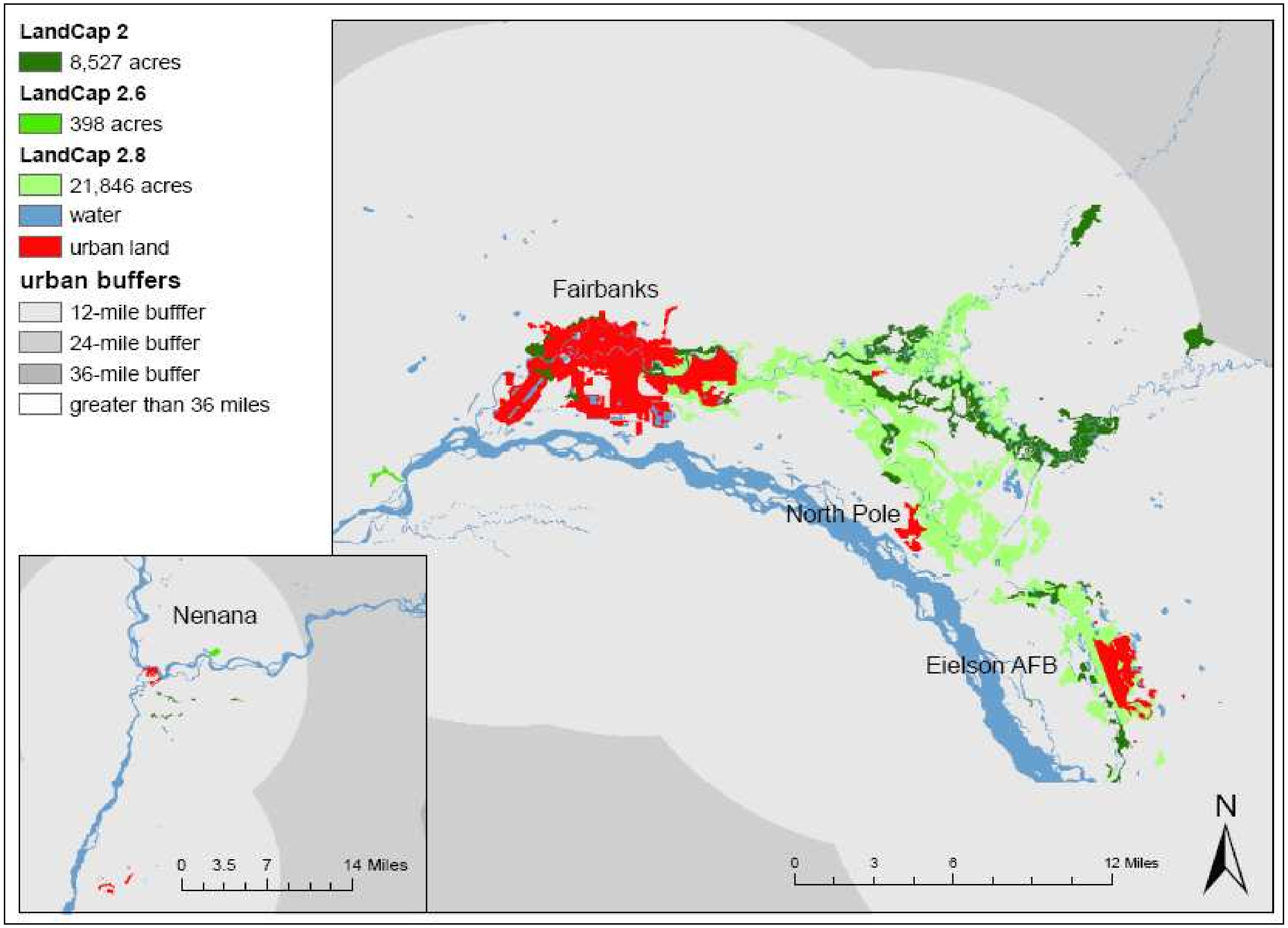

Figure 4.5 Local Food Production Scenario C – 30,770 acres

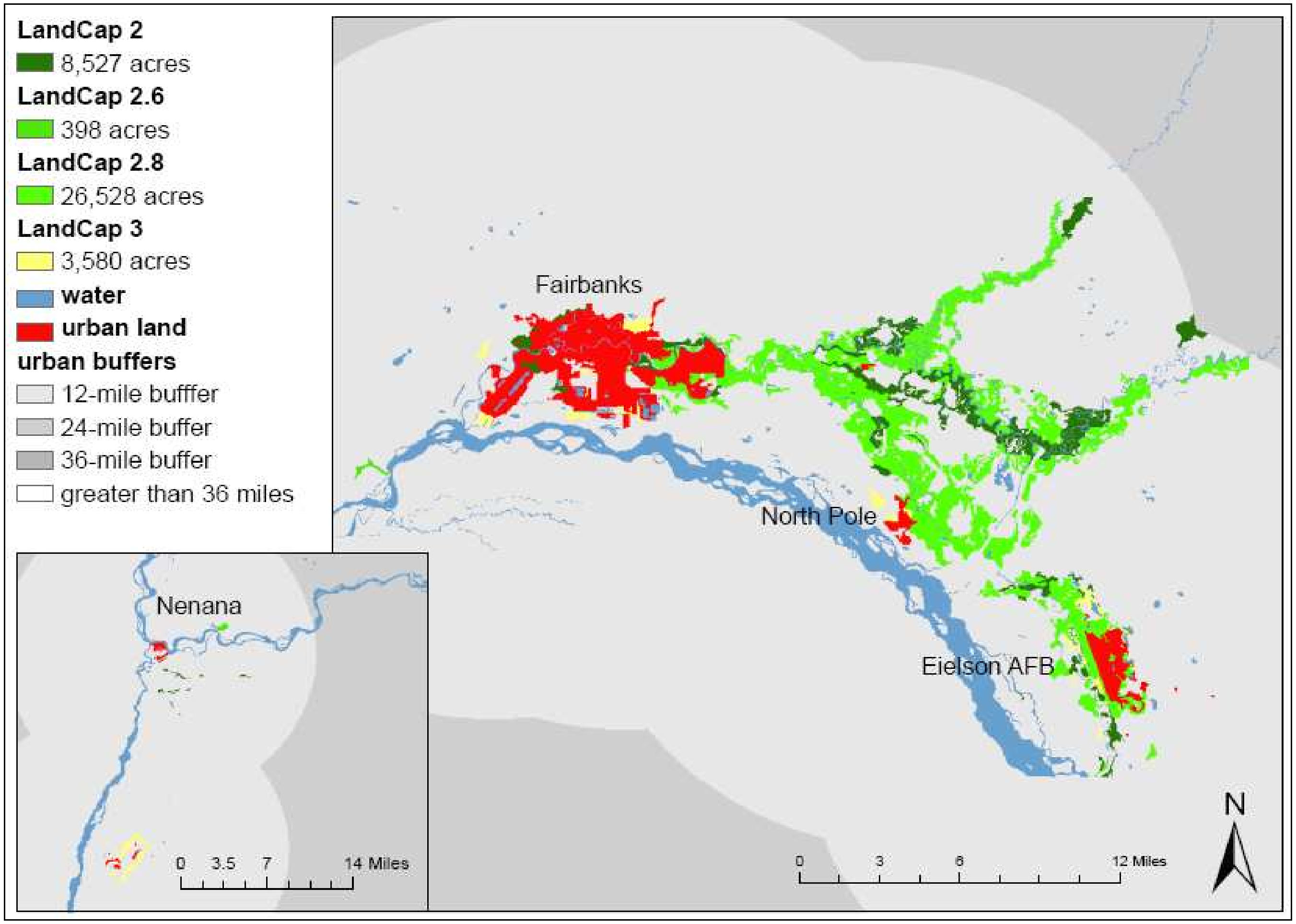

Figure 4.6 Local Food Production Scenario D – 39,033 acres

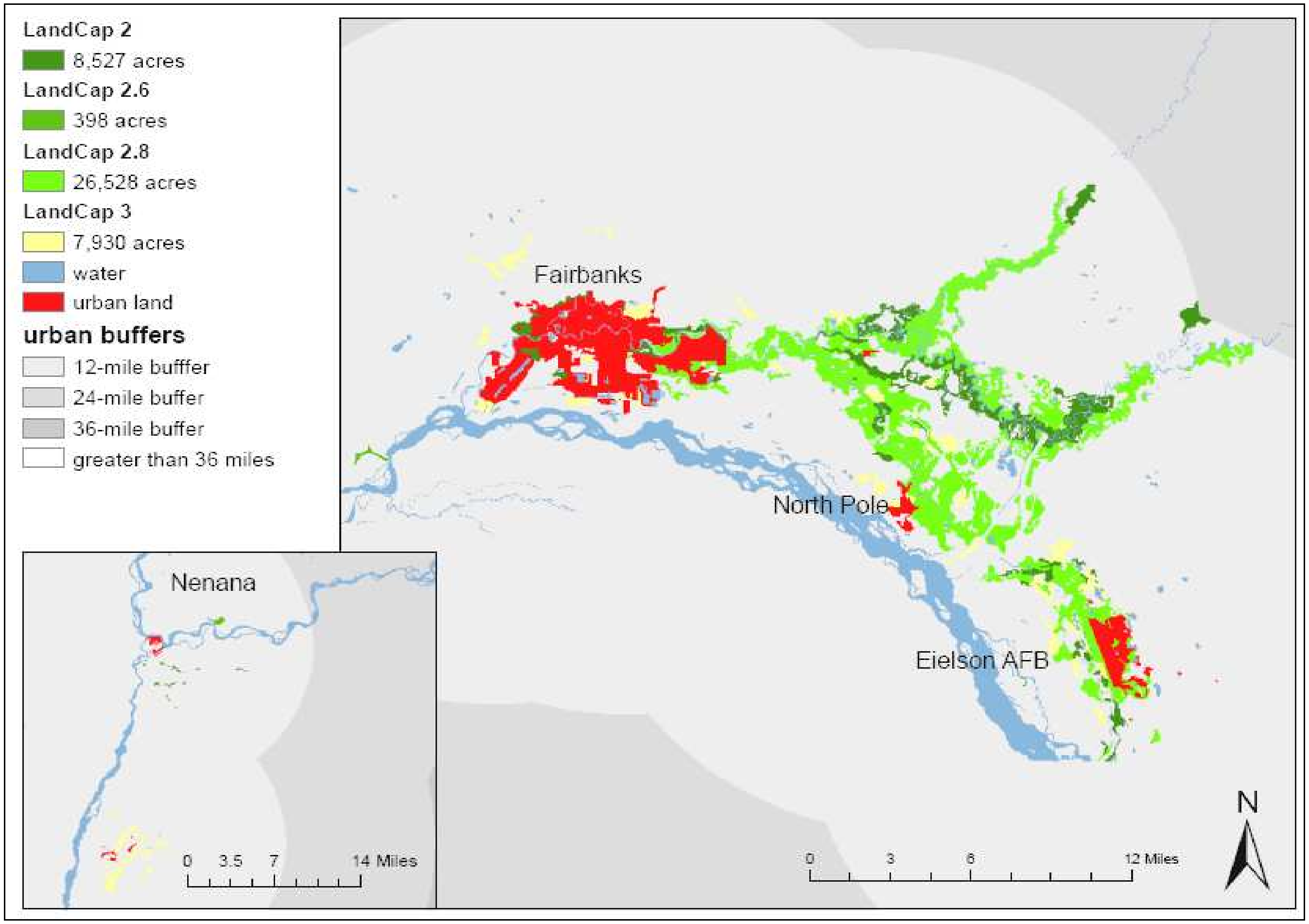

Figure 4.7 Local Food Production Scenario E – 43,381 acres

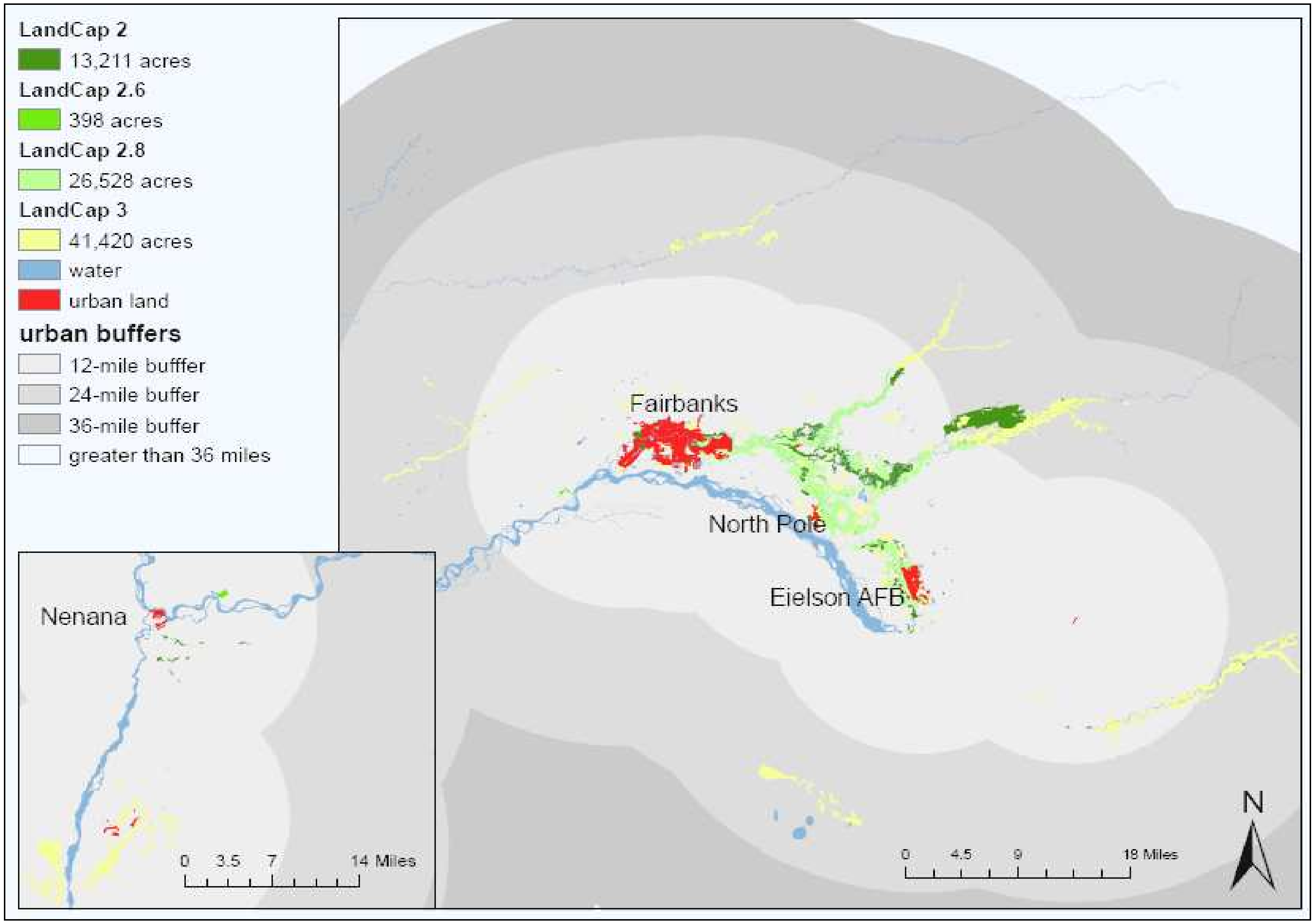

Figure 4.8 Local Food Production Scenario F – 81, 557 acres

4.9 Discussion

Based on these assumptions: that nutrients in the raw form of grains and vegetables are the same as in cooked form, that current yields are comparable and consistent with other lands and into the near future, and that agricultural production and diets will be limited to the most commonly grown grains and vegetables in the region, the FNSB has more than enough land to feed the community at its current population level. However, it bears repeating that our assumptions place sizable limits on the type of agricultural production modeled and the diet available to residents.

While I was able to model a diet (Scenario D) that meets the major nutritional needs of the community using as few as 4 crops, Sen (1981) notes that nutritional requirements are not the same as food requirements; simply meeting nutritional requirements without accounting for taste, preference, or variation often results in a diet that is "monumentally boring." If the available food is not palatable, culturally acceptable, or simply too routine and monotonous people may not eat it and its contribution to food security will be diminished.

The assumption that current crop yields will hold into the future is also somewhat problematic. The arctic and subarctic regions of the world are likely to experience significant biological and physical changes due to climate change (Intergovernmental Panel on Climate Change 2001; McCarthy and Long Martello 2005). Climate-change projections indicate that water may become scarcer in the region, limiting future agricultural potential, despite increased growing degree days due to rising temperatures (Juday, et al. 2005). In a climate change scenario, any large agricultural enterprise in the region is likely to require irrigation or other water provisioning infrastructure (Juday, et al. 2005), factors which may increase the cost of farming in the region. Due to the logistic and climatological challenges of high-latitude agriculture, barring major agricultural collapse in other regions due to climate change, imported foods are likely to remain less expensive than those grown in arctic regions (Juday, et al. 2005)[6]. If local production is not capable of lowering food costs in the region, then the local food system does not meet the critical equitable access test for a functional food system.

Rather than suggest that Fairbanks, or any community, design a food system based on hypothetical scenarios, we suggest the LFS footprint approach as a tool that communities can use to help assess their needs and resources and begin the challenging process of designing a healthy food system. The LFS footprint is in a preliminary stage of development. We hope, and encourage other researchers, to pursue several additional lines of inquiry to strengthen the method for the benefit of individual communities and provide a framework for future academic studies in the area of food-system localization and food-system reform.

The specific food and nutritional needs of the community must be the basis for any food-system plan (Amede, et al. 2004; Robinson, et al. 2003). Nutritional-optimization modeling can play an important role in this process. Optimization modeling allows food-system planners and advocates to design a nutritionally sound, sufficiently diverse diet appropriate to the agricultural region (Amede, et al. 2004). A nutritional-optimization model for the Fairbanks community is currently being constructed (Luick 2008), but was not available at the time of writing.

Food preference is not addressed in this study, but should be included in any assessment of community needs. Surveys, interviews, and dietary recall and food frequency studies should be used to discuss food preferences and current food sources with a cross-section of the community. Identifying culturally preferred foods, and identifying sources of those foods, is particularly important in a multi-cultural community like Fairbanks.

A detailed agricultural census of the region in question should be undertaken. All current farms should be mapped onto the LFS footprint maps. At present, GIS maps showing the location of farms in the Fairbanks region are not available to the public due

[6] It is important to note, however, that climate change is expected to have a significant negative impact on agricultural productivity worldwide (Brown 2004), meaning that, despite the challenges of subartic agriculture, its importance in food security regionally and globally may grow.

to privacy concerns. Farmers should be included in every step of the agricultural census and, with their permission, all current farms should be mapped and their potential for expansion considered, given soil and land conditions as well as development pressures. Food-system planners also need a census of exactly what is grown locally and the yields of all common local crops. While I had aggregate yields for the entire region available, a more detailed census will identify different farming practices and crops that may produce better yields.

The current market prices and demand for local produce should also be part of the agricultural census. This includes the cost of individual items at the local farmers' market as well as community-supported share prices. Assessing the current market prices and demand can help determine how much production per farmer would be required to make each farm economically sound – ensuring the farmers a stable and fair income.

Farmers should also be included in an assessment of human capital in the region. The number of farmers required to produce the desired amount of food should be calculated. If there are not enough people in the community with the knowledge and skills to farm, opportunities for recruitment to the region or education of current residents should be considered. An important source of local food production knowledge is local gardeners. Previous research has assessed the level of production at the Fairbanks Community Garden (see Chapter 3, p. 54), but the same type of assessment can and should be applied to home gardeners in the community.

Programs like the well-established Master Gardener Program at the University of Alaska's Cooperative Extension Service can help train additional people to garden at a household level and, thus, increase the expert knowledge base in the region. Master Gardener Programs are common at many land grant universities and can be an excellent source of information and education in the food-system-development process.

In addition to a detailed agricultural census, an assessment of the use of wild foods (large game animals such as moose and caribou, fish, and berries) by urban residents would be extremely beneficial to the process of planning a food system for

Fairbanks. A census of urban residents' use of wild foods, which potentially could be conducted by community members as part of a community food assessment, could aid in food-system development in 3 ways. First, it would help determine the extent to which these foods already contribute to the regular diet of community residents.

Secondly, an accurate census of current participation in subsistence practices could help determine the extent to which expansion of subsistence activities among urban residents is desired. Alaska State regulations give a priority, in times of scarcity, to those with a customary and direct dependence on the resources; Federal regulations prioritize rural residents over urban during times of scarcity (Getches, et al. 1998; Haynes 2003). These regulations may inhibit a large-scale increase in reliance on subsistence hunting and fishing to enhance the food system.

The third benefit of an urban-subsistence census would be to identify the locations in which urban residents usually harvest their resources. A map of common harvest areas in and around the community would help to determine whether increased agricultural production would interfere with these harvest areas.

Finally, the current development level of agriculturally capable lands should be determined and any additional development pressure on those lands assessed. Like many other North American cities, some of the best agricultural land in the Fairbanks region is adjacent to urban areas, under development pressure, or already developed. Between 1992 and 1997, the U.S. converted more than 6 million acres of agricultural land to developed uses (American Farmland Trust 2008). By overlaying a map of current land parcels on the agricultural soils map of the FNSB (see Fig. 4.2), I found that much of the agriculturally capable land close to urban areas is already used for residential or commercial purposes. The steps Fairbanks took in its land-development process vary from the usual pattern. Rather than move from forest to farmland then farmland to urban land, Fairbanks largely jumped straight from forest to urban or other residential land. By skipping the intermediate farmland step, residents may be unaware of the agricultural potential of lands in the region. Demonstrating, through the LFS footprint process, where the most agriculturally viable lands are in the region can help residents, planners, and legislators make well-informed land-use decisions. The need to carefully plan future land use is becoming more crucial to the region, which is expected to reach a population of 100,000 by 2018, if not sooner (Fairbanks North Star Borough 2005).

While development pressure on agriculturally capable lands is an issue common to many urban areas, Fairbanks has an addition concern related to land-use change. Much of the surrounding land is still boreal forest. The most common land-use change pattern in the region has been from forest to urban, skipping the farmland stage that occurred in many other urban areas. A land-use change from forest to agriculture has a range of potential effects on the surrounding ecosystem, including loss of wildlife habitat and regional biodiversity, loss of subsistence resources, reduction in carbon sequestration, and hydrological changes which might effect water quality and quantity regionally (Foley, et al. 2005; Randolph 2004).

If local food production is identified as a priority for the community, there are several effective methods to protect the agricultural lands available. After creating an LFS footprint to determine the amount of land required, a Land Evaluation and Site Assessment (LESA) would be valuable in further specifying which land can and should be dedicated to agricultural production in the region (Randolph 2004). A LESA assessment uses a combination of soil and site assessments, such as adjacent land use, water availability, and transportation accessibility, to rate the relative importance of agricultural lands in a given region (Pease and Coughlin no date). The LFS footprint approach suggests giving priority to lands closest to population centers. A LESA assessment, which is usually conducted by a committee of local stakeholders, can refine the site assessment standards based on specific local conditions. Once the most suitable lands are selected, farmland protection measures such as agricultural easements can be instituted by the local government to preserve working lands while allowing development on other, less agriculturally valuable, lands.

4.10 Conclusion

I structured the LFS footprint approach in a way that flips around many of the current discussions on the development of local food systems. Few studies have focused on assessing the ability of local-food-system initiatives to meet the needs of all community members and their environment. And none have yet to inquire into broad community needs, the local resources that might be applied to those needs, or, to put it more generally, what is both possible and practical to consider in terms of designing a food system for any given community. I began my assessment by identifying the nutritional and food security needs of the community then assessed whether the local region is capable of meeting those needs. My scenarios are intended as hypothetical illustrations of what is *possible* in the Fairbanks region. Although my results are not intended as a specific prescription for building a local food system, the local food system footprint is intended to act as a foundation for further examination of the current food system and planning for future food systems.

The local food system footprint method identifies the broad overall needs of a population – both the nutritional needs and the amount of land required to meet those nutritional needs. Once the overall requirements have been identified, the community can refine their investigations using tools like a community food assessment, which focuses on where food currently comes from and how it is distributed within the community, and Land Evaluation and Site Assessment, which helps to determine, specifically, which lands are available for local agricultural production.

The food system that emerges from a detailed assessment and planning process may or may not be locally based, regionally based, or globally based; it may in fact be based on a combination of various scales and sources. The LFS footprint might point to previously unrecognized resources or vulnerabilities in terms of land availability, suitability, and productivity. Visualizing the amount of land required to feed the community may provoke discussion about efficient use of resources, local vulnerabilities due to climate, or vulnerabilities related to reliance on external resources.

I propose this examination of community resources as a way to avoid the "unreflexive, romantic reaction against the global system" (DuPuis and Goodmand

2005) that sometimes emerges from dissatisfaction with the dominant food system and, instead, develop a food system based on meeting community needs in ways that protect environmental resources and promote social welfare. Community engagement and conscious food-system planning, using effective tools, can result in food systems that elevate processes and outcomes over fixed ideas of form or scale. By shifting the focus to outcomes, food systems can be designed to address the looming questions of how best to make food healthful, available, and accessible to a growing population in ways that efficiently use land, energy, and human resources, and protect or even improve the ecosystems upon which we depend.

5 Food-System Design: Methodological Issues and Data Gaps

5.1 Introduction

The preceding papers examine different aspects of one particular community's food systems, Fairbanks, Alaska, but place the community within the context of both the global food system and the movement toward more local or "alternative" food systems. The studies view the food systems at work in Fairbanks as they currently exist and then challenges this community, and others, to imagine what their food system could be – what they need, what resources they have available, and how they would like to use their natural and human resources to meet those needs.

My first task in assessing food systems was to determine what makes up the current foodscape, or the multiple places where food is available in the community (after Winson 2004), what works well in the current system, and what needs to be improved. The overarching question I posed at this stage was: How accessible – both physically and economically – are food resources within the community? Where are food outlets located, who has access to different kinds of food outlets, and how do food prices vary by food-outlet and food-origin?

As are many other food-system researchers, I am interested in the potential role of local food production in a healthy urban food system, I included current local-food-system initiatives such as community supported agriculture (CSA) enterprises and the Tanana Valley Farmers' Market in my foodscape assessment. I then examined local food production at an individual scale through the Fairbanks Community Garden. The same questions are relevant for all local-food-system initiatives: who participates and why? What are the barriers to and opportunities for participating in the initiatives? And, most importantly, which initiatives are working particularly well and why?

After examining the food system, as it currently exists, I chose to ask what is possible for the future of the community food system. This stage involved determining the large-scale needs of the community in terms of foods and nutrients, then assessing the ability for the socio-ecological system (land, climate, and human resources) to meet those needs. Although these papers are based in one particular community, the methods and approaches I use, and developed specifically for this study, are transferable and can be used to undertake similar studies elsewhere to provide more community-specific information as well as to develop a body of research from which general conclusions about local-food-system initiatives can be discerned.

5.2 Food Access and Food-System Resilience in a High-Latitude City

My first study of food access in Fairbanks (see Chapter 2; p. 16) drew strongly from public health literature in which the connections between low food access and poor health outcomes are a common topic (Algert, et al. 2006; Morland, et al. 2002; Wang, et al. 2007). The influence of Amartya Sen (1981) who clearly differentiates food availability and food access is also implicit in this study. Sen points out that simply having adequate stores of food available in a region is no guarantee that the population, particularly those without the financial means to purchase the food, will have access to it. Food availability does not determine food security – food access does. The human-health outcomes of a food system depend on whether people can access nutritious and sufficient food.

The field of public health has developed strong frameworks and methods for assessing food access (see for example: Algert, et al. 2006; Bodor, et al. 2007; Hendrickson, et al. 2006; Larsen and Gilliland 2008; Morland, et al. 2002). Proximity and access to healthful foods has been linked to better physical-health outcomes (Bodor, et al. 2007; Inagami, et al. 2006; Wang, et al. 2007). We can, and should, insist that any new food-system initiative make food at least as accessible as the current food systems at work in our communities, and plan accordingly, if these new systems are to ensure food security and positive health outcomes. In pursuit of this goal of determining the level of access to locally grown foods, I took spatial analysis methods, developed by public health researchers, to study general food-access issues and applied those methods to my study of LFS initiatives.

I mapped all existing food outlets – supermarkets, convenience stores, specialty food stores, and local-food outlets including the Tanana Valley Farmers' Market

(TVFM), community-supported agriculture (CSA) pick-up sites, and all locations listed as accepting Farmers' Market Nutrition Plan Coupons. Locally grown foods are unlikely to be available in supermarkets because the corporate entities who own the major food outlets prefer to deal with suppliers who can provide a consistent, year-round flow of products, as opposed to the small-scale, seasonal products more common in community or local food systems (Kloppenburg Jr., et al. 1996). Using census data that identified the population center of each census tract in the Fairbanks North Star Borough (FNSB), I was able to calculate average distances from these population centers to the various food outlets in the region and compare access between tracts with household incomes above and below the median for the FNSB. I was also able to compare the whole community's access to local foods and imported foods by measuring the distances from all population centers to supermarkets and local-food outlets.

I found that lower- and higher-income census tracts are approximately equidistant to supermarkets and local-food outlets, which is a good indicator of food access equity in Fairbanks. However, while I was unable to gather data on access to personal transportation, based on previous studies of food access in low-income communities (Whelan, et al. 2002), I made the assumption that lower-income households are less likely to have personal transportation and would find the additional distance to local-food outlets a barrier to participation in the nascent local food system.

When I compared access to supermarkets and local-food outlets for all Fairbanks residents, I found, again that the average distances to the closest supermarket (3.31 miles) and closest local-food outlet (2.89 miles) are not significantly different. However, most of the local-food outlets in Fairbanks are CSA pick-up sites and require membership to access food at that location. Most Fairbanks residents who wish to purchase locally grown foods will need to do so at a public outlet like the Tanana Valley Farmers' Market, which is an average of 7.59 miles from census-tract centroids, a much longer trip to access local foods than the 3.31 average miles to a supermarket.

Even for households with personal transportation, the location and timing of local-food outlets (usually only on particular days and times) means most residents need to make special shopping trips to access these foods. Allen (1999) makes a similar observation in her overview of the strengths and weaknesses of local-food-system initiatives. The additional time required to participate in the local-food economy creates barriers to participation for those with limited time or flexibility due to work and family responsibilities (Allen 1999). Macias (2008) and Alkon (2008) each found that farmers' markets targeted at low-income people, through siting of the markets in particular neighborhoods, improved access for low-income people. Public health practitioners have used similar approaches in their attempts to improve nutritional outcomes in low-income households (Algert, et al. 2006).

In addition to assessing physical access, I studied economic access to locally grown foods. I tracked the prices of a subset of vegetables available at the TVFM and in supermarkets in order to assess the economic accessibility of locally grown foods. I was not able to assess food prices for foods purchased through a CSA due to the lump sum, up-front payment format and weekly variability of amounts and types of foods contained in the farm shares. The critical work of tracking the cost and amount of food produced in CSAs must be pursued in the future and appropriate methods developed to do so. One possible approach is to simply calculate the aggregate per pound cost of weekly shares. But any attempt to quantify CSA share costs will require significant participation on the part of CSA farmers. In my earlier study of small farmers in the Fairbanks region, I found that record keeping varies significantly among the farmers.

Over the course of 7 weeks during the summer of 2007, I visited the TVFM and local supermarkets weekly to record the prices for each vegetable included in my sample. Supermarkets carried some Alaska - grown vegetables from the Matanuska-Susitna region of the state, so I was able to compare 3 groups: out-of-state; Alaska, but out-of-FNSB, and FNSB-grown vegetables. My findings indicate that FNSB-grown foods available on a per item basis through the TVFM are more expensive than comparable foods from outside the region. This price difference points to a potential economic access barrier for lower-income households who wish to purchase locally grown foods.

This finding highlights one of the most difficult challenges for local food systems – the need to support local farmers and ensure them a fair wage while also keeping food accessible to lower-income residents. These dual goals have proven particularly problematic. CSA enterprises, which have been successful for small farmers because the structure allows them to share their risks among a group of consumers, are not necessarily ideal for low-income consumers who lack the ability to make an up-front annual payment. While some CSAs, the larger and more well-established ones in particular (Guthman, et al. 2006), are able to offer alternate payment schedules, this is not economically feasible for all farmers. Small-scale farmers are less likely to receive the government subsidies that help reduce costs for large-scale growers and are less likely to be in a position to absorb the financial shock of a poor growing season. Without those subsidies, and with use of more environmentally sound, but also more labor-intensive farming methods, food produced by small-scale farmers tend to be higher than comparable non-local foods, reducing food access for low-income consumers. But, farmers and farm families deserve a "decent return" for their work (Allen 1999), and are entitled to charge the prices that permit that return. State-funded programs like the Farmers' Market Nutrition Program that provides coupons for use on locally grown foods are one approach to improving local-food access, but the program depends on the state's ability and willingness to subsidize the food system. The tension between supporting farmers and supporting low-income residents is likely one of the major challenges of creating a local food system.

Local-food-system initiatives, if they are to be considered effective and successful, should be capable of producing the human and environmental-health outcomes of food security, social welfare, and environmental security. If we are to fundamentally shift the way we produce, process, consume, and think about food, one would hope we would be shifting toward a better system than we have currently. Targeting of particularly food-disadvantaged neighborhoods by local-food-system practitioners or other health programs, combined with the use of government food-entitlement programs or subsidies may be one effective approach to improving food access and health outcomes for low-income households (Algert, et al. 2006; Guthman, et al. 2006; Macias 2008). The process of spatial analysis and other quantitative assessments that reveal patterns in both the conventional (global) and alternative (local) food systems at work in a community can be used to help LFS practitioners target specific sites for food distribution and, therefore, improve food access within the community.

While food systems have not been a traditional topic of urban planning, the American Planning Association has recently issued a policy statement on the need to consider food security in the physical design of cities (American Planning Association 2007). As a result, food-system advocates may have new partners within their cities who can use tools such as zoning, tax incentives, and re-allocation of development rights to encourage the siting of stores and markets in areas of need and in areas accessible to the whole population.

5.3 Food-System Localization at Ground Level: A Case Study of the Fairbanks Community Garden

My second study (see Chapter 3, p. 54) was an attempt to understand who participates in current local-food-system initiatives. In building the research design and scoping the problem, I chose to focus on the Fairbanks Community Garden in order to work with people who were directly involved in food production. This component of the larger food-system study attempted to identify barriers to and opportunities for direct participation in LFS initiatives. I used a range of research methods including surveys, interviews, economic valuation, and wildlife surveys – an approach appropriate to the study of a socio-ecological system like a garden.

The community gardening literature ranges from gardens' roles in community building and social activism (Baker 2004; Hynes 1996; Smith and Kurtz 2003; von Hassell 2002) to their potential for improving food security in urban areas (Brown and Carter 2003; International Development Research Centre 2004). One study (Voicu and Been 2008) has linked community gardens to a positive effect (rising) on property values adjacent to the gardens in New York City. Matteson (2007) joins a trend more common in European research (Andersson 2006; Colding, et al. 2006) in which the environmental effects of urban gardens (and greenspaces in general) are assessed. Matteson examined the role of New York City community gardens, and type of garden, in providing insect habitat.

Beyond the ecological and large-scale economic studies of urban gardens, few studies have attempted to actually quantify the nutritional and economic contributions such gardens make to individual gardeners and their communities. Blair, et al. (1991) authored one of the few studies to evaluate the role of gardening in the lives of gardeners in terms of nutritional changes and the economic value of garden produce. They conclude that gardening is a strategy that overcomes many of the barriers to increasing vegetable consumption for inner city residents by directly providing fresh vegetables to gardeners who consume them and share them with others in the neighborhood. However, few additional studies have replicated the work of Blair, et al. to determine whether it is applicable in other cities. My experience in attempting to replicate this work proved logistically challenging, due to the need to coordinate with a number of individual gardeners over an entire gardening season, which might account for the lack of replication by others as well.

During my first field season in the FCG (2006), I surveyed gardeners to determine their reasons for gardening, what they typically grow, and their gardening practices. I found that most people garden primarily for enjoyment. I followed up with semi-structured interviews in order to ask more detailed questions about gardening practices, types of plants in each garden plot, and, most importantly, outcomes from gardening and the community garden that I had not considered in my survey. These interviews yielded some touching and insightful stories about the garden and the importance of the practice of gardening in the lives of many participants. The information garnered through semi-structured interviews helped me to broaden my frame of reference and to understand that, while the garden does produce food, the practice is much more personal for most people. Tapping into the personal connections people feel to their garden, community and environment can be a powerful force in promoting and sustaining both local food and local environmental projects.

Returning to the garden in 2008 gave me the opportunity to conduct a quantitative assessment of the FCG. I attempted to develop and enact a method to measure the amount of food being produced in the FCG garden plots. I recruited 10 volunteers to participate in the study and met with each one at least 3 times during the late summer, once garden harvests had begun. I weighed and recorded each item harvested during each meeting and extrapolated these findings to the estimated 9 weeks of possible garden harvests. I was able to estimate the economic value of garden harvests per plot by calculating how much a gardener would have paid to purchase his or her harvest at a supermarket or the local farmers' market. Results ranged from approximately $9.87 worth of vegetables per week to $37.18 per week depending on where comparable foods are purchased and the type of vegetables grown. The experience or skill level of the gardener as well as the weather in a given year may also play a role in the amount of food produced. Links between experience and economic value of harvest, such as how many years it takes for the average gardener to produce a harvest that offsets household food costs should be explored further. Longitudinal studies of garden harvests could also help identify the specific impacts of poor weather on food production in the region.

Another important line of inquiry I was not able to undertake is to calculate the percent of their household's food that community gardeners are able to produce. In the original survey gardeners self-reported that 36% of them produce 50% or more of their household's seasonal (summer) vegetables in the garden. However, the harvest survey returned a relatively low average replacement cost of $15.51 per week, which on the surface seems like too little to make a significant contribution to offsetting household food expenditures, but the size of the offset depends on how a family allocates its food budget. Further study to determine exactly what percent of household food is being produced in the garden might help gardeners and local-food advocates determine the most successful strategies for increasing production and nutrition levels.

Taking a cue from the trend toward viewing cities as unique ecosystems, particularly the contributions of greenspaces to urban ecosystems (Alberti and Marzluff

2004; Andersson 2006; Barthel, et al. 2005; Colding, et al. 2006; Gilbert 1989; Godefroid and Koedam 2003; Honnay, et al. 1999; Kinzig, et al. 2005; Nilon and Huckstep 1998), I included a study of wildlife on small-scale agricultural lands in the Fairbanks area into my food systems inquiries. Although preliminary in nature, these findings indicate that birds may benefit from the diverse habitat spaces created by small-scale agriculture[7]. I suggest that additional studies focus on comparisons of bird species diversity and abundance in developed urban neighborhoods and the community garden to identify any specific effects of the FCG on the urban ecosystem.

Urban agriculture, which in North America is often found in the form of community gardens, is gaining popularity. It promises opportunities for fresh, healthful food, greater interaction with the local environment, and increases in greenspaces in urban areas. As I found in my study, it is also an activity that brings participants a great deal of pleasure and promotes community interactions. Gathering data on the social and personal aspects of community gardening was relatively straightforward. Most participants find it to be a positive activity in their lives and they were happy to share their knowledge, experience, and beliefs through surveys, interviews, and casual conversation. Gathering data on the food and nutritional outcomes was much more challenging – but is at least as important as other outcomes and so we must find ways to gather this data. Blair, et al. (1991) assessed community gardens based on estimates of potential harvest rates developed by horticulturalists. However, as I witnessed during both summers at the FCG, one cannot necessarily rely on projections of harvest made at the beginning of the gardening season because of the potential for weather, individual gardener skill, or other circumstances to greatly affect plant growth and garden production. In 2006, a late frost caused significant damage to garden plants, reducing the overall output of the gardens. Then, in 2008, poor weather conditions slowed and reduced harvests yet again. Recording the actual output of the gardens will yield more accurate data on the food and nutritional outcomes of gardening. However, this is a time-consuming and logistically challenging undertaking. Based on my experience, I

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[7] I wish to acknowledge and thank Anna Maguire, my field assistant, who conducted the bird surveys and the staff of the Alaska Bird Observatory who provided indispensible technical advice and support.

would repeat the study by recruiting gardeners much earlier in the season – as they are planting their gardens so that the "intended" crops can be recorded. I found that asking gardeners to record their own harvests, even when equipment and forms were provided, proved ineffective in most cases. The researchers need to be involved in the data collection to ensure accuracy. Researchers should meet regularly with gardeners to record the state of the garden, specific gardening practices, any unforeseen circumstances that affect the crops prior to harvest, and record as much of each garden's harvest as possible. Such data collection should occur over a period of several years to smooth out any one year's over- or under-abundance. Local-food-system advocates and practitioners can use this data to anticipate what to expect from their initiatives.

5.4 Local Food Footprints: A Tool for Food-System Planning

My third study (see Chapter 4, p. 92) moved beyond my assessments of what is already being produced in the Fairbanks community to project what might be possible for the region if the scale of food production was increased to create a fully local food system. Can a balanced and nutritious diet be provided using only local land resources? What is the smallest amount of land required to meet the nutritional needs of the entire population? This chapter builds implicitly, if not explicitly, on Bennett's concept of the ecological transition, or the process of converting natural substances into "natural resources" for human consumption (Bennett 1976; Bennett 1993). The local food system footprint I designed provides a chance to visualize the natural substances (land) that will be converted to resources (agricultural land) used to feed the population.

The approach, of calculating food and nutritional needs, and laying those needs out on the landscape has previously been undertaken on a household scale(Amede, et al. 2004; Robinson, et al. 2003). Amede, et al.'s study and Robinson, et al.'s framework for agricultural development both start with the assumption that the meeting the nutritional needs of the household is of primary importance in a small-scale agricultural system. Given the fact that in an urban community like Fairbanks, most people are engaged (and will continue to be engaged) in non-subsistence labor, I needed to scale up these household-level assessments. I assumed that the hypothetical LFS represented by the

LFS footprint would be predominately professionally managed. However, because of my experience in the FCG, I recognize the importance of creating and maintaining spaces where people can engage in household-scale food production if they wish.

I began the LFS footprint analysis by determining the total number of calories required to feed the population of the Fairbanks region. Although I used an estimate of calories based on USDA daily recommended intake levels for various age and gender groups, it may be possible to make a more precise estimate by using the most current census data, which reports gender and age categories for the region. I included the major nutrients found in each of the selected food crops to ensure that in addition to caloric needs, my model would also meet nutritional needs. Through an iterative process of calculation and reallocation of different crops and percent of individual crops in a basic spreadsheet, I developed a series of crop scenarios that meet various food and nutritional requirements ranging from simple caloric needs, to caloric plus major nutritional needs, to the most diverse diet possible given the sample of crops selected. Once the nutritional scenarios were developed, I mapped each scenario onto agriculturally suitable lands in the Fairbanks region.

All of my scenarios were based on the need to provide 2,435 calories per day to a rounded population of 95,000 people for a year. The scenario that meets caloric needs with the smallest amount of land in production (20,198 acres) uses only potatoes. The scenario with the greatest crop diversity (equal percent of each of 10 crops) requires 81,557 acres in production. The scenario that produces adequate nutritional outcomes with the least land (39,033 acres) uses a combination of potatoes, barley, broccoli, and carrots.

The point of the LFS footprint was not to design a food system for the community, which is not the role of any single person, but rather to prompt LFS advocates to begin any food-system realignment or redesign with a clear understanding of what the community needs, wants, and has available to them. For example, I found that a nutritionally balanced diet could be provided to the current community population using approximately one-third of agriculturally capable land – leaving plenty of space for population growth. However, that diet is extremely limited (only 4 crops are used) and is, therefore, unrealistic for consideration of an actual food-system model. In addition, some of the land I identified as agriculturally suitable (capable of agricultural production and in close proximity to population centers) is already developed for largely residential uses. It is unrealistic to think that a community would remove residential development to make room for agricultural production. But, pointing out that some of the best agricultural land in the region is covered by housing (a situation repeated around the country) may spark discussion about the direction and rate of future development in the region.

I developed the LFS footprint approach as a way to explore a number of the major issues in food-system design and development: identifying the needs of the community, including caloric, nutritional, and food preferences; providing a way for community members to visualize their food needs in a concrete (local land) context; and encouraging people to think about what it would mean, in terms of land use, environmental impact, and economic impact, to produce their food locally. Important questions for community discussion include:

- How much land the community wants to devote to food production and what amenities might be lost in the land conversion process?
- Which crops and foods are most desirable to community members?
- How much processing will be required, based on the crop choices, and are facilities available locally or regionally?
- What kind of food production methods should be used? What are the benefits and trade-offs of using organic production methods versus more conventional farming methods?
- What are the ecological impacts of converting large quantities of land to agricultural use?

Although I do not claim that an entire food system can be rationally modeled and designed using this method, the method can be improved to provide more detailed and accurate data on which to base these important discussions. First, in terms of the data quality, nutritional optimization modeling would significantly strengthen the model by providing much more specific data on nutritional needs in the community and the range of crops capable of meeting those needs. Second, I relied solely on published crop yield data for the region. Local farmers, who use a variety of farming practices, could potentially provide much more detailed information on locally adapted crops and crop yields.

Most importantly, the lesson from this exercise is that designing, or even speculating about building a community food system is not the purview of any one person – no matter how sound and accurate the data. The LFS footprint process should be a community undertaking that involves residents, farmers, land-use planners, environmental officials and advocates, among a long list of other concerned community members. I ask that people use the LFS footprint to begin a conversation about community needs and preferences, available resources, the consequences of allocating those resources to one use or another, and what their vision of a food system suitable for the community, local or not, looks like, acts like, and provides the community.

5.5 Conclusion: Engagement at all Scales

In the search for ways to improve human and environmental health outcomes through the redesign of food systems, too much attention has been given to the scale of food systems and too little attention given to the specific practices and outcomes within any given system. There is nothing inherently good, bad, positive, or negative in any scale: large, small, local, regional, or global (Born and Purcell 2006). The goal of food-system reform – whether labeled local, proximate, alternative, or sustainable – is to address the problems in the dominant food system. This reform will require attention to protagonists and processes at all scales and in all places of the food systems that support us. The global food system has not yet succeeded in producing nutritious, accessible food to all people at all times, nor are those practices which are common within the system ecologically sustainable in the long term. However, greater localized control and production does not guarantee these outcomes either. The problem to be addressed through food-system reform is that we, as a society, have never consciously planned our food systems, let alone designed one capable of creating food, environmental, and social security; and we currently lack the methods and information to do so.

Practices and approaches that improve the key food-system outcomes of food security, environmental security, and social welfare should drive food-system design. More research is needed in this area in order to address significant data gaps in the overall effectiveness of alternative food-system initiatives in meeting these key out-comes, particularly in the area of equitable food access. I would like to see more rigorous assessments of all sectors of food systems so that we can begin the process of collecting a set of best practices that can be shared among and adapted to all communities – rich, poor; net-producers, net-consumers; politically-strong, or politically-weak.

Our efforts to develop alternative food systems based on rigorous inquiry and assessment should also encourage us to continue our contact with and involvement in the global food system in order that we might continually push for change and reform within and outside of our own communities. Although academics engaged in food-system reform have attempted to make clear that they seek change at all scales and in all communities (Hinrichs, et al. 1998; Kloppenburg Jr., et al. 1996), as with many nuanced issues, the message is not necessarily reaching the general public where the food-system issues play out. I fear that the public over-simplification of food-system-reform messages have lead some people to use local-food-system initiatives as attempts to simplify a complex set of issues in such a way as to make them feel protected from the complexity: if we don't like how food is produced elsewhere, it seems easier to decide to produce it ourselves, where we can see it, than to challenge the multinational industries and political institutions that currently control the global food system. But, any attempt to insulate ourselves from the perceived harm of the global food system can also reduce our sense of solidarity with those still engaged in the system, but who lack the power to secede.

We should not completely remove ourselves from the dominant food system no matter how much we might disagree with its major protagonists and practices, because in doing so, we risk reducing our ability to remain aware of the problems and to influence decisions and promote change – for our benefit and for the benefit of others with even less political influence[8]. Instead, we should use our assessments of successful, and unsuccessful, food-system practices to move toward lasting food-system reforms that address the food security, environmental, social, and cultural needs of communities and their people.

[8] Andrew Szasz describes the process of withdrawal from perceived harm and the consequent reduction in political or social engagement it brings in his book "Shopping Our Way to Safety: How We Changed from Protecting the Environment to Protecting Ourselves." University of Minnesota Press 2007.

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Appendix A

Human Subject Research Approval

INSTITUTIONAL REVIEW BOARD

UNIVERSITY OF ALASKA FAIRBANKS

UAF ORI Office of Research Integrity

Teresa Lyons, Research Compliance Administrator
Chancellor's Director for Research Suite
P.O. Box 75720
Fairbanks, AK 99775-7270

Office of Research Integrity
212 West Ridge Research Building
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August 9, 2005

Subject: IRB review of Human Subjects Application form IRB 05-52

Dear Dr. Gerlach,

Members of the University of Alaska Fairbanks Institutional Review Board (IRB) have reviewed the following Human Subjects Application. This protocol will be approved via an expedited review process in accordance with CFR Title 45 §46.101 Category 7: Research on group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

IRB Protocol Number:	05-52
Investigator/Instructor:	Craig Gerlach, Ph.D.
Title of Project/Course:	*Community Gardens in Urban Alaska: Urban Planning and Community Sustainability from the Roots Up*
Date Received:	08/08/05
Date Approved:	08/09/05
Annual Continuing Review Report:	Due July 1, 2006

NOTE: The UAF Policy for the Protection of Human Research Participants is attached. The UAF IRB approved training is available online at **www.uaf.edu/irb/training.htm**

Procedural changes or amendments must be reported to the IRB, and no changes may be implemented without prior IRB approval. Congratulations and good luck with this very interesting project.

Teresa Lyons
Research Administrator

Attached : *Request for Modification Application*
UAF Policy for the Protection of Human Research Participants is

Appendix B
Animal Care and Use Approval

UAF
UNIVERSITY OF ALASKA
FAIRBANKS

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Institutional Animal Care and Use Committee
909 N Koyukuk Dr. Suite 212, P.O. Box 757270, Fairbanks, Alaska 99775-7270

June 19, 2008

To:	S. Craig Gerlach, PhD Principal Investigator
From:	Erich H. Follmann, PhD IACUC Chair
Re:	IACUC Assurance Application

The University of Alaska Fairbanks Institutional Animal Care and Use Committee (IACUC) reviewed the following Assurance at their June 10, 2008, meeting. This Assurance was approved with no requests for revisions or modifications; therefore I am pleased to issue approval.

Protocol#:	08-44
Title:	*Local Food Systems and Community Sustainability*
Received:	June 3, 2008
Approved:	June 10, 2008
Review Due:	June 10, 2009

The PI is responsible for acquiring and maintaining all required permits and permissions prior to beginning work on this assurance. Failure to obtain or maintain valid permits is considered a violation of an IACUC assurance, and could result in revocation of IACUC approval.