

**IDENTIFYING DIVERSE INFRASTRUCTURE NEEDS, BARRIERS, AND
OPPORTUNITIES FOR ENHANCING FOOD SECURITY: A CASE STUDY OF THE
ISLAND OF NEWFOUNDLAND**

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Abstract

Hunger and food insecurity are on the rise globally. A study of food infrastructures has the potential to offer sustainable solutions embedded in communities and networks. This thesis examined the extent to which an infrastructural lens may provide insight and understanding that could help inform the development of more sustainable solutions to systemic problems with food security on the island of Newfoundland.

The purpose of this research was to analyze food (in)security in Newfoundland using an infrastructure lens, and to identify infrastructural needs, barriers, and opportunities to improve overall capacity for improving food security.

This research combined data from literature reviews, content analysis and semi-structured interviews with key informants, and utilized a diverse infrastructures analytical lens which enabled the researcher to describe the state of current food infrastructures, identify existing infrastructural barriers to food security, and suggest infrastructural solutions and recommendations. Data was organized into themes with trends, commonalities, and differences using NVivo. All of the data points were then re-organized into three overarching categories: needs, barriers, and opportunities. The data in each category was re-analyzed into codes within each category.

The results were categorized into infrastructural solutions and recommendations including building processing facilities, enhancing clean energy infrastructure, overcoming ecological factors using technology and innovation, public education campaigns, government incentives, institutional leadership, cooperation and sharing, and a poverty reduction strategy.

This thesis concluded that globally recognized challenges to food security, including access and distribution, are intrinsically tied to infrastructure. Infrastructural analyses and solutions can enhance capacity for improving food security and offer sustainable solutions.

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Table of Contents

Abstract	2
Acknowledgements	3
Table of Contents	4
Introduction	6
Challenges to Food Security	7
Climate Change.....	7
Poverty	8
Distribution of Food.....	9
Global Food Trends	10
Role of Infrastructure	11
Food Security Infrastructure in Islands	12
Research Objective	14
Conceptual Framework	15
Policy Importance	18
Literature review	19
Terminology and Definitions	19
Food Infrastructure Perspective	22
Historical Food Trends in Newfoundland	23
Current Food Trends in Newfoundland	28
Physical Food Infrastructures.....	30
Ecological Food Infrastructures	32
Social Food Infrastructures	34
Significance of Infrastructure Lens	44
Research Methods	45
Case Justification	45
Ethical Considerations	46
Interviews	47
Data Collection	47
Data Analysis	48
Results	50
Infrastructural Needs	51
Increase Accessibility of Local Produce	51
Support for Producers	53
Increase Availability of Local Seafood	54
Secondary Processing Facilities and Storage	56
Clean Energy Source.....	57
Public Interest and Skills.....	58
Basic Livable Income.....	59

Infrastructural Barriers.....	61
Remoteness and Distance.....	61
Ecological Infrastructures	63
Time and Expense of Production	65
Lack of Producer Cooperation and Planning	66
Public Perspective	68
Certification Process for Local Producers.....	69
Legislation and Policy Process.....	70
Infrastructural Opportunities	72
Legislation and Policy Instruments	72
Sharing Programs and Farmer Cooperation	74
Markets	76
Public Awareness	76
Technology Investment	77
Physical Infrastructure	78
Summary of Results.....	80
<i>Discussion.....</i>	<i>82</i>
Physical Infrastructure Solutions.....	82
Ecological Infrastructures.....	84
Social Infrastructures.....	85
Public Education and Awareness.....	86
Government Incentives	87
Institutional Leadership.....	88
Cooperation and Sharing	89
Poverty Reduction Strategy.....	90
<i>Conclusion.....</i>	<i>93</i>
<i>References</i>	<i>96</i>
<i>Appendices.....</i>	<i>106</i>
Appendix A – Recruitment Email	106
Appendix B - Interview Guide.....	107
Appendix C – Informed Consent Form	109

Introduction

Hunger and malnutrition are on the rise globally. After decades of steadily decreasing rates of world hunger and malnutrition, hunger levels saw a sudden rise in 2015 and have since remained relatively unchanged (Food and Agriculture Organization [FAO], 2023). In addition, the COVID-19 pandemic significantly derailed already failing attempts to end world hunger (FAO, 2023). Despite the countless initiatives put forth every year by various humanitarian organizations and governments, we are not on track to end world hunger and achieve food security by 2030 as anticipated by the United Nations Sustainable Development Goals (FAO, 2023). There is an opportunity to rebuild our understanding of the root causes and symptoms of hunger and develop more sustainable solutions and strategies to end hunger and work towards food security. According to the Food and Agriculture Organization (FAO),

Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. The four pillars of food security are availability, access, utilization, and stability (FAO, 2009, p. 1).

Scholars recognize that there is a disparity across the globe regarding hunger and nutrition. Feeding the world's growing population with limited geographical resources has been a point of concern for decades; however, the reality is that food production continues to increase (FAO, 2021b; Patel, 2012). Simultaneously, while hunger and food production are rising, there are also increasing rates of food waste. Almost one third of food is wasted globally (Timmermans et al., 2014). Furthermore, as hunger rises, so does obesity and malnutrition (FAO, 2021b; Patel, 2012). More people globally are overweight or obese than underweight (Global Food Security, n.d.; Patel, 2012). While some populations continue to go hungry, there is excess food in other parts of the world. In order to ensure food security, food production, distribution, and consumption patterns

must be analyzed, and connections and networks must be strengthened (Denning, 2022; Riches, 1997; Patel, 2012).

Challenges to Food Security

There are many obstacles to obtaining food security that require urgent research attention and policy action. Along with the disparate patterns of food consumption as well as food waste, scholars have identified an additional three major challenges: climate change, poverty, and distribution.

Climate Change

Many reports point to climate change as one of the largest threats to food security (FAO, 2021b; Mbow et al., 2019). Warming climates have seen a change in precipitation, an increase in pests and diseases in livestock and crops, and changes in the movement and behaviour of fish species (Mbow et al., 2019). For example, warmer weather has allowed pests and diseases to expand their previous boundaries and are threatening new regions and crops (Mbow et al., 2019). Increased use of pesticides in Newfoundland in recent years, for example, is evidence of the threat of the spread (Reza & Sabau, 2022). Extreme weather events are also more frequent; droughts, floods, and wildfires threaten entire crops and livestock (Mbow et al., 2019). In Newfoundland, for example, half of farmers surveyed by Reza and Sabau (2022) explained that rising temperatures are causing droughts and, thus, they have needed to water their crops more frequently in recent years. Drought and heat are agricultural stressors known to reduce crop yield by up to 50% (Lamaoui et al, 2018).

At the same time, food production is a major contributor to climate change (Mbow et al., 2019; Reza & Sabau, 2022). Agricultural land use and livestock produce around 20% of global greenhouse gas emissions (Mbow et al., 2019). Deforestation and peatland degradation that are

associated with intense agriculture contribute another 10% of global greenhouse gas emissions (Mbow et al., 2019). Making food production cleaner and more sustainable is required (Reza & Sabau, 2022).

Climate change may also open regions that were previously unsuitable for agriculture. Some scholars project that northern regions will be able to expand their agriculture due to longer growing seasons and warmer climates (King et al., 2018; Motha and Baier, 2005; Uleberg et al., 2014). However, precautions should be taken to ensure sustainable agricultural development. Best practices should be determined to ensure sustainable solutions and avoid any unintentional consequences (King et al., 2018; Uleberg et al., 2014).

Overcoming the challenges of climate change in food security would require strong environmental policy. Agriculture intensification is a contributor to climate change; agricultural practices that currently support global food production and distribution are unsustainable (Reza & Sabau, 2022). Climate resilient infrastructure that can mitigate the impact of climate change on food production could play a role in improving food security (Denning, 2023), suggesting a need to examine the role of infrastructure in future food security.

Poverty

Another major challenge for food security is poverty. With rising prices across the food system, it is harder for consumers to afford nutritious foods, and for producers to earn a decent living. Poverty is generally rooted in systemic issues, which can be overcome with better social supports. Various governments offer their citizens with either supply or consumption interventions in order to make food more accessible (Denning, 2023). Supply interventions include subsidies on seeds, fertilizer, and utilities (e.g., energy and water); credit and insurance for farmers; or long-term solutions such as infrastructure (e.g., roads or irrigation) (Denning, 2023). These

interventions support farmers and other food producers. Consumption interventions can include public food distribution programs, school meal programs, food vouchers, or cash transfers (Denning, 2023). These interventions support consumers. With increasing food prices, more people will need to use food aid. Poverty is one of the largest barriers to food security (FAO, 2023), but strong social systems that address poverty go hand in hand with food security.

Distribution of Food

Graham Riches (1997) studied hunger in developed countries and points out that, according to the United Nations (UN), there is enough food to feed the world population. Even in Riches' time, the paradox of increasing rates of hunger and increasing rates of food waste and obesity indicate that food production is not the issue, but rather distribution and access. Food security is fundamentally a political problem (Riches, 1997). Riches explains that:

If [hunger] is to be eliminated in first world countries, to say nothing of its abolition in developing countries, the roots of hunger must be acknowledged to be man-made (the term is used advisedly). As Fernand Braudel (1985, p. 31), the eminent French historian, once said, 'Today's society, unlike yesterday's, is capable of feeding its poor. To do otherwise is an error of government.' (1997, p. 12).

Riches studied hunger in developed countries including Canada, Australia, the United States, United Kingdom, and New Zealand. Riches explains that since the 1990s, the world has been capable of producing more food than the population can consume, as evidenced by the current rise of food waste. The fact that some people continue to go hungry is not a matter of ecological or physical capabilities, but rather a question of distribution and planning (Riches, 1997). According to the FAO, hunger in developed countries increased from 13 million in 2006 to 16 million in 2012 (Nierenberg, 2018). The popular belief that increasing production is the solution to hunger has proven untrue due to the coexistence of undernourished people and obese people. Revolutionizing

the network of food distribution is required in order to allow access to food for all (Nierenberg, 2018; IPES-Food & ETC Group, 2021).

Global Food Trends

Governments have attempted to address these challenges to food security through various means. Some of the most common are international food aid and intensified agricultural production through technological advancements (Patel, 2012; Denning, 2023). The global focus on increased production has left the current global food system dictated by profit-driven corporations and international trade agreements (Patel, 2012). A transformation of this system may be required in order to ensure food security for all (Patel, 2012; Denning, 2023).

International trade and global supply chains have offered consumers the opportunity to access foods from various parts of the world. The network of food trade and marketing ranges from raw produce, to processed foods, to food inputs such as fertilizer and seed, and to packaging of each of those products along the way (Denning, 2023). There is increasing global dependence on international trade for food supplies and inputs, and “today, the food system is a complex network of trade dependencies and international supply chains, characterized by increasing interconnectivity” (Bailey & Wellesley, 2017, p. 3). The interconnectedness of food trade means each actor is vulnerable to any sudden disruptions in the network. Self-reliance and localized solutions can help overcome these challenges and foster food security (Denning, 2023).

Bailey & Wellesley (2017) identify chokepoints in the global food trade as maritime straits, coastal infrastructure, and inland transport infrastructure. Some solutions they offer include integrating chokepoints into risk management, improving infrastructure, and creating strategic storage solutions (Bailey & Wellesley, 2017). Any transportation and shipping infrastructures are

also vulnerable to extreme weather events and political instabilities. Depending heavily on imports is a vulnerability for countries and communities that rely on imported food.

Role of Infrastructure

Infrastructure, as indicated above, plays a vital role in the production, distribution, and consumption of food. A network of infrastructures is needed to ensure accessibility to food. Infrastructures of food production can include irrigation, storage, and processing facilities (Menon & El Bilali, 2020). Strong agricultural infrastructures are vital to ensure sufficient crop production. Establishing agricultural infrastructure is often the first step in eradicating poverty in developing countries (Menon & El Bilali, 2020).

Transportation infrastructures are the backbone of food security as transportation plays a major role in distribution and access (Otter, 2014; Menon & El Bilali, 2020). Rural and remote communities have the most difficulty accessing the food distribution network due to the poor transportation infrastructure (Otter, 2014; Menon & El Bilali, 2020). Islands in particular are vulnerable to any transportation disruptions. The dependence on water and air shipping increases risks associated with weather, can result in shortages for an island, and can increase shipping costs (Growing to Give, n.d.; Lowitt et al., 2015). Iceland, for example, imports 50% of its food and is dependent on imports of fodder, fertilizer, and oil to produce the remainder (Bailes & Jóhannsson, 2011). If affected communities respond to this challenge by strengthening their local food production infrastructures, they may be able to produce a larger yield for local communities rather than relying solely on imports.

Supermarkets, farmers markets, restaurants, and other food retail outlets are consumption infrastructures (Otter, 2014). As costs of production and transportation rise globally, so do the cost of final products. More and more people are depending on social aid to be able to afford food

(Denning, 2023). Island communities often see the most expensive products as shipping costs largely contribute to the price of food (Lowitt et al., 2015)

Strong infrastructures are vital for ensuring food security, yet there are few studies that focus specifically on the diverse infrastructure needs, barriers, and opportunities, especially in an island context. Shipping vulnerabilities, climate change, poverty, and increasing global hunger levels suggests that there are systemic issues with access to food at various points within and across infrastructure systems. A study of infrastructure may therefore help to address food insecurity.

Food Security Infrastructure in Islands

Islands are unique cases for food security and infrastructure. Food security is particularly vulnerable in islands due to exasperated effects of the recognized global challenges to food security discussed above, such as climate change and distribution issues. Isolation, dependence on shipping, and unique varying geographies and climates make each island an interesting case. Many island communities depend on food imports and, therefore, are at higher risk of vulnerability due to infrastructure disruptions and their lack of other avenues for food provision (Lowitt et al., 2015). The effects of climate change are particularly challenging as rising sea levels threaten coastal communities and infrastructures (Mbow et al., 2019).

As a result, many island governments, such as Hawaii, Ireland, and Newfoundland, are shifting towards the promotion of local food production with the hopes of reducing dependence on imports (Department of Agriculture, Food, and the Marine, 2020; Office of Planning, Department of Business, Economic Development & Tourism, 2012; Government of Newfoundland and Labrador, 2019). The island of Newfoundland is a unique case study among islands due to its settler-colonial history, infertile soil, highly productive marine resources, and long documented

struggles with food security, hunger, and malnutrition (Bavington, 2010; Cadigan, 2009; Lowitt, 2014).

Though Canada is among the most food secure countries globally (Economist Impact, 2023), rural and remote communities are often left behind and continue to face challenges in access to food. The island of Newfoundland is no stranger to food insecurity. The island is home to sparsely populated communities spread out over a large landscape (Food First, n.d.b). Parrish et al. (2008) have researched food security in coastal communities across Canada. They argue that “food production and availability are dependent on many factors, both social and environmental” (p. 2). To increase food security, both the contemporary and historical food access issues need to be addressed. In order to understand the barriers to food security in the island of Newfoundland, a novel approach is required.

Research Objective

The purpose of this research is to analyze food (in)security in Newfoundland using an infrastructure lens, and to identify infrastructural needs, barriers, and opportunities to improve overall capacity for improving food security in Newfoundland. It uses a novel infrastructure lens (Foley et al. in preparation) to analyze the state of current food infrastructures, identify the existing infrastructural barriers to food security, and suggest more sustainable infrastructures for the future of community planning. This research attempts to answer the following questions: How can an enhanced understanding of food infrastructures help to address food security? What are the infrastructural needs, barriers, and opportunities of food security in Newfoundland? Research objectives include understanding how food security and infrastructure are linked, how an infrastructure lens can help address food security, and how more sustainable and resilient infrastructures can be created in order to reduce the risk of food insecurity in the future.

Conceptual Framework

This research will use a new infrastructure lens to analyze food insecurity in Newfoundland. The focus of this research is the relationship between food security and infrastructure. According to Foley et al. (in preparation), the traditional idea of infrastructure as large public works projects does not fully encapsulate the diverse kinds of infrastructures that researchers in multiple disciplines have identified (Bristow et al., 2010; Casey, 2005; Neuman, 2006). Therefore, Foley et al. (in preparation) suggest that infrastructure can be any network that supports life. In addition to man-made infrastructure, other types of infrastructure include biological and ecological infrastructure, such as soil, waterways, and habitats; and social infrastructure, such as family and community networks and services. Foley et al. (in preparation)'s review of infrastructure research demonstrates how infrastructures are not limited to roads, bridges, and other public works. Their review of interdisciplinary literature suggests that infrastructure is often conceptualized in three distinct types or categories—physical, ecological, and social—which helps inform the conceptual framework and analytical approach taken in this thesis.

Physical infrastructures can be defined as human-made facilities that support public wellbeing and the networks between them; they connect producers, service providers, and consumers (Foley et al., in preparation). Neuman (2006) explains that “infrastructures form the physical basis of networks”; they are channels between the structures that they connect. Life supports such as water, energy, information, people, goods, and waste are transported through physical infrastructures (Neuman, 2006). Neuman (2006) emphasizes that infrastructures empower and transform receivers, such as “an electrical grid [which] brings electricity—power—to a city or a building, and helps to convert the city or building from a mere assemblage of bricks

and mortar into a factory, office, or other productive unit in an urban economy” (Neuman, 2006, p. 7). Foley et al. (in preparation) identify some coastal physical infrastructures like dykes, wharfs, ferries, fish landing ports and processing plants, as well as storage and transportation facilities.

Ecological infrastructures are naturally occurring infrastructures that provide life supports. These could be ecosystem services that support ecological, social, and economic benefits (Bristow et al., 2010). These infrastructures provide life supports such as fresh water, climate regulation, soil formation, and disaster risk reduction (South African National Biodiversity Institute [SANBI], 2014). Bristow et al. (2010) identify aquifers and wetlands as examples of ecological infrastructures that provide water capture, storage, and purification. They highlight soil as a particularly important infrastructure as it is the basis for other ecological infrastructures, including agricultural food production. Soil provides storage and supply of water and nutrients for plants, and acts as waste treatment and removal (Bristow et al., 2010). Foley et al. (in preparation) highlight that Green infrastructures and Blue infrastructures are distinct as they can include natural or semi natural infrastructures that are designed and strategically planned. Many governments are taking Green and Blue infrastructures into consideration for strategic planning for environmental policies (Foley et al., in preparation; de Silva and Wheeler, 2017).

Social infrastructures provide life supports for community and societal well-being. These include “services and processes that enhance the social capacity of communities” such as community, cultural, or recreational networks (Casey, 2005, p. 3), as well as knowledge production and information sharing (Karasti et al., 2016). Examples of social infrastructures include school systems, recreation centres, institutions, governance, and knowledge sharing (Foley et al., in preparation). In coastal communities, fisheries are a major infrastructure that encompass physical (fishing gear, processing plants), ecological (currents, migration patterns), and social

infrastructures (fishing knowledge, job provision, economic assets, policy) (Foley et al., in preparation).

This thesis suggests that this new analytical insight into infrastructures can expand the scope of food security research and uses the case study of Newfoundland to do so. Newfoundland's problems with food production and transportation are not new; however, they have yet to be analyzed with an infrastructural lens. The globally recognized challenges to food security, including access and distribution, are intrinsically tied to infrastructure; therefore, an infrastructure lens is needed to truly understand and ameliorate current food security conditions. Analyzing the island's food security problems with a diverse conceptualization of infrastructure at the core may provide valuable insights for future community resilience building. This conceptual lens is helpful because it can identify diverse needs required for building resilient and sustainable infrastructure in communities. Understanding diverse needs is vital for the provision of and access to a variety of food and food services. Foley et al. (in preparation)'s expanded definition of infrastructure allows for a better cognizance of how communities are built, and what services and networks are created.

Policy Importance

The significance of food security in Newfoundland and Labrador is indisputable. Governmental efforts to promote food security and nutrition in the province can be traced back to the 1930s (Kealey, 2008). The island consists of rocky, acidic, infertile soil, which makes large-scale agriculture difficult (Cadigan, 2009). There is a heavy dependence on the ferry from mainland Canada for imports of many groceries (Food First NL, 2015). Any delays in the ferry can postpone shipments across the whole island. The majority of produce available in grocery stores is expensive and not fresh. Newfoundland's long history of struggle with food security has created a wealth of knowledge about food preservation and innovative tactics to make some farming viable (Parrish et al., 2008). Subsistence hunting and fishing are also popular across the island; however, popularity is declining due to modern barriers such as lack of time and rising costs (Food First NL, n.d.b). Many of the challenges Newfoundland faces align with the global challenges to food security experienced by many islands.

A study of diverse infrastructural needs and supports for food security may allow the province to overcome many of its food security issues. Policy makers may be able to repurpose existing infrastructures or create new, more sustainable infrastructures in order to improve food security and reduce reliance on external resources. Furthermore, understanding infrastructural barriers can aid in planning resilient and sustainable communities, which reduces the risk of food insecurity in the future. Food security has been of political interest in Newfoundland since the 1930s (Kealey 2008). The importance of food security in the province is apparent, and more comprehensive research is required to fully understand the role infrastructure plays in food security.

Literature review

Terminology and Definitions

A variety of terminology has been used in the study of food security including food system, foodscape, and food regime. An understanding of these different terms serves as a basis of food security research.

According to the Intergovernmental Panel on Climate Change (IPCC), a food system encompasses production, transport, processing, packaging, storage, retail, consumption, loss, and waste (Mbow et al., 2019). A food system encompasses all the physical aspects of food production and consumption. Food First NL reported in 2015 that 90% of the produce consumed in Newfoundland is imported via ferry (Food First NL, 2015). Therefore, the majority of the physical aspects of production and processing happen outside the island. Transportation within the island and food retailers are the only parts of the commercial food system in Newfoundland. Newfoundland is self-sufficient in milk, chicken, and egg production; therefore, the food system for these products is strong in Newfoundland. It is important to note that the dairy industry in Canada is highly regulated and protected from global competition (Painter, 2007). This has led to the development of a market for dairy production and consumption within the province. However, the island is still dependent on the import of animal feed (Food First NL, 2015). A rise in barriers to accessing traditional wild foods in Newfoundland further weakens the food system (Food First NL, 2015). Any disruptions to the global food system will have severe repercussions in Newfoundland due to its high dependence on imports.

A foodscape analytical perspective looks at the interactions that unfold when food is obtained, or the connection between people, places, and food. This helps identify food security as an interaction between the household and community (Lowitt, 2014). On the global stage, among

trade agreements and international shipping, it is easy to forget that food is a basic need of survival and not simply a commodity (Patel, 2012). Food is also a basis for culture and family; there is a social aspect, a building of connections and relationships around food (Lowitt, 2013). A foodscape perspective understands these interactions and places them at the forefront of food security study.

Vonthorn et al. (2020, p. 16) define foodscape with the following explanation:

‘Foodscape’ is the right term when explaining how food landscapes are shaped, influenced, transformed by social practices (shopping, cooking, eating), by political and legal institutions, by economic decisions, and by relations of power within food systems. ‘Foodscape’ should also be the preferred term when examining how food landscapes are perceived differently by each of us according to our “historical, linguistic and political situatedness”.

Therefore, foodscape takes on a social and cultural element mixed with the physical. The interactions between the realities of food access and the social nuances of collecting food create a foodscape. Lowitt (2014) studied the foodscape in Bonne Bay, Newfoundland. She discovered that the perceptions around fish as a commodity rather than food are changing the foodscape in Newfoundland. The coastal foodscape of Newfoundland is threatened by a focus on fish exports rather than local consumption, and by food policy forgetting to include fisheries and focusing on agriculture (Lowitt, 2014). Political choices are changing local consumption habits and, therefore, the foodscape is changing.

A food regime analyzes food production and consumption in the context of major historical changes, political actors, and international relations (Foley & Mather, 2018). The first international food regime is identified from 1870s-1930s, and is characterized by colonialism, imperialism, a British hegemony, mono-cultural agriculture, exploitation of colonial resources, and emerging settler states (McMichael, 2009). The second food regime from 1940s-1970s is characterized by industrialism, mercantilism, mechanization, an American hegemony, surplus export, and global supply chains linking specialized agricultures (McMichael, 2009). The third and current food

regime is debated by various scholars, though some recurring themes persist: environmentalism and corporate agribusiness. Increased production, environmental limitations, and protests from activists are also defining the current food regime (Foley & Mather, 2018).

A food regime analysis of Newfoundland requires an understanding of Newfoundland's history, which is expanded upon later in this literature review. For now, this section will highlight the characteristics relevant to Newfoundland's food regimes. Its first food regime was characterized by an established colonial government and salt cod exports to European markets dominating its economy (Cadigan, 2009; Foley & Mather, 2018). Newfoundland's second food regime was characterized by joining Canada, a modernization of the fishery, an increase in offshore fishing, and a shift towards US markets rather than European markets (Cadigan, 2009; Foley & Mather, 2018). The current food regime in Newfoundland is debatable but could be characterized by a shift towards specialized products with environmental considerations (Foley & Mather, 2018).

Food regimes highlight political contexts in which food production and consumption occurs. Food regimes offer a higher level of analysis compared to foodscapes which focus on the practical details of the food system. Yet, there is further opportunity to enrich such food security research through an infrastructure perspective.

Food Infrastructure Perspective

A food infrastructure perspective could expand the scope of food security research. A focus on infrastructures is compatible with foodscape and food regime perspectives research, but it allows for a more interdisciplinary and holistic approach to the study of food security with a focus on sustainable communities. Foley et al. (in preparation)'s definition of infrastructure extends beyond the traditional perspective that infrastructures are roads, bridges, and other public works. It views infrastructures as a network of life supports, including human-made or naturally occurring types. There are three main categories: physical, ecological, and social.

Physical infrastructures can be defined as human-made facilities that support public wellbeing and the networks between them. Life supports such as water, energy, information, people, goods, and waste are transported through and supported by physical infrastructures (Neuman, 2006). Ecological infrastructures are naturally occurring, and they provide life supports such as fresh water, climate regulation, soil formation, and disaster risk reduction (SANBI, 2014). Societal infrastructures provide supports such as community, knowledge, and governance (Foley et al. in preparation). Infrastructure is inherently an interconnected network, so an infrastructure lens can provide an interdisciplinary, holistic analysis of the often hidden root causes of food insecurity and hunger, not just the symptoms. Isolated efforts to address food insecurity have proven unsuccessful as evidenced by the rise in hunger.

If infrastructure can be defined as a network of life supports (Foley et al., in preparation), then a food infrastructure is a network that supports the whole food system, or networks which provide access to food sources. In its most basic sense, infrastructure provides access. Food security is access to food. Therefore, a strong food infrastructure can ensure food security.

Historical Food Trends in Newfoundland

Newfoundland has been facing the same challenges with regard to food security for centuries (Keske, 2018). An understanding of Newfoundland's current and historical food infrastructures is important to consider when planning sustainable solutions. Difficulties with climate, dependence on trade, and limited resources are recurring themes, particularly in Newfoundland's settler-colonial history (Keske, 2018). Scholars have been studying food security in Newfoundland for more than a century, whether as a focus on nutrition, diet, or food preservation tactics, all of which fall under today's definition of food security. The island of Newfoundland "became a laboratory for scientists and medical doctors because of its isolation, homogeneous settler population, and reputation for poverty" (Kealey, 2008, p. 177).

The geological and ecological infrastructure of Newfoundland is unique and diverse. The abundance in marine resources contrasts the sparse land resources (Cadigan, 2009). Most of the soil across Newfoundland is acidic, shallow, contains gravel, and little humus (Cadigan, 2009). Low water retention leaves way for leaching and erosion, making agriculture far more difficult (Cadigan, 2009). Infertile soils make for a weak ecological infrastructure as soil is the basis for other ecological infrastructures (Bristow et al., 2010). In comparison, the currents in the Grand Banks create the perfect environment for phytoplankton and zooplankton, which provide food for the fish and crustaceans, which in turn are the food for seabirds and marine mammals (Cadigan, 2009). The ecological infrastructure in the water is much stronger than on land. The marine resources of Newfoundland have always been abundant and bountiful. The predictable seasons, and abundance of fish and mammals to hunt, allowed many First Peoples to thrive in Newfoundland. For seven millennia, different groups of people lived along the coasts of Newfoundland where they could combine the land and water resources (Cadigan, 2009).

Throughout the 1600s and 1700s, various Europeans visited Newfoundland's shores and established seasonal fisheries, until 1825 when the first colonial government and resident fisheries were established by the British Empire (Cadigan, 2009). With these permanent establishments came the development of new physical and social infrastructures that interact with ecological infrastructures.

As salt cod became a worldwide commodity, the cod fishery became the backbone of Newfoundland society (Cadigan, 2009; Innis, 1978). The government of Newfoundland at the time was heavily influenced by traders and merchants (Innis, 1978). As the population grew, so did social classes, political parties, and troubles in Newfoundland's social economy (Cadigan, 2009). Disagreements between the poor fishers and rich merchants was cause for contention, and fishers often required public relief from the government (Cadigan, 2009). Social infrastructures grew along with the various needs of the growing population through the 19th century.

In 1855, Newfoundland became a responsible government which allowed for more executive decision making while still being accountable to the British Empire (Cadigan, 2009). With winter weather halting fishing, construction of public works, and road building, many Newfoundlanders were unemployed in the winter months (Cadigan, 2009). A diversification of the economy hoped to amend this. By developing landward resources, such as lumber and a railway, Newfoundland hoped to decrease dependency on the sea (Cadigan, 2009). However, due to limited funding and little support from the British Empire, the development of land resources always remained secondary as the fisheries continued to prove lucrative (Cadigan, 2009; Innis, 1978). Development of the fisheries continued despite apparent evidence of overfishing and failing inshore fisheries since the 1830s (Cadigan, 2009). Social infrastructures were defined by the salt cod trade and growing popularity of the fisheries. Ecological infrastructures that were once strong

started to see a decline as overfishing grew. Development of land resources and fisheries saw the construction of new physical infrastructures. The Grenfell Mission, founded in 1892, sought to bring healthcare to people living in northern Newfoundland and discovered quickly that the restricted diet available to residents played a major role in malnutrition and rise of disease (Kealey, 2008). Fishers often purchased six months' worth of supplies on credit to last the winter when harbours would freeze and shipping became difficult. Winter supplies included flour, tea, oleomargarine, tinned milk, and other dried or canned goods (Kealey, 2008). Diets would be supplemented with "wild meat, fish, root crops, and berries available locally" (Kealey, 2008, p. 180). Self-provisioning was key in each household so that they could depend less on credit from merchants (Lowitt, 2014). However, "by spring many families ran out of supplies and lived on salted meat or fish, bread and tea. The result was malnutrition and dietary deficiency diseases such as beri-beri, night-blindness, scurvy, and rickets" (Kealey, 2008, p. 180). Newfoundland's dependence on shipping created a wealth of food preservation tactics, however nutrition often suffered.

In 1907, Newfoundland became a Dominion and transformed from a responsible government under the British Empire to an independent self-government (Cadigan, 2009). During this time, Newfoundland attempted and failed to expand various markets to the United States, and continued attempts to develop land resources, while remaining heavily dependent on the fisheries. Railroad development debts, war debts, and the Great Depression saw Newfoundland give up their democratic self-government to a British Commission in 1934 (Cadigan, 2009).

In the 1930s, supplements of calcium and vitamins in the form of milk and orange juice were provided to some families in the Northern Peninsula by the Grenfell Mission. These families were visited the following year, and the children were notably healthier (Kealey, 2008). The

following year, they were encouraged to collect seeds and create backyard gardens to increase their vegetable supply (Kealey, 2008). Societal infrastructure around health was developed through this distribution.

A study of the health of British colonies in 1936 recommended that malnutrition could be combatted through “subsidization of food costs, cheap freight rates, the elimination of duties, and increased home production” (Kealey, 2008, p. 180). They recognized that dependence on imports made food more expensive, and the precarious income of workers made it even harder to afford. The 1940s saw a rise in nutrition councils made up of “specialists in nutrition, agriculture, forestry, and fisheries” evidencing a growing interest in food security on the island (Kealey, 2008, p. 183).

After the Second World War, a weak economy, lack of jobs, and a rise in hunger forced Newfoundlanders to re-evaluate their governance (Cadigan, 2009). Joey Smallwood, a champion of Confederation, promised a stronger economy and better jobs if they joined Canada (Cadigan, 2009). Newfoundland held a referendum and officially joined Canada in 1949 with Joey Smallwood as the first Premier of the new province of Newfoundland and Labrador (Cadigan, 2009). He promised economic development, modernization, and industrialization. However, in reality, worker disputes and labour strikes rose, while resettlement of communities caused major disruptions to many Newfoundlanders (Cadigan, 2009). Outport fishing communities were relocated to urban centres to allow for industrialization of the fishery and easier access to government social services (Bavington, 2010). Disruptions in societal infrastructure and development of physical infrastructure characterized this time period.

The efforts to improve nutrition and health in Newfoundland continued post-Confederation. By the 1950s, it was commonplace that staples such as milk and flour were enriched with vitamins, and free orange juice and cod liver oil was distributed among the

population until 1968 (Kealey, 2008). Attitudes towards nutrition were improving as mothers were often targets of government educational campaigns regarding nutrition. Free incentives were no longer required as mothers often chose the healthy supplements themselves. The 1950s also saw a shift towards a cash economy rather than merchant credits, encouraging people to purchase processed foods (Lowitt, 2014). Eventually, by the 1970s, many Newfoundlanders started to enjoy the fruits of modernization with unprecedented social and educational services (Cadigan, 2009). Prospects for hydroelectricity and oil also held hope for land development and economic diversification. Physical and societal food infrastructures developed even more over this time.

Post confederation, the federal government took over fisheries management, marking a shift away from community-based decision making (Bavington, 2010). Furthermore, the fisheries continued to modernize and offshore fishing grew more popular, “with this change, organization of the fishery slipped from the fishermen’s hands and increasingly became the purview of fisheries scientists and managers” (Bavington, 2010). Ecological infrastructures were under increased pressure as industrial fisheries expanded and continued to overfish. Inshore fishers started voicing their concerns about the declining cod stocks (Bavington, 2010; Cadigan, 2009). Newfoundland was dependent on federal financial assistance and federal policy over the fisheries (Cadigan, 2009). The direct sale of seafood from harvesters to local people or restaurants was prohibited as most of Newfoundland’s seafood was exported globally (Lowitt, 2014). Some informal networks persisted that allowed people to access local seafood; however, the heavy commercialization and industrialization of seafood production, and policy focus on supporting exports started a decline in local seafood consumption (Lowitt, 2014). Societal infrastructures around seafood saw a shift as local seafood became less accessible.

Gardening and other subsistence culture waned post-Confederation as women took up jobs at fish processing plants, leaving no adult at home to tend to the gardens (Omohundro, 1994). Jobs were more desirable as wages were needed in the new cash economy. The construction of roads also made accessing supermarkets easier than tending to a garden (Lowitt, 2014). International trade brought a diversity of foods to supermarkets which added to their appeal as well (Lowitt, 2014). As new physical food infrastructures emerged, social infrastructures changed. Traditional pathways of food provisioning declined in popularity as commodified goods became the norm (Parrish et al., 2008). Knowledge started to be lost and social infrastructures weakened.

As cod reproduction reduced and overfishing continued, cod stocks declined drastically, forcing the Government of Canada to ban all commercial fishing of Northern Cod (Bavington, 2010; Cadigan, 2009). The cod moratorium in 1992 caused major changes to Newfoundland's norms as 30% of the population found themselves unemployed overnight, resulting in waves of social disruptions, such as long-term unemployment and migration (Foley, 2019). Intensified commodification and industrialization of the codfish developed a notion of fish as a commodity to be sold rather than a food to be consumed (Lowitt, 2014). Ecological infrastructures finally broke down as the waters reached their limits. As a result, physical and societal infrastructures also saw a shift.

Current Food Trends in Newfoundland

A rise of diabetes and obesity in Newfoundland has forced nutrition back into the spotlight (Kealey, 2008). Recent studies suggest that Newfoundlanders have the highest rates of diabetes and obesity and the lowest rates of vegetable consumption in Canada (Food First, 2015). The recommendations from the 1936 health survey resonate in today's Newfoundland as high cost of food, transportation, and lack of local production are the leading causes of food insecurity on the

island (Food First, 2015). The repeating themes over the course of Newfoundland’s history calls for a novel approach to sustainably tackle food security issues in Newfoundland. Traditional foodways that focus on local production such as gardening, fishing, hunting, and berry picking are becoming increasingly difficult to access due to modern barriers such as rising costs of gear, lack of time, impact of climate change on the predictability of ice freezing and melting, and herd migration (Food First, 2015; Parrish et al., 2008). The challenge of food security and nutrition is not new in Newfoundland, yet effective, sustainable solutions are still lacking. A novel approach is required in order to properly address food security.

Some examples of food infrastructures that exist in Newfoundland are outlined in Table 1 below. The following sections delve into the current state of these food infrastructures in Newfoundland and how they have been influenced by its unique history and environment. The recurring themes that persist in Newfoundland’s food trends such as dependence on shipping, lack of local produce, lack of local seafood, and rising costs are analyzed through an infrastructure lens in the following sections.

TABLE 1: Examples of food infrastructures in Newfoundland

Physical Food Infrastructures	Ecological Food Infrastructures	Social Food Infrastructures
<ul style="list-style-type: none"> • Grocery stores, corner stores • Farmers markets, farm stands • Roads • Ferry 	<ul style="list-style-type: none"> • Migration patterns • Weather patterns • Planting and harvesting seasons • Farm ecosystem • Fertile soil • Fishing seasons 	<ul style="list-style-type: none"> • Informal networks • Social aid • Policy and governance • Community gardens • School programs

Physical Food Infrastructures

In the context of the food system, physical food infrastructures in Newfoundland often revolve around access points and transportation. This could include grocery stores and corner stores, where food is most commonly purchased in Newfoundland (Food First NL, 2015). Many Newfoundlanders purchase food from convenience stores or gas stations since the majority of rural communities do not have a full-service grocery store (Food First NL, 2015). These smaller stores do not often stock fresh produce (Food First NL, 2015). Fresh and healthier food options also tend to be more expensive than processed foods (Food First NL, 2015). Farmers markets and farm stands are also common food infrastructures; however, they are not as widespread or accessible in Newfoundland. The St. John's Farmers Market is a major player in providing local food access to the public and is one of only five farmers markets across the island that are open to the public year-round (Poitevin, 2015; Government of Newfoundland and Labrador, 2019). A map of these farmers markets is displayed later in this paper (see Figure 4).

Transportation such as roads and the ferry are vital for food access in Newfoundland (Food First NL, 2015). Oftentimes, people in rural areas will travel upwards of 200 kilometres and plan grocery trips every two weeks to larger city centres rather than purchase food locally due to the unavailability of fresh produce and the high costs (Lowitt & Neis, 2018; Vodden et al., 2018). As of 2015, food imports via ferries are responsible for 90% of the produce consumed in the province, despite regular delays caused by adverse weather conditions, vessel maintenance, labour strikes, or icy conditions (Food First NL, 2015). Newfoundland would only have a two-to-three-day supply of fresh food if the ferry was disrupted (Food First NL, 2015). The whole island depends on a system that is quite unreliable and has caused shortages in communities across the province (Food First NL, 2015). Long shipping times force the cost of shipping to increase and the freshness of

the produce to decrease (Food First NL, 2015). Produce deterioration is commonplace and up to 50% of imported produce may be wasted due to deterioration (Doyle, 2014). High cost for low quality produce is the norm across Newfoundland (Food First, 2015).

Energy infrastructures also play a major role as energy is in every step of the food system. Currently the global food system accounts for 30% of global energy consumption (FAO, 2011). Most of the world continues to rely on fossil fuels for their energy (FAO, 2011). A shift to more sustainable, renewable energy is needed to develop a more sustainable food system. A shift to more energy efficient choices can also help. The FAO (2016) has identified a few energy efficient switches for the agri-food system including: solar irrigation, drip irrigation, precision agriculture, conservation agriculture, solar food processing, and wind water pumping. Newfoundland is one of the largest producers of crude oil in Canada, and 58% of energy consumption in the province is from petroleum products (Government of Canada, 2024). The province's consumption of gasoline is 36% higher than the national average per capita (Government of Canada, 2024). Newfoundland also produces a significant portion of Canada's hydroelectricity and is expanding its wind energy generation as well (Government of Canada, 2024). Hydroelectricity accounts for almost 96% of Newfoundland's energy source, but much of it is exported to Quebec (Government of Canada, 2024).

Other physical infrastructures that encourage food security, including greenhouses and community gardens, are expanded upon in the social infrastructure section due to their tendency to serve communities and provide a space for communal activities.

Ecological Food Infrastructures

Food production is largely influenced by ecological infrastructures in Newfoundland. Though popularity is decreasing due to rising costs and less time, subsistence hunting and fishing are common in Newfoundland. Migration patterns of caribou, moose, and fish are examples of ecological food infrastructures. These patterns are changing due to climate change, making access more difficult (Food First NL, 2015).

Weather patterns, and planting and harvesting seasons are also key infrastructures of farming and agriculture. Warming weather has seen an increase in drought, and a need to increase irrigation (Reza & Sabau, 2022). An increase in pests has also been noticed by Newfoundland farmers due to warming temperatures, as evidenced by a more frequent use of pesticides (Reza & Sabau, 2022). Climate change is causing a shift in weather patterns and therefore the seasonality is changing as well. Farm ecosystems are changing as a result of warming climates.

Fertile soil and arable land are ecological infrastructures that Newfoundland naturally lacks. Newfoundland has the lowest number of commercial farms in Canada and has an aging farmer population (Food First NL, 2015). Food production on the island is particularly low due to environmental factors such as acidic soil and harsh winters. The provincial government has attempted to bolster Newfoundland's local food production with initiatives such as "The Way Forward on Agriculture" which aimed to double food self-sufficiency in the province by 2022 (Government of Newfoundland and Labrador, n.d.a). Newfoundland is known to produce some root vegetables such as potatoes, turnip, carrot, and cabbage (Government of Newfoundland and Labrador, 2019; St. Pierre & McComb, 2022). The 2021 census reported 344 farms in the province of Newfoundland and Labrador, a 15.5% decrease from 2016 (St. Pierre & McComb, 2022). The most frequent type of farm are vegetable and melon farms which account for 23.5% of total farms,

followed by greenhouse, nursery, and floriculture at 16.3% (St. Pierre & McComb, 2022). Other food production in the island includes meat, poultry, eggs, dairy, honey, and herbs (Government of Newfoundland and Labrador, 2019).

Small scale commercial farms play a vital role in the production of food. According to FAO data, small scale farms produce one third of global food supply (FAO, 2021a). Larger farms are the most common in Newfoundland, and there is little data and representation of small farms. In 2010, 80% of the produce produced in the province was produced by 10% of the farms in the province, proving that large scale farms dominate (Doyle, 2014). There is an opportunity to focus on the production capabilities of small-scale farms in Newfoundland.

The recreational fishery, which allows people within the province to catch a limited number of fish for subsistence purposes, is regulated by the federal Department of Fisheries and Oceans (DFO). Generally, it is open on weekends from July to September, with exact dates published each year (Government of Canada, 2023b). The federal government determines retention limits, specifications on gear, and processing at sea versus on land (Government of Canada, 2023b). This recreational fishery is the only time that people in Newfoundland are permitted to fish for cod for personal consumption. As a result, it is commonly referred to as “the food fishery” or a subsistence fishery by Newfoundlanders (Lowitt, 2014; Poitevin, 2015). The season of the fishery is determined by the ecological infrastructure of the cod stocks, migration, and behaviours as outlined in the Integrated Fisheries Management Plan (Government of Canada, 2017). Fishing management and regulation is an example of how ecological infrastructures of fish population and migration is intertwined with the social infrastructure of governance and legislation. More research on the commercial fishing regulations and the roles of federal and provincial government are outlined in the social infrastructures section.

Social Food Infrastructures

Newfoundland is well known for its neighbourly attitudes and strong social cohesion. Therefore, it is not surprising that social food infrastructures are quite strong. Alternative food networks are common. For example, some people had access to local seafood through informal means before direct sales were legalized if they personally knew a fisher (Levkoe et al., 2017; Poitevin, 2015). Social food infrastructures can include these informal networks, public perceptions and beliefs, governance, social aid, or community development.

Public perception around seafood in Newfoundland is quite unique. While fish is widely regarded as a cultural symbol of Newfoundland, studies of seafood and fisheries in Newfoundland are often done with an economic lens and very rarely have a food consumption perspective (Foley & Mather, 2018). Food security studies often revolve around agriculture and, thus, seafood is forgotten (Foley & Mather, 2018; Poitevin, 2015). Fish and seafood are often perceived as a commodity for export rather than as a food for consumption (Asante et al., 2021; Levkoe et al., 2017; Poitevin, 2015). As a result, young people are consuming less fish and critical food skills are being lost (Lowitt, 2014). Lack of access to seafood has impacted local consumption habits. A study in the Bonne Bay region showed that seafood consumption in households is declining (Lowitt, 2013). Local seafood is notoriously difficult to purchase in grocery stores in Newfoundland (Poitevin, 2015). Direct sales of local seafood were illegal until 2015 (Fisheries and Aquaculture, 2015), and it is difficult to access local seafood without personally knowing a fisher (Lowitt, 2014; Poitevin, 2015). Lack of access to seafood and decreased consumption is leading to loss of fish preparation skills (Lowitt, 2014; Poitevin, 2015).

There is an opportunity for markets to change public perception and encourage consumption. The snow crab fishery developed in Newfoundland in the 1960s. Before then, any

accidentally caught snow crab were released because no one had the knowledge or skills to prepare it as food (Lowitt, 2014). The development of the snow crab market changed public perception, introduced new food skills, and changed diets in the population (Lowitt, 2014). Newfoundland is reliant on the export of seafood, but this model has proven to be unstable, especially in the face of global events, such as the COVID-19 pandemic when exports were halted (Asante et al., 2021). There is an opportunity for seafood to fill a gap in food security studies in Newfoundland. Diversifying the market, creating alternative markets, and keeping some seafood for local consumption could help create a more sustainable system (Asante et al., 2021).

Financial challenges are the single largest threat to food security in Newfoundland (Traverso-Yepez et al., 2018; Food First NL, 2015). The provincial government introduced a poverty reduction strategy in 2006, which had a direct impact in decreasing food insecurity at the time (Hussain & Tarasuk, 2022; Loopstra et al., 2015). Since then, both poverty and food insecurity have once again risen (Hussain & Tarasuk, 2022). Single parent households and seniors are most vulnerable to food insecurity since their incomes are limited (Callahan, 2003; Traverso-Yepez et al., 2018). Lack of time, lack of food preparation skills, and limited mobility are also factors that impact single parent households and seniors' food security (Callahan, 2003; Traverso-Yepez et al., 2018). Many transitional solutions are available, such as food banks and community kitchens, which can provide meals to vulnerable populations (Traverso-Yepez et al., 2018). However, for structural, holistic, and sustainable solutions to food insecurity, social infrastructures such as poverty reduction strategies and strong food policies are needed (Traverso-Yepez et al., 2018).

School food programs are another transitional program that offer meals to students, thus reducing the burden on households and allowing students to have nutritious foods (Traverso-Yepez

et al., 2018). Greenhouses and gardens in schools offer a more permanent solution (Doyle & Traverso-Yepez, 2018). A study of the St. Francis Greenhouse in Harbour Grace shows that the school greenhouse is a source of pride and inspiration (Doyle & Traverso-Yepez, 2018). The greenhouse has been operating for over twenty years, and many students developed their interest in biology and food from the greenhouse (Doyle & Traverso-Yepez, 2018). Initial investment and continued management are the most difficult pieces of creating a successful school greenhouse (Doyle and Traverso-Yepez, 2018). The St. Francis Greenhouse has successfully created connections between students and the food system including:

(1) students were exposed to new foods; (2) teachers felt enhanced motivation to engage students with the greenhouse because of their concern about the lack of food knowledge and also concern about the nature of “modern” food; and (3) students learned that local food production was possible (Doyle & Traverso-Yepez, 2018, p. 102).

The Greenhouse creates connections between people and their environment and encourages involvement in the food system. This is an example of an integration of physical and social infrastructures.

The rise of social movements encouraging self-production are evident in the rise of community gardens. Community gardens can be considered a social infrastructure not only because they provide food, but also because they provide social, cultural, youth development, economic, health, and ecological benefits (Vodden et al., 2018). Community gardens foster relationships, provide access to fresh produce, facilitate knowledge and skill exchange, encourage self-sufficiency, reduce packaging and fuel inputs, encourage waste reduction, and provide a communal green space, among other benefits (Vodden et al., 2018). They can play a major role in creating a sustainable food system and therefore contribute to food security. The Centreville-Wareham-Trinity (CWT) community garden offers fresh produce to residents in the CWT and Indian Bay area and saves them driving 200 kilometres to Gander and back (the closest large town

with full-service grocery stores) (Vodden et al., 2018). Usually, smaller stores in the region often have a low stock of fresh produce, so the commute to Gander is necessary (Vodden et al., 2018). Community gardens in rural parts of Newfoundland offer a source of fresh produce to residents. However, the lack of funds and managerial skills are often the downfall of community gardens (Vodden et al., 2018). See Figure 3 for a map of community gardens in Newfoundland.

Working towards food self-sufficiency is one way to decrease dependence on external factors and improve food security. Governance and policy are key social infrastructures that can drive self-sufficiency tactics. Newfoundland's provincial government is attempting to improve food self-sufficiency in the province as evidenced by 'The Way Forward' program which planned to double food self-sufficiency by 2022 (Government of Newfoundland and Labrador, n.d.). It was announced in December 2022 that the target was met, and Newfoundland produces 21% of the produce it consumes, compared to 10% previously (Fisheries, Forestry and Agriculture, 2022).

The milk industry in Newfoundland may be perceived as self-sufficient since Newfoundland's dairy farms produce all the milk consumed on the island (Government of Newfoundland and Labrador, 2018), but in reality, that is not the case. Federal regulations protect the dairy industry in Canada, allowing for a strong market for local milk (Painter, 2007). Furthermore, since inputs like cow feed are imported (Government of Newfoundland and Labrador, n.d.c), and dairy processing happens outside of Newfoundland (Government of Newfoundland and Labrador, 2018), the dairy industry is not yet self-sufficient.

Policy and relations between different levels of government constitute a major social infrastructure that impacts food security in Newfoundland. The provincial government is a major player in *agricultural* food security as they have multiple programs and initiatives to support food self-sufficiency. Conversely, the interactions between federal and provincial governments with

regards to *seafood* plays a major role in what seafoods are available for local consumption. The federal Department of Fisheries and Oceans (DFO) and provincial Department of Fisheries and Aquaculture (DFA) have different jurisdictions. DFO is responsible for managing everything in the water including scientific assessments, ecosystem health monitoring, and managing quotas (Poitevin, 2015). The DFA manages the catch after it has landed. This includes processing, distribution, and sales (Poitevin, 2015). The policies created by each level are networks through which access to seafood is granted; therefore, it is a food infrastructure.

Small scale fishers are also often forgotten in policy and governance discourse. Any challenges in the fisheries often disproportionately affect small scale fishers (Poitevin, 2015). Small scale fishers also more directly contribute to local food systems and therefore are a vital part of the food security equation (Poitevin, 2015).

FIGURE 1: Map of Newfoundland. The Blue points show the ferry terminals. The Sydney-Port aux Basques route operates year-round, while the Sydney-Argentia route operates only in the summer. The Yellow points are various cities and highly populated towns along the Trans-Canada Highway. The Grand Banks and St. Anthony are highlighted because they are mentioned in this paper. This map was created using Google Earth.

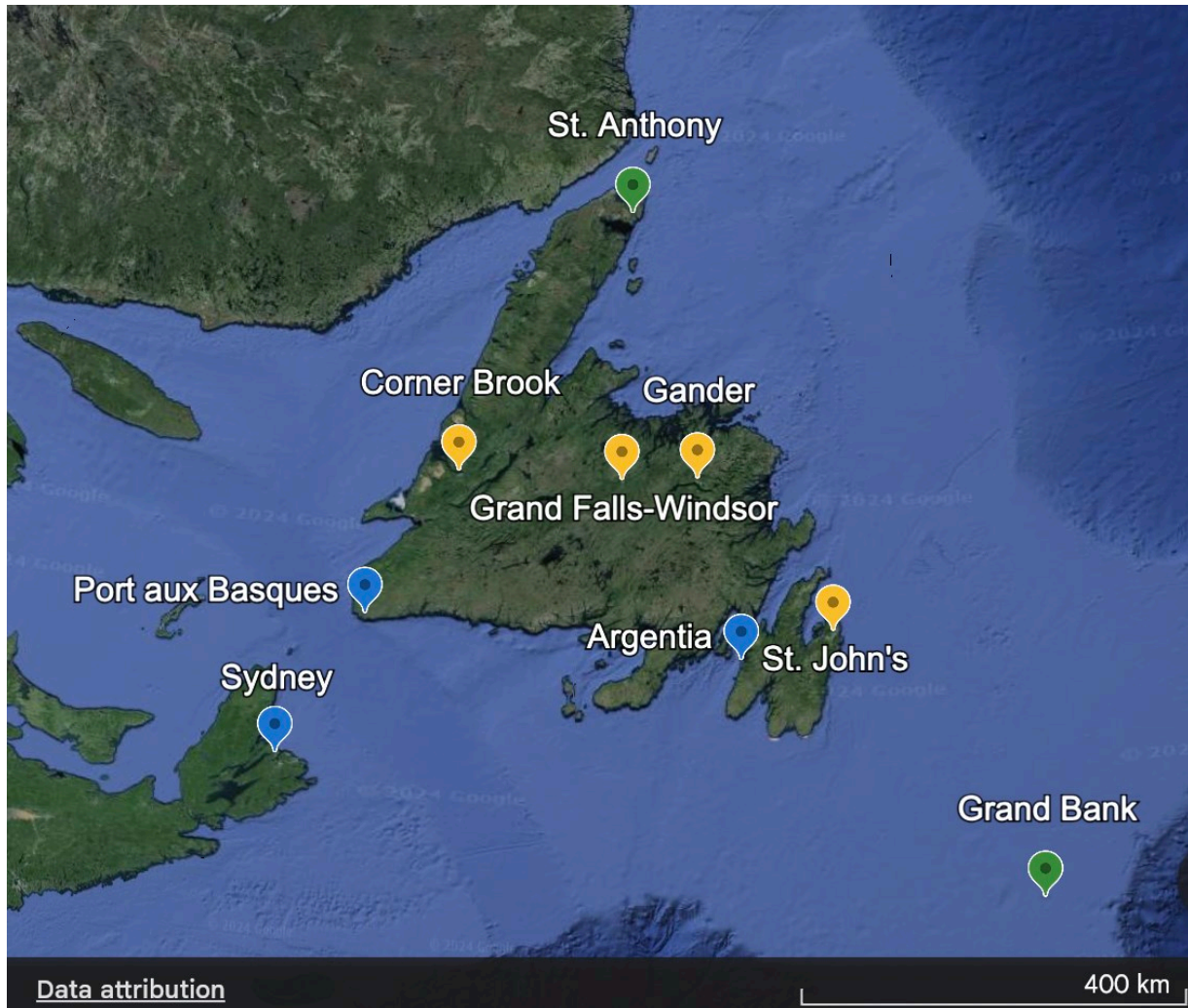
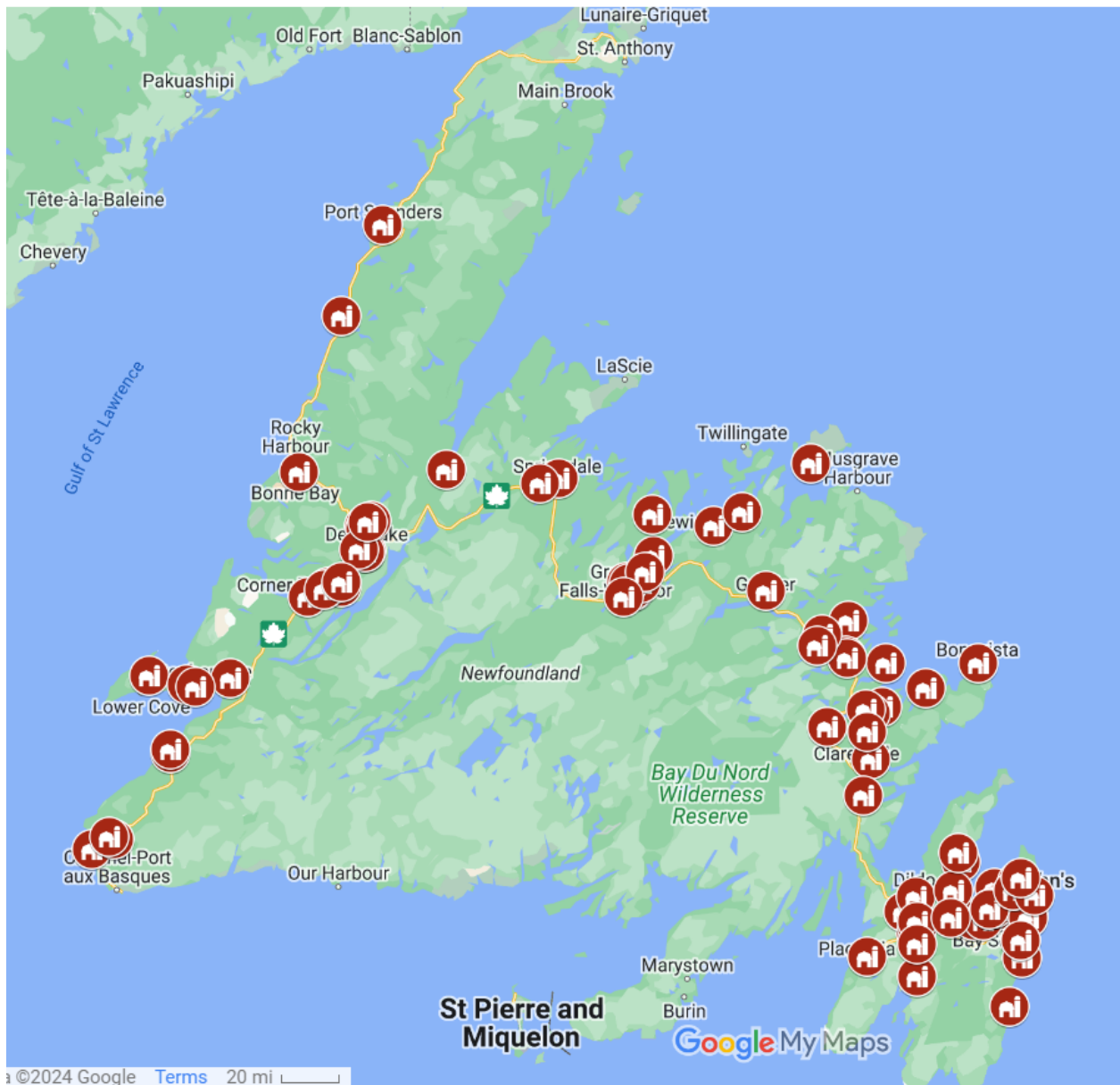


FIGURE 2: Map of farms in Newfoundland. Taken from NL Grown, a food map created by the Food Producers Forum (2023). This data includes vegetable farms, berry farms, orchards, apiaries, meat farms, poultry farms, dairy farms, and nurseries.



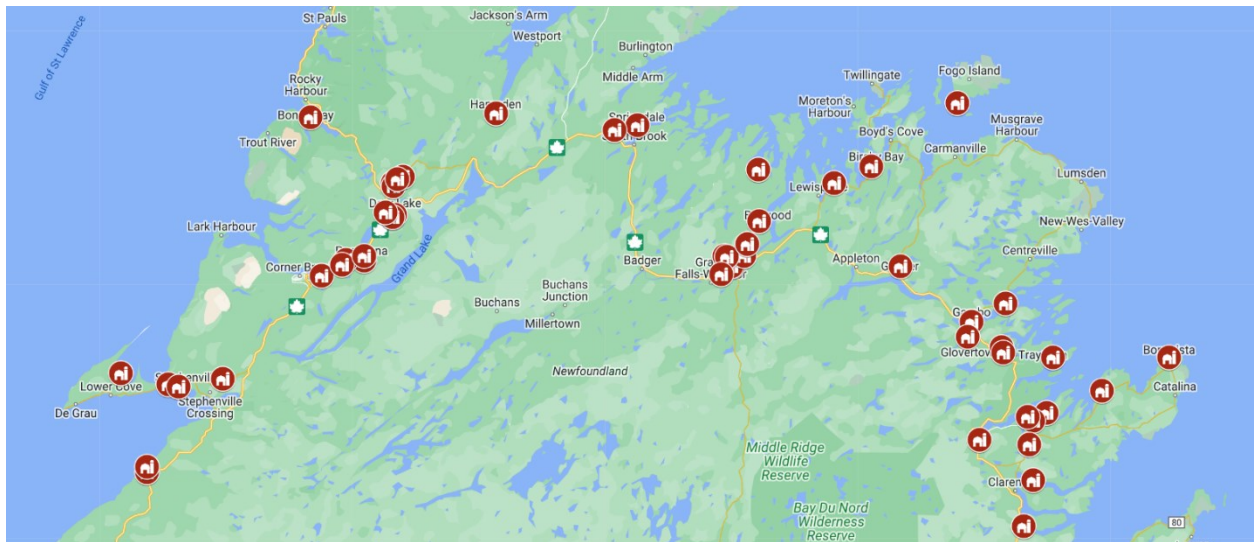


FIGURE 2.1 (top): Map of farms in Newfoundland (Food Producers Forum, 2023), zoomed in to highlight the spread of farms along the Trans-Canada Highway, and the concentration of farms around larger population centres like Corner Brook and Grand-Falls Windsor.

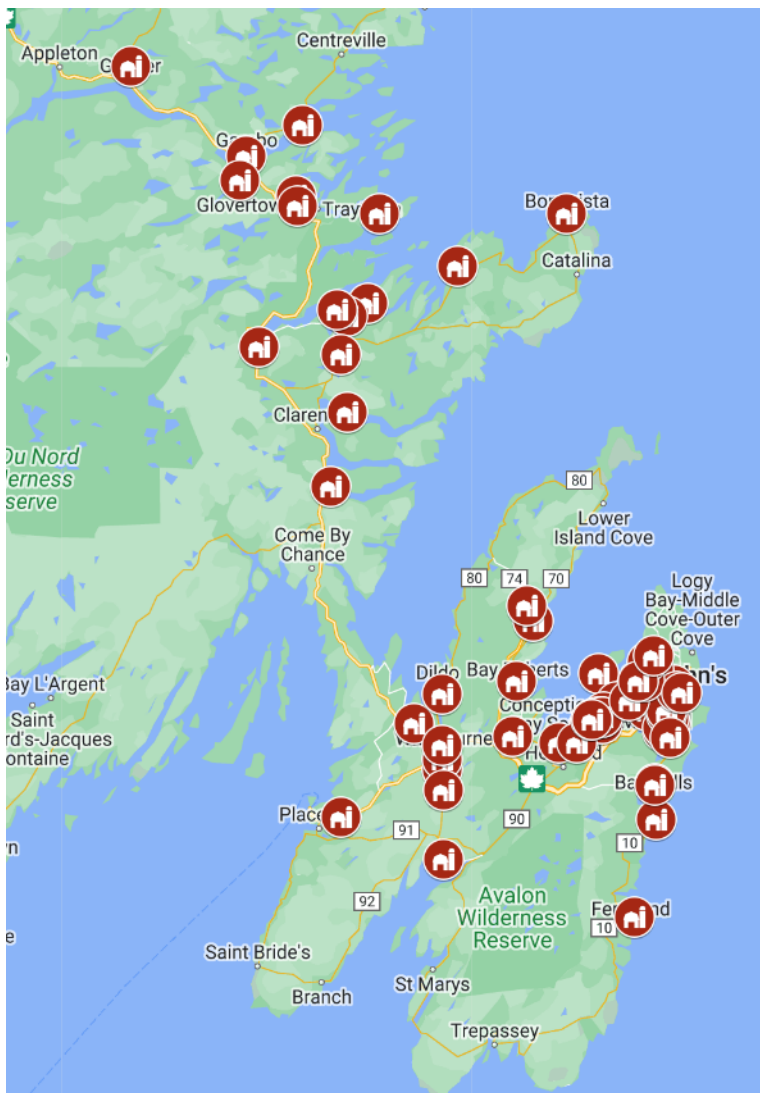


FIGURE 2.2 (left): Map of farms in Newfoundland (Food Producers Forum, 2023), zoomed in to highlight concentration of farms in the Avalon peninsula.

FIGURE 3: Map of community gardens in Newfoundland. Taken from NL Grown, a food map created by the Food Producers Forum (2023).

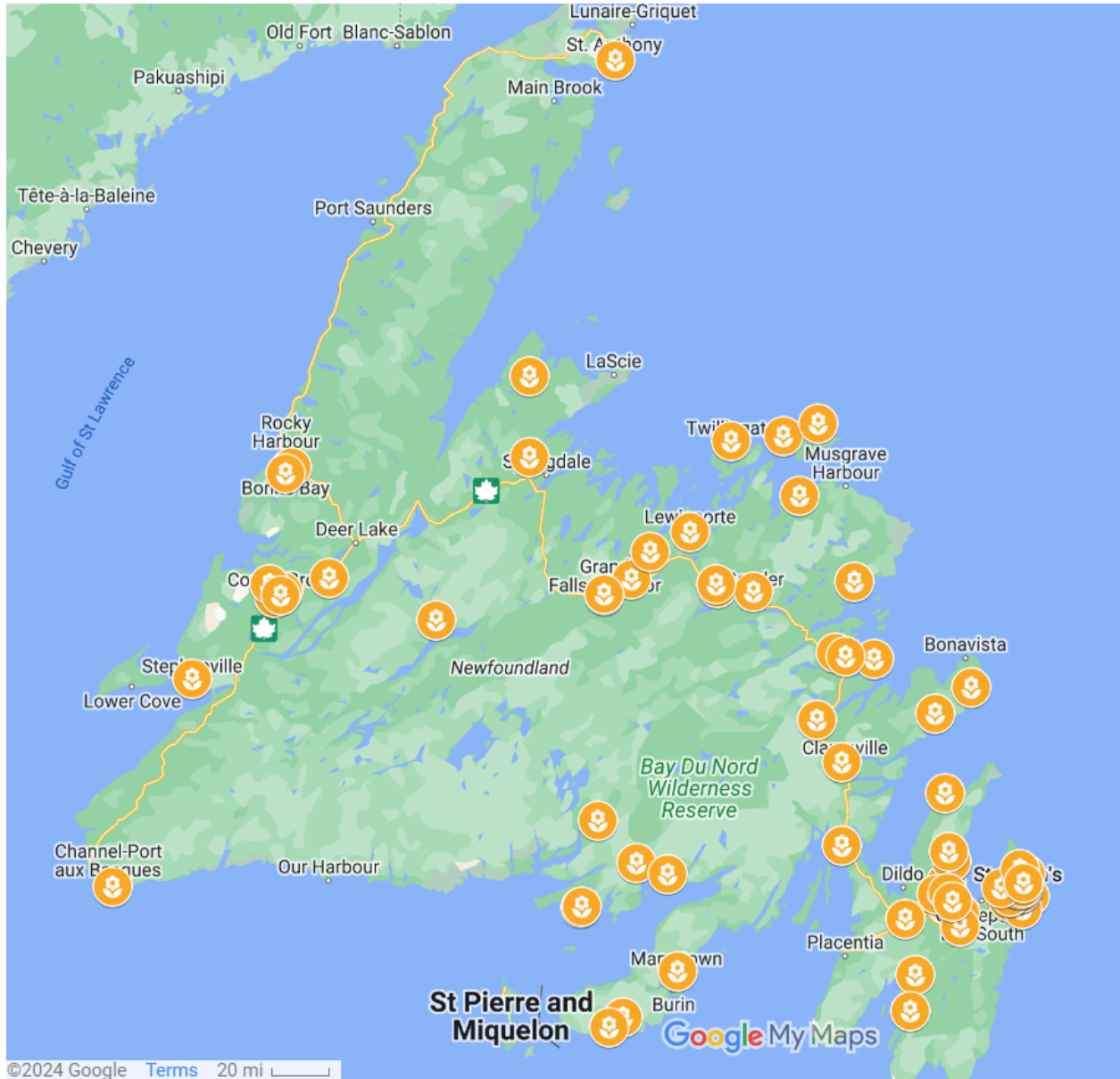
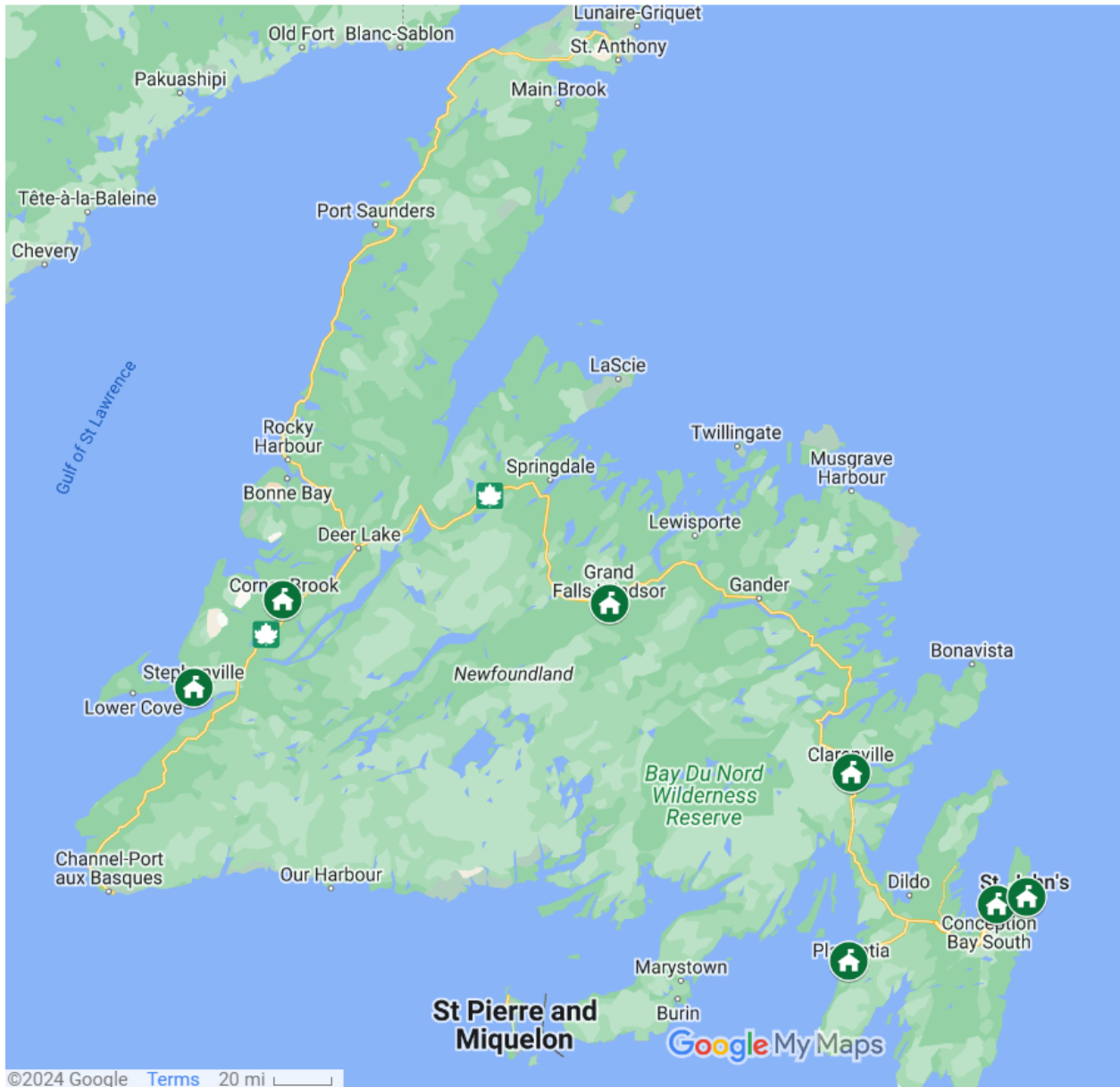


FIGURE 4: Map of farmers markets in Newfoundland. Taken from NL Grown, a food map created by the Food Producers Forum (2023).



Significance of Infrastructure Lens

Newfoundland's problems with food security are not new; however, they have yet to be analyzed with an infrastructural lens. This novel interdisciplinary approach may provide insight and understanding that could help develop more sustainable solutions to Newfoundland's systemic problems with food security. This conceptual lens is helpful because it can identify diverse needs required for building resilient and sustainable infrastructure in communities. Understanding diverse infrastructure needs is vital for the provision of and access to a variety of food and food services. These broad definitions of infrastructure will allow for a holistic understanding of the reality of barriers to food security in communities. Historical trends have shown temporary solutions to different food access problems. A study of food infrastructure has the potential to offer sustainable solutions embedded in communities and networks. A food infrastructure is a network across which food and food inputs can be transported. Therefore, a strong food infrastructure is equivalent to access, which in turn will lead to food security. By identifying the infrastructural needs, barriers, and opportunities for food security, we can create sustainable solutions to address food security in Newfoundland.

Research Methods

The purpose of this research is to apply a novel analytical infrastructure lens to food security in Newfoundland in order to identify fundamental infrastructural needs, barriers, and opportunities to enhance overall capacity for improving food security in Newfoundland. This research is an in-depth case study that uses a combination of primary and secondary sources in order to accurately paint a picture of the current food landscape and adopt solutions based on lived experience. While the literature review above helps create understanding, the following research employs informational semi-structured interviews to more richly answer the research questions with additional data and insight from people knowledgeable about food security challenges and opportunities in Newfoundland. It also provides the opportunity to find sustainable solutions that can be implemented to ensure more resilient communities in the future. The data collected is based on causes, processes, and beliefs, therefore a qualitative approach is necessary (Kanazawa, 2018).

Case Justification

The significance of food security in Newfoundland is indisputable. Governmental efforts to promote food security and nutrition in the province can be traced back to the 1930s (Kealey, 2007, p. 185). Infertile soil, heavy dependence on imports, high cost, and low quality of produce are the norm in Newfoundland. Political interest in food security on the island is apparent, but more research is required to determine to the nature and significance of diverse infrastructures in understanding the needs for, barriers to, and opportunities to address food insecurity in the province. This research focuses on an island infrastructure; therefore, Labrador is outside of the scope of this paper. Labrador's unique food infrastructures would require a separate in-depth study.

Ethical Considerations

This research involves human participants and therefore required review by the Grenfell Campus Research Ethics Board (GC-REB). Participants completed a video or phone interview. The interviews were audio recorded so answers were collected in the participant's own words. Information on food accessibility and infrastructural disruptions and improvements were collected. Information will be returned to the participants in the form of a summary of the results and discussion from this thesis.

There were no known expected physical, psychological, social, or financial harms from the interview process. Likewise, there were no immediate benefits of participation in the survey. Participants' response contributed to the data from literature surrounding food security and infrastructure in Newfoundland and adds to the existing literature new original data that may be used in future projects. There is a chance that participants' responses will contribute to future policy making in Newfoundland and Labrador. Otherwise, there were no expected immediate benefits for each participant.

Participation in the interviews was completely voluntary. Participants could refuse to answer any question. The interviews were not targeted at vulnerable populations or children under the age of consent. No incentives were offered and there was no coercion for completion. The process included an informed consent form signed by the participant and returned to the researcher prior to the interview.

Participant identities were collected only in the consent form. The transcripts and audio recording did not include their name or other identifiable information. Any published data will be presented in aggregate form, so individuals cannot be identified. Data will be kept for a minimum

of five years, as per Memorial University policy on Integrity in Scholarly Research. This research was approved by the GC-REB on January 28, 2023.

Interviews

Interviews can provide insights into human nature and interaction with the environment (Kanazawa, 2018). A major advantage over surveys or other research methods is the opportunity to ask interviewees for clarification or elaboration (Kanazawa, 2018). This may also encourage the researcher to explore a topic they initially did not consider (Kanazawa, 2018). The interviews were used to ground the literature review by either verifying or contradicting the existing research, and further identify major undocumented infrastructure needs, barriers, and opportunities. Interview questions were organized largely around the different types of infrastructure identified in the conceptual framework.

In order to identify infrastructural needs, barriers, and opportunities, some guiding descriptive questions were necessary. These include: How is food normally accessed by Newfoundlanders? What barriers are there to accessing food? How would infrastructural disruptions affect accessibility to food? What infrastructures could improve access to food? The guiding questions were produced as a result of the data collected through the literature review.

Data Collection

Preliminary web-based research was conducted to curate a list of potential interview participants. A mixture of government employees, NGOs, producers, suppliers, distributors, and academics were identified as having or likely to have substantial experience and knowledge of food security needs, challenges, and opportunities in Newfoundland. The participants were researched online; their email addresses were available online and collected; and interview invitations were sent to their emails. The snowball method was also used. Following each

interview, some participants were asked if they could recommend others who would be interested in this research. In total, 36 people were invited to participate, of which 11 accepted the invitation. Participants were purposefully sampled across government, producer, NGO, and academic sectors. However, a higher number of government employees and academics responded positively. All the participants were given the same information. The interviews were roughly the same length of time, and everyone who was willing to participate was interviewed. Participants were given a short preamble of the research in the interview invitation, including a brief description of the definition of diverse infrastructures used in this research, as well as an informed consent form to be signed and returned. The interviews took place over Microsoft Teams, Zoom, or telephone at the discretion and comfort of the participant. The audio was recorded and transcribed using Otter.ai. The transcripts were reviewed and uploaded to NVivo for data analysis. The interviews ended when the research reached a saturation point when the answers were repetitive, and all willing participants were interviewed. A copy of the recruitment email, interview guide, and informed consent form are attached in Appendices.

Data Analysis

The first step in qualitative data analysis is data familiarization where the transcripts are reviewed, and the data is organized for analysis (Kanazawa, 2018). Each transcript was re-read, and patterns, themes, and general ideas were highlighted. Similarities and repetitions across different participants were noted.

Next, data reduction was carried out whereby the data was processed into themes (Kanazawa, 2018). The transcripts were uploaded to NVivo in order to organize the data. Trends, commonalities, and differences between answers were categorized. Preliminary codes were created based on the patterns which emerged when highlighting transcripts. As they were re-read,

the codes were rearranged, and new codes were added. The mixed nature of the interview questions in this research requires a mixed inductive and deductive data analysis approach. Setting codes and categories based on the research questions allowed for structure and direction (Kanazawa, 2018).

Some sample preliminary codes include: climate change, cost, ferry, backyard farming, policy barrier, and schools. Some of these codes were edited for more clarity. For example, cost was divided into consumer cost and producer cost. School was divided into existing school programs, suggested school programs, re-education, rewilding, and skills. All of the data points were then re-organized into three overarching categories: needs, barriers, and opportunities. The data in each category was re-analyzed into codes within each category.

Results

The following section will outline and explain the various needs, barriers, and opportunities for food security that were collected through the key informant interviews. After organizing and analyzing the collected data, the needs, barriers, and opportunities for food security in Newfoundland can be simplified as follows:

TABLE 2: Infrastructural needs, barriers, and opportunities identified by participants.

Needs	Barriers	Opportunities
<ul style="list-style-type: none"> • Increase accessibility of local produce • Support for producers • Increase availability of local seafood • Secondary processing facilities and storage • Clean energy source • Increase in public skills and interest • Basic livable income 	<ul style="list-style-type: none"> • Remoteness and travel distance • Ecological factors • Time and expense of production • Lack of farmer cooperation and planning • Public perspective • Certification process for local producers • Legislation, policy process 	<ul style="list-style-type: none"> • Legislation and policy instruments • Sharing programs and networks • Farmer cooperation • Markets • Public awareness • Technology investment • Physical infrastructure

Infrastructural Needs

Increase Accessibility of Local Produce

A major need identified by four participants is increasing the accessibility of local produce. Participants claimed that local produce is fresher and cheaper than imported produce and, therefore, addresses two major pillars to food security. According to these participants, the majority of people in Newfoundland access their food through grocery stores, but the availability of local produce in grocery stores is often quite limited. One participant summarized this well:

“We know the majority of food is accessed at grocery stores. However, for our farmers to get into grocery stores they require a certain level of food safety requirements, CanadaGAP [Good Agricultural Practices], and certain liability. So, creating a variety of access points, whether it's online food hubs, farmers markets, farm markets, grocery stores, having a lot of different access points for local food, and being able to have the infrastructure to support the movement of food in this province.”

There was a perception among some participants that farmers in Newfoundland are producing more than the public realizes, but they are often excluded from grocery stores due to certification requirements and bureaucracy. Farmers markets or direct sales at the farm are often the only avenue for accessing local produce, according to several participants. One participant noted that there used to be more direct sales, but due to the COVID-19 pandemic, consumers were forced into online orders from grocery stores, which do not always have local produce. Creating infrastructures that serve as food access points for local produce in Newfoundland was considered essential by participants.

Farmers markets were discussed as another key infrastructural need. There are only nine farmers markets in Newfoundland, of which five operate year-round, and four of those are in the St. John's metropolitan area (Government of Newfoundland and Labrador, 2019). Participants stated that dedicated physical spaces for farmers markets to operate are needed in order to increase the number of farmers markets. One participant suggested schools or hospitals as specialized

distribution points. Multiple participants advised that farmers markets help keep food prices low since there are fewer costs associated with transportation and shipping, and there is no intermediary to pay. According to one participant, the cost of produce at the farmers market is comparable to grocery store produce because farmers feel pressure to keep the prices competitive. Shorter shipping times also result in fresher, better quality produce and a lower carbon footprint. Participants strongly believed that farmers markets are a key piece of infrastructure that foster connections between producers and consumers and improve food security.

The results also revealed the importance of integrated physical and social infrastructures. The interviews suggested that there is a need, for example, to build physical infrastructure for farmers markets and simultaneously encourage people to use them so that access to locally produced crops can be increased. For one participant, “a farmers market is a social place where you exchange ideas, you meet with people, you socialize on top of buying food”. Farmers markets are a key piece of social and physical infrastructure. They provide a space for community and building connections. These comments reinforce existing studies which find that, for example, “the economic interactions that take place at farmers markets are combined with a variety of social interactions that make the markets valued community institutions” (Brown & Miller, 2008). An increase in farmers markets in Newfoundland would contribute to both physical and social infrastructure. A case study of the West Coast Farmers Market found that physical infrastructure, especially an indoor space, is needed in order to accommodate a year-round farmers’ market (Temple & Carter, 2012). Furthermore, an organizing body, or social infrastructure, is needed to coordinate the vendors, space, and logistics of operation (Temple & Carter, 2012). Creating these access points for local produce is an infrastructural need for food security in Newfoundland, but

an infrastructural analysis reveals that meeting this need requires careful consideration of multiple types of infrastructural supports, including physical and social.

Support for Producers

Public institutions provide crucial infrastructural support for food production, distribution, and access processes. According to interviewees, farmers need more support from the government in order to keep producing food. One participant explained that, historically and globally, farmers have always been provided with financial support because farming is such a volatile profession. There are many factors outside of the farmers' control, such as weather conditions or trade agreements, that can impact their earnings. However, as this participant described, "financial support in our province for agriculture is choppy and it's divided between the federal government and the provincial government." In Newfoundland, funding is not easily accessible for farmers, according to multiple participants. They explained that the lack of government assistance is one of the factors impacting the decline in the number of farms in Newfoundland, causing the average age of farmers to rise (also supported by Food First NL, 2015; Reza & Sabau, 2022).

One participant explained that lack of support is a factor that discourages young people from pursuing farming as a career, and, as a result, many farmers do not have a succession plan. It is likely that these farms will simply close down in the future, resulting in a huge loss of food sources. This participant gave the example of an organic produce farm on the Avalon peninsula that is now a horse stable, offering horseback rides and lessons. If this trend continues, the participant lamented, Newfoundland will lose its producers of food. The interviews suggested that there is a need to incentivize farming and make it a more attractive profession to encourage more people to become farmers. Public funding could be a key social infrastructure that supports existing

farmers and encourages new potential farmers. Production of local produce is a key part of food security.

Although there is some funding available through the provincial government, there are restrictions on eligibility. For example, for the Provincial Agrifoods Assistance Program (PAAP), a requirement to apply for funding is a revenue of at least \$15,000 per year (Agriculture Programs and Funding, 2023). Three participants explained that this restriction excludes small-scale farmers who arguably need more financial support than larger farms. If there is no support for small scale farmers, a vital source of food will be lost. Small scale farming needs more support from the government in order to thrive as it has the potential fill the local market and provide fresh produce within Newfoundland. Multiple participants asserted that governance that supports all types of farmers is needed.

Another factor brought up by two participants is the lack of cooperation among farmers. In some instances, farmers are wary of working together because of competition. However, as the two participants explained, there are certain aspects that would benefit all farmers, like pooling resources, reducing shipping costs, or information sharing. If farmers were encouraged to organize and cooperate, they could work together to improve crops and decrease costs. This points to the challenge and opportunity of creating social infrastructures of farmer collective action and support that can help improve food security in Newfoundland.

Increase Availability of Local Seafood

Six of the participants described a noticeable lack of local seafood availability in Newfoundland. Many of them explained that seafood is not considered a food source for the people here, instead it is a commodity to be exported (also supported by Lowitt, 2013; Poitevin, 2015). One participant explained that “fishing just primarily here is recognized, is only really recognized,

as a product for export, to make money to provide a wage for people and so that does not address really food security or food sovereignty issues.” Seafood has the potential to fill food security gaps in Newfoundland, but the physical and social infrastructure around fishing is based on a model of export (Foley & Mather, 2018; Foley, 2019). More infrastructural supports are required to allow fish to stay in Newfoundland.

One social infrastructure through which people access local seafood is informal markets and networks, and recent changes in social infrastructure may help further facilitate these. When Newfoundland joined Canada, the federal government focused the fisheries on export; therefore, the direct sale of seafood by fish harvesters was prohibited (Lowitt, 2014). Informal networks and markets were the only way to access local seafood, until direct sales were legalized in 2015 (Fisheries and Aquaculture, 2015; Lowitt, 2014). Despite this, local seafood is still difficult to access according to multiple participants. One participant stated that seafood is accessible “if you're in the loop,” otherwise it is virtually impossible to access fresh local seafood. Another participant encouraged the creation of formal alternative food networks in order to fill the food security gap; however, competing interests between fish harvesters and processors make this difficult. This participant believed there is potential for the government to step in and help establish these networks by encouraging subsistence fishing. Alternative seafood networks could be a key piece of social infrastructure that could increase access to seafood in Newfoundland. A social infrastructure that encourages connections between harvesters, processors, and consumers could allow seafood to contribute a larger role in the food system in Newfoundland. Infrastructural change is needed to make seafood more accessible.

Secondary Processing Facilities and Storage

Six of the participants pointed to lack of secondary processing and storage facilities as a major missing infrastructure in Newfoundland. Secondary processing includes making products shelf stable, flash freezing, or processing milk into dairy products. Storage includes vegetable storage, abattoirs, and large-scale cold storage. Three participants explained that having the processing facilities in Newfoundland would create jobs and allow easier access to the finished products. By relying less on shipping, costs would be kept low, and food would be fresher. For example, one participant explained that Newfoundland is self-sufficient in milk, but not all dairy products. Newfoundland milk is sent to Nova Scotia to be processed and is then brought back as products such as butter, cheese, and ice cream. Recently, construction of a dairy processing facility has been approved so there is movement in this direction (CBC News, April 2023).

Construction of storage facilities for vegetables and abattoirs is another piece of physical infrastructure that could contribute to food security in Newfoundland. One participant explained that these structures are far too expensive for food producers to build on their own, so they need government support. Having more storage facilities will also create more access points, allowing the food to reach consumers more quickly. Another participant explained that “storage of the food access, in terms of access points” answers the logistical questions of “how do the farmers come to the people? Do the people go to the farmers? And how do we do that in an effective manner, given the cost of gas and all those sorts of things?” Having local storage units would shorten shipping times, allow for fresher food, reduce waste, reduce carbon emissions, and reduce shipping costs. Storage facilities are a physical infrastructure that could further food security in Newfoundland.

Multiple participants identified that secondary processing is scarce on the island and there is an opportunity to process the foods that are produced in Newfoundland and make them shelf

stable, thus keeping the food fresher and creating jobs. The participants added that creating storage facilities would also contribute to creating more access points for local produce. These are physical infrastructures that play a key role in the food system and can contribute to food security in Newfoundland.

Clean Energy Source

Participants expressed the significance of transitioning towards a low or post-carbon energy source. Moving away from oil and gas is the first step towards sustainability, according to four of the participants. Two participants believed that dependence on oil and gas is a barrier to effective climate policy, which goes hand in hand with food security. One participant described that if farmers want to grow food, especially in the winter in Newfoundland, “you better have a very sustainable source of energy, which is cheap... to get the energy equation correct for farmers, there's just not a priority there”. This participant explained that farming demands a lot of energy, so having a renewable and affordable energy source is vital for food security. A shift in focus in climate policy and energy infrastructure is required in order to solve the energy equation problem.

One participant explained that prioritizing a shift away from oil and gas will also contribute to solving issues related to transportation. Transportation and shipping are major players in food security in Newfoundland. This participant described that transporting anything across, and to, the island is a struggle, even for transporting energy sources, which is needed to transport everything else. By solving the energy issue, other goods will follow suit.

Another participant argued that the provincial government is not focusing on the health of ecosystems as they claim to be. They believe that as long as there is a dependence on oil and gas, the environment will not be a priority. Another participant explained that energy infrastructure needs to be a priority; individuals and households should be able to participate in discussions

related to the origin of their energy and the use of carbon taxes. These participants have noticed a lack of commitment from the government to move away from oil and gas. They argued that a shift in government priority is required. Governance and policy regulations are social infrastructures that could be bolstered to encourage moving away from oil and gas. Prioritizing clean energy is an infrastructural need in Newfoundland.

Public Interest and Skills

Knowledge and public perception are significant social infrastructures. Four participants noted that public interest and skills are needed to help improve food security in Newfoundland. The efforts that are made to fill shelves with fresh local food, and to create more access points for fresh food and seafood, would be pointless if no one is going to cook with the food. Education and awareness are necessary to complete the cycle.

Knowledge about food provisioning, whether it is traditional Indigenous knowledge or settler knowledge, is being lost. Interviewees suggested that older generations are not passing on their knowledge because many people are not interested in learning it. One participant described an organic fertilizer mixture that their grandfather made of capelin and lobster shells; unfortunately, they did not have the chance to learn the recipe before he passed. They stated that “there’s a whole host of knowledge that’s disappearing.” Another participant explained that fewer people are involved in fishing and, therefore, “those skills are being lost and now you have to purchase things and so that that kind of traditional ways of accessing are lost.” Objects that used to be handmade by fishers must be purchased commercially, which adds to the cost of fishing and excludes people from participating. Education is required to keep these skills alive, the participant added. There is some movement in this direction by Food First NL who created Seniors’ Celebration of Food and Film (SCOFF) series. This series documents food preservation and

preparation skills taught by seniors with the intention to pass on that knowledge (Food First NL, n.d.a).

Furthermore, food skills are similarly being lost. Two participants explained that the market for seafood is smaller than before partly due to a lack of knowledge about cooking and preparing fish (also supported by Lowitt, 2013; Potevin, 2015). This can result in food waste. For example, most people prefer to have just a cod filet, so they throw away the nape, sound, organs, and head. Another participant emphasized the importance of knowing how best to use the food; for example, understanding which cooking methods allow consumers to gain the most nutrients and how to avoid wasting parts of the fish. They explained that paying more attention to food security as an environmental issue can also encourage more people to start caring about the environment. Lost food preparation knowledge and skills could be regained through stronger social infrastructure.

In contrast, two participants explained that there is a growing interest in backyard farming, foraging, growing, or hunting food. One participant stated that some municipal legislation restricts backyard farming (also supported by Fairbridge, 2021). The participants believed that education, social supports, and policy change are all required in order to support people in producing their own foods. These findings suggest that careful consideration about fostering traditional knowledge and forging new knowledge for food education and skills development is necessary in developing infrastructure to increase access to local foods.

Basic Livable Income

According to two participants, a large part of the food security equation is the cost of food and lack of income. Social supports, like a basic living wage, are required in order to address food insecurity. One participant felt that Newfoundland could create jobs rather than focus on growing produce in order to have a livable income so that people can have dignified access to food. Another

participant explained that there is a disconnect between a wage-earning economy and a subsistence one: “If you're going to depend on a wage economy for people to earn a living, you've removed them from the land and the ability to be self-sufficient. So, you need to provide them a basic income because you're requiring them to be a wage earner”. For this participant, people cannot work a typical Monday to Friday job and also grow or collect their own food. If the government is going to promote a wage economy, they also need to provide a basic livable income. Organizations such as Food First NL are also promoting the importance of a livable income as a key in addressing food security. Policy changes and social infrastructure are required to address this.

Infrastructural Barriers

TABLE 2: Infrastructural needs, barriers, and opportunities identified by participants.

Needs	Barriers	Opportunities
<ul style="list-style-type: none"> • Increase accessibility of local produce • Support for producers • Increase availability of local seafood • Secondary processing facilities and storage • Clean energy source • Increase in public skills and interest • Basic livable income 	<ul style="list-style-type: none"> • Remoteness and distance • Ecological factors • Time, expense of production • Lack of farmer cooperation and planning • Public perspective • Certification process for local producers • Legislation, policy process 	<ul style="list-style-type: none"> • Legislation and policy instruments • Sharing programs and networks • Farmer cooperation • Markets • Public awareness • Technology investment • Physical infrastructure

Remoteness and Distance

One major barrier for food security in Newfoundland identified by every single participant was shipping and transportation issues related to the geographical distance of the island from the mainland, and the remoteness of towns in Newfoundland. Being an island, there will always be additional logistical planning and higher costs for shipping in Newfoundland (Growing to Give, n.d.). Historically, shipping has always been Newfoundland’s greatest challenge (Kealey, 2006). With such a heavy dependence on imports, Newfoundland is vulnerable to any disruptions in shipments. Two participants explained that any disruptions not only affect consumption, but also production since growth inputs (e.g., fertilizer, seed, and cuttings) are also imported. One participant explains that as the island is prone to bad weather, trucks are often lined up for days waiting to board the ferry. Timing is especially crucial when transporting live products and fresh produce. The time and cost of importing also negatively affects the quality of products and reduces the diversity in offerings. Physical infrastructures of import transportation to Newfoundland are not strong and, therefore, it continues to be a major barrier to food security.

Distance and remoteness of communities within the island itself is also a transportation challenge. Three participants pointed out that the dispersed population adds to transportation difficulties, and one participant added that farmers are also “in all these little nooks and crannies”. As mentioned previously by Vodden et al. (2018), consumers will often travel up to 200 kilometres to purchase fresher produce in more populated towns and cities. This participant highlighted the fact that farmers face the same struggle in bringing their produce to the consumer. Another participant highlighted that the transportation of energy around the island is also a challenge, which is why the transition to a clean energy source is crucial in Newfoundland. Dependence on the ferry and ground transportation is a dependence on oil and gas.

The different demographical regions of Newfoundland also provide different access to foods. One participant described this well:

the larger the size of the population is, the more buying power they have in terms of affordable fresh, high quality food and so with many small communities that are dispersed over a large area, their buying power is limited and so they have to sometimes take what they get in terms of distribution, and they might feel like they're at the end of the distribution chain, and not getting necessarily the best quality food.

Newfoundland's large geographical area, small population, and remoteness contribute to the residents' inability to demand fresher food. Another participant described how economies of scale dictate that larger populations, like the Avalon peninsula, would have access to fresher food, better stocked grocery stores, and more diversity in offerings whereas areas like St. Anthony would have fewer grocery store pickings, but higher access to local cod, moose, and berries. The economies of scale may also apply to the lack of seafood availability in Newfoundland. The participant described that the market might not be large enough to be worthwhile of local producers, and that it is easier to export the whole catch rather than work out the logistics of distributing it locally.

Reliance on long-distance transportation infrastructure is a well-known issue in Newfoundland. One participant explained that “everybody knows that transportation is a challenge, but nobody really knows how to fix it”. Distance between Newfoundland and the mainland and remoteness within Newfoundland are barriers that affect local produce availability, seafood availability, construction of secondary processing facilities and storage, and clean energy infrastructure. Stronger, better informed transportation infrastructure could resolve the transportation issues and carve a path to food security in Newfoundland.

Ecological Infrastructures

Unique ecological infrastructures are key determinants in the access to food in Newfoundland. A major barrier identified by eight of the participants are ecological infrastructures such as the acidic and rocky soil, harsh weather conditions, and the impacts of climate change (also supported by Cadigan, 2009, and Reza & Sabau, 2022). One participant described that farmers in Newfoundland have an extra challenge compared to most other farmers across Canada due to the acidic nature of the soil; there is one more step in the preparation of the land before planting. Another participant explained that rocking and using limestone in order to make the soil more suitable for agriculture are a necessary part of farming in Newfoundland, so farmers must put more time, effort, and cost into their soil. Soil is a key ecological infrastructure for food production (Bristow et al., 2010), and the soil in Newfoundland makes it difficult to farm on the island.

Newfoundland is known for its harsh winters. The growing season is limited due to the weather conditions. One participant explained that any attempt to extend the growing season by using greenhouses or coal frames is an added expense for farmers. Another participant stated that these ecological limitations prohibit the drive for self-sufficiency on the island, and full self-

sufficiency is impossible to achieve. The harsh weather also exacerbates any challenges with shipping as outlined in the previous section. One participant pointed out that a storm would delay imports of food production supplies into the island, thus disrupting the entire supply chain.

Climate change is disrupting seasons and patterns that Newfoundland experiences. One participant stated that farmers are tracking weather more closely; multiple frost events are changing the planting times for farmers (also supported by Reza & Sabau, 2022). Two participants reported that with the warmer weather there is also an increase in pests and diseases which impact crops and livestock (also supported by Reza & Sabau, 2022).

One participant explained that the impacts of climate change have been noticed in the fisheries as spawning and migration behaviours of certain species are changing, as well as molting seasons. Another participant explained that “fish are moving, we are losing fish, they’re moving, they’re responding to climate change. So we need to be able to, I think, respond rapidly too.” Developing policy around the fisheries is a slow process, but rapid response is required in order to keep up with climate challenges. Climate change is disrupting the ecological infrastructure of species behaviour, thus a change in fishing strategy and policy might be required in order to react appropriately.

These ecological challenges are responsible for the limited availability of local produce and contribute to the transportation difficulties Newfoundland experiences. By extension, these ecological challenges also hinder the development of secondary processing and storage facilities, or a clean energy source. An increase in self-sufficiency could help eliminate some of Newfoundland’s vulnerabilities. Ecological infrastructures are difficult to change, but social and physical innovations may help circumvent them.

Time and Expense of Production

Time and expense of food production is a barrier that was pointed out primarily for individual households looking to be self-sufficient. Six participants noted that tending to a garden or backyard farm requires time and an upfront investment that many people may not have. This is also historically what marked the shift away from family gardens in the 1950s (Lowitt, 2013). Four participants noted that hunting and fishing are quite expensive: first for the gear required, then for the licences, and finally the ability to physically access hunting and fishing grounds (also supported by Food First NL, 2015). Participants explained that regulations on the seasons and fishing days of the week may impact an individual's ability to participate. Furthermore, the transportation required to reach these locations for hunting, fishing, or gathering berries would be expensive for anyone who does not have their own vehicle. Hunting and gathering food are not as accessible as they used to be. These barriers to household self-sufficiency contribute to dependence on imported foods.

Fish harvesters also face challenges specific to time and expense. Although direct sales have been legalized, many fishers are unable to participate. One participant explained that coordinating sales, transportation, taxes, and all those extra steps are a lot of extra work, and it is not always feasible for the fisher to do it themselves. Another noted that "it's so time-consuming to sell direct sales when you can just offload it all to the processor and be done with it." Legalizing direct sales seemed beneficial because fishers now had the option to sell to whomever they choose, but, in practice, they still depend on the processor due to logistical challenges. In the end, there effectively is no choice. Another participant explained that direct sales are not feasible because there is too much catch for the harvester to sell on their own; the processor has the time,

infrastructure, and expertise to take care of that. Therefore, allowing direct sales is not an immediate or viable solution to increase fisher's income or to alleviate food security challenges.

Along with production, the long shipping times associated with distribution result in high costs for everyone involved. The costs associated with shipping is a barrier identified by three of the participants. Furthermore, costs associated with inflation exacerbates any other costs. It is harder for consumers to purchase foods and for producers to purchase inputs.

Therefore, the time and expense for production limits the availability of local produce and seafood, reduces avenues to financially support producers, and contributes to the loss of skills related to self-sufficiency.

Lack of Producer Cooperation and Planning

A barrier listed by three participants is the lack of cooperation and planning along the food system in Newfoundland. Cooperation and sharing are social infrastructures that could benefit all players. One participant noted that there is a culture of competition between farmers that is unnecessary but, if overcome, could make food access easier. They explained that farmers could share knowledge, tools, or costs of imports. This cooperation could result in increased food production and potentially cheaper prices. Another participant offered a solution of connecting local fish harvesters with small port fisheries and consumers. They explained that this could shorten the value chain to secure a better price for fish harvesters and provide consumers with better quality fish for a cheaper price. Organization is needed between the fishers, the small ports, and the consumers in order to keep local fish feeding Newfoundlanders.

Another participant explained that self-organization can provide local distribution streams with quality product, but support would still be needed to create access points. They explained that "it should all be mapped into some logical model of how we're going to progress and get to this

point in a certain determined amount of time, and there should be performance indicators”. Planning is required to know how to streamline, how to optimize, how to determine what is needed, and how gaps can be filled. It is also crucial to self-assess and understand where there are shortfalls and how they can be overcome.

The lack of cooperation may also be a hindrance to generating better access to local produce in grocery stores. A lack of organization and cooperation is stopping grocery stores from stocking local produce, according to one participant. They explained that farms in Newfoundland are smaller and fewer when compared to Ontario or Nova Scotia, and therefore have smaller crops. As a result, one farm in Newfoundland might not be able to meet the demand for produce that a supplier seeks. Rather than contacting multiple farms in Newfoundland to collect everything they need, it is easier for the supplier to contact one larger farm outside the island that has a larger crop or more variety. The participant explained that if farmers organized themselves, they could streamline the supply chain and make themselves more attractive to buyers. Importation could be reduced if local farmers formed groups based on their location and crops, and together offered their produce to suppliers. Some participants explained that the same approach could be applied to larger institutions, such as hospitals or the University. These large institutions are powerful infrastructures of food consumption that have the opportunity to support local producers and be a leader in advocating for local consumption. By creating a social infrastructure based on cooperation and collaboration, farmers could integrate themselves into larger infrastructures.

The participant continued to explain that government should be responsible for funding and organizing this collaboration. There are smaller organizations and municipalities looking towards strategic planning but, “we're doing it with no future budget to implement. We're doing it based on desire and what we believe is our need. Why isn't government who are the ones that hold

the majority of investment potential?” Two participants also suggested that smaller municipalities want to see this happen, but they do not have the funds or the outreach to achieve any of the strategic plans they create. Lack of planning and cooperation between food producers is a social infrastructure problem that impedes the widespread availability of locally produced foods and stalls the creation of secondary processing and storage facilities. Cooperation is a social infrastructure that farmers can rely on for support.

Public Perspective

Public perspective is a barrier listed by five participants. Many participants list entitlement as an issue. Multiple participants believe that a consumerist culture, where consumers feel entitled to the cheapest product and a diversity of products at all times, is hindering any consideration for local or seasonal food. One participant claimed that “the average Newfoundlander doesn’t care where [their food] comes from, and that’s our fault, so how do we build that?” They explained that the majority will always choose the cheapest option, even if it is less ethical or has a higher carbon footprint. Therefore, awareness of the context of food systems and cultures might make some people more understanding of limitations on diversity. In the meantime, they suggest that local products should be made as cheap and accessible as possible in order to encourage local consumption.

Two participants also explained that people assume local produce is more expensive. One of them explained that farmers feel the need to compete with grocery store prices and so they do keep their rates as cheap as possible. Also, because local farmer produce is fresher and has traveled a shorter distance from farm to table, it will stay fresher longer at home which is better value for the money being spent. The participant also stated that attitudes should move towards eating seasonally, rather than expecting all food to be available year-round. At the moment, the public

consumerist perspective prevents Newfoundland from availing of local food. A shift in attitude would promote reliance on locally sourced food and, in turn, reduce dependence on imports. A change in the cultural infrastructure of food preferences and habits could contribute to achieving food security. It is important to note that some participants do not believe Newfoundland is capable of being self-sufficient; they believe there will always be a need to import certain foods, nevertheless, there is still a benefit to increasing local production and decreasing dependence on imports.

One participant highlighted that the general population may be distrusting of greenhouses or other innovations in food growing technology due to the disaster of the Sprung Greenhouse in the late 1980s. The provincial government invested \$22 million into a hydroponic greenhouse that failed to live up to the large claims of ending food insecurity in the island and improving land resources (Blair, 2015). Viability and profitability of the greenhouse in a Newfoundland context was poorly researched and resulted in production at a loss, or entirely failed crops (Blair, 2015). This participant explains that the Sprung Greenhouse disaster makes it almost impossible for any organization in Newfoundland to secure funding for a greenhouse today. They explain that public perception around greenhouses is hindering investments in technology or innovation in agriculture.

Certification Process for Local Producers

The Canada Good Agricultural Practices (CanadaGAP) certification process for local producers has been cited as a barrier preventing local produce from entering grocery stores. As a result, farmers often depend on direct sales at a farmers' market or farm stand, despite knowing that most people access food through grocery stores. One participant explained that they attempted to pursue an organic certification, but the process was too expensive for them to complete; they were running an organic farm but could not obtain certification. This participant believed that

farmers who are making efforts to produce organic products should not bear the full cost of a certification. Incentives could be provided to purchasers and wholesalers to choose local organic produce so that farmers are supported. The participant explained that farmers might even be willing to switch from inorganic to organic produce, but only if there is a market for them to make the same income. If the certification process was easier and cheaper, more farmers would be willing to participate. These economic and governance aspects are social infrastructure barriers that, if remedied, could increase the availability of local produce in Newfoundland.

Legislation and Policy Process

A barrier to food security cited by every participant was legislation or the policy process. Each of the needs outlined previously can be traced to legislation or policy barriers, demonstrating the significance of governance infrastructures in addressing food security challenges. Participants explained that most local produce is difficult to access due to a lack of funding and support for farmers, lack of organization and physical space for farmers' markets, and the CanadaGAP certification process. Local seafood is prioritized by the government as an export commodity rather than a food source for the local population. The construction of secondary processing and storage facilities require government investment as they are expensive and large-scale projects that farmers cannot build on their own. The participants also argue that as long as the provincial government continues to depend on oil and gas, research for and implementing a clean energy source will not be prioritized. Certain provincial and municipal legislation restricts backyard farming, barring people from attempting to grow their own food or raise chickens. Focus on a wage economy removes people from their connection to their environment and, in turn, their food. A basic livable income can only be achieved with government support. One participant summarized it well:

We need a really good conversation and changing in ... the policy and governance around food, in terms of access, you know, affordability, availability, quality, everything right, it

is, it is a changing landscape, changing demographic and many things are changing around us. So there's no reason why we should not be thinking about changing food policy and think more from the system [infrastructure] perspective as well.

Food policy must undergo a substantial change in order to more accurately reflect the realities that Newfoundlanders face today. Legislation and the policy process are barriers for each of the needs outlined by the participants.

A major disconnect with food policy in Newfoundland is the inconsistency between the federal and provincial government, especially with respect to the fishery. One participant explained that since the water around the province is federal jurisdiction, the federal government regulates the harvesters and determines the quotas. However, the provincial government manages the selling and distributing of the fish, therefore impacting processors more directly (also supported by Potevin, 2015). This participant outlined that, when there is a disagreement between the two, “all of a sudden these fishers are caught into a network of political decision making, which is not helping them at all”. The disconnect between the federal and provincial government around fishing in Newfoundland has major repercussions. This has been an ongoing struggle since Newfoundland joined Canada through confederation in 1949 (Bavington, 2010; Cadigan, 2009). At the end of the day, the fishers are the ones who are impacted the most, and the local population loses access to local seafood. Another participant explained that no governing body is willing to take responsibility for the fishers. A social infrastructure that takes care of fishers is needed in Newfoundland.

Legislation and policy are a barrier that affects every single need identified by the participants in this study. Given the centrality of governance, and its relationship with other infrastructures, it must be examined more carefully. Governance is uniquely positioned as a social infrastructure that plays a role in influencing or even determining physical and ecological infrastructures. Therefore, governance can play a major role in helping or hindering food security.

Infrastructural Opportunities

TABLE 2: Infrastructural needs, barriers, and opportunities identified by participants.

Needs	Barriers	Opportunities
<ul style="list-style-type: none"> • Increase accessibility of local produce • Support for producers • Increase availability of local seafood • Secondary processing facilities and storage • Clean energy source • Increase in public skills and interest • Basic livable income 	<ul style="list-style-type: none"> • Remoteness and distance • Soil quality, poor weather, climate change • Time, expense of production • Lack of farmer cooperation and planning • Public perspective • Certification process for local producers • Legislation, policy process 	<ul style="list-style-type: none"> • Legislation and policy instruments • Sharing programs and networks • Farmer cooperation • Markets • Public awareness • Technology investment • Physical infrastructure

Legislation and Policy Instruments

Legislation and policy instruments are social infrastructures that could increase access to local food and encourage a clean energy transition. Lack of supportive policy was the largest barrier to food security identified by all the participants. Some policy instruments can be useful in working towards food security. Two participants pointed to quotas as policy instruments that could help improve production. Generally, quotas are applied to fish, but they can be useful for vegetables as well. For example, one participant explained that since Newfoundland is known for being able to grow turnips, cabbages, potatoes, and carrots, almost all farmers grow these even though the population may not demand it. To avoid a surplus in one particular vegetable, farmers can be better informed beforehand to vary their crop. For seafood, one participant explained that the quotas are much too large for local consumption and, therefore, export is a necessary part of the fishery. They noted that this is another reason why direct sales are not feasible. The quotas are too large for one fisher to sell directly. Future research may wish to explore the possibility of a separate quota for local consumption.

Two participants proposed that the provincial government should offer incentives or subsidies to consumers who buy local. One of these participants believed that financial incentives to buy local fish can stimulate the local market. The other participant explained that, currently, the only incentive consumers have to buy local is simply “because it is the right thing to do”, which does not resonate with the average Newfoundlander attitude as discussed in the “Public Perspective” section above. Financial incentive is required in order to encourage more people to buy local. Policy instruments are a key social infrastructure that can be used to influence public behaviour (Winfield, 2009).

With respect to the need for a cleaner energy source, a participant proposed rebates and/or another funding mechanism as a solution to offset the dependence on oil and gas. They explain:

We could tinker and say, you know, the government could tax my gasoline. Show me where I can access that for, you know, carbon offsetting, or food security, which I think are inextricably linked in a lot of ways. And I can draw money from that to invest in myself into my own household and save myself money and also create healthier options for me and my family.

If people knew that engaging in certain behaviours would lead to tax rebates, they may be encouraged to move away from oil and gas, which will directly address environmental concerns and indirectly contribute to food security. The participant suggested that these rebates could help fund backyard gardens, solar panels, or other endeavours on a household scale. These policy instruments can truly encourage people to make choices that are more local, more ethical, and better for the environment. Policy instruments could create a social infrastructure of incentives.

Another participant suggested legislation for sustainable fishing practices to support ecological infrastructure in the ocean. They explained that the infrastructure of fishing gear often harms the ocean environment and, thus, restrictions are necessary. They explained that “if you damage the ecosystem when you're fishing for one type of fish, no fish are going to come back to that area so that harms every fishery that you're, that you want to work with.” Gear plays a large

part in harming the oceans, but restricting gear would result in slower fishing, so the participant acknowledged the resistance to implement such a policy. However, they emphasized that if sustainable fishing practices are to be realized, restrictive policy is necessary. This is an opportunity to help restore ecological infrastructures that have been disrupted. Policies that more effectively restrict gear infrastructure would allow ecological infrastructures to slowly restore themselves and create a healthier ecosystem, allowing for a more sustainable and stable fishery. As the participant explains, all fisheries will be impacted if there is harm to just one type of fish; therefore, a healthy ocean infrastructure is required for all fisheries.

Another offer for legislation from this participant revolved around the recreational, or food fishery. The participant explained that many people cannot avail of the food fishery due to the expense of owning and operating a boat. However, they explain that there is an opportunity to fish cod from the shore, but only when the capelin roll. Capelin are small fish that ‘roll’ on beaches to spawn in shallow waters, which brings cod and other sea life to the shore as they feed on the capelin (Cameron, 2023). The food fishery is only open on certain days of the week—usually weekends—so it does not always coincide with a capelin roll. The participant explained that governing these ecological occurrences is impossible, and it is another avenue by which people are forced to lose their connection with their environment. They believed that these policies could be reassessed to better allow people to access food as they wish. Legislation and policy instruments that support and encourage access to local produce and seafood, a transition to clean energy, and protect the environment are social infrastructures that can contribute to food security.

Sharing Programs and Farmer Cooperation

A variety of sharing programs recommended by participants could be a social infrastructure solution to some food security challenges. One participant pointed out that bulk purchasing

programs are readily available for dried goods. An organization or a group of individuals could make bulk purchases together to share shipping costs. They explained that the Gros Morne Inn uses a bulk purchasing program to supply their pantry; it is an easy model that others can follow. Sharing and cooperation is a social infrastructure that can help achieve food security for remote communities.

Furthermore, as two participants outlined, there is an opportunity for institutions like hospitals and the University to be a leader in purchasing local, organic produce. They explained that large scale institutions purchasing local foods would cut down on shipping and allow more money to flow within Newfoundland. By increasing accessibility of local produce in large institutions, public perspective around local food could be improved, exposing more people to local produce and encouraging its consumption. Institutions are key social infrastructure, and their physical presence is a bonus logistical convenience.

Another participant stated that these large institutions could offer farmers an opportunity to self-organize. If farmers cooperated and worked in regional working units, they could more easily market themselves to larger institutions and supply them with fresh, local produce. Individual challenges that farmers face such as shipping, packaging, and storage could be shared amongst the unit, reducing cost and time for each farmer involved. Working in units would also allow farmers to share resources, trade knowledge, and create a network of support.

This social infrastructure of sharing and cooperation could overcome some challenges caused by distance and remoteness, weather conditions, time and expense of production, lack of farmer cooperation, and public perspective. As a result, it would fulfill the needs of improving accessibility of local food, supporting local producers, and increasing public interest.

Markets

Some participants offered the creation of new markets as an opportunity to improve food security. Markets are a social infrastructure that exchange goods and services. One participant explained that provincial and federal legislation restricts the development of alternate and informal markets, and there is little interest in developing a local market for seafood because the export market is so lucrative. This participant pointed out that while the export of seafood is necessary, there is an opportunity to invest in a local market that could provide access to local seafood for Newfoundlanders and encourage the consumption of fish. According to this participant, legalizing direct sales is not enough; people need to be incentivized to purchase local seafood, and local seafood needs to be made more accessible.

Another suggestion is to open a formal market for seal consumption. One participant claimed that it would contribute to managing the overpopulation of seal, would help regenerate cod stocks, and provide a source of protein that is highly nutritious. The creation of the market, they suggested, would also contribute to economic growth with the creation of new jobs, and the protection of the cod fishery. They point to the successful kangaroo meat market in Australia as an example. As a wild food, there is a low carbon footprint and a diversity of nutrients in seal meat.

Public Awareness

Public awareness and education are a social infrastructure that could work towards food security, as identified by seven participants. One participant pointed out that there is a growing interest in individual or household food self-sufficiency, but people lack the knowledge to be able to participate in it. Re-education could be useful. Food skills around the best use of produce and reducing waste could be taught. Learning to choose seasonal and local produce would be important. One participant described it as a “slow food movement”, learning to value each meal

more (also supported by Patel, 2012). Another explains that “we only have one stomach” so teaching frugality and valuing meals is important. A connection with food needs to be fostered. It would encourage people to care about their food more, opt for local products, and be more involved in their own food security. One participant explained that this connection would eventually extend to conservation and environmental protection from the angle of food security. It would create a sense of responsibility to stewardship and sustainability. It would contribute to climate action in general.

It is important to note that while self-sufficiency is regarded as a solution for food insecurity, many interviewees believed achieving full self-sufficiency in Newfoundland is impossible. However, they claimed that working towards it can decrease dependence on imports and other vulnerabilities. The avenue towards self-sufficiency is worth pursuing, but it does not have to be a final goal. This is why, participants argued, focusing on slow food and understanding benefits of seasonality is important, rather than a push for full self-sufficiency.

Technology Investment

Some participants offered technological solutions to improve food security in Newfoundland. One described that Newfoundland should “smartly tap into the globalized capitalist train, cherry pick what we need and make our communities stronger, more resilient, and self-sufficient by using technologies”. The participant believed that solutions are available globally, but a decision-maker or organization must establish the island’s needs, research existing ideas and technologies, select which would work best for the island, create an implementation plan, and encourage people to participate.

Another participant pointed to an online platform in Iceland as an example. They observed that, in Iceland, fishers upload information on their daily catch to a particular platform (e.g., what

types of fish and how much of each) and the public can immediately purchase them online. If physical spaces require too much effort and cost to maintain in Newfoundland, there is an opportunity to create a digital market. Iceland's model could be a useful starting point. Digital infrastructure is a growing physical and social infrastructure that continues to support human life.

Another participant outlined the importance of developing technologies. They described it as “the growing sciences”, since growing food or ornamentals or cannabis all overlap in their physical infrastructural needs. They pointed out that technology around cannabis production developed drastically since its legalization; the use of greenhouses, the heating system, carbon dioxide system, and a computerized controlled environment are all technologies and physical infrastructures used in cannabis growing that could be applied to food production. They explained that if cannabis can be grown in Newfoundland, surely some other tropical plants can as well. There is an opportunity for future research to explore this possibility.

Investment in growing science and technology could increase the production of local foods. It would cut down on travel distance and be less susceptible to weather disruptions. Technology and innovation are a mixture of physical and social infrastructures that could help bolster food security in Newfoundland.

Physical Infrastructure

Improving physical infrastructure in Newfoundland would contribute to many of the food security challenges on the island. As previously mentioned, the construction of secondary processing and storage facilities would be useful as they can help to overcome the challenges of remoteness and travel distance. These physical spaces would allow for products to stay in the island and create more access points across the island, thus reducing dependence on the ferry. Another participant suggested that port facilities could be improved to have some processing or flash

freezing of products for preservation. Physical infrastructures for different access points are also key. Farmers markets are a major source of local produce, but they require designated indoor physical spaces in order to operate year-round (also supported by Temple & Carter, 2012). An investment in physical infrastructure would be required in order to address some of Newfoundland's food security issues.

Summary of Results

The following table analyzes the same food infrastructures outlined in Table 1. Having studied various food infrastructures, and having heard from the participants, one can better understand the role each infrastructure plays in determining access to food, and how an infrastructure lens can help to address food security. Recommendations are given that have the potential to address each one. Each recommendation is explored in depth in the following Discussion section.

TABLE 3: Recommendations to improve food infrastructures in Newfoundland

Examples and key features of food infrastructures	Recommendations
Grocery stores, corner stores <ul style="list-style-type: none"> • Most common access point • Often excludes local sources • High costs for local producers 	<ul style="list-style-type: none"> • Storage facilities to increase access points for local food • Growing technology and innovation to increase local production • Support local producers through: public education, incentives, institutional leadership, cooperation and sharing, poverty reduction strategy
Farmers markets, farm stands <ul style="list-style-type: none"> • Good source of local food • Very few in Newfoundland • Perception of high costs 	<ul style="list-style-type: none"> • Storage facilities to increase access points, thus decrease shipping costs, thus decrease consumer costs • Public education, government incentives, institutional leadership to make local produce and farmers markets more popular
Roads <ul style="list-style-type: none"> • Travel time and distance results in not fresh produce and high shipping cost 	<ul style="list-style-type: none"> • Storage facilities to increase access points, thus decrease distance travelled, shipping costs
Ferry <ul style="list-style-type: none"> • Travel time, distance results in not fresh produce and high shipping cost • Dependence on ferry is a vulnerability 	<ul style="list-style-type: none"> • Storage and secondary processing facilities, and growing technology and innovations to increase local production, decrease dependence on ferry • Public education, government incentives, institutional leadership to popularize local produce consumption
Migration patterns <ul style="list-style-type: none"> • Changing due to climate change 	<ul style="list-style-type: none"> • Clean energy source to mitigate climate change • Restrictions on fishing gear to support marine ecosystems

	<ul style="list-style-type: none"> • Analysis of climate change impacts on infrastructure
<p>Weather patterns</p> <ul style="list-style-type: none"> • Changing due to climate change 	<ul style="list-style-type: none"> • Clean energy source to mitigate climate change • Analysis of climate change impacts on infrastructure
<p>Planting and harvesting seasons</p> <ul style="list-style-type: none"> • Changing due to climate change 	<ul style="list-style-type: none"> • Growing technology and innovations to overcome challenges • Analysis of climate change impacts on infrastructure
<p>Farm ecosystem</p> <ul style="list-style-type: none"> • Changing due to climate change • New pests and diseases arising 	<ul style="list-style-type: none"> • Clean energy source to mitigate climate change • Growing technology and innovations to overcome challenges • Analysis of climate change impacts on infrastructure
<p>Fertile soil</p> <ul style="list-style-type: none"> • Cost, effort, and time of preparing soil for farming in Newfoundland 	<ul style="list-style-type: none"> • Growing technology and innovations to overcome challenges
<p>Fishing seasons</p> <ul style="list-style-type: none"> • Changing due to climate change 	<ul style="list-style-type: none"> • Clean energy source to mitigate climate change • Restrictions on fishing gear to support marine ecosystems • Analysis of climate change impacts on infrastructure
<p>Informal networks</p> <ul style="list-style-type: none"> • Are strong in Newfoundland but difficult to access if not involved • Formal networks are more accessible 	<ul style="list-style-type: none"> • Cooperation and sharing encourage existing practices • Recommendations that increase local production (growing technology, cooperation and sharing) and accessibility to local food (storage, institutions) can reduce the need for informal networks
<p>Social aid</p> <ul style="list-style-type: none"> • Exist but only treat symptoms of food insecurity, not root causes 	<ul style="list-style-type: none"> • Recommendations that increase local production and accessibility to local food can reduce the need for social aid
<p>Policy and governance</p> <ul style="list-style-type: none"> • Dictates most production and consumption habits 	<ul style="list-style-type: none"> • All recommendations have policy implications. Careful planning is required to avoid unintended consequences
<p>Community gardens</p> <ul style="list-style-type: none"> • Exist but need skills in order to use effectively 	<ul style="list-style-type: none"> • Public education to increase skills and knowledge
<p>School programs</p> <ul style="list-style-type: none"> • Some exist, could expand • Need funding and planning 	<ul style="list-style-type: none"> • Public education to increase skills and knowledge

Discussion

The results of this research have outlined the infrastructural needs, barriers, and opportunities for food security in Newfoundland. Various actions and commitments across the island have been operating to combat food security; however, these have been operating independently, in silos. In their current state, these actions have had little to no success. Participants echoed the sentiments of researchers in the field of food security: there must be a fundamental shift in how the problems are approached and solutions are created.

The results of this research highlighted overlaps between physical, ecological, and social infrastructures. This overlap could provide an answer for integrated interdisciplinary solutions. Interconnected solutions that complement and bolster each other could decrease the risk of vulnerabilities. For example, increased self-sufficiency is regarded as a solution to food security, but many participants claimed that achieving full self-sufficiency is impossible in Newfoundland. A fully self-sufficient island may be prone to new vulnerabilities like fluctuating productivity in local produce and climate change variations. Self-sufficiency is not a simple solution that can ensure food security. Instead, this thesis found that movement towards self-sufficiency combined with other solutions can work together to enhance Newfoundland's capacity for food security.

Viewing food security through an infrastructure lens is an opportunity to refresh and reinvent existing efforts. Infrastructure is a network; it is able to bring these silos together and make connections between them. Key findings from this research can be categorized into the following infrastructural solutions: physical, ecological, and social.

Physical Infrastructure Solutions

Many participants argued that physical infrastructures are needed to support existing local production. The provincial government seems to share an interest in developing physical

infrastructure as well. The Way Forward on Agriculture plan aims to increase secondary processing facilities in the province (Government of Newfoundland and Labrador, n.d.d). The provincial government has also committed funding for a dairy processing facility on the island which recently passed environmental assessment (CBC News, 2023; Fisheries and Land Resources, 2020). The proponent and the owner-operator of the proposed plant is the Real Dairy Company of Newfoundland, and the cost to complete this vision is estimated at \$25 million (CBC News, 2023; Real Dairy Company of Newfoundland, 2022). Endeavours like this require substantial investment, including planning and funding (CBC News, 2023). In addition, precautions must be taken to ensure that any new developments are environmentally acceptable (Government of Newfoundland and Labrador, n.d.e). While the development of new physical infrastructures is a slow and expensive process, there is movement in that direction. It is also important to note that the dairy industry in Canada is highly regulated and protected from global competition (Painter, 2007). This may play a role in ensuring a market for purchasing local dairy products, which may not necessarily translate to other food processing facilities. More research on the viability of creating secondary processing facilities for other food industries is needed.

Some participants pointed to the need to develop a clean energy infrastructure and move away from oil and gas. The provincial government plans to develop both. The Renewable Energy Plan is a five-year plan put forth by the provincial government in 2021 with a goal to harness the provinces' wind, hydro, and tidal energy sources and achieve net-zero emissions by 2050 (Government of Newfoundland and Labrador, n.d.f). At the same time, the provincial government has also committed to doubling oil and gas production in the province (Government of Newfoundland and Labrador, n.d.a). Participants in this study expressed that developing both industries shows a lack of commitment to environmental endeavours.

Ecological Infrastructures

Various ecological infrastructures were recognized as barriers to food production in this study. Newfoundland's soil and weather conditions make farming difficult. There are efforts to overcome these barriers through research and innovation in partnerships between the provincial government, Memorial University Grenfell Campus, and Agriculture and Agri-Food Canada (Government of Newfoundland and Labrador, n.d.g).

Urban agriculture and innovative farming techniques can help overcome these ecological hurdles. Innovative farmers like Green Farms NL and Living Water Farm are using vertical gardening and hydroponics to grow microgreens and leafy vegetables year-round in Newfoundland (Green Farms NL, n.d.; Kennedy, 2022; Living Water Hydroponic Farm Ltd, n.d.; Tobin, 2021). This innovative farming technique is an example of the connection between physical and ecological infrastructures that can overcome ecological barriers and fulfill food security needs. Costs of implementing these endeavors may prove to be less than the larger physical infrastructures proposed previously. However, thorough research and planning would be required. The disaster of the Sprung Greenhouse would likely discourage large scale funding for an endeavour like this, but on a small scale, these endeavours have proven successful. Future research could work with existing organizations to develop a model or a best practice guide to encourage new businesses with similar interests. The provincial government also has various funding opportunities for small and medium businesses, and businesses that support a transition to a greener economy including the Business Development Support Program, Community Capacity Building, or Green Transition Fund Program (Government of Newfoundland and Labrador, n.d.h). These endeavours offer infrastructural solutions to problems that Newfoundland has faced forever, so there is an opportunity to invest and encourage people to take up similar endeavours.

The results highlighted how the use of certain fishing gear causes damage to ecological infrastructures. One study found that most of the plastic ingested by cod in Newfoundland came from fishing gear (Saturno, 2020). As the gear is used in abrasive conditions, it is likely to fragment and create small plastic particles that are easily ingested by fish (Saturno, 2020). Another study compared the impacts of handline fishing gear, cod pots, and gill nets. Gill nets were found to be the most harmful to the environment, and yet the most widely used by inshore cod fishers (Rouxel, 2017). Another study found that large whales often get tangled in fishing gear and there are records of this since 1979 (Benjamins et al., 2011). When the cod moratorium halted all commercial cod fishing in 1992, the number of whale entanglements also declined, but have since risen again due to fishing gear from the growing crab fishery (Benjamins et al., 2011). Careful consideration of the impact of fishing gear around the growing fisheries must be taken into account. Future research on blue infrastructures could provide a solution.

The impact of climate change on food production is well documented (Mbow et al. 2019; Reza & Sabau, 2022) and discussed by participants. The impact of climate change on ecological infrastructures that support the food system would need to be further analyzed. Specific planning and future modelling would be beneficial. Some research on the changing climate and expectations for future agriculture exists (King et al., 2018; Motha & Baier, 2005); however, there is a need for local planning and policy to keep up with current research. Climate resilient infrastructures are needed to ensure food security. Governance and policy making must also keep up with changing ecological infrastructures.

Social Infrastructures

Governance and the policy process have been repeatedly highlighted as a need, barrier, and opportunity for food security in Newfoundland. Many participants were quick to point at different

levels of government for inadequate action, slow decision making, or withholding funds. However, it is important to remember that a change in policy may not fulfill intentions and may have unintended consequences. For example, many Newfoundlanders disapproved of the prohibition of direct sales of fish, but once it was legalized, the logistics of processing were too much for many fishers and, therefore, the change in policy did not benefit them as intended. While some participants urged a push for local seafood markets, others suggested that a localized seafood market might not be worthwhile due to Newfoundland's low population and high fish quota. People often offer simple solutions or blanket criticisms; it is important to assess the viability of suggestions and to analyze claims.

Governments at every level still have a responsibility to address food security issues. There have been successful government campaigns in the past. For example, providing and promoting enriched milk and orange juice in the 1950s was a successful tactic that improved nutrition (Kealey, 2008). Some efforts are being made by the provincial government and Food First NL today, however a stronger investment is needed. Two interview participants claimed that the average Newfoundlander is not aware of the benefits of purchasing locally, or is simply not motivated to do so. Currently, the provincial government's efforts to encourage purchasing locally is limited to one webpage titled "Why Buy Local?" (Government of Newfoundland and Labrador, n.d.b). While this page outlines the benefits of local food and how Newfoundlanders can access more local food, more effort is needed to make this a priority. Some suggestions made by participants are outlined below. These are actionable recommendations that could be considered by governing bodies.

Public Education and Awareness

Participants in this study explained that public awareness and education campaigns can be used to encourage people to purchase local produce. Awareness around food security can be

integrated into the school curriculum. Efforts such as the St. Francis greenhouse (Doyle & Traverso-Yepe, 2018) prove the effectiveness of having students involved in the growing and harvesting of foods. Little Green Thumbs is an organization that works towards food literacy. The organization provides indoor gardens to expose students to the natural world and creates a curriculum related to the environment (Little Green Thumbs, n.d.). Outcomes of this program range from sustainable resource use, species identification, pollution, nutritious foods, and pesticides (Little Green Thumbs, n.d.). On a similar note, essential food skills can be taught, and students can be encouraged to keep food skills and traditions alive. Courses such as home economics can be re-introduced as electives to gauge student interest. Two participants pointed out that ingraining a love and respect for food and its sources in young children can set up a future of mindful adults. Education in schools is an important first step, however spaces to practice these skills as an adult must also be established. Foresight and future planning are needed.

Public education in household self-sufficiency can also encourage people to increase their food security. Two participants pointed out that there is a growing interest in self-sufficiency, but educational programs and access to knowledge are needed. A survey conducted by the Food Producers Forum found the same, so they are creating a network for food producers to learn and share knowledge (Food Producers Forum, n.d.). There is an opportunity to encourage the same cooperation and sharing among farmers and fishers.

Government Incentives

Policy instruments, such as incentives, can be used to change public behaviour in order to achieve policy goals (Winfield, 2009). Two participants pointed to financial incentives to encourage consumers to choose local produce. The Food Producers Forum (n.d.) has identified projects that communities could undertake to improve their self-sufficiency, but funding would be

required to make this a reality. Offering incentives or rebates to households that start their own backyard gardens or greenhouses could encourage household food self-sufficiency. Offering local produce at grocery stores for a cheaper rate than imported could help encourage more local food purchases. This could be achieved by giving funding to farmers so that prices could be lowered. The funding could also go towards CanadaGAP certification so that more farmers can sell their produce at grocery stores. By encouraging people to buy local produce, local farmers will also have more support and can continue to produce. With a shifted focus on local produce, Newfoundland can reduce dependence on the ferry imports. Government incentives can encourage the general public to support local producers.

Institutional Leadership

Large institutions, like the University and hospitals, have an opportunity to be a leader in food security initiatives by purchasing local and organic produce. Partnering with local producers could allow for higher quality produce. Effort from the management and administration departments at these institutions is needed in order to make this a priority. Having locally sourced produce will also allow many Newfoundlanders to be exposed to the variety and quality of produce available in Newfoundland. Support from these large institutions would help local farms become more profitable. The University and their researchers have relationships with local producers through their research, so a partnership could easily be forged.

The Government of Ontario has committed to encouraging the increase of local food procurement in large public institutions like universities, colleges, and hospitals (Ministry of Agriculture, Food, and Rural Affairs, 2021). Through research and consultation, they have created and shared procurement tools and resources for colleges, universities, long term care facilities, hospitals, municipalities and schools (Ministry of Agriculture, Food, and Rural Affairs, 2021). A

Local Food Framework offers a step-by-step guide for procuring local foods in Ontario (Mohawk College Office of Sustainability and Climate Change, 2017). There is an opportunity for these tools to be used in Newfoundland. Research will need to be conducted to translate the guidelines for a Newfoundland context, but they can provide a starting point.

By modelling the behaviour, large institutions could encourage smaller ones and households to make the shift to local goods. This change in behaviour will encourage the purchase of local food, stimulate the market for local producers, decrease dependence on the ferry, reduce carbon footprints, increase self-sufficiency, and, ultimately, improve food security.

Cooperation and Sharing

Cooperation among farmers is a strong need identified by many participants. Local produce is available but difficult to access because the farms are sparsely located. Self-organization can make smaller farms more appealing to large purchasers. Cooperation and collaboration can also allow farmers to share costs for tools, fertilizers, shipping, and other inputs, thus reducing cost of production. Cheaper production can also translate to savings for the consumer, making food security more achievable. This would also contribute to keeping produce local and decreasing dependence on ferry imports. There is an opportunity for farmers to work together either based on proximity, type of crop, farm size, or simply mutual understanding.

The Food Producers' Forum has created a Provincial Food Network in response to the growing desire for cooperation. They offer the creation of food hubs across the island to improve access to food and encourage cooperation (Food Producers Forum, n.d.). A food hub could be a production site like gardens or a greenhouse; storage like communal freezers or pantries; educational programs such as workshops, seminars, or classroom engagement; or composting to

produce healthy soil (Food Producers Forum, n.d.). An organization or group is needed to coordinate among the farmers.

A variety of cooperatives exist in Newfoundland, with a total of 69 currently listed by Cooperatives and Mutuals Canada (n.d.). However, only 6 of these are related to agriculture, food processing, or fishing (Cooperatives and Mutual Canada, n.d.). The Newfoundland and Labrador Federation of Co-operatives renewed a Memorandum of Understanding with the provincial government with both parties working towards the development of new cooperatives, training, and public awareness (Newfoundland and Labrador Federation of Co-operatives, 2023). There is an opportunity for a co-operative of farmers or other food producers to come together in Newfoundland. By sharing resources and knowledge, farmers may increase productivity, decrease costs, and decrease dependence on the ferry.

Poverty Reduction Strategy

Poverty is the single largest culprit of food insecurity across the world. As evidenced in Hussain and Tarasuk's study (2022), and supported by many participants, there is a clear relationship between household income and food insecurity in Newfoundland. Between 2007 and 2011, food security improved in Newfoundland as the provincial government introduced a poverty reduction strategy (Hussain & Tarasuk, 2022). Oftentimes, when income is reduced, the food budget is the most flexible one and the easiest to reduce (Food First NL, 2015). Nutritious meals are often replaced by calorific processed foods that are cheaper (Food First NL, 2015). As a result, poverty reduction is a major need for improving food security. Holistic strategies that target social inequalities are needed in order to ensure food security. Food banks and soup kitchens help relieve the immediate effects of food insecurity, but they are not permanent solutions. Some participants pointed out that as Newfoundland has shifted to a wage economy, so people are forced away from

producing their own food. Therefore, if Newfoundland should continue to be a wage economy, people should receive a basic living wage. Income levels are not the only indicator of financial stability. Other factors such as unaffordable housing, unexpected medical expenses, and other sudden expenses can all impact household financial stability and therefore impact food security (Loopstra et al., 2015). Creating a poverty reduction strategy can contribute to achieving food security. In November 2023, the province released a new poverty reduction strategy that will focus on: reducing childhood poverty, creating meaningful and sustainable employment, improving income, and supporting seniors (Government of Newfoundland and Labrador, n.d.i). This three-year plan aims to make Newfoundland and Labrador one of Canada’s healthiest provinces by 2031 (Government of Newfoundland and Labrador, n.d.i). This may be helpful in reversing food insecurity, but monitoring and evaluation of the strategy will be required.

TABLE 4: Summary of discussion

Policy Recommendations	Problems they address	Current efforts and potential hurdles
Secondary processing and storage facilities	<ul style="list-style-type: none"> • Creates more access points for food accessibility • Provides support for existing local production 	<ul style="list-style-type: none"> • Dairy processing facility recently approved • High cost • Planning required • Slow process • In depth research on viability and profitability needed
Clean energy source	<ul style="list-style-type: none"> • Works towards net zero emissions • Creates a more sustainable food system 	<ul style="list-style-type: none"> • Provincial government commitments to develop both renewable sources, and fossil fuels • Profitability of oil and gas shadows the benefits of clean energy sources
Growing technology and innovation	<ul style="list-style-type: none"> • Overcomes ecological challenges • Supports small businesses 	<ul style="list-style-type: none"> • Small businesses using hydroponics and greenhouses • Public fear of greenhouse investment • Costs
Fishing gear restrictions	<ul style="list-style-type: none"> • Supports marine ecosystems 	<ul style="list-style-type: none"> • Evidence of damage and harms to environment

		<ul style="list-style-type: none"> • Immediate profitability of fisheries shadows long-term benefits of conservation efforts
Analysis of climate change impacts on infrastructure	<ul style="list-style-type: none"> • Prepare for future infrastructural changes 	<ul style="list-style-type: none"> • Some future modelling for agriculture exists • Need for local planning and policy to match research
Public education	<ul style="list-style-type: none"> • Food skills and traditions maintained • Foster sense of responsibility and accountability • Challenges certain public perceptions 	<ul style="list-style-type: none"> • Programs in some schools • Some programs led by Food First NL and Food Producers Forum • Need physical space to practice
Government incentives	<ul style="list-style-type: none"> • Encourages public to change behaviour 	<ul style="list-style-type: none"> • Potential unintended consequences • Often presented as a blanket solution with little empirical support
Institutional leadership	<ul style="list-style-type: none"> • Support local producers • Provides access points for local food • Sets an example that may encourage others 	<ul style="list-style-type: none"> • Need to translate outside efforts into a Newfoundland context
Cooperation and sharing	<ul style="list-style-type: none"> • Decrease costs and increase productivity and efficiency • Reduce dependence on ferry 	<ul style="list-style-type: none"> • Provincial Food Network and proposals of food hubs by Food Producers Forum • Planning required
Poverty reduction strategy	<ul style="list-style-type: none"> • Poverty is the largest culprit of food security 	<ul style="list-style-type: none"> • New provincial strategy released in November 2023 • Potential unintended consequences • Need to monitor effects

Conclusion

This paper has explored the infrastructural needs, barriers, and opportunities for enhancing food security in Newfoundland. Recommendations to improve overall capacity for food security in Newfoundland were suggested. The significance of food security research in Newfoundland is indisputable. Various organizations are working on the food security problem, but none have analyzed it from an infrastructural lens. In its most basic sense, infrastructure provides access. Food security is access to food. Therefore, a strong food infrastructure can ensure food security. Infrastructural analyses and solutions could help address food security issues in Newfoundland. Being an island brings unique challenges to the food security question, and infrastructural considerations could overcome these challenges.

The intersection of many infrastructures is a key theme that continued to present itself in this research. Farmers markets and community gardens are examples of physical and social infrastructures. A physical space is needed for these endeavours, and both provide a social network for its participants. Farmers markets are few in Newfoundland, but community gardens are more common (Food Producers Forum, 2023). The importance of providing a physical space for these social interactions is highlighted. Another example is the impact of ecological infrastructures on both physical and social aspects. The collapse of the cod fishery disrupted physical and social infrastructures in Newfoundland (Bavington, 2010; Cadigan, 2009). The interdependence and interactions between all the infrastructures is a delicate balance. Connections between complementary social infrastructures are also crucial for future planning. Education and public awareness programs that encourage interest are only useful if people are given spaces to practice and participate in them, lest the regained knowledge simply be lost again in the future. Since infrastructure is a network of life supports, damage or disruption to one area will be experienced

in other areas. Simultaneously reinforcing and invigorating one area can help another. An infrastructural lens could allow for previously independent solutions to work together to create holistic, sustainable, and long-term solutions.

For further consideration, a study of food sovereignty might be conducted. Food sovereignty is “the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems” (Declaration of Nyeleni, 2007). Food sovereignty ensures that the food production is sustainable. A study of food sovereignty would be more useful after general awareness and interest is increased so that communities may exercise the right to define their food systems. The study of food sovereignty was outside the scope of this thesis but would be useful in creating sustainable and climate resilient communities.

Furthermore, a similar study focusing on Labrador would be beneficial. This was outside the scope of this research since an island infrastructure was the focal point. A study of Labrador’s unique history, geographical makeup, and social norms that form its food infrastructures would require a further in-depth study. Similar research in a Labrador context is crucial to improve the province’s overall food security.

Community led food assessments are being coordinated by Food First NL to analyze assets and gaps in the food system of various communities in Newfoundland and Labrador (Food First, n.d.c). They take an interdisciplinary approach and include infrastructural approaches. These assessments could prove useful across the province as they allow residents to think about and take responsibility for their food system, thus improving their food security and food sovereignty.

The globally recognized challenges to food security, including access and distribution, are intrinsically tied to infrastructure; therefore, an infrastructure lens is needed. The struggles of food

insecurity are felt in all countries, and specific geographies have unique challenges. Global food trends are dependent on trade, so transportation must be secure. The global production of food is not the root cause of food insecurity given the amount of food wasted daily across the world. However, distribution, ethical consumption, and awareness must be addressed to ensure that sufficient, nutritious food is available to all. Eliminating hunger is a social and a political issue rather than a production issue. An infrastructural approach to hunger and food security is needed.

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Appendices

Appendix A – Recruitment Email

Subject: Interview Invitation: Researching Food Security in Newfoundland

Hello,

My name is Pratyusha and I am a graduate student at Memorial University's Grenfell Campus in Corner Brook. I am doing my master's thesis research on food security infrastructure barriers and needs in Newfoundland, and my project is supervised by Dr. Paul Foley from the Environmental Policy Institute at Grenfell Campus. My research involves analyzing the relationship between infrastructure and food insecurity, with a focus on large islands like Newfoundland. I would like to invite you to participate in my research.

I am conducting interviews with various knowledgeable individuals in the field of food security and infrastructure on the island of Newfoundland. **The goal of the interviews is to learn about current food pathways, and barriers and opportunities for food security on the island.** The information collected from this research could be used to inform policy making and community planning.

I believe that you might have valuable insight that could further my research. If you are interested and able to participate in this research, **please let me know by responding to this email and completing the attached informed consent form.** The interview is expected to be about 30 minutes long, over Zoom video call. If you could also provide an idea of your availability to schedule an interview in the coming weeks that would be greatly appreciated.

If you have any questions or would like more information, please do not hesitate to reach out.

Thank you,

Pratyusha

Appendix B - Interview Guide

The purpose of this research is to identify fundamental infrastructure needs, barriers, and opportunities for food security, with an overall goal to improve capacity for understanding and addressing food security problems for the island of Newfoundland. It will specifically research the state of current infrastructures, identify existing infrastructural barriers to food security, and suggest more sustainable infrastructures for the future of community planning. The research defines infrastructure broadly as a network of life supports, including physical infrastructure like ferries, roads and bridges, ecological infrastructures like marine ecosystems and soil, and societal infrastructure like good governance institutions and resilient communities.

- Tell me a bit about yourself. Where are you from, your job, how you've come to know a lot about the state of food security in Newfoundland?

Current state of food infrastructure

- Can you tell me about the accessibility of food in Newfoundland? Where does the food come from; how do most people access food?
 - How does this access differ across the island? Cities vs towns vs rural vs coastal
 - How long does it take to have food delivered? What condition is the food in upon delivery?
 - How far or close are people to food sources (proximity to grocery stores, other sellers, producers themselves)
 - What transportation needs are there in order to ensure food access?
 - What infrastructure is required for improving access?
 - What can be provided/produced locally? Production infrastructure and capacity?
 - Thoughts on the infrastructure requirements for building self-sufficiency in the island?
 - How likely are people to opt for local products rather than imported?
 - How accessible is knowledge on soil quality, weather conditions, etc
 - How common are other tactics such as greenhouses, hydroponics, etc
 - Who monitors/controls/manages access to food security across the island?
Locally?
 - Is the food healthy? Processed?
 - Is the food affordable? How common are food banks and soup kitchens
 - With inflation and rising prices how does that impact access to food. How can that be mitigated?
- In your opinion, how versed are the people of NL about the state of food security?
- Have you noticed any major historical changes in accessibility to food?
- What kinds of food are easy to access and what is harder? What types of foods are consumed more often than others (Produce vs seafood, wild foods vs store-bought)?
Seasonal differences?
- How much food waste is produced? What kinds of foods are wasted more than others?
Produce vs meats? Imported vs local?

Infrastructure disruptions:

- If physical infrastructures were disrupted, how would that impact you or people you know? For example, if/when the ferry is delayed, how does that impact you or people you know? What about shipping?
- If ecological infrastructures were disrupted, how would that impact you or people you know? For example, natural disasters, climate change, unsustainable fishing practices, contamination?
- If social infrastructures were disrupted, how would that impact you or people you know? For example, food banks, financial aid

Infrastructure barriers:

- What barriers to food security have you noticed? What would you identify as barriers to food security? Have community members shared any barriers/concerns with you about the state of food security locally or provincially?

Infrastructure needs/requirements/improvements:

- What needs to be addressed in order to make food more accessible?
 - What do you consider a priority? Are there any infrastructures that require more attention? What infrastructures need to be addressed?
- Are there physical infrastructures that can be improved? How?
- Are there ecological infrastructures that can be improved? How?
- Are there social infrastructures that can be improved? How?
 - How can we mobilize communities to become more educated or make tangible improvement themselves to infrastructures?
- Do you have any innovative solutions to address these ongoing problems? How do you work to improve food security in NL?

Appendix C – Informed Consent Form



20 University Drive
Corner Brook NL A2H 5G4
☎ 709-639-2591
✉ epi@grenfell.mun.ca
www.grenfell-epi.com

You are invited to participate in a research study entitled “Identifying diverse infrastructure needs for enhancing food security: A case study of the island of Newfoundland”

Researcher: Pratyusha Akunuri, MA Environmental Policy Candidate
Environmental Policy Institute, Grenfell Campus
Email: pakunuri@grenfell.mun.ca

Supervisor: Dr. Paul Foley, Associate Professor
Environmental Policy Institute, Grenfell Campus
Email: pfoley@grenfell.mun.ca

Project Summary

The purpose of this research is to identify fundamental infrastructure needs, barriers, and opportunities for food security, with an overall goal to improve capacity for understanding and addressing food security problems for the island of Newfoundland. It will research the existing infrastructural barriers to food security, the state of current infrastructures, and suggest more sustainable infrastructures for the future of community planning. The research defines infrastructure broadly, including physical infrastructure like ferries, roads and bridges, environmental infrastructures like marine ecosystems and soil, and societal infrastructure like good governance institutions and resilient communities.

This research attempts to answer the question: What are the infrastructural needs and barriers to food security in Newfoundland and Labrador? Research objectives include understanding how food security and infrastructure are linked, and how more sustainable and resilient infrastructures can be created in order to reduce the risk of food security in the future. This thesis will identify and consolidate existing knowledge and information on food security issues in the province, as well as its existing infrastructures.

Procedures

- You will participate in an interview 30-60 minutes long.
- The interview will take place virtually, at a time that is convenient to you.
- The session will be video and audio recorded.
- Topics to be discussed include, but are not limited to:
 - Infrastructures that affect the accessibility of food
 - How infrastructure influences how food moves through the island
 - Relationship between food security and different kinds of infrastructure

- The infrastructure requirements for self-sufficiency in the province
- Personal thoughts on improving food security
- The researcher(s) will make some notes as part of their own reflection activity.
- You may request a copy of the recording for review and revision (indicate preference below).
-

Confidentiality

- The confidentiality of your comments will be protected to the fullest extent possible.
- If your comments are quoted (e.g. in a publication or presentation), your name and any other identifying information will not be included.
- Only the researcher and supervisor will have the access to the raw collected data (e.g. recordings/ transcripts), except that each participant may request a transcript of their own comments for review.
- Raw data will be kept on locked-up and/or password-protected devices in the researcher’s or supervisor’s care.

Right to Withdraw

- Participation is voluntary.
- You may withdraw from the project for any reason, at any time, without explanation or penalty.
- You can choose not to answer individual questions.
- You have the right to revise your comments or have them removed from the record. Removal of comments may be limited if the comments have already been integrated into analysis or disseminated as part of a presentation or report. Should you have any concern, please give notice of withdrawal or comment revision as soon as possible.

Follow-Up

- You may contact the researcher with any questions or to learn about the overall results of the study (use the contact information at the top of this form).
- If you leave your email address at the bottom of the form, the researcher will inform you about any reports emerging from the study and may follow-up with you to collect additional data.

Consent

Typing your name below is equivalent to a signature that indicates that: you have read and understood the study description provided, you have had an opportunity to ask questions and they have been answered to your satisfaction, and you consent to participate in the project.

_____ *Name of Participant*

_____ *Signature*

_____ *Date*

To receive updates and follow-up notices, leave your email here:

_____ *E-mail Address*

Would you like to receive a recording of your comments for review? No Yes
(put e-mail address above)

One copy of this consent form will be left with you, and one copy will be taken by the researcher.