HUNGRY AND HURTING

Assessing Recent Trends in Food Bank Visits in Ontario

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FEED ONTARIO

Abstract

The purpose of this project was to create a publicly available web mapping application to display changes in food bank usage over time. In collaboration with Feed Ontario, a tool was developed that will raise awareness for the issue of hunger in Ontario. Using methods surrounding data manipulation, spatial and statistical analysis, cartographic visualization, and web technology the final application was configured using the ArcGIS JavaScript API (v 4.11) and various types of software (Esri's ArcGIS Pro 2.5, ArcGIS Online, Microsoft Access, and GitHub).

The final application used a combination of visual web mapping techniques to easily locate provincial electoral ridings with high per capita food bank use and provide contextual statistics pertaining to the socioeconomics of food bank users. These additional statistics help to interpret trends and identify subgroups of the population who use these services. Specifically, this project found that food bank use can be directly connected to disability and social assistance recipients, which made up approximately 70% of food bank users over a four year-period. It was also established that 71% of food bank users were private renters during this same period. This provides added context and may point to socioeconomic factors that are driving the hunger crisis.

Overall, this study revealed further insights into the increasing trends of food bank usage across Ontario. The hunger problem is extremely relevant in the province of Ontario and deserves further investigation.

Keywords: food insecurity, spatial analysis, temporal, Postal Code Conversion File (PCCF), Story Map, time series

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1. INTRODUCTION

1.1 Problem Definition and Importance

Hunger can be defined as the inability to obtain sufficient, nutritious, and personally acceptable food and can be linked with poverty, unemployment and social assistance recipients (Davis & Tarasuk, 1994). Hunger is an ongoing issue in the province of Ontario and cannot be mitigated without concerted efforts by policymakers to address its root causes. In 2018 alone, food banks in Ontario were visited more than three million times (Garach & Sparrow, 2019). This project seeks to provide a well-rounded understanding of hunger relating to the socioeconomic factors that drive this crisis, and to identify spatial trends relating to food bank use. From a policy perspective, reducing the hunger problem long-term requires the ability to identify areas that are suffering most from hunger.

1.2 Client Identification

The client, Feed Ontario (formerly known as the Ontario Association of Food Banks), is the provincial representative for over 1200 food banks and food services across Ontario. Their work is based on three main pillars: providing food to those in need, supporting food banks to grow their capacity by providing additional services to their communities, and taking part in research initiatives to identify and target root causes of hunger.

Feed Ontario has worked closely with a data collection hub called Link2Feed which specializes in data collection relating to food bank use, trends, and statistics. This include tracking unique individuals visiting food banks, as well as total visits. It is important to note that one individual could be accessing a food bank more than once. These data have been collected over a four-year period and has been previously used to generate annual reports to identify the cost of poverty and hunger in Ontario.

1.3 Background

There has been considerable increase in the need to understand the spatial relationships that fuel hunger. However, little attention has been given to finding ways that we can use food bank data to visualize hunger in a spatial way.

In previous works concerning food bank data Black & Seto (2018) established that there is no standard best practice for evaluating food bank usage data spatially. Presently, there has only been one *spatial* application of food bank data on a provincial scale, which was created by previous GIS Application Specialist candidates at Fleming College in 2019. This application was created to represent food bank use in Ontario by provincial electoral riding for the year 2018. Through the use of an interactive map, the project was designed to draw attention to the high food bank use areas in hopes of getting on policymakers' agendas. The interactive aspect of this map is the user's ability to click and compare three ridings and their corresponding three socio-economic attributes. After making their selection of three ridings, the user can then scroll down to see a separate section comparing an additional five attributes. This is currently the only visualization that exists of food bank data on a provincial scale. This map was a huge success and created an excellent foundation for exploring food bank use in Ontario.

1.4 Study Area

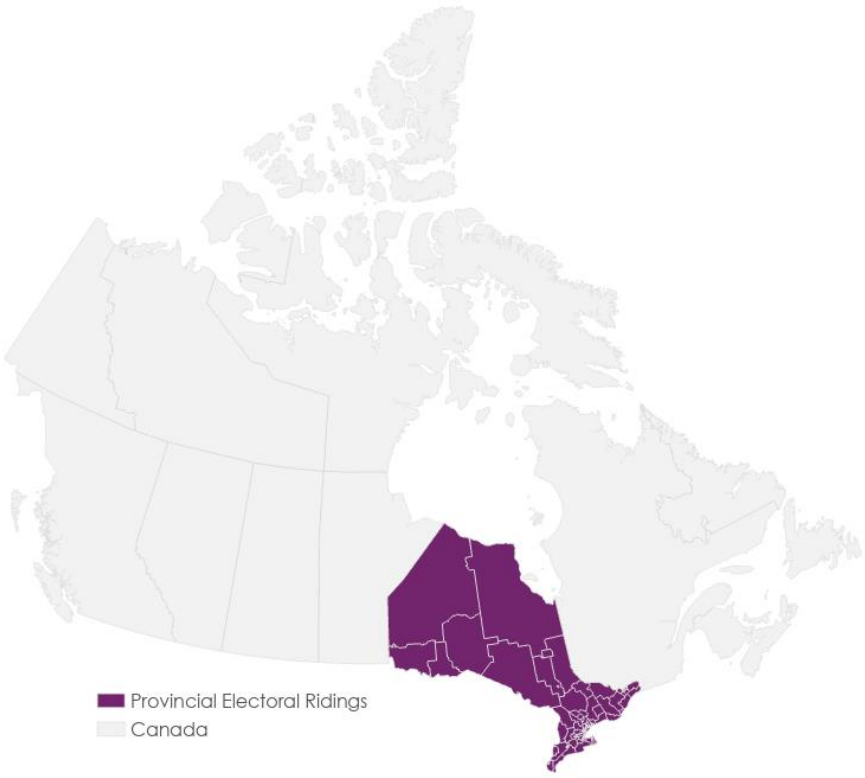

Figure 1. The study area (using Web Mercator Projection) is the Ontario electoral district boundaries highlighted in purple.

1.5 Project Scope and Objectives

The overall goal of this project was to raise awareness for the issue of food insecurity in Ontario and understand how food bank use has changed over time. The client's ongoing mission is to provide valuable information on food bank use (and more broadly, food insecurity) in an accessible, and easily digestible format to a wide audience. This audience includes Feed Ontario's network of over 1200 hunger-relief organizations, policymakers, and the general public alike. By making this information available, key players in the conversation surrounding food insecurity may begin to dive deeper into the root causes of hunger, which will ultimately lead to inspiring policymakers to make informed decisions about how to tackle this widespread issue across the province.

This project has achieved the client's wishes to host an even more robust and informative tool to spatially represent changes in food bank use over time. The success of the previously created application was leveraged by incorporating data for four years (i.e. 2016 to 2019, as opposed to a single year. Contextual demographic data was also included in order to help users interpret trends, and interactive features within the application allow for easy exploration of recent trends across Ontario.

By building on the success of the interactive map created by Fleming College students in 2019, this new mapping application visualizes changes in food bank use on a monthly and annual basis. It also provides a ready-to-view comparison of riding attributes and statistics. This allows the client to visualize the shifting locations and magnitudes of need over time, thereby helping steer the allocation of supports to reach areas of highest need.

2. METHODOLOGY

As previously mentioned, spatial analysis of food bank use has been sparse and underrepresented in the literature. The methodology that was followed throughout this study is explained below, and is described as it pertains to general resources and requirements, data preprocessing techniques, spatial and statistical analysis, visualization techniques, and the use of web technology to develop the final product for our client. For a summary of timelines related to the methodologies presented, please refer to Figure 1 in Appendix A.

2.1 Resources and Requirements Summary

In order meet the goals and produce the desired deliverables for the client, a variety of skills and resources were required. This includes human skill sets, software/technology, and data. The technology that were used included a GitHub repository account for writing and hosting code, Esri's suite of products for spatial analysis and hosting the final application (in particular, ArcGIS Pro 2.5 and ArcGIS Online), and Microsoft Access for big data processing and querying.

2.2 Data Manipulation

2.2.1 Data Acquisition

The data used to complete this study were gathered from several key sources: Elections Ontario, Fleming College (and indirectly, Statistics Canada), and a third-party company called Link2Feed. Elections Ontario was used as a source of the Ontario electoral ridings shapefile, as well as population data for these ridings. Fleming College provided the Postal Code Conversion File (PCCF) used for creating point locations of postal codes, which was provided to the College by Statistics Canada. Finally, Link2Feed provided the food bank use data, which were received via the client.

The datasets containing counts pertaining to food bank use were provided by Link2Feed and were received through the client as Comma Separated Value (.csv) files. These files contained raw counts of total visits to food banks as well as counts of unique individuals who were visiting food banks. Socioeconomic data about individuals who visited food banks—specifically housing type and primary source of income—were also provided in separate files. These data were organized within

their respective files according to the postal code of visitors, as well as the time frame they pertained to. These data were collected by food bank employees as visitors entered food bank facilities, which were then added to the Link2Feed database in real time. Therefore, human error was a primary concern and is explained in further detail below. For a list of the datasets acquired for this study, please see the metadata presented in Table 1 in Appendix A.

2.2.2 Data Preprocessing

Due to human error at the time of data collection, not all records in the original datasets were properly associated with valid Ontario postal codes. This made it impossible to spatially represent them, as they lacked any information that could associate them with a geographic location. As such, these data were omitted at an early stage of this project, but the counts of omissions were tracked in a separate file (to see an excerpt from this file, see Figure 2). In doing so, it was possible to ensure that the visit counts in the final output remained consistent with the counts that were recorded after the preliminary stage of screening the data, and that no additional data were lost over the course of completing this project. For more information about the process used to eliminate invalid postal codes, please refer to section 2.3 Spatial and Statistical Analysis.

In total, approximately 5% of annual visits and 5% of monthly visits were omitted from the final map outputs. In order to ensure that users are aware of this detail, this statistic is stated within the User Guide, which is made readily available in its own tab within the final Story Map output.

STATISTIC	TIME PERIOD	ORIGINAL VALUE	OUTPUT VALUE (AFTER DATA CLEAN-UP)	COUNT NOT REPRESENTED	PERCENTAGE NOT REPRESENTED
Annual Total Visits	2016	2773919	2566300	207619	7.48
	2017	2903946	2728223	175723	6.05
	2018	2994611	2870667	123944	4.14
	2019	3201623	3131583	70040	2.19
Annual Unique Visitors	2016	454104	410184	43920	9.67
	2017	465840	433189	32651	7.01
	2018	471497	447540	23957	5.08
	2019	484286	473816	10470	2.16

Figure 2. Excerpt of file used to track data omissions over the course of this project.

2.3 Spatial and Statistical Analysis

2.3.1 Spatial Join to Provincial Electoral Ridings

As previously mentioned, the raw data received from the client were in Comma Separated Value (.csv) format. These datasets were not spatial, but they did include a field tracking the postal code that each record was associated with. This provided an avenue to spatially represent these data, but required the use of a Postal Code Conversion File (PCCF) to associate each postal code with a single point location. This posed a challenge, as unique postal codes are often represented by multiple point locations. For a summary of steps taken to successfully complete the spatial and statistical analysis outlined here, please see Table 2, Appendix A.

The PCCF was obtained through Fleming College, and was made possible by Statistics Canada's Data Liberation Initiative. As outlined by Statistics Canada in the Reference Guide provided with their PCCF, there is a one-to-many relationship between unique postal codes and their point locations. Since some postal codes have multiple point locations that straddle multiple geographic boundaries, Statistics Canada developed the Single Link Indicator (SLI) to indicate the single most representative point for each unique postal code in the file (Statistics Canada, 2019, p. 21). The SLI is assigned by Statistics Canada and takes several key factors into consideration, such as precision of the geocoding of points and population distribution. Ultimately it was decided to use the SLI to determine the representative single point location for unique postal codes in the food bank data.

Once it was established that the SLI would be used, a join was performed between each of the original data files and the PCCF, using the postal code as the joining field. This assigned an XY coordinate pair to each of the valid postal codes in the food bank use datasets, which allowed for the creation of a point layer of postal codes with their corresponding food bank use data. Furthermore, a spatial join was performed between these points and a polygon feature class of Ontario electoral ridings (obtained through Elections Ontario), which allowed for the display of food bank use in a more simplified, easy-to-digest way—by electoral riding across the province.

2.3.2 Calculating Food Bank Visits

It is important to note that in order to visually represent food bank visits by electoral riding, the values were standardized per capita to create meaningful percentage values that could be easily

interpreted by a wide audience (Figure 3). This calculation was performed since the total population of ridings are not all equal. Therefore, only representing the *raw* total number of food bank visits as a thematic map used to represent statistics (or choropleth map) would not be a fair representation, and would likely misguide users and lead to false interpretations/conclusions being drawn from the final product.

$$\left(\frac{\text{Total Individual Visits}}{\text{Total Population (Riding)}} \right) \times 100$$

Figure 3. Per Capita calculation used to display food bank visits in the mapping application.

2.4 Visualizing Changes in Food Bank Usage

Once the data were processed and standardized, ESRI's ArcGIS Pro 2.5 was used to create two feature classes: one for annual food bank use, and another for monthly food bank use. These feature classes each contained fields representing counts of unique visitors, total visits to food banks, primary sources of income, and housing types. The first of these feature classes was dedicated to displaying a summary of data collected on an annual basis, therefore each electoral riding had a separate record for each year the data had been collected (2016, 2017, 2018, and 2019). Since there are a total of 124 provincial electoral ridings, this meant that there were 496 records in the annual dataset. Similarly, the second feature class was dedicated to displaying monthly data, which included 48 months of data for each riding. This resulted in a total of 5952 records in the monthly dataset. In combination, these layers were used to display food bank visits in a choropleth map to easily visualize high and low areas of usage over time, as seen in Figure 4.

Another way of visualizing changes in food bank usage was to reference the data in a more graphical output. To do this, an ArcGIS Dashboard was created as well as popup templates to display the relevant statistics to fully understand the question "Who is accessing food banks?". These graphs were created using standardized values for the primary sources of income and housing as well as demonstrating the increasing trends of food bank visits in Ontario. These calculated statistics, in combination with the choropleth maps created to visualize change over time, are the components that

were used configured using web development strategies in the final application. For more information about how this was done and what the final output looked like, please see section 3.2 Who is Accessing Food Banks.

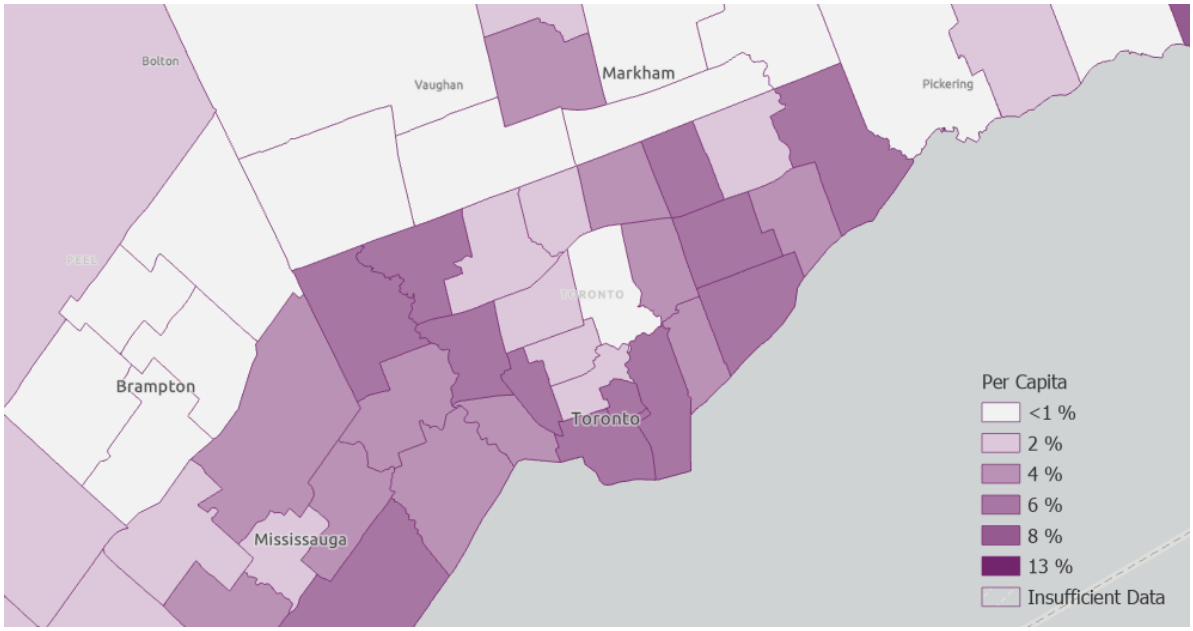

Figure 4. A choropleth map of food bank visits in Toronto/GTA in 2016 where darker areas represent a higher per capita food bank use.

2.5 Web Development

The feature layers for monthly and annual food bank visits mentioned above were incorporated into a configurable time series application that are held in ESRI's ArcGIS Online interface. This application was hand coded based on a template of Flash Flooding (Ekenes, 2019), modified to visualize changes in food bank visits both on annual and monthly time scales. The application was configured using a combination of Hyper-Text Markup Language (HTML), Cascading Stylesheets (CSS) and JavaScript (JS) files. All code was created referencing the ArcGIS JavaScript API (v 4.11) to call hosted feature layers and ESRI widgets to complete the user-friendly app. All source code was housed in a GitHub repository for an easy, open-source option to web hosting.

2.5.1 Configuration

With the use of the code template developed by Ekenes (2019), sections of code were used to accomplish a key technical goal set out by the client, which was the ability to visualize changes in food

bank use over time. This was made possible by defining constants within our code (Figure 5), which were directly related to fields within the feature layers containing data on food bank use. Functions that allow for filtering of the data based on these two fields were then configured (Figure 6), which provides the user with a ready-to-view application showing temporal change.

```
define(["require", "exports"], function (require, exports) {
    "use strict";
    Object.defineProperty(exports, "__esModule", { value: true });
    exports.years = ["2016", "2017", "2018", "2019"];
    exports.months = ["January", "February", "March", "April", "May", "Ju
});
//# sourceMappingURL=constants.js.map
```

Figure 5. Code snippet of constants being identified for the purpose of filtering data by time frame, taken from the code for the monthly visits map.

```
function onCellSelect(cell) {
    var year = constants_1.years[cell.col];
    var month = constants_1.months[cell.row];
    if (mousemoveEnabled) {
        highlighted = { col: cell.col, row: cell.row };
        layerView.filter = new FeatureFilter({
            where: "Year = '" + year + "' AND MonthName = '" + month + "'"
        });
    }
    updateGrid();
}
addCanvasListeners();
```

Figure 6. Code snippet of constants being used in a function to filter the layer view according to the grid cell that the user is hovering over with their cursor, taken from the monthly visits map.

For simplicity, the annual and monthly time series were configured in separate repositories on GitHub. These repositories were then hosted as a Uniform Resource Locator (URL) by an ESRI ArcGIS Online Story Map application. All source code files can be found archived with Fleming College for future reference.

The methodology outlined above illustrates how data preprocessing, spatial/statistical analysis, visualization, and web development brought the client's vision to life. The culmination of these efforts has resulted in a web mapping application to display changes in food bank use over time, demonstrating the accomplishment of this project's course objectives.

3. RESULTS

The final deliverable is a hosted web mapping application embedded on the client's website. This application will allow policymakers and public users alike to explore Ontario's hunger problem through a user-friendly, interactive tool. As per the client's request, this application provides a single, unified environment that showcases maps of both annual and monthly food bank use data. In addition, it showcases supplemental demographic data (shown in non-cartographic formats, which can be viewed within popups and a dashboard that are integrated within the final Story Map), which provides a visual display of who is accessing food banks the most. For a full user guide, please see Appendix B.

3.1 Time-Based Filtering of Data

For both maps that were produced (i.e. Annual Visits and Monthly Visits), the ability to filter food bank use by time frame has been integrated into the application. Using the grid located on the left side of each map (Figure 7), the user can easily filter the data that are shown on the map.

Because the grid was configured to have on-hover functionality that quickly queries and updates the map on the fly, the user must simply hover their cursor over the grid cell that represents the point in time that they are interested in seeing displayed on the map. Alternatively, the user can filter the data by clicking on any of these cells, which will temporarily disable the on-

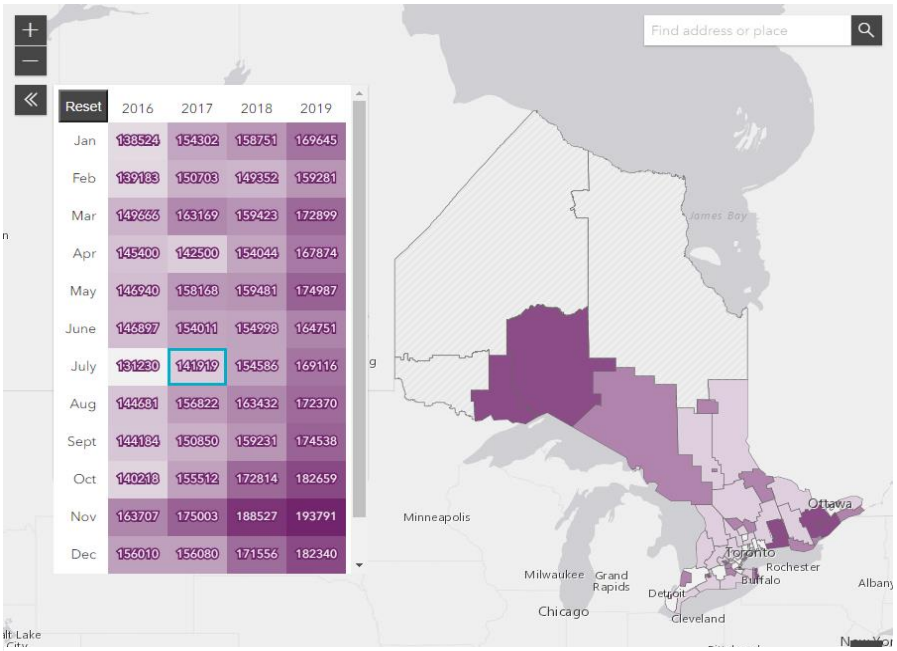

Figure 7. Snapshot of Monthly Visits map that shows the grid (left) for filtering data displayed on the map. Users may hover over or click on individual grid cells to see unique visits to food banks displayed on the map.

hover functionality. In doing so, this allows the user to hover their cursor overtop of the map itself (without losing their selection), at which point they may begin clicking on electoral ridings of interest in order to activate the popups. This provides additional information about the demographic profile of individuals who visited food banks during that time period and in that specific riding.

In addition to allowing the user to filter the data shown in the map, this grid calculates the total number of visitors during each time period, which is represented by the number within each grid cell. This number represents the total number of unique visitors across all of Ontario, and is calculated on the fly within the coded map template. The background colour of each of these grid cells is a quick and easy way for the user to see if the total number of unique visitors is relatively high or low compared to the other time periods shown in the map. Light colour signifies a relatively low number of unique visitors, while darker colours signify a relatively high number.

3.2 Who is Accessing Food Banks?

In order to provide added context and answer the question of who is accessing food banks most in Ontario, supplemental data were included in this application as per the client's request. The purpose of this is to be able to use this application to see trends in the data in terms of who is most at risk, and to help guide where efforts should be directed in order to address the hunger issue efficiently and effectively.

3.2.1 On-Click Popup

Along with the counts of unique individuals visiting food banks (as shown in the map and within the counts listed in the left-justified grid), the on-click popups provide additional statistics regarding food bank use for each electoral riding, which are triggered by click events by the user. As seen in Figure 8, these statistics include population of riding (according to 2016 census data), total unique individuals, total number of visits to food banks (categorized by Adults, Children, and Total), housing types of visitors, and primary sources of income of visitors. In order to provide the user with a snapshot of the most common housing types and sources of income of individuals who have visited food banks in each riding, the popups display primary income and housing type statistics in the form of bar graphs. The ability to quickly obtain a snapshot of the most common traits of individuals who visit food

banks was a key need expressed by the client. As such, the use of showcasing additional trends in graphical format have been expanded upon. These features are displayed in an ESRI Dashboard within the final Story Map. This Dashboard and its features are explained in detail below.

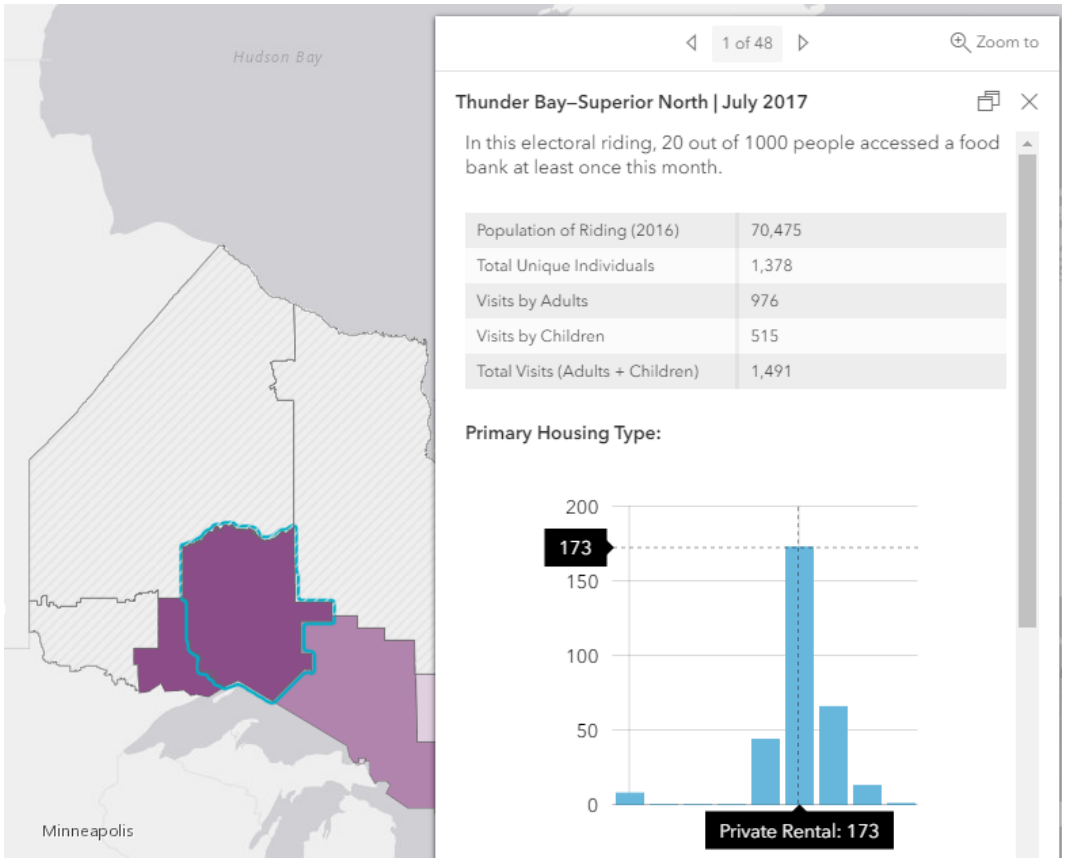

Figure 8. Popup window showing prevalence of various housing types among visitors to food banks in the riding of Thunder Bay—Superior North in July 2017.

3.2.2 Unique Individual Visits vs. Total Visits

One of the most important details that the client was interested in is the total number of unique individuals and total visits to food banks, which will help them to provide adequate services to areas that have the highest need. As seen in Figure 9, the number of unique individuals visiting food banks has been increasing over time. Visualizing these changes monthly can help the client identify reasons for food bank visits that can lead to policy changes in income or housing initiatives to help lower these trends. For example, in November of 2019, food banks in Ontario recorded the highest number of unique individuals visiting a food banks to date, sitting at a count of approximately 193,800 individuals.

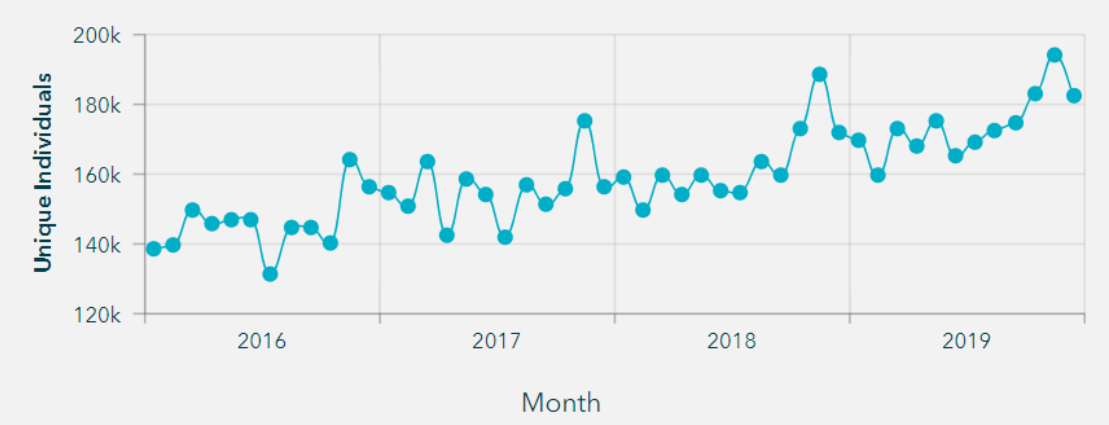

Figure 9. Line graph representing unique individuals visiting food banks by month, highlighting overall trend as well as specific months when peaks and dips have occurred.

It is important to note that unique individuals visiting food banks differ from total visits to food banks, which is due to the fact that one person may visit a food bank multiple times in a given time period. Figure 10 represents total visits to food banks by month over four years. As seen below, November of 2019 also had the highest number of total visits, sitting at a total of approximately 288,400. These statistics and visualizations of trends are very important to the client, as they will help guide them as they allocate appropriate resources during these high-use times and to formulate strategies to flatten this increase in food bank visits.

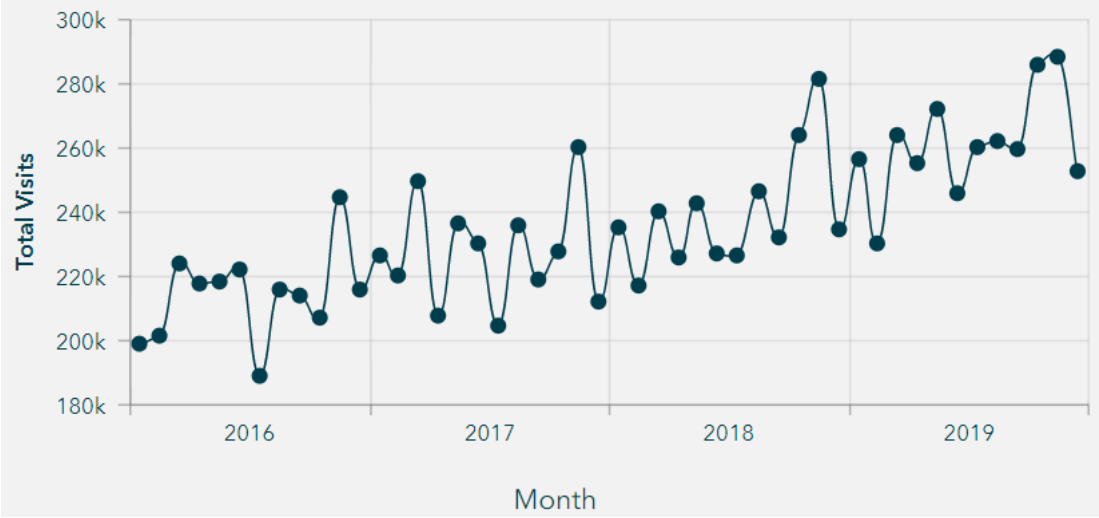

Figure 10. Line graph representing total visits to food banks by month.

3.2.3 Primary Sources of Income

Another important piece of information to display are the primary sources of income of food bank visitors. In this application, the income data was standardized to be represented as a pie-chart to visually and statistically compare the categories of income. In Figure 11, it was found that 36.24% and 33.72% of food bank user's relied on disability and social assistance as primary sources of income, respectively. The primary categories of income over a collective four years were: disability, social assistance, employment income, pension, and no income source.

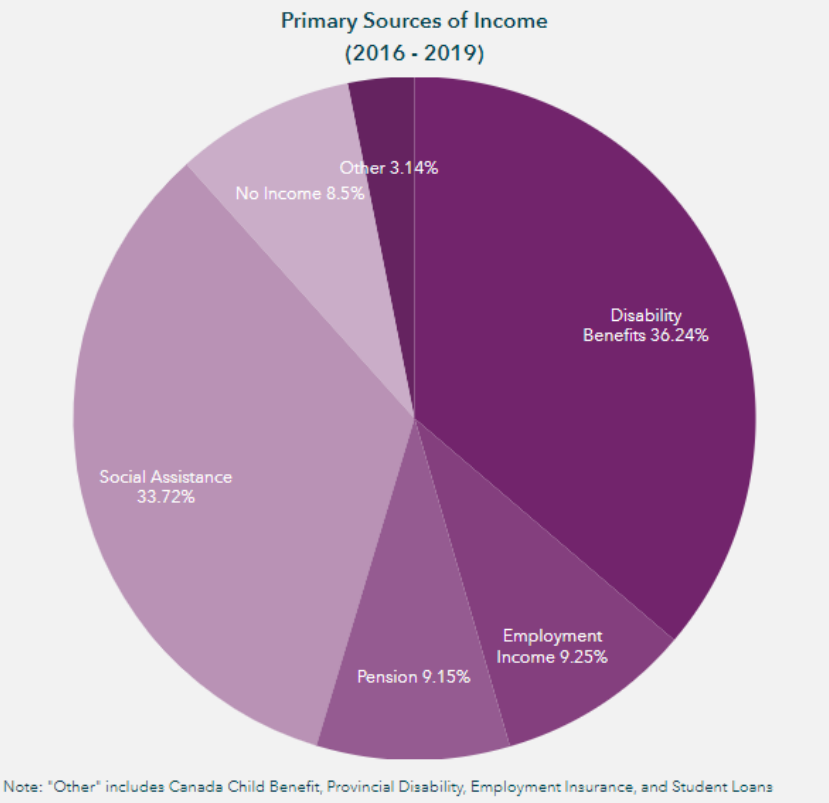

Figure 11. Pie chart used in the Dashboard displaying five main categories of primary sources of income calculated over a four-year period.

3.2.4 Primary Housing Types

Housing information was also collected and standardized to display where food bank visitors were currently residing at their time of visit. This pie chart in Figure 12 clearly identifies the three primary categories of housing: private rental (71.16%), social housing (18.42%) and own home (5.19%). All of these statistics can be found in our web mapping application to allow for full comprehension of the hunger problem in Ontario.

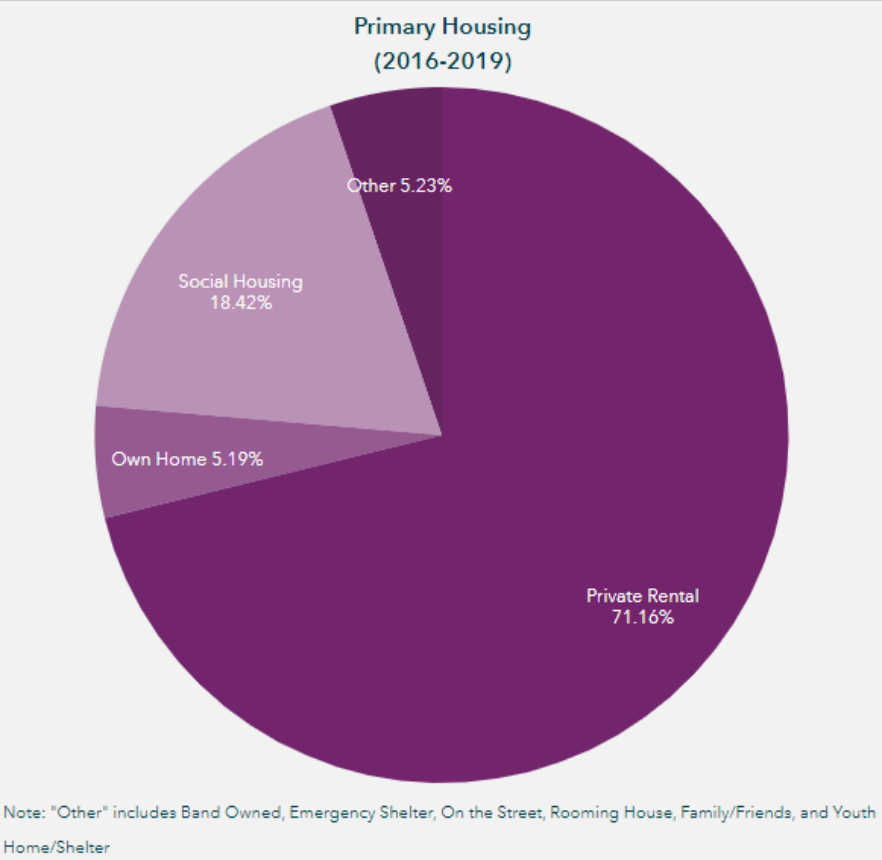

Figure 12. Pie chart used in the Dashboard displaying five main categories of primary sources of income calculated over a four-year period.

3.3 Web Mapping Application

3.3.1 Widgets

To improve the user experience, the JavaScript API was used to add ESRI widgets into our custom application. In addition to the collapsible grid for filtering data (previously described at great length) and the default zoom in/out widget, this includes a search bar and collapsible legend. These two added widgets enhance the user experience by allowing them to interact with the application and have it catered to their needs, while simultaneously ensuring that the final product is not overly cluttered with frivolous functionalities.

The search widget (located in the upper right corner of the map, Figure 13) allows the user to search an address or place of their choice, which then triggers the map to zoom to the location they have specified. This is especially helpful for users who may know the name of the location they are interested in but do not have knowledge of its placement on this map within provincial electoral ridings, and eliminates the need to perform a separate search in their browser.

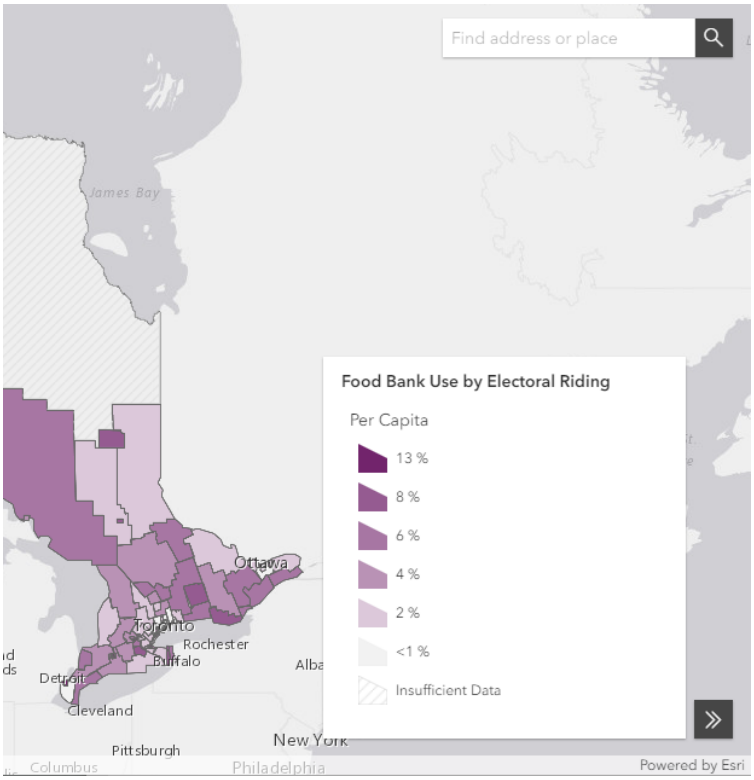

Figure 13. Seen in upper right corner, Search widget allows user to search an address or place and immediately zoom to it. In bottom right corner, collapsible Legend widget can be seen.

The collapsible legend widget (located in the bottom right corner of the map, Figure 13) provides the user with the opportunity to free up space to be able to view the map easier. This ability to collapse and expand is also available with the previously discussed grid on the left side of the map. Both of these widgets are expanded by default, which was requested by the client to ensure that users who are not familiar with web maps would be aware of the presence of these features.

3.3.2 Story Map

In order to combine all desired elements into a single application, an ESRI Story Map was used with an accordion-style table of contents. This allows the user to easily switch between viewing the Annual Visits (2016-219), Monthly Visits map, Who is Accessing Food Banks? dashboard, and the User Guide (Figure 14). This ensures that all elements of the final product are displayed in a single, unified environment in which users can explore how food bank use has changed in recent years. By providing robust supplemental demographic information and a user guide within this final application, the user is empowered to peruse the application freely and investigate trends in the data at their own pace.

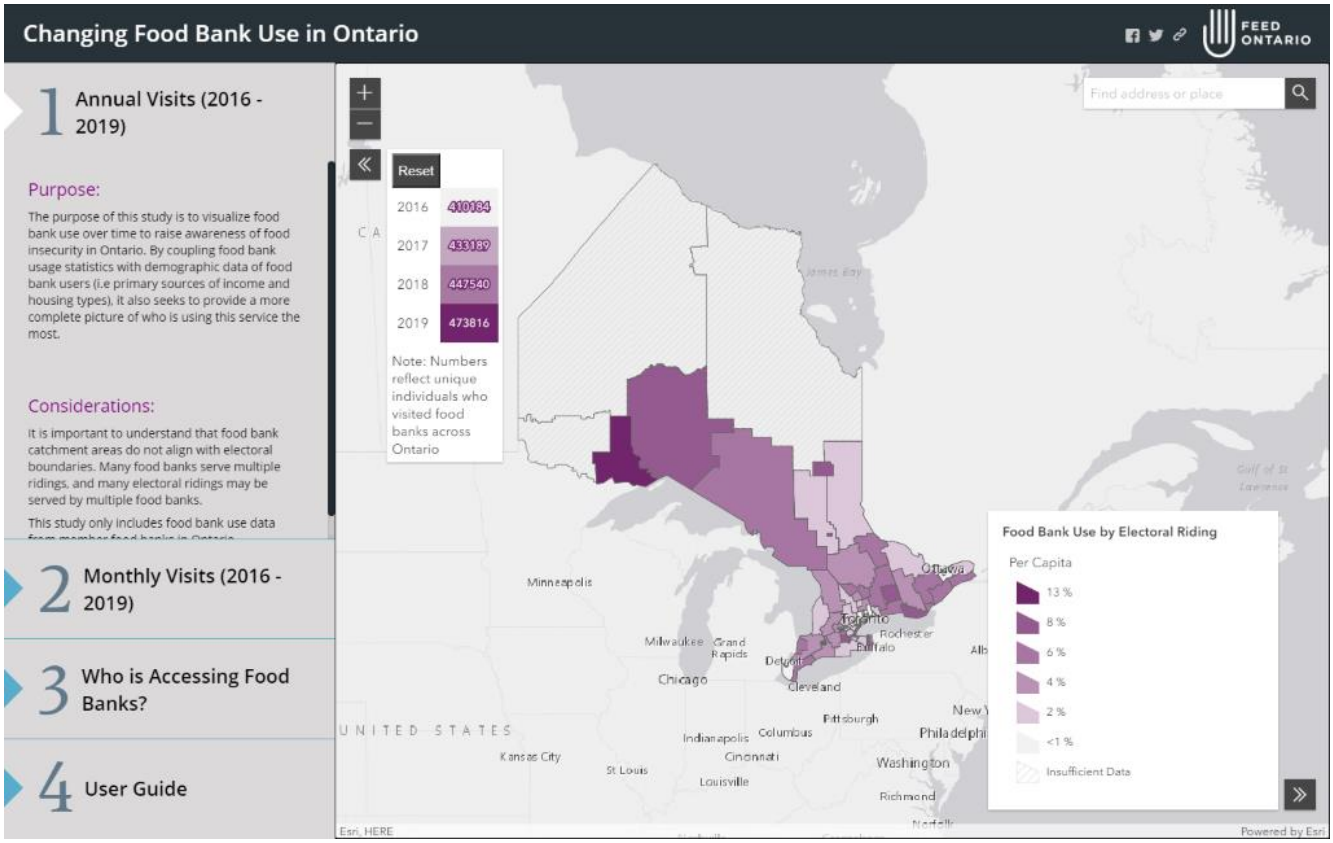

Figure 14. Final web mapping application hosted in an Esri Story Map showcasing the overall combination of widgets, time filtering capabilities, and accordion table of contents for easy viewing.

4. DISCUSSION

4.1 Feeding Change

By creating a visual application with informative graphs that reference data on a timescale, the ability to extract various statistics relating to food bank use is very easy. For example, Figure 15 was created to highlight food bank use in 2019 as well as the changes in total number of visits over a four-year period. This application demonstrates the ability to highlight key trends so the client can leverage this information to provide resources accordingly and to see whether their efforts and initiatives through their network of food banks have or have not been successful.

Provincial Electoral Riding	Food Bank Use Per Capita	Total Number of Unique Individuals	Total Number of Visits	% Change from 2016 to 2019*
Hamilton Center	13 in 100	12, 712	117, 058	↑ 12.94 %
Ottawa South	12 in 100	14, 170	71, 737	↑ 0.27 %
Thunder Bay - Atikokan	11 in 100	8, 351	29, 078	↑ 7.12 %
Ottawa - Vanier	10 in 100	11, 481	56, 755	↑ 4.56 %
Windsor West	10 in 100	12, 554	73, 330	↑ 16.20 %
London - Fanshawe	10 in 100	11, 396	47, 698	↑ 13.10 %
Ottawa Center	9 in 100	10, 998	59, 686	↑ 9.53 %
Kitchener Center	9 in 100	9, 367	66, 032	↓ -0.58 %
Windsor - Tucumseh	9 in 100	10, 187	60. 535	↑ 17.88 %
Kitchener South	9 in 100	8, 822	74, 791	↑ 18.29%

* These numbers represent the percentage of change in total number of visits from 2016 to 2019

Figure 15. Top 10 provincial electoral ridings with the highest per capita concentration of food bank use in Ontario in 2019.

By accompanying the web mapping application with statistics, future research can be conducted to perform analysis as to the reasons why these increases or decreases are happening in order to effectively combat the hunger issue in Ontario.

4.2 Future Research and Recommendations

Given the fact that food insecurity is such an important issue not only in Ontario, but also on a national and global scale, it is of utmost importance to keep projects like this available to the public

going forward. It is the goal of the client to keep this project alive beyond the academic term at Fleming College, as well as to see this project maintain accuracy and relevance over time. Whether by continuing to add new data each year, or by building on the most successful aspects of our deliverables, there are several requirements and recommendations to maintain the momentum that began with the project undertaken by previous Fleming graduates in 2019.

First, keeping the project available beyond the academic term at Fleming College will ensure that this valuable final product will be put to good use. With the guidance of Shawn Morgan, the client has applied for an ESRI ArcGIS Online account through the Nonprofit Organization Program. This will ensure that this project's lifespan will carry on beyond Fleming College, as the Story Map and its contents will no longer rely on the College's resources to keep the services running. This will also facilitate future work with ESRI's suite of products, allowing Feed Ontario to perform spatial analysis and create visual representations of hunger/food access patterns across the province moving forward.

Secondly, it is recommended that Feed Ontario continues to reach out to Fleming College to maintain this partnership for the annual collaborative project—the technology and options available to communicate spatial information is constantly evolving, and it would serve Feed Ontario well to continue using the most current, user-friendly technology that is available. At Fleming, students are gaining the necessary skills to effectively use the most current technologies available in the industry, making them an asset to the Feed Ontario team. In addition, this would benefit Feed Ontario by ensuring that the most up-to-date food bank usage data can continue to be displayed, which will provide policymakers with the most relevant information to advocate for long-term solutions to hunger and poverty in Ontario.

The third recommendation is not one that is required to maintain this project but rather is a suggestion that could enhance the offerings of projects like this in the future. Having a live feed of data from Link2Feed would allow for an interactive application that can display real-time data on food bank usage across the province. This would provide the advantage of having a much more current display of food bank usage data, which would be particularly useful during times of increased usage in response to events such as natural disasters or worldwide pandemics. However, this poses obvious challenges because the food bank usage data is currently managed by a private third-party, and data must first

undergo quality assurance checks before being made publicly available. As such, implementing this would require much more discussion between the client and the third-party that hosts the data, but is nevertheless an idea that warrants further exploration.

5. CONCLUSIONS

By creating a tool to visualize the changes in food bank usage over time, our project and the final Story Map that has been developed will continue to help Feed Ontario catalyze long-term solutions to end food insecurity in Ontario. By using an arsenal of skills such as data preprocessing, spatial and statistical analysis, enterprise web technology and cartographic visualization techniques, the client's vision has been brought to life to increase visibility of the issue of hunger in Ontario. Above all, this project will also provide decision-makers with access to accurate, current, and easily digestible information that will allow them to assess the hunger problem across the province. Through this interactive web mapping application, it can draw attention to the need for ongoing efforts to translate raw food bank data into meaningful, informative formats so that users can address food insecurity in more efficient and innovative ways.

6. LITERATURE CITED

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7. APPENDICES

Appendix A: Figures and Tables

Figure 1. Gantt chart for timelines of completion by week.

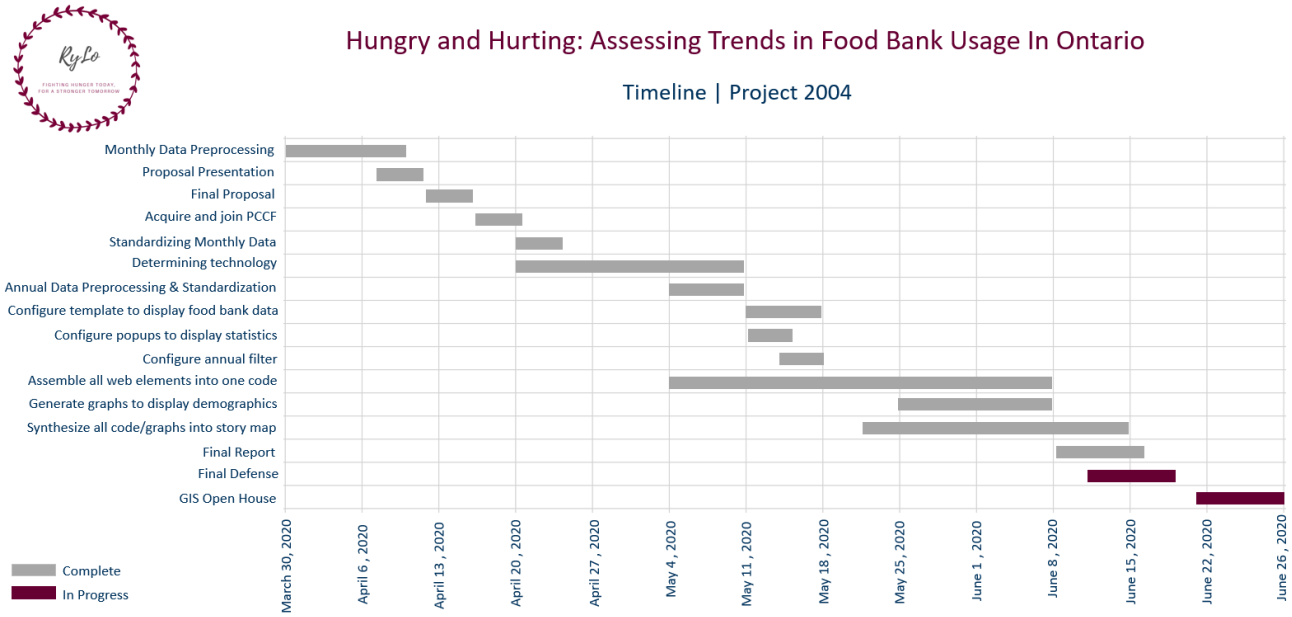


Table 1. Metadata Table

File	Source	Information	Currency
electoral_districts.shp	Elections Ontario	Shapefile containing the provincial electoral districts for the province of Ontario	2018
Multiple .csv	Link2Feed	Ontario food bank visits (unique visits, as well as duplicate)	2016-2019 (retrieved 2020)
Multiple .csv	Link2Feed	Ontario food bank socioeconomic attributes of visitors	2016-2019 (retrieved 2020)
Postal Code Conversion File (PCCF) (.txt)	Fleming College via Open Data agreement with Statistics Canada	Text file containing latitude and longitude coordinates for each postal code in Ontario	2019
Demographics for Ontario Boundaries .csv	Elections Ontario	Total population for each Ontario electoral riding	2016

Table 2. Data Preprocessing and Statistical Analysis

ITEM NUMBER	GOAL	STEPS	SOFTWARE	RESULT
1	Pare down Postal Code Conversion File (PCCF) to represent Ontario postal codes with a Single Link Indicator (SLI) of 1 (i.e. the single representative point for each unique postal code in Ontario)	1) SQL statement selecting all records with a province code for Ontario 2) SQL statement selecting all records with SLI value of 1	Microsoft Access	Refined PCCF for unique Ontario postal codes
2	Generate new tables in Access with annual stats for who is using food banks (i.e. children, adults, and combined total) for each postal code	1) SQL statement to get the annual stats for each unique postal code in the file 2) QA/QC to make sure no data were lost 3) Export to csv	Microsoft Access	Four new .csv files with annual stats on unique food bank visitors, grouped by postal code
3	Join PCCF and food bank data tables to assign spatial location to each postal code, which will also eliminate records with invalid postal codes	SQL statement joining food bank usage data with PCCF for each individual table	Microsoft Access	.csv files of food bank usage data joined with PCCF
4	Convert PCCF table to point data	Display XY values to create a point feature class of all postal code locations	ArcGIS Pro 2.5	Point layer of postal codes with attributed food bank data
5	Spatially join the new point feature class with Ontario electoral boundary layer	Use the spatial join tool to represent which postal codes are contained within each electoral riding	ArcGIS Pro 2.5	Ontario electoral boundary layer identified with food bank data
6	Standardize the output boundary layer to per capita food bank use	(Unique Individuals/Total Population of the Riding) *100	ArcGIS Pro 2.5	Symbolized choropleth map displaying food bank use per capita by electoral riding

Appendix B: User Guide

User Guide

Icons

Chart – an interactive grid displaying month/year combinations to explore food bank visits over time.

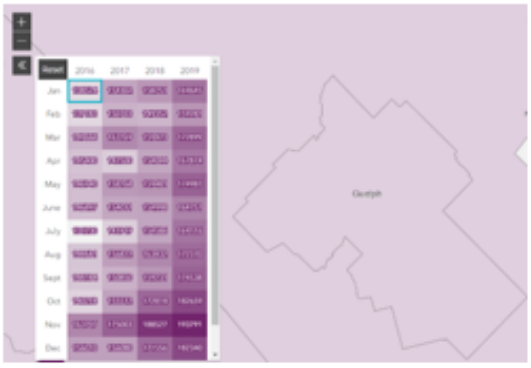
Zoom In/Out - allows you to easily zoom to a location of interest. You can also use the scroll wheel on your mouse/trackpad to pan and zoom around.

Search - any city, address, or location can be searched to automatically zoom into the location.

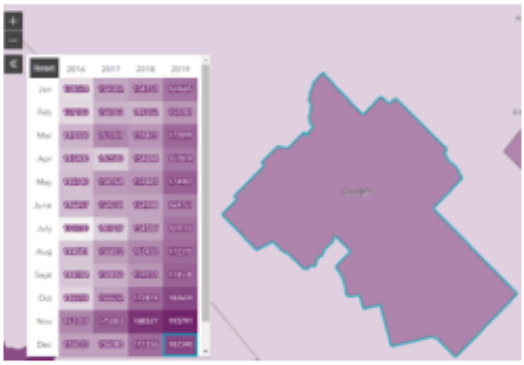
Legend – reveals the colour ramp representing individual food bank visits per capita

Tips and Tricks

- Once the **chart** icon is expanded, you can hover the cursor over the grid to quickly see the changes in food bank usage over time (both on the Monthly and Annual tabs).

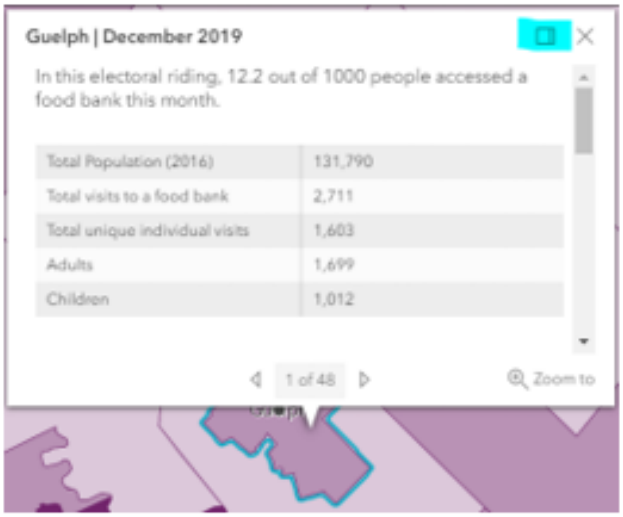


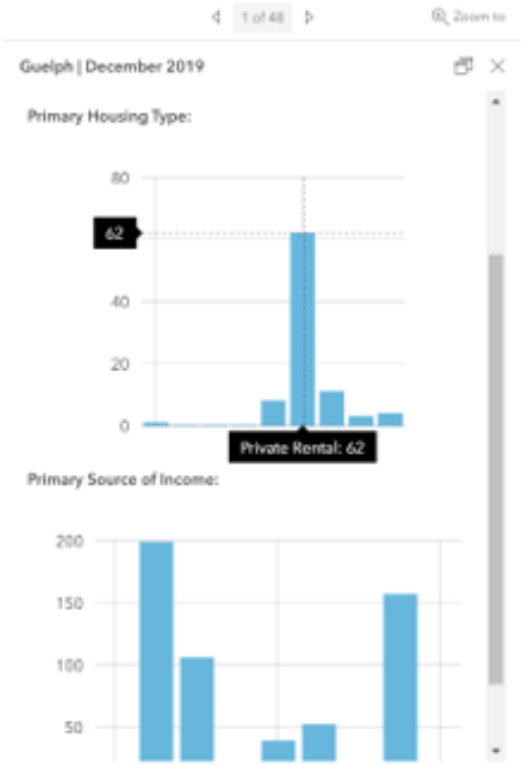
January 2016



December 2019

- If you would like to have more information about food bank use in an electoral riding, you can simply click on the riding of interest and a popup will be displayed with socioeconomic information.



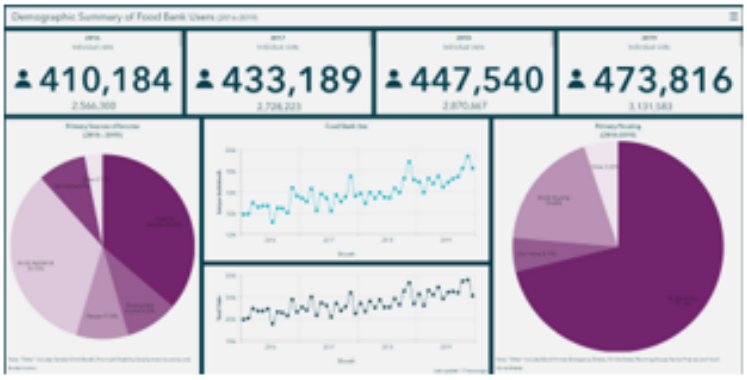


In the previous example, December 2019 was selected from the chart, the information for that month and year is displayed here.

Click the highlighted icon to dock the popup window for easy viewing.

Primary Housing and Income Data

For more information and an overview of statistics relating to monthly data over four years you can refer to the "Who is Accessing Food Banks?" tab. Here you can find data visualized in pie-charts and line graphs as well as reference statistics for a more complete view of food bank visits over time.



To Note:

Due to data entry errors, some food bank visits could not be spatially represented on these maps. As a result, approximately 5% of recorded food bank visits are not reflected.