

## Mapping Food Desert Persistency in Thunder Bay, Ontario, 1996-2006

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### Abstract

Thunder Bay, Ontario is a remote community that has been identified in recent government reports as having high percentage of residents living below the poverty line as well as having the largest increase in the province in food bank usage from 2007 to 2009. Identifying neighbourhoods with multiple risk factors and poor access to full-service food retail provision (i.e., food deserts) is a key step in strengthening the local food system. Food deserts were found in all three census years used in this study. Two food deserts persisted and many new food deserts appeared on peripheral regions of the city over this time period.

**Key words:** Food insecurity; Food security indicators; Food desert mapping

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### INTRODUCTION

Ten percent of Canadians have difficulties meeting daily food requirements on a regular basis and some inherently vulnerable groups have rates two to five times higher than that (Che & Chen, 2001; Power, 2007; Damman et al., 2008; de Schutter, 2012). This equates to approximately three million people across the country; a number that

may be rising given current trends of increasing food bank usage and growing unemployment rates in the country (Riches, 2002; Spence, 2009). The United Nations Special Rapporteur on the right to food has recommended that Canada implement immediate steps to address the lack of political inertia on this issue (de Schutter, 2012).

Identifying food deserts (i.e., urban neighbourhoods with high social deprivation and poor access to full-service food retailers) is an effective way to visualize a community's state of food insecurity (Furey et al., 2001; Kirkup et al., 2004). Food desert mapping shows that access to food is dependent on a number of factors that extend beyond geography and location. Rather than ask residents direct and sensitive questions, food desert studies determine the types of food-retail outlets that are available to neighbourhoods, what the level of accessibility to healthy, nutritious food is for locals and what physical and economic barriers may be restricting the health and diet of residents (Donkin et al., 1999). Identifying the pockets of disadvantage that are emerging through food desert studies would allow politicians and planners to take action in alleviating barriers to community food insecurity (Reisig & Hobbiss, 2000; Smith & Morton, 2009).

The specific goal of this project is to identify and examine the persistence of food deserts in Thunder Bay, Ontario, using Canadian census data from 1996 to 2006. The Urban Poverty Project included Thunder Bay in the list of cities in Ontario with a large proportion of households having to pay more than 30% of their income on shelter costs (CCSD, 2007) and food bank usage in Thunder Bay had the sharpest increase in the province of Ontario from 2007 to 2009 (Spence, 2009). While these findings are not directly indicative of food insecurity rates, they do suggest an increase in the presence of individuals facing difficulties in attaining healthy and culturally-appropriate food. This project, it is hoped, will lead to a stronger local food system and to educate its residents about food insecurity issues.

## 1. LITERATURE

The term *food deserts* refers to populated areas in a community that have little to no access to full-service food retail provision (Cummins & MacIntyre, 1999). There are two extremes of household food insecurity: households with high and disposable income and several available vehicles; and households with limited income and little to no access to vehicles, living far away from the nearest grocery store (Furey et al., 2001). Identifying and addressing the existence of food deserts is a complicated, yet important, undertaking for a community.

Food deserts are areas of social exclusion as residents are not able to fully participate in the social, cultural and economic aspects of a community (Stephens, 1996). Research in Ireland discussed how participants in focus groups living in food deserts complained about missing the social aspect of food shopping in their own neighbourhoods (Furey et al., 2001). A food desert may therefore have additional profound effects of worrying social isolation (Reisig & Hobbiss, 2000).

Mapping food deserts involves combining data on food retail locations with a population's socio-economic information. Merging these two types of information gives a broader view of a community's food system and choices available for residents (Hyman et al., 2005). The study of urban food insecurity has been most extensive in the United Kingdom (Donkin et al. 1999; Wrigley, 2002; Rex & Blair 2003; Kirkup et al. 2004) and the United States (Blanchard & Lyson, 2002; Antin & Hora, 2005; Short et al., 2007). While Canada shares some similarities with these nations, its geography, demographic, political and economic characteristics suggest that the experiences of its citizens may be unique (Smoyer-Tomic et al., 2006). Studies of food desert mapping have been completed for the cities of Edmonton, Alberta in 2006, Montreal, Quebec in 2007 and London, Ontario in 2008. Each of these studies used distinct approaches in conducting their research with mixed results on the existence of food deserts.

The earliest study done in Edmonton used demographic data from the 1999 Civic Census along with food retail locations (Smoyer-Tomic et al., 2006). They hypothesized that supermarket accessibility would be lower in the inner city than in suburban areas and that accessibility would be limited in areas of high need. The study yielded surprising results that seemed to reject the main hypothesis. Areas classified as being in the highest 'need' bracket, found in the inner city, were also those with substantially better access to supermarkets; conversely the suburbs were found to be lacking in nearby food retail outlets. They did find six neighbourhoods with 'unsupportive local food environments' that could be considered food deserts. Overall, the study concluded that in 1999 there was relatively good access to supermarkets in Edmonton's inner city with a few isolated neighbourhoods in older,

low-income neighbourhoods that were tentatively classified as food deserts.

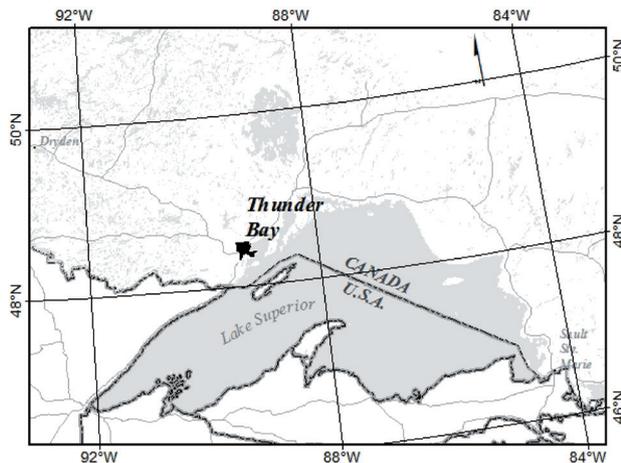
Apparicio et al. (2007) focused on finding food deserts in Montreal, Quebec. They began their research with a similar hypothesis to the Edmonton study that low-income or inner city census tracts would have lower accessibility to food retail outlets than other neighbourhoods. The socio-demographic factors that they chose to incorporate into their study were low-income population; and a social deprivation factor that included data on single-parent families, unemployment rates, low levels of education and recent immigration. This approach allowed the researchers to identify census tracts where risk factors affecting social deprivation were cumulative. Their conclusions were similar to those found in the Edmonton study; specifically that inner-city neighbourhoods had the highest degree of accessibility to grocery stores. They sought to explain this result by positing that suburban development is, on principle, less dense and preferred by middle-income families that own personal vehicles. Thus, supermarket chains tend to build fewer, but larger, stores in these areas and establish more, smaller, stores in the high-density urban cores. Overall, this study concluded that geographic accessibility to food was not a pressing social issue in the city, claiming that currently Montreal has no food deserts.

Larsen and Gilliland (2008) studied food deserts in the relatively smaller Canadian city of London Ontario (375,000 in London vs. 1.8 million in Montreal and 730,372 in Edmonton) and applied a temporal analysis, studying the change in the presence of food deserts and location of food retailers over the period from 1961 to 2005. Similar to Apparicio et al. (2007), this study used several socio-economic variables such as low educational attainment, single-parent families, low-income and unemployment rate, to map neighbourhoods with multiple risk factors. Their analysis concluded that access to food retail outlets had dramatically decreased over the given time period for many, if not most, neighbourhoods in London. Additionally, they found that when public transit routes were not considered, low-income neighbourhoods had the worst access to food retail outlets in the city.

The literature makes it evident that identifying places where social deprivation is elevated and access to healthy and varied food is questionable is an important early step to the development of sustainable, food secure, communities. The effects of food deserts on community and individual health have been well documented in research conducted in cities the world over. Research in northwestern Ontario may provide insight on the state of food insecurity in a different setting. While most food desert research has been conducted in large city centres (see Furey et al., 2001; Whelan et al., 2002; Apparicio et al., 2007; Short et al., 2007), this research examines a smaller urban centre in a remotesetting.

## 2. STUDY AREA

Thunder Bay is on the west coast of Lake Superior in northwestern Ontario (see Figure 1). With a population of just over 100,000 it is the biggest urban centre in northwestern Ontario, accounting for 50% of the region's population. Thunder Bay was previously two cities, Port Arthur and Fort William, until 1970 when they were forced to amalgamate after many decades of competition over economic opportunities had created large debts for both cities (Tronrud & Epp, 1995). Today, Thunder Bay has a diversified economy based on the industries of pulp and paper, manufacturing, telecommunications, research and development, mining, tourism and retail.



**Figure 1**  
**Thunder Bay, Ontario**

Northwestern Ontario has a variable climate with extreme temperatures recorded between -47°C in the winter to 38°C in the summer. This variable climate, dominated by the cold season, results in a fairly short growing season of 120 days (Ontario, 2008) which limits regional agricultural production. The lack of local large-scale agricultural production leaves most northwestern Ontario residents dependent on production and import from southern latitudinal areas (TBFAN, 2004). As in many other remote urban centres, the transportation of food over long distances results in elevated prices (Hinricks & Lyson, 2007). Citizens of northwestern Ontario have been found to pay an additional \$60 more per week on food and sundries than their southern Ontario counterparts (TBEJC, 2007). The remote location coupled with a strong dependence on distant areas for food makes

cities in northwestern Ontario inherently food vulnerable and makes achieving food security a bigger challenge.

## 3. METHODS

An extensive literature review identified over two-dozen demographic variables used to identify risk factors related to food insecurity (e.g., low income, high unemployment). This list was compared to the complete Canadian census variable list searching for demographic variables that were available for all three census years of this study, and for those variables that were available at the most detailed scale available. In Canada the smallest sampling area for which census data is available changed from the enumeration area (EA) in 1996 to the dissemination area (DA) in 2001. EA and DA census data normally represents approximately 300-500 people, and are used in many urban studies to convey and analyze at the neighbourhood scale (Hyman et al., 2005). This process identified ten demographic risk factors suitable for food desert mapping. Data redundancy was examined using principal components analysis (PCA) and confirmed using a Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Hinton et al., 2004). Additionally, Bartlett's test of sphericity can be used to identify whether a relationship exists between the variables. The PCA results showed the variables for single-parent and female-led single-parent households had the strongest degree of correlation ( $r = .962, .951$  and  $.975$  for 1996, 2001 and 2006 respectively;  $p < 0.001$ ). Additionally, the variables for average income per family member and average family income showed high degrees of correlation for all three years ( $r = .965, .874$  and  $.966$  for 1996, 2001 and 2006 respectively;  $p < 0.001$ ). Reducing highly correlated variables with an  $r$ -value exceeding 0.8 (or below -0.8) has been recommended (Hinton et al., 2004). The variables single-parent families and average family income were kept because they were more commonly used in previous research. The KMO and Bartlett's tests run for 1996 (KMO=0.543, Bartlett's=26 243.678,  $df=28$ ,  $p < 0.001$ ), 2001 (KMO=0.602, Bartlett's=17 807.151,  $df=28$ ,  $p < 0.001$ ) and 2006 (KMO=0.651, Bartlett's=49 864.336,  $df=28$ ,  $p < 0.001$ ) affirmed the use of PCA for the datasets. Table 1 shows the eight food insecurity risk factors selected for use in this study. The selected Ontario census data was 'cleaned' manually in a spreadsheet for entries that may cause errors (such as unnecessary zeroes or missing data) (Hull, 2000; Minot & Baulch, 2005).

**Table 1**  
**Final List of Socio-Demographic Risk Factors**

Indicator	Scale	Source and calculation
Average family income	EA/DA	Average individual / familial income as detailed in the Canadian census
Percent of households spending more than 30% of income on shelter	EA/DA	Number spending >30% on shelter as detailed in the Canadian census

To be continued

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Indicator	Scale	Source and calculation
Percent of population under age of 15	EA/DA	Number of individuals under 15/total population
Percent of population over age of 65	EA/DA	Number of individuals over 65/total population
Number of single parent families	EA/DA	Number of single parent families as detailed by the Canadian census
Population with low-education	EA/DA	Number of individuals with less than grade 9 education as detailed by the Canadian census
Unemployment rate	EA/DA	Unemployment rate as detailed by the Canadian census
Individual use of alternative transportation	EA/DA	Use of alternative transportation, as detailed by the Canadian census

For the purpose of this project, full-service grocers were defined as grocery stores that consistently sold all four food groups throughout the year (i.e., fruits and vegetables, grains, dairy, and meats and/or meat substitutes). Food retailers were contacted by telephone to confirm their selection of food for sale and self-designation. In a few 1996 cases, these criteria could not be confirmed by telephone, and several long-term residents of Thunder Bay were contacted for confirmation.

A 500-metre buffer was created around each of the grocery stores to represent what is deemed in the literature as an acceptable walking distance to obtain groceries (Donkin, 1999; Larsen & Gilliland, 2008). Though other studies have used larger buffers to assess walking access, this study assumes that 500 metres accurately represents the distance that inherently vulnerable groups such as the elderly, disabled or single parents could conceivably walk to obtain groceries on a regular basis, particularly during harsh northwestern Ontario winters.

Using a similar methodology to those employed by Cummins and MacIntyre (1999) and Apparicio et al. (2007), each of the eight census variables were reclassified and tallied to produce an Accumulated Risk Factor (ARF) that simplified the mapping process and the graphic presentation of multiple risk factors. Each of the eight census variables were reclassified into quartiles and the number of times the DA/EA was in the worst quartile was totaled producing an ARF score. Overlaying the grocer locations and walking buffers on top of the ARF scores allowed us to create one map for each year of the study that incorporates all eight risk factors and portrays the walking access each in neighbourhood to a full-service grocer. For this study, we define food deserts as a neighbourhood that has an ARF score of five or higher and is outside the 500m walking distance. The three maps were then compared to examine the persistence of food deserts in Thunder Bay from 1996 to 2006.

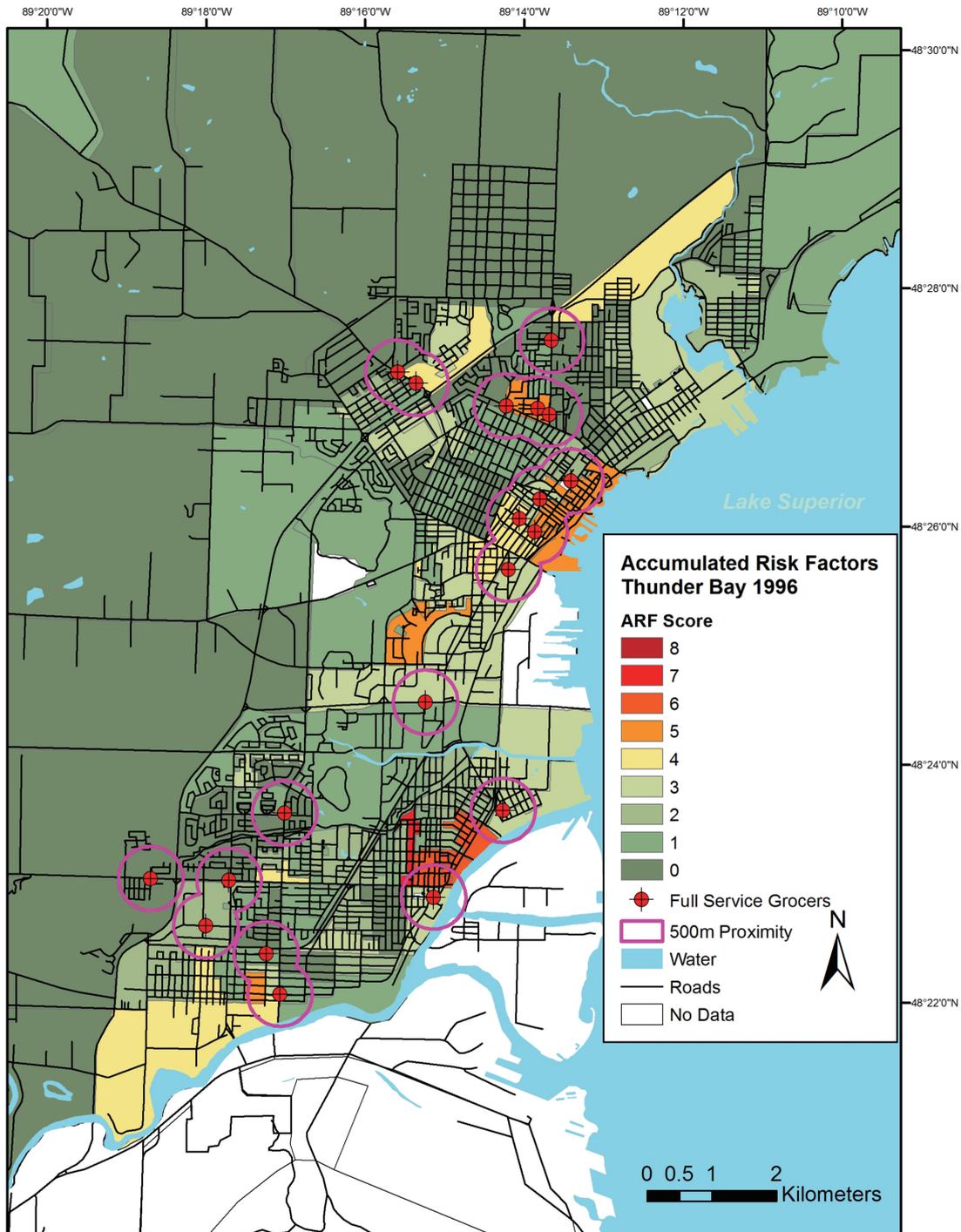
#### 4. 1996 RESULTS

Figure 2 shows the 1996 ARFs and full-service grocer buffers for Thunder Bay at the enumeration area (EA) level. There were 20 full-service grocers in Thunder Bay in 1996; somewhat clustered in the north and south ends

of the city. The population of Thunder Bay was stable from 1991 to 1996, increasing by only 0.5% over that time period. Local unemployment in 1996 was very high at 10.7%.

In 1996, food deserts are found in two parts of the city (see Figure 2). The first is located in the central part of the city. This food desert is comprised of one EA and has an ARF score of five. This neighbourhood was mainly residential in the northern section and commercial in the south. The residential parts are a mixture of single-family homes and multiple-residence townhomes and fourplexes. Grocery shopping options are to the south and to the northeast but are further than the 500m walking distance used in this study. The five high risk factors for this neighbourhood include a high percentage of elderly residents (24%), high percentage of single parents (7.6%), high unemployment (22%), high percentage of residents with only a grade nine education (12%), and a high percentage of residents spending more than 30% of their income on housing costs (19%).

The second food desert is located in the southeastern part of the city, which includes most of the old Fort William downtown core, and is comprised of portions of three EAs. This neighbourhood has a very high ARF score of six, among the highest for Thunder Bay for the time period covered in this study. This “Intercity” area of Thunder Bay has gone through major changes since the two cities amalgamated in 1970 (Tronrud & Epp, 1995). There are two nearby full-service grocery shopping options, one to the northeast and one directly south where the walking buffer covers a significant portion of the high risk area. Two of the three EAs have a high percentage of elderly (23.8% and 31.2%). Two of the three EAs have a high percentage of single parents (7.9% and 5.6%). All three EAs have a high unemployment rate (18.8%-38.1%). Two of the three EAs have a high percentage of residents using alternative transportation (14% and 14.5%) and all three EAs have a high percentage of residents with only a grade nine education (13.6%-20%). All three EAs also have a high percentage of households spending more than 30% of their income on housing (20%-43.4%). All three EAs also have very low household average annual incomes (\$18,375-\$43,228).



**Figure 2**  
**1996 Accumulated Risk Factors and Food Desert Map of Thunder Bay, Ontario**

### 5. 2001 RESULTS

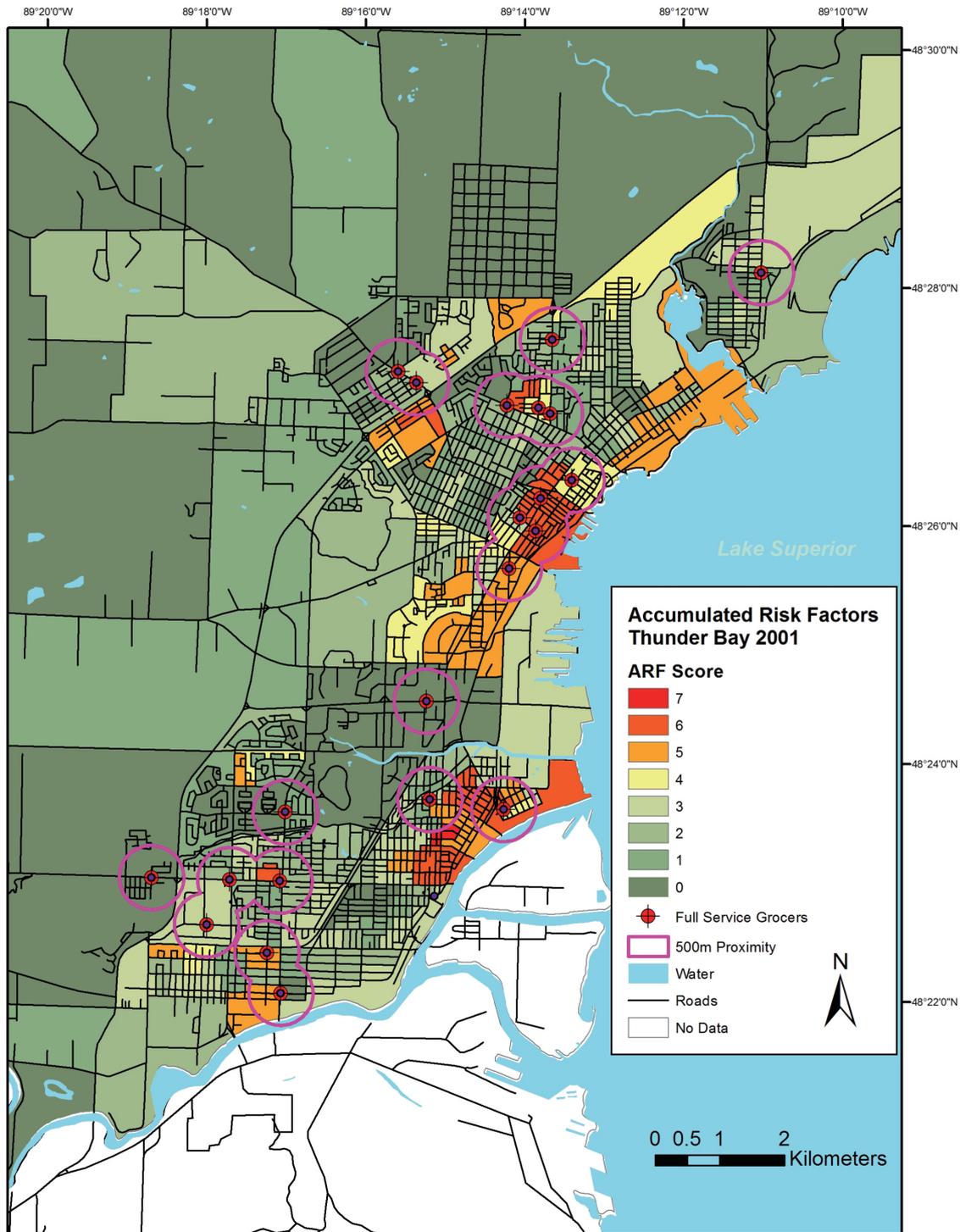
Figure 3 shows the 2001 ARFs and full-service grocer buffers for the city of Thunder Bay at the dissemination area (DA) level. There were 22 full-service grocers in Thunder Bay in 2001 showing a clustering pattern in the north and south parts of the city similar to that found in 1996. Population dropped 4.1% from the 1996 level and the 2001 Thunder Bay unemployment rate also dropped

to 8.8% from 10.7% in 1996; linked at least in part to the residents who moved out of Thunder Bay seeking jobs.

In 2001, the north end of Thunder Bay has developed three new food deserts (see Figure 3). The most northeastern of these three new northern food deserts is a neighbourhood comprised of two DAs, both with an ARF score of five. This area is a mainly an older residential neighbourhood whose shopping options are to the south

or to a new (i.e., since 1996) full-service grocer to the northeast; but distances are significantly longer than 500m. One of the two DAs had only 255 residents in 2001 and some census variables were not provided possibly due to confidentiality concerns. This DA has 43.1% elderly and 29.4% of residents with only a grade nine education. Both DAs have high unemployment rates (20% and

22.5%) and both have a high percentage of residents with only a grade nine education (11.4% and 29.4%). Both DAs have a high percentage of residents that are single parents (5.9% and 9.1%). One of the DAs has a high percentage of residents paying more than 30% of their income for housing (27.4%) and one DA has low average family income (\$40,800).



**Figure 3**  
2001 Accumulated Risk Factors and Food Desert Map of Thunder Bay

The northernmost food desert in Thunder Bay is one DA that has an ARF score of five (see Figure 3). The closest full-service grocer option is not far south of this neighbourhood but it is across the TransCanada Highway (#11/17) and is therefore quite dangerous for many non-vehicle modes of transport (e.g., walking, biking). This DA has 23.4% of residents under 15 years of age, 14.1% of residents are single parents, and 30.8% of residents spend more than 30% of their income on housing costs. This DA had an unemployment rate of 13.3% and an average household income of \$41,093.

The food desert in the northwestern part of Thunder Bay is just south of two full-service grocers but, as with the previously discussed food desert, these residents would have to cross the TransCanada Highway (#11/17) to access these two nearest stores (see Figure 3). Other grocer options are to the east but are further away. This neighbourhood is comprised of three DAs, two of which have an ARF score of five and one with an ARF score of six. This neighbourhood is mainly residential but has various commercial businesses on its northeastern edge. All three DAs have low average family incomes (\$25,262-\$48,755 per year), all three DAs have a high percentage of residents who are single parents (6%-14.6%), and all three DAs have a high percentage of residents paying more than 30% of their income for housing (20.8%-58.7%). One DA has a high percentage of residents with only a grade nine education (26%) and two of three DAs have a high percentage of residents under 15 years of age (30.5%, 38.2%). Two of the three DAs have a high unemployment rate (14.6%, 22%) and two of three DAs have a high percentage of elderly (21.4%, 37%).

The central part of the city now has increased from one to two food deserts in 2001, both with ARF scores of five (see Figure 3). These two food deserts are a mixture of single- and multiple-residential homes with a significant amount of commercial development on the eastern parts. Residents have grocery shopping options to the northeast and to the south but most areas are outside the 500m walking distance. Risk factors in these neighbourhoods include high percentages of residents that are single parents (11.8%, 18.5%), high percentage of residents who pay more than 30% of their income on housing (54%, 54.3%), and both DAs have low average household incomes (\$39,019, \$43,530 per year). One of the two DAs has a high proportion of elderly (22.4%) and one DA has high unemployment (18.5%). One of the two DAs has a high percentage of residents with only a grade nine education (21.2%) and a high percentage of residents who are under 15 years of age (28.3%).

The food desert in the southeastern corner of Thunder Bay found in 1996 (see Figure 2) has increased in size; partially due to the closure of one full-service grocer in the southern section and opening of another in a new grocer northwest corner of this food desert (see Figure

3). This food desert is comprised of parts of six DAs and has ARF scores ranging from five to seven, with four of these DAs scoring six. With such high ARF scores for these six DAs, risk factors are numerous. All six DAs had high percentages of residents paying more than 30% of their incomes on housing (22.7%-70.3%), had low average family incomes (\$26,714-\$45,790 per year) and had a high percentage of residents with only a grade nine education (12.3%-18.2%). Five of the six DAs had a high unemployment rate (10%-20%) and had a high percentage of residents who are single parents (5.9%-9.2%). Four of the six DAs had a high percentage of elderly (24.7%-31.2%) and half of the DAs had a high percentage of residents using alternative transportation (13%-21%).

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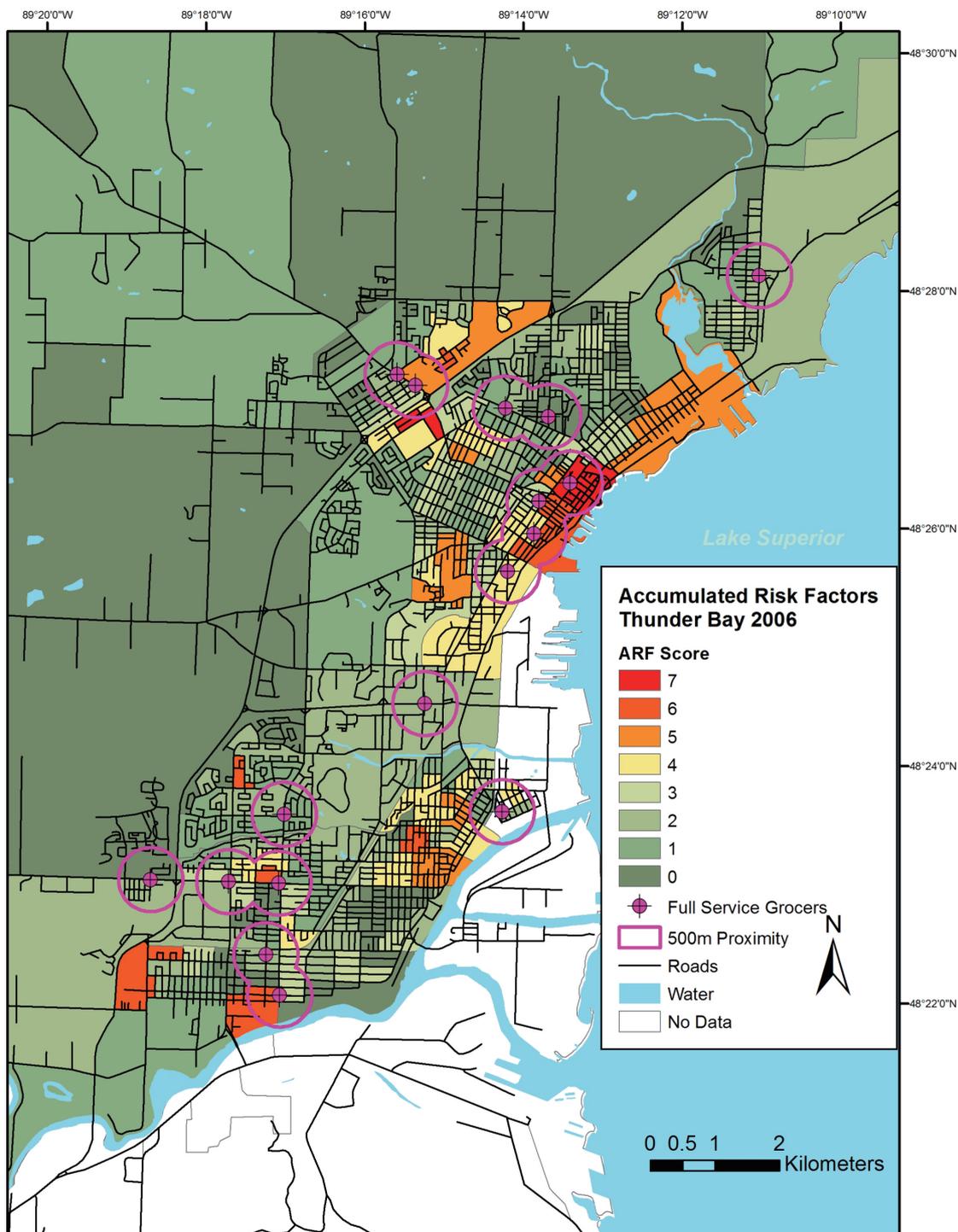
## 6. 2006 RESULTS

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Figure 4 shows the 2006 food deserts for the city of Thunder Bay at the dissemination area (DA) level. The number of full-service grocers dropped to 17 from 22 in 2001 and maintained similar north and south clusters as found in both previous census years. Population stayed nearly constant from 2001 with only a 0.1% increase and unemployment level in the city dropped from 8.8% in 2001 to 7.2% in 2006.

The food desert pattern in the northern part of Thunder Bay in 2006 is similar to 2001. The north end of Thunder Bay lost two full-service grocers from 2001 affecting the north edge of the city possibly the most over this time interval. Risk factors for these food deserts mimic the 2001 situation so will not be restated.

The food deserts previously found in the central part of Thunder Bay have shifted a bit further north in 2006. This neighbourhood is primarily residential with many types of high-density housing, including townhomes and apartment buildings. The full-service grocer situation for this central area was stable from 2001. The southeastern corner of Thunder Bay lost one of its two 2001 full-service grocers but the ARF score for more than half of this area's DAs improved from 2001. These changes created a slightly larger and more diverse food desert situation compared to 2001. The southwestern region of Thunder Bay lost one of its seven clustered grocery stores and the small food desert in the southwest corner of Thunder Bay has expanded to two DAs (see Figure 3). Both these DAs have an ARF score of six and both DAs have risk factors including high unemployment (10.5%, 21.1%), high percentage of households paying more than 30% of their income for housing (23.8%, 28.5%), high percentage of residents with only a grade nine education (24.4%, 32.7%), high percentage of single parents (13.4%, 13.6%), high percentage of residents under 15 year of age (26.8%, 27.1%), and both DAs have low average household income (\$41,276, \$48,517).



**Figure 4**  
**2006 Accumulated Risk Factors and Food Desert Map of Thunder Bay, Ontario**

## 7. FOOD DESERT PERSISTENCE AND TRENDS

The food desert maps of Thunder Bay, Ontario, created for this study clearly depict changes over ten years and three censuses. There are several neighbourhoods in the central part of the city and the old Fort William central business district that are consistently food deserts that may require

attention from the city's social planners. Persistent food deserts from 2001 and 2006 also include neighbourhoods in the most northern and most southern parts of the city. This pattern could be expected for a city with a stable population base because most full-service grocers want to be centrally located rather than on the city's edge.

Overall the food desert situation in Thunder Bay is worsening. This is a similar result to the study in London,

Ontario by Larsen and Gilliland (2008) whose work can be considered possibly more comparable to the research in Thunder Bay despite the difference in population of the two cities (i.e., ~100,000 in Thunder Bay, ~375,000 in London). The London study found a correlation that the poorest neighbourhoods were those most likely to have poor access to supermarkets. Although a similar correlation statistic is not reported in this research for Thunder Bay, both low average household income and households paying more than 30% of their income on housing were common risk factors for many food deserts found in this study.

Smoyer-Tomic et al. (2006) and Apparicio et al. (2007) both came to the exact opposite conclusion in their Canadian city studies: specifically that poorer neighbourhoods actually had the best access to food. These contrasting results may be due to the significantly larger populations and densities found in larger cities (i.e., ~800,00 in Edmonton, ~1.8 million in Montreal). Realistically, grocers often rely on a customer base or population density threshold to establish confidently in a city. The low population density of Thunder Bay could account for the dispersed distribution of grocery stores over the landscape. Additionally, neighbourhood and inner city gentrification projects that are ongoing in larger cities may dispel some of the obstacles reported by chain-supermarkets that have stopped them from opening in these areas. Similar gentrification projects in the city of Thunder Bay have been limited.

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## CONCLUSION

Thunder Bay is an isolated city in northwestern Ontario with only a small amount of local food production. This regional food insecurity aspect of living in an area with low food production per capita is well understood by long-term residents. Food insecurity on a neighbourhood level was less well understood and needed to be examined. Using Canadian census data from 1996, 2001 and 2006 along with full-service grocer locations, food deserts were found in Thunder Bay for all three census years. The two food deserts found in 1996 persisted throughout the entire study and at least three new food deserts were identified in 2001 which persisted through to 2006. This study has demonstrated that neighbourhoods in Thunder Bay may be experiencing social stresses through the proliferation of food deserts.

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