Major Research Paper

Organic Waste Diversion in Atlantic Canada

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Abstract

Sustainable waste management is essential for reducing greenhouse gas emissions, conserving landfill space, and producing valuable end-products. Organic waste diversion plays an important role in sustainable waste management with various environmental and economic benefits. Organic waste diversion is not a new concept, and many areas have had systems in place for over 20 years. One area where there are significant variations in residential organics waste diversion rates is Atlantic Canada. This research paper investigates the factors that contribute to these variations and explores the barriers and opportunities for increasing diversion across the region. Through a comprehensive literature review, the study investigates several factors that may affect diversion rates, including population density, access to composting facilities, curbside collection, and public education and outreach programs. The paper explores unique challenges in organics waste diversion in rural areas of Atlantic Canada due to limited access to resources and infrastructure. The study also highlights various opportunities for progress, such as increased funding for diversion programs and more data collection and reporting on waste management. Overall, this research paper provides insights for policymakers and practitioners looking to improve diversion rates and advance sustainable waste management practices in Atlantic Canada.

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Introduction

Waste in Canada

Humans have had a significant impact on the environment through the extraction of resources and the continuous cycle of take, make, and waste. Over time the gravity of our impact has been recognized, and with this responsible and sustainable waste management has become a prominent topic in conversations and decisions surrounding environmental stewardship and climate change mitigation. For decades waste in Canada was disposed of in dumps, unlined landfills, through open burning, or it was shipped across borders or oceans to be dealt with by another country. The long-standing mentality surrounding waste was out of sight, out of mind. Even though there have been many changes to waste systems there is still a considerable disconnection between our consumption and the resulting waste. There is no simple solution to change habits, close landfills, and provide efficient waste infrastructure to many rural or remote areas of the country.

A recent study ranked Canada as the 8th most waste-producing country among the Organisation for Economic Co-operation and Development (OECD) member states (Sensoneo, 2022). Reports from Statistics Canada show that only about 30 percent of Canada's waste is diverted, and the other 70 percent of waste is sent for disposal in landfills, incineration facilities, and through thermal treatment or residual waste processing (ECCC, 2022). In Canada waste is primarily managed through provincial governments with limited oversight from the federal government. Many provinces further delegate the responsibility of waste management to municipal or regional authorities. Therefore, the amount of waste being diverted and disposed of varies across the country, some areas being more efficient than others, but, as a whole Canada is far from the most efficient country at managing waste. There is not one reason for this

inefficiency. It may not entirely be the fault of poor waste management systems but instead the rate at which we consume. Some might argue the waste is managed so efficiently the average Canadian has no concept of how much there is or where it goes (Wilkins, 2017). It is also worth mentioning that much of the effort on waste reduction and diversion has been focused primarily on residential waste streams. However, institutional, commercial and industrial (IC&I) sectors in Canada produce about two-thirds of the total waste and generally have much lower diversion rates (Statistics Canada, 2022).

Recently there has been a peaked interest from various stakeholders throughout the federal government, private industries, and academia in creating a circular economy. A circular economy is designed to be driven by three principles; eliminate waste and pollution, circulate products and materials at their highest value and regenerate nature (Velenturf et al., 2021). In terms of waste, these principles can be demonstrated as a hierarchy. Figure 1 is an example of a commonly used waste hierarchy showing the most preferred waste treatment method to the least preferred option. There is a multitude of both environmental and economic benefits that stem from the diversion of waste. One of the most notable benefits is the preservation of landfill space. There are over 3,000 landfills across Canada, about half of those landfills have already reached capacity and many more will reach capacity in the coming years or decades (ECCC, 2022b). Some other benefits are that waste disposed of in more sustainable ways is often less expensive, and places less demand on natural resources.

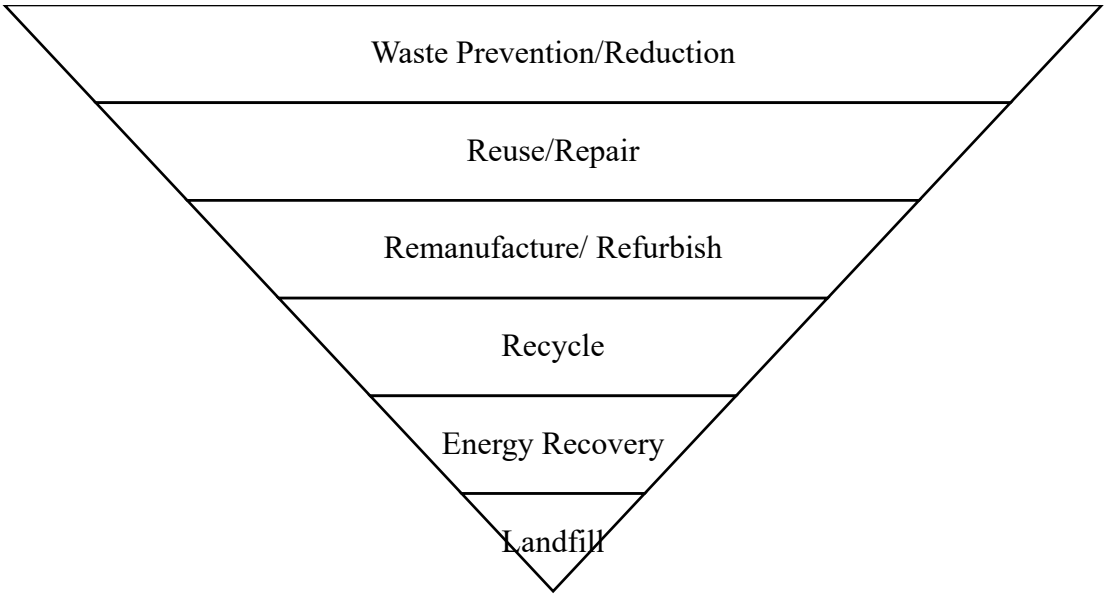


Figure 1. Hierarchy for preferential treatment of waste (ECCC, 2021).

The most preferred waste treatment option is to reduce or prevent waste at the source. The least preferred is disposing of waste in a landfill. Recycling is the process of converting waste into usable material and falls somewhere in the middle of the waste hierarchy. Over the past 40 years, various recycling programs have been implemented in cities across Canada. These programs allow the diversion of paper, metals, certain plastics and organic materials from the landfill. Recycling has become a widely used method of diverting waste for environmental benefits. With that said, although recycling is much preferable to landfilling, reducing waste at the source will always be the most sustainable option (ECCC, 2021).

Organic Waste Diversion

Organic waste is estimated to make up 30 to 50 percent of municipal solid waste in developed countries (Treadwell et al., 2018). Organic waste consists of any biodegradable material from plants or animals. In residential waste streams, this can be divided into two broad categories of yard waste and kitchen waste. Kitchen waste consists primarily of food waste, this

includes fruit and vegetable scraps, bones, eggshells and spoiled food. Although reduction of waste is always the preferred option, kitchen waste is unique in that regardless of efforts and success in reducing food being wasted there will always be some amount of inedible organic waste entering the waste stream (Treadwell et al., 2018). Therefore, there is a need to develop policies, programs, and infrastructure to divert organic waste from landfills. In addition to yard and kitchen waste, there has been an emergence of a third stream of organic waste in recent years which consists of compostable or biodegradable plastics. There are still a lot of questions surrounding the use of these products however there is potential for them to be processed with organic waste (Viera et al., 2021).

One reason it is important to separate organic waste is that when disposed of in landfills, it breaks down to create leachate which can pollute the soil and water bodies surrounding the landfill site. Organic waste in landfills also produces methane, a greenhouse gas (GHG) more than 20 times more potent than carbon dioxide (GNFLD, 2019). The resulting benefits of organic waste diversion include nutrient recycling, improved soil management practices, reduction of GHGs, and economic benefits. In the past, many households composted organic waste in backyard compost bins or gardens but over time, this has become a less common practice and more and more organic waste has entered the waste stream (Elliott, 2008). A Canadian study completed in 2007 calculated the environmental benefits of composting organics to be $50 per tonne compared to only 8$ per tonne for traditional landfilling (GNS, 2009). In 2014, Giroux Consulting completed a study for the Canadian Council of Ministers of the Environment (CCME) that investigated investments in organics programs. This report indicated that investing in either high- or low-tech systems for organics would be the most valuable option in terms of opportunities to significantly increase diversion (Giroux, 2014).

Although diverting organic waste may appear to be the obvious choice there are still a few barriers to wide-spread adoption in Canada. The first is the low cost of landfilling in many Canadian provinces. Most landfill tipping fees do not capture external costs. Cheap disposal in landfills can disincentivize innovation and other diversion opportunities. Second is the high cost associated with the development and maintenance of certain organics processing technologies. Many rural areas lack the funds to develop infrastructure to process organics and transporting waste to the nearest facilities can be costly. The last component is public acceptance and willingness to participate (Hénault-Ethier, 2017). Some of the reasons that people choose not to separate and compost their organic waste come down to factors such as smell, and inconvenience (Pickering, 2020).

Diversion Methods

The term waste diversion refers to any method which prevents waste from going to landfill. However, for the context of this research diversion will be used only in the context of recycling. Therefore, diversion refers to the recycling of organic waste and equation one represents the organic waste diversion rate.

Equation 1. Organic Diversion Rate = $\frac{Organic\ Waste\ Diverted}{(Organic\ Waste\ Diverted)+(Organic\ Waste\ Disposed)}$

The recycling of organic material can be completed through two main methods: composting and anaerobic digestion. The main difference between these methods is the presence (aerobic) or lack of oxygen (anaerobic). Composting is an aerobic process that releases carbon dioxide, water and heat and results in the production of minerals, biomass and humus. These by-products can be applied to the soil for plant uptake, thus recycling nutrients and minerals. Anaerobic digestion relies on microorganisms to degrade organic material in the absence of

oxygen. This process releases biogas that can be used for heat or energy production. The remaining solid material from anaerobic digestion consists of biosolids and dissolved organic matter (EREF, 2021).

Home composting and industrial composting rely on the same principles but due to differences in scale and infrastructure they are often considered to be distinct from one another. The process for backyard composting is relatively simple requiring only some outdoor space, an optional compost bin and a source of green waste (wet and soft materials like grass clippings and food scraps) and brown wastes (dry woody materials). The process of home composting requires some maintenance and attention but can provide a direct source of nutrients for gardens or other landscape projects (RRFB, 2023). Backyard composting is not captured in most reports on organics diversion. Industrial composting can be done using a few different methods or technologies. Static pile, windrow and in-vessel composting are commonly used methods. The main difference between these methods is how oxygen is incorporated into the system. Windrow and static pile composting rely on passive aeration and optionally turning to aerate. Both methods are primarily used to process leaf and yard waste and agricultural materials. The various types of in-vessel composters typically use forced aeration. This allows them to process a broader range of organic materials, including kitchen waste (EREF, 2021). Anaerobic digestion can also occur in a variety of vessels or structures. Two key factors differ between digestors, one being the moisture content of the organic waste, and the second the system will either be batch or continuous. For batch systems, all waste is placed into the digestor at once and remains until the digestion is complete. In continuous systems, waste is, as the name suggests, continuously added to the digestor (EREF, 2021).

Research Objective

Advancing organics waste diversion can have significant economic and environmental benefits. Atlantic Canada is an interesting case study for organics waste management and an area I am familiar with. Of the four Atlantic Canadian provinces, Nova Scotia and Prince Edward Island, have led the way in organics diversion while New Brunswick and Newfoundland and Labrador have shown less development in this area.

Generally, across Canada, there has been less research on organics diversion compared to the diversion of materials like plastic, paper or metal. There is a broad lack of data in the area which makes determining best practices and opportunities for advancement more challenging. Statistics Canada presents data on waste diversion for each of the provinces, but this high-level data is not enough to gain a full understanding of waste management practices. Additionally, individual attitudes, knowledge, and demographics can influence the composting behaviour at the household level. By compiling the available sources of data, I aim to create a comprehensive overview of organic waste diversion in Atlantic Canada.

The objective of this research paper is to summarize the existing waste management practices, policies and programs in each of the Atlantic Canadian provinces and to explore how these practices have resulted in differences in organic waste diversion rates. Completing a detailed summary of the current state of organics waste diversion will allow the discussion of lessons learned as well as possible barriers and opportunities to progressing or maintaining diversion rates in the Atlantic region.

Scope and Methodology

Due to the scope and timeline of this research project, I will not be collecting observations but using data that is already available for analysis. The research scope only covers

organic waste diversion through organics recycling (industrial composting, home composting and anaerobic digestion). Reducing or preventing organic waste are important forms of waste diversion but are not captured within the scope. Additionally, only the residential streams of organic waste were considered. Lastly, the focus of data analysis will be on composting kitchen waste only because yard waste is already more widely collected and diverted throughout Atlantic Canada.

Information regarding the policies and programs in place for each province was collected from various provincial and federal government documents, provincial websites and peer-reviewed academic articles. Data on broad-scale provincial on per capita waste diversion was obtained through Statistics Canada reports based on data from two waste management industry surveys, for both the business and government sectors. Data on household-level composting behaviour was obtained from the Statistics Canada Households and the Environment Survey (HES). This survey has cross-sectional design and has been conducted every two years since 2007. It aims to provide context to scientific measures of air and water quality, and greenhouse gas emissions, by gaining a better understanding of household behaviour and practices concerning the environment.

The first component of my research is a qualitative analysis in which I used the above sources of data surrounding waste management systems in place to compile summary tables. These were used to observe general differences in waste management practices as well as policies and programs pertaining to organic waste diversion across the four provinces. Leading to discussion of what aspects of the waste management systems may be contributing to higher diversion rates in NS and PEI. The second component of my research surrounded the actual household behaviour and how different variables may contribute to participation in organic waste

diversion. Using the HES I was able to provide a fuller picture of organic waste diversion through various demographic and socio-economic variables. The dependent variable for this study was composting behaviour. This can be broken down into the following categories: the household separates organic waste (yes or no), if yes how was the organic waste composted (collected, depot, backyard compost, other) and if the household had a municipal composting or organics collection program for kitchen and/or yard waste but did not use it. The independent variables that I selected to observe to gain a better understanding household composting behaviour were the province of residence (NS, NB, NFLD, or PE), households in a census metropolitan area (CMA) versus non-CMA, the type of dwelling and household income. Statistics Canada reported the response for each question regarding composting based on province of residence for the period of 2009 to 2019. However, to tabulate and compare the other independent variables ODESI was used and the most recent HES on this database was from 2015.

One of the main limitations of this study is potential sampling bias. The HES excludes households located on reserves and other aboriginal settlements, households of full-time members of the Canadian Armed Forces, and households in certain remote regions. Additionally, the HES is set out to represent Canadian households, but the sample size of respondents is relatively small for each Atlantic province (Appendix B). Additionally, the survey data is self-reported and runs the risk of respondents answering in a way they perceive to be more socially desirable rather than entirely honest. Each survey iteration is responded to by a different sample of households so although I have analyzed responses over time, these were used to observe if there were general trends. Additionally, there are many possible confounding factors such as social norms, attitudes or environmental knowledge. For example, it is possible that an

individual's motivation and therefore participation in the waste diversion practice is external to the existence of a policy or program and they would continue the same practice with or without the intervention.

Provincial Waste Management

Organic waste diversion rates vary considerably across the Atlantic Canadian provinces. PEI and NS have much higher diversion rates than NB and NFLD. The higher diversion rate may be attributed to a more top-down approach with the implementation of province-wide landfill bans on organic waste. While NB and NFLD have relied mainly on regional authorities to develop infrastructure and manage organic waste. The following sections will outline the past and current state of organic waste diversion as well as the policies, programs and targets in place for each province.

New Brunswick

The first New Brunswick Solid Waste Management Plan was adopted in 1987. This plan proposed a regional approach to waste management and resulted in the establishment of a series of Regional Solid Waste Commissions. There are 12 total regional commissions across the province, shown in Figure 2. These commissions are composed of local decision-makers and each region is responsible for providing waste disposal services to the municipalities, rural communities, and local service districts (GNB, 2023).

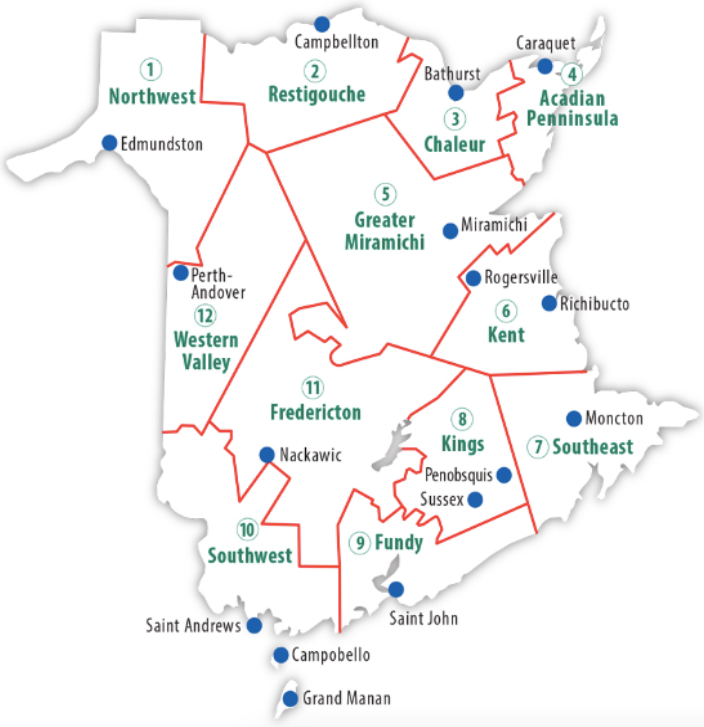


Figure 2. Map of NB showing the 12 Regional Solid Waste Commissions (RecycleNB, 2023).

The Government of New Brunswick has not played an overly active role in developing policies and programs and still manages waste through a primarily regional approach. This approach was designed to allow for differences in population and infrastructure to be addressed in the different areas across the province (GNB, 2001). Recycle NB is the only provincially run government agency. They manage waste reduction programs for designated materials such as tires, paint, oil and electronics and provide environmental stewardship province-wide (RecycleNB, 2023). The last provincial waste management strategy was released in 2001, entitled Waste Reduction and Diversion, An Action Plan for New Brunswick. This document was intended to outline province-wide intentions for the management, diversion and reduction of solid waste over the following five years. One of the requirements of this strategy was that each solid waste commission would implement a region-wide recycling program for composting all organic waste by the end of 2006 (GNB, 2001). Most regions fulfilled this by providing guidance

and/or programs promoting backyard composting. As of 2022, only four regions offer organics collection or compost as a stream of curbside waste collection. In 2012, the auditor general completed a review of the solid waste commissions. At the time of this review, it was found that the governance and function of the solid waste commissions were adequate and functioning as documented in provincial legislation. One recommendation in this report was the transparency of information and data regarding solid waste disposal and diversion and the recommendation to keep information on each commission's website up to date (GNB, 2012).

More recently, the New Brunswick Government has released 5-year climate action plans for 2016 to 2021 and 2022 to 2027. The 2022 to 2027 plan is entitled "Our Pathway to Towards Decarbonization and Climate Resilience" (GNB, 2022). Within this plan, one pillar is the reduction of GHG emissions and a subgoal for this pillar is the reduction of waste and turning it into a renewable resource. As part of this commitment, the provincial government will continue to develop and implement a Solid Waste Management Action Plan to reduce GHG emissions by reducing landfilling of organic and other recyclable materials. As well as assessing opportunities to prevent waste (e.g., food waste). Another target within the plan sets the precedent that the government will support the development of strategic projects (e.g., anaerobic digestors and bioreactors) to produce and utilize renewable energy from organic waste, including animal waste and by-products by 2027 (GNB, 2022).

Although there have been targets and aspirations for increased diversion of organic waste in the noted action plans, many of these targets had no date attached or were not achieved by the date set out. Overall, NB appears to perform very well in diversion rates per capita compared to other provinces across the country in reports by Statistics Canada (Statistics Canada, 2022). However, this is largely due to the non-residential diversion of organic waste. The residential

diversion rates are weak in comparison to other provinces (GNB, 2012). The province does not track any data regarding organic waste diversion and the respective facilities, nor is there public reporting of any data that is recorded (EREF, 2021).

There are 30 organic waste processing facilities in NB, 29 static or windrow facilities and one anaerobic digestion (AD) facility (EREF, 2021). Most of the province's composting capacity is through static pile and windrow composting, which are primarily used to process leaf/yard and agricultural waste. Regions 6,7,8,9 offer curbside collection for leaf and yard waste as well as kitchen waste. These regions include both CMAs Moncton and Saint John and overall, they serve about 47% of the population. The Government of NB offer a backyard composting handbook on their websites (GNB, 2010). All of the regions offer some form of guidance regarding backyard composting on their website. At a minimum, the regions provide the provincial handbook, or some have developed their own guidance and promotional material. Additionally, some regions offer programs where residents can purchase compost bins for home composting.

Newfoundland and Labrador

The most recent provincial waste management strategy for NFLD was released in 2002 and aimed to achieve province-wide modern waste management (GFNLD, 2002). The primary goals outlined in this strategy were to: divert 50% of solid waste, reduce the number of waste disposal sites by 80%, eliminate open burning and incineration, and phase out unlined landfills. The implementation plan and funding commitment were announced in 2007. The target was for the strategy to be fully implemented province-wide by 2025. There was an acknowledgement that the strategy would not be able to be fully implemented for Labrador and other remote regions of the province but still emphasized continuing to improve waste disposal practices in

those regions. The most recent waste diversion data from Statistics Canada indicate that NFLD is not yet close to achieving the 50% diversion target with only 11% of waste being diverted. Although it is unlikely, they will achieve all the 2025 targets the province has shown to be actively monitoring progress. The province has released a series of strategy monitoring reports to document the process of the above goals, with the most recent final review report in 2019 (GNFLD, 2019).

It is estimated that organic waste makes up 30% by weight of the province's waste. The original strategy noted it was a priority to divert organic waste but had limited guidance on how this would be achieved. The final monitoring report talks extensively about organic waste management and the importance of diverting this material. While also acknowledging that there is no consensus on how to move forward with developing infrastructure. The report notes concern over the costs required for expansion and upgrades of infrastructure. The ultimate objective of this review is for the government to develop an organic waste management strategy and to implement an appropriate provincial landfill ban on organic waste by 2025 (GNFLD, 2019). Even in recent years, it is estimated that only 2.5 % of the organic waste stream is being diverted, despite efforts to increase participation in home composting. In 2014 the province hired Dillon Consulting to complete a report on organic waste diversion in the province. The completed report provided a comprehensive analysis of the state of organics management in NFLD and a series of projections using waste forecasts, geographical constraints and available technologies (GFNLD, 2014). Using the projections, the report presented seven scenarios for the management of organic waste. The proposed solutions had an average cost of $138 million net present value. However, the Dillon report lacked a phased implementation or priority action plan, and many waste management officials consider this to be a hindrance to progressing organics

diversion. The large price tag without a phased approach made it too costly for the government to undertake (GFNLD, 2014).

NFLD has divided the province into eight operational waste management regions on the island portion and an additional four in Labrador (figure 3). Two regions are host sites and have fully functional lined landfills where other transfer regions transport their waste. There is a total of 14 organic waste processing facilities in NFLD, 13 composting facilities and one anaerobic digestor. About 50% of the population lives in areas with some form of composting programs for yard and leaf waste. However, there are only a few regions in the province that offer programs for composting kitchen waste. Approximately 9% of the population has access to these programs, and most of the programs rely on household drop-off rather than offering curbside pickup (EREF, 2021). Similar to NB, the province and many of the regions offer guidance on how to begin composting organic waste in a backyard composter. The multi-materials stewardship board (MMSB) commenced a program in 2005 in which it partners with municipalities to offer compost bins to residents at a reduced cost. Since 2005, the MMSB has partnered with over 170 municipalities and distributed over 30,000 compost bins. Both home composting and curbside collection pilot programs offered by the MMSB have had considerable buy-in, but often the municipalities do not have the resources to maintain them past the pilot stage (GNFLD, 2014).

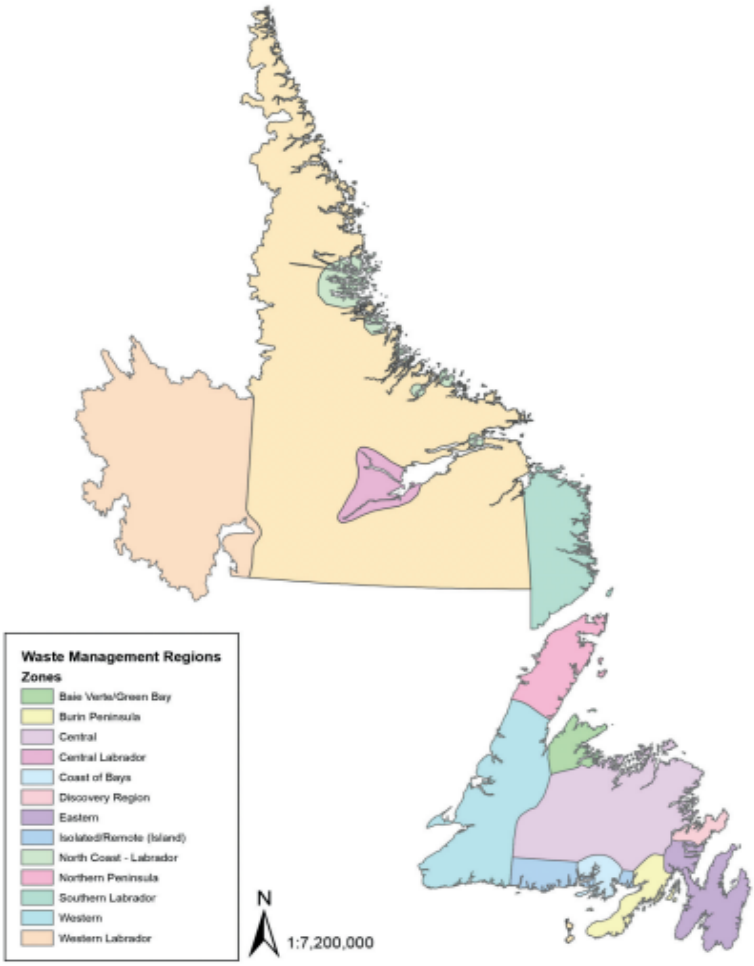


Figure 3. Map of NFLD showing the 12 operational waste management regions (GNFLD, 2019).

Nova Scotia

NS was the first province in Canada to implement a solid waste management strategy in 1995 and was the only province to reach the Canada-wide goal of a 50% diversion rate by 2000 (Giroux, 2014). NS is a leader in waste management and the province has been recognized across Canada and the world for its success in waste reduction, recycling and composting. The 1995 solid waste management strategy led to much success in reducing waste being sent to landfill as well as enhancing economic activity in the province. By 2007-2008 the average Nova

Scotian was only sending 430 kilograms of waste to landfills annually. At the time, this was about 50% less than the average Canadian (GNS, 2009). The strategy was renewed with more aggressive goals starting in 2007. Rather than lessening the pressure on their already successful waste reduction efforts the strategy renewal set to reduce the average 430 kilograms per person to below 300 kilograms per person by 2015 (GNS, 2009). As of 2018, they had not yet achieved that target and the total weight of waste being disposed of was 409 kg per person (Statistics Canada, 2022b).

In 1994, the municipality of Lunenberg on the South Shore of NS was the first municipality in North America to include compostable organic material in its curbside collection program (GNS, 2009). The province started to introduce landfill bans in 1997 on most recyclable, reusable or hazardous materials including organic waste. The bans were gradually phased in over three years. The widespread introduction of organic waste diversion programs in municipalities across the province in 1999 was a key factor in the achievement of the 50% diversion goal by 2000. In just one year the amount of organic waste being diverted increased from approximately 15 metric tons to 45 metric tons (GNS, 2009). Overall, the waste diversion rate of about 50% has remained consistent over the following decades but the amount of waste being generated has continued to increase. The province has completed a few waste audits with the most recent audit completed in 2017, and one finding within these audits is that although there is a lot of organic waste being diverted and the province has widespread access to curbside organics collection, organics are still one of the largest components of waste ending up in NS landfills (Divert NS, 2018).

Divert NS has developed various programs and funding initiatives that are available for municipalities to increase the efficiency of municipal solid waste resource management. Funding

can be used for research, technological innovation or for implementing programs like recycling of textiles, collection of scrap metal and green cart collection of pet waste. Each municipality is required to report their progress on waste reduction goals. The province provides funding through Divert NS (formally Resource Recovery Fund Board), based on the volume diverted from landfill. These diversion credits allow municipalities that are diverting more waste to receive more funding (Giroux, 2014).

Nova Scotia has seven solid waste management regions, shown in Figure 4. The composting programs vary slightly within those regions, however, the overarching landfill band on organics ensures there are diversion options in each region. The seven regions are serviced by 24 composting facilities, and their services cover 97% of residents across the province (EREF, 2021). One concern in NS is that the compost facilities are reaching their capacity and many need to be upgraded or repaired (Gorrie, 2015). There have been some efforts made to reduce the amount of organic waste heading to facilities. However, inevitably, in the coming years the province will likely need to maintain, upgrade, or possibly expand the capacity of organics processing. Other resources offered by the province and regional authorities include providing educational guidance documents to encourage backyard composting. Additionally, in 2016 they introduced a Food Bank Tax Credit for farmers to incentivize donating food that may have otherwise gone to waste (EREF, 2021).

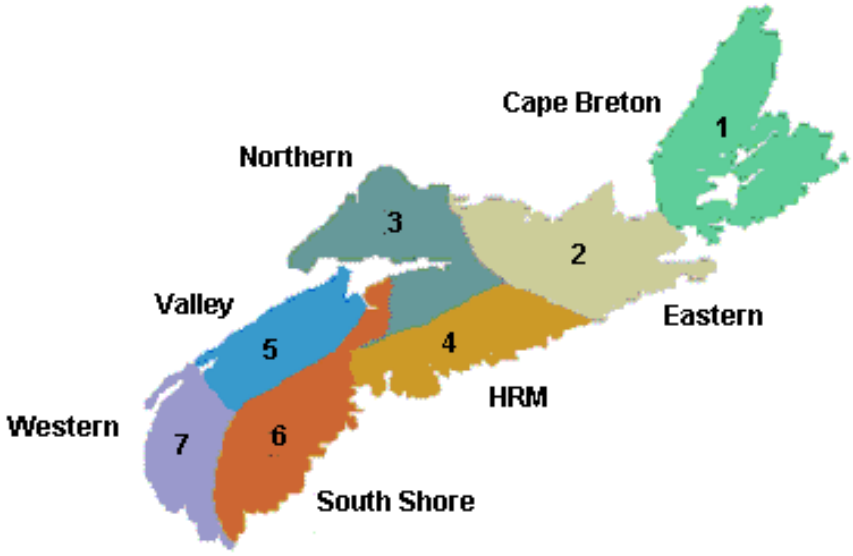


Figure 4. Map of NS showing the division of the 7 solid waste management regions (GNS, 2023).

Since the evident success of Nova Scotia's waste reduction and diversion efforts in the early 2000s there have been many case studies and explorations on why they were so successful. One thing the province has attributed to being able to achieve higher diversion rates is by requiring garbage to be disposed of in clear garbage bags. A study on eight municipalities requiring clear bags saw a 40% drop in the garbage disposal and an increase in recycling, organics and beverage container returns (GNS, 2009b). A study by Richter et al. compared the Nova Scotia and Canadian waste management models. The study looked at waste diversion practices from 1996 to 2010, and during this time waste diversion in Nova Scotia increased by 35% while the national average was only a 1.5% increase. The greater diversion rate was attributed to better non-residential diversion programs. However, the NS government spent about 20% less than the national average on waste collection and transportation which was attributed to the higher population density in Nova Scotia (Richter et al., 2017). Another study mentions that a crucial element of the success was the ability of the province to connect the environment to the

economy. Government and businesses were able to see organic waste as a resource. Additionally, even though the implementation and maintenance of their organic's diversion program has had its challenges, it is still regarded positively by the public. Nova Scotians have a sense of accomplishment in that they have achieved something unique (Wagner, 2007).

Prince Edward Island

The Government of Prince Edward Island recognized in the 1980s that the province's poorly developed community landfills would not be equipped to deal with increasing amounts of solid waste. This led to the creation of the Waste Watch program. The program was initiated in one of the three Island counties in 1984 and was gradually expanded to cover the entire island by the late 1990s. The Island Waste Management Corporation (IWMC) was established to manage the program and the collection and disposal of all solid waste. Waste Watch requires all businesses and residents to sort their waste into four streams recyclable paper, recyclable other, compostable and garbage (GPEI, 2023).

PEI is unique in the Atlantic Canadian provinces in that it has not published an overarching strategy or action plan specific to waste. However, the province has implemented a regulation banning the disposal of organic waste in landfill through the Environmental Protection Act in 2002 (GPEI, 2022). There are some mentions of waste in other provincial climate and environmental strategies. For example, in the provincial energy strategy published in 2016, it was mentioned that they were investigating the possibility of using all organic waste to create biogas rather than composting the material. Early estimates suggested that the biogas produced would be enough to fuel the entire waste collection fleet for the island (GPEI, 2016). The only real target set for waste diversion in the province was in the 2018-2023 Climate Action Plan

which states that an ongoing government initiative is “diverting more waste per person from landfill than any other province” (GPEI, 2018). As of 2018, the province was diverting more waste per capita from residential sources than all other provinces at 188 kg per person. They were third for waste diverted from non-residential sources falling behind Quebec and British Colombia (Statistics Canada, 2022a).

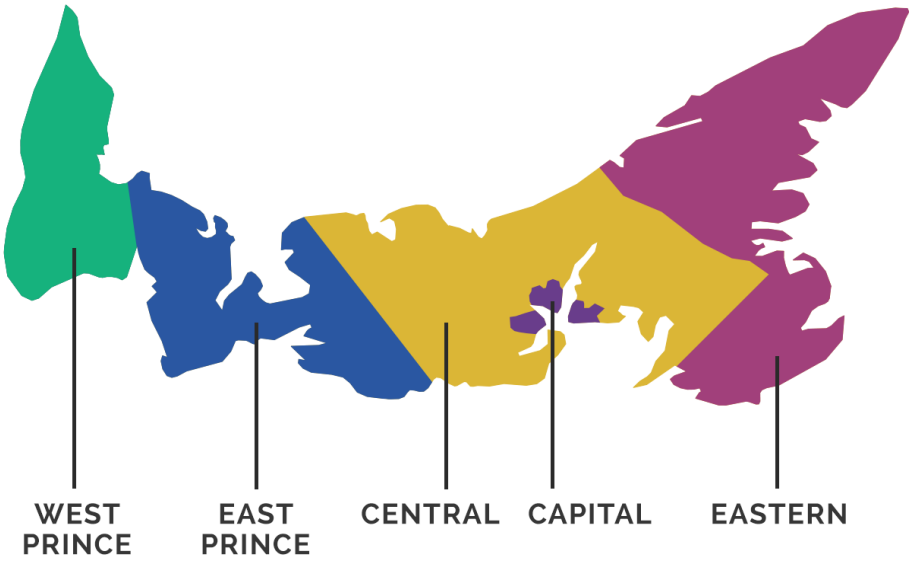


Figure 5. Map of PEI showing the IWMC collection regions (IWMC, 2023).

IWMC oversees and sub-contracts garbage collection through the five regions, seen in Figure 5. The only differentiating factor between the regions is their curbside collection schedule. Organic waste is collected bi-weekly and brought to the Central Composting Facility. This facility uses containerized composting technology which was selected in part due to environmental requirements for odour control and groundwater protection. The facility is one of the largest of its kind and can process 30,000 tonnes of waste (IWMC, 2018). PEI did not have any provincial guidance or promotional resources for backyard composting. The only educational resources available are those regarding correct sorting practices for collection.

Summary of Provincial Waste Management

In order to gain a better understanding of how each province manages organic waste the following section presents a comparison of various components of the waste management practices for each of the Atlantic provinces. Table 1 looks at the numeric per capita data for waste disposal and diversion across the four provinces. The data on waste diversion and disposal data demonstrates the extent of the differences in waste management between the provinces. Per capita NS and PEI dispose of the least and divert the most waste by weight with a 45% and 54% diversion rates respectively. Meanwhile, NB has a 24% diversion rate and NFLD only a 10% diversion rate. Looking at the per capita diversion of organic waste, NB diverts 105 kg per person which is not much lower than NS and PEI at 139 and 129 kg per person respectively. However, as previously mentioned a large portion of this is attributed to IC&I organics diversion. When looking at the residential per capita diversion of organic waste, NB performs much lower than PEI and NS. NFLD did not report how much organic waste was diverted by residential sources, but total organics diversion was only 2 kg per person.

Table 1. Summary of per capita waste disposal, diversion, total diversion rate and organics diversion rate for Atlantic Canadian Provinces. (Statistics Canada, 2018, 2022a & 2022b).

	NB	**NFLD**	**NS**	**PEI**
Per Capita Waste Disposal (kg per person)	659	711	409	351
Per Capita Waste Diversion (kg per person)	212	79	330	370
Total Diversion Rate	24%	10%	45%	54%
Per Capita Organics Diversion (kg per person)	105	2	139	129
Per Capita Residential	33	N/A	87	104

Organics Diversion (kg per person)				

The following two summary tables examine the general approaches to waste management in Atlantic Canada. This high-level overview of jurisdictional differences in waste management aims to account for the variations in diversion rates. These tables compare jurisdictional approaches to policy frameworks, waste prevention and reduction, and waste diversion programs. Table 2 looks at overall approaches to waste management for all waste streams, while Table 3 specifically focuses on approaches to organic waste management. PEI and NS are interesting to compare for their waste management approaches. Although their diversion rates indicate similar outcomes, their approaches have been different. The one key similarity between the two provinces is that both have legislated landfill bans for organic waste. PEI, possibly due to its small size and higher population density, introduced one overarching entity to oversee all waste diversion, this, along with the landfill ban on organics, they have achieved high rates of diversion. NS, on the other hand, has implemented most interventions at its disposal, having developed strategies, reviewed, and renewed them, set numeric targets for waste diversion and disposal, and published educational guidance for diversion in addition to implementing the organics landfill ban. Looking solely at the factors outlined in Tables 2 and 3, NB and NFLD have some similarities in their approaches to waste management and organic waste diversion. Both provinces developed an overarching strategy/action plan in the early 2000s; however, they have struggled to achieve the goals or targets set out in these strategies. Overall, NB took a more voluntary approach to organics management, with each region developing its own approach to organics diversion, with most relying on backyard composting as the only option. There remain many opportunities to further organic waste diversion in the province. NFLD set out to achieve a

50% waste diversion rate by 2020 but has yet to reach that target. The province has shown interest and intent to implement organics diversion across the province, going as far as hiring a consultant to develop a comprehensive options analysis. However, there has yet to be much progress, especially in advancing curbside collection, which is only accessible to 9% of the population.

To identify the key factors that may be attributed to the success of NS and PEI in diverting organic waste, the approaches the two provinces have in common include the landfill ban, data tracking and widespread collection of organics. It is challenging to attribute the provincial success to any one of these factors individually and it is likely some combination of them all. While NB and NFLD have also developed strategies and set targets, they have faced challenges in achieving their goals, such as limited curbside collection services and a lack of infrastructure. Despite these challenges, there is still significant potential for organic waste diversion in these provinces.

Table 2. Summary of general waste management systems across Atlantic Canada.

	NB	**NFLD**	**NS**	**PEI**
Over Arching Policy or Strategy for waste	Action Plan 2001	Strategy 2002	Strategy 1995 (Renewed 2009)	None
Policy includes a vision for upstream reduction or prevention?	No	No	Yes	N/A
Numeric target for waste diversion	No	50% by 2020	50% by 2015	No
Numeric target for waste disposal	No	No	300 kg/person by 2015	No
Does the province implement performance measurement to monitor waste diversion	Yes- legislated for EPR programs only (Does not include organics)	Yes- legislated for EPR programs only (Does not include organics)	Yes- Legislated for all materials	Yes- Not Legislated

Table 3. Summary of organic waste management systems across Atlantic Canada.

	NB	NFLD	NS	PEI
Guidance or policy on organics diversion	Voluntary provincial policy driver	None (Intent to develop landfill ban by 2025)	Legislated (Landfill ban) at provincial level	Legislated (Landfill ban) at provincial level
Data Tracking	No	No	Yes	Yes
Public Reporting of Data	No	No	No, some provincial waste audits	No
Curbside pickup of source-separated kitchen waste	Partial, 47% of population	Partial, 9% of population	Yes	Yes
Educational programs or documentation on backyard composting	Yes, provincially and each region	Yes, provincially and some regions	Yes, provincially and some regions	No

Household Composting Behaviour

Responses to the Households and the Environment Survey were analyzed to gain a better understanding of composting practices and behaviours at the household level in Atlantic Canada. Additionally, to observe if demographic factors such as living in a CMA, household type, and income showed any significant impact on composting practices. All data for the following figures can be found in Appendix B. Figures 6 through 9 show the composting practices of households from the six HESs from 2009 to 2019 (Statistics Canada, 2021). Figure 10 through 12 look at the responses to the demographic factors from the 2015 HES.

Figure 6 looks at the percentage of households that composted either kitchen or yard waste over the ten-year period of 2009 to 2019. Nationally the percentage of households composting increased over the period and averaged 67%. PEI and NS were above the national average while NB and NFLD fall below. The percent of households in NS and PEI remained

relatively constant averaging 94% and 96% respectively. Household responses in NB showed some variation over the ten years but averaged just 63% over the entire period. Using a linear trendline NFLD showed a slight increasing percentage of households who composted by about 0.8% each year and averaged 50% of households over the ten-year period. Overall, there were no significant changes to the number of households in Atlantic Canada composting kitchen and yard waste.

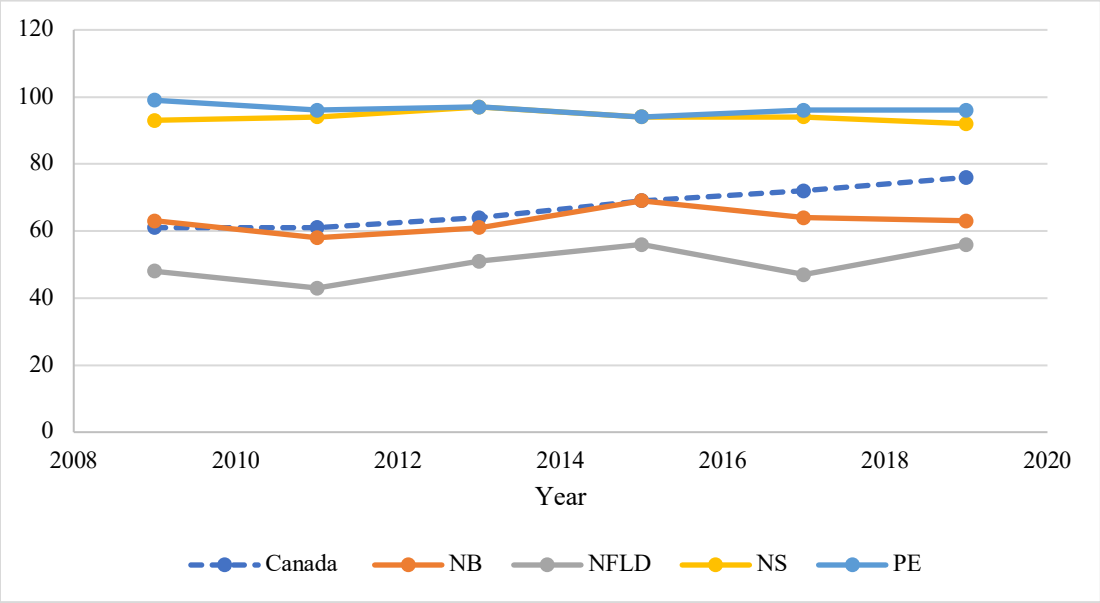


Figure 6. Percentage of Households that composted kitchen and/or yard waste from 2009 to 2019.

Figure 7 shows what percentage of households separated and composted kitchen waste. The trends from 2009 to 2019 were generally the same as those in Figure 6. NS and PEI both had a slight decrease in participation compared to the previous figure which also included yard waste but still averaged 92% and 95% respectively over the period. Comparing Figure 6 and 7 for NB and NFLD there is a significant drop in composting participation when looking at just kitchen waste. NB averaged 63% of households for yard and kitchen waste but averaged only 46% of households for kitchen waste. Likewise, NFLD averaged 50% of households for both streams of organic waste but dropped to only 29% when looking at just kitchen waste. However, over the

period each province has showed an increasing trend in composting of kitchen waste. NB showed an increase at a rate of about 1% per year and likewise NFLD showed an increase at about 0.7% per year.

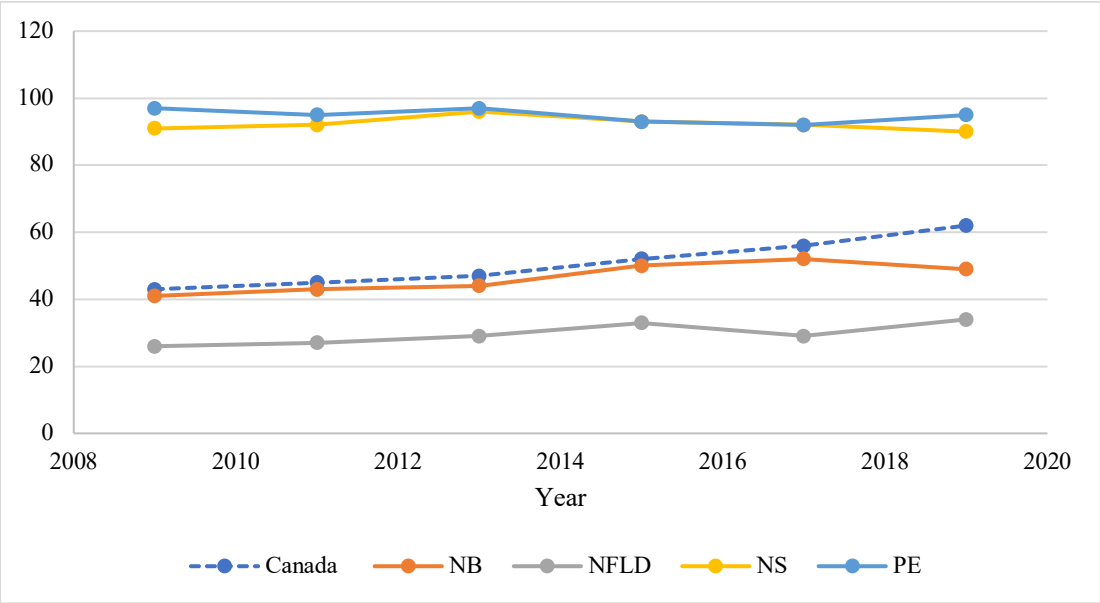
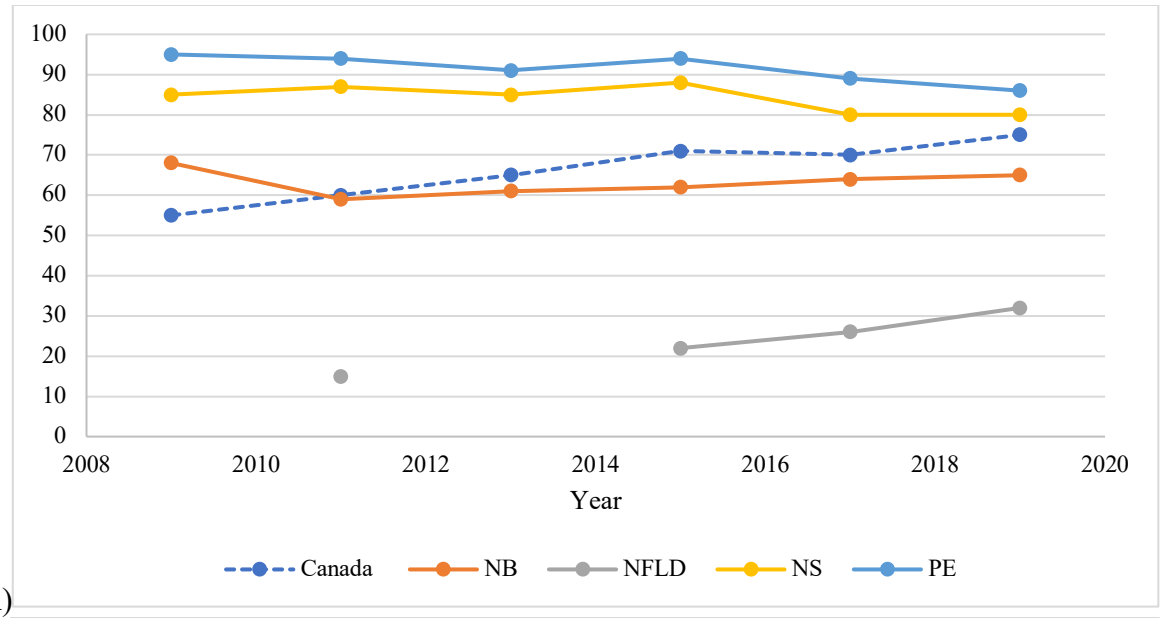
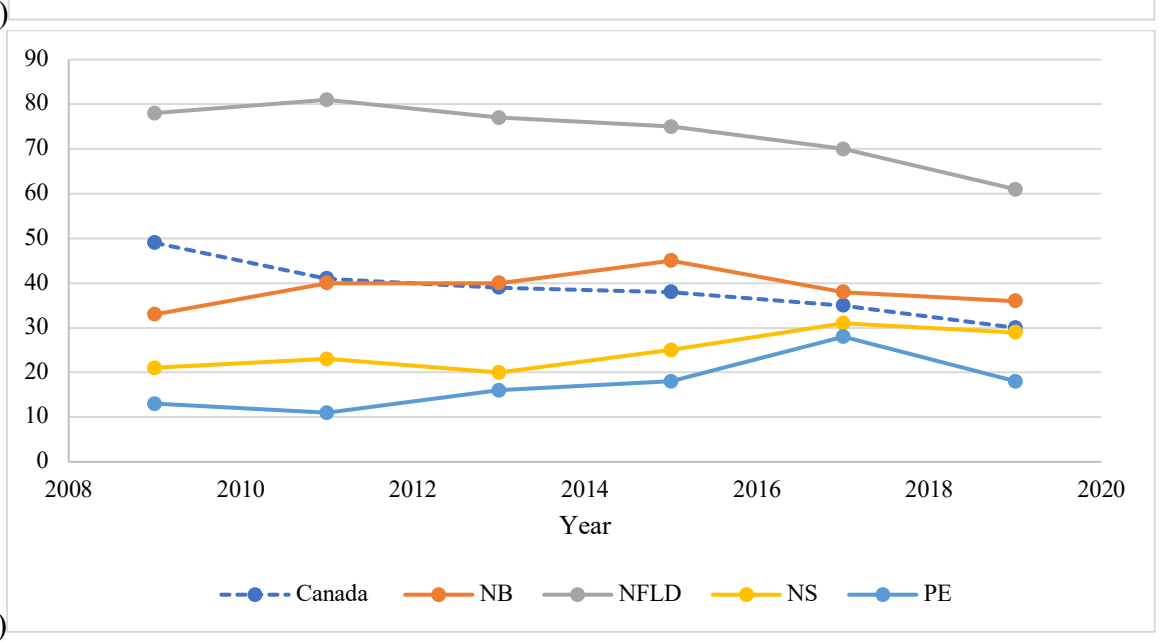


Figure 7. Percentage of households that composted kitchen waste from 2009 to 2019.

To determine how the households were composting kitchen waste the HES categorizes the composting of kitchen waste into four methods: through a municipal or private collection program, taken directly to a waste depot, put into a compost bin, pile or garden and lastly composted by some other method. Figure 8a shows the percent of households from those that composted kitchen waste in each province who had the waste collected by a municipal or private program from 2009 to 2019. Figure 8b shows the percent of households from those that composted kitchen waste in each province who had put their kitchen waste in a compost bin, pile or garden from 2009 to 2019. The number of households taking waste directly to a depot or composting by some alternative methods were negligible in the Atlantic provinces, so these methods are not included.



A)



B)

Figure 8. Percentage of households of those who composted kitchen waste that: **A)** had it collected by the city or private company. **B)** put it in a compost bin, pile or garden.

NFLD had a significantly lower average than the national average for households utilising a municipal or private collection. However, it also has the highest percentage of households using backyard composting as their method of composting kitchen waste. From 2015 to 2019 the percentage of households using municipal or private collection in NFLD increased at a rate of 2.5% per year while over the same period backyard composting decreased at a rate of

3.5% per year. Both PEI and NS showed a slight decrease in the percentage of households using municipal or private collection, 0.8% and 0.6% per year respectively, but both had an annual average increase of 1% in households utilizing backyard composting. NB did not show significant change in either method over the ten-year period and averaged 63% of households utilizing collection and 39% backyard composting.

Figure 9 shows the linear trendlines for the percentage of households that responded that they had access to a municipal composting or organics program but did not use it in each province over the 10-year period. All provinces showed a generally increasing percentage of households that responded they did not use the program they had access to over time. It is possible that the non-participation is simply increasing proportionately to the number of households with access to composting programs. Other possible reasons for non-participation in composting programs are discussed later in this paper.

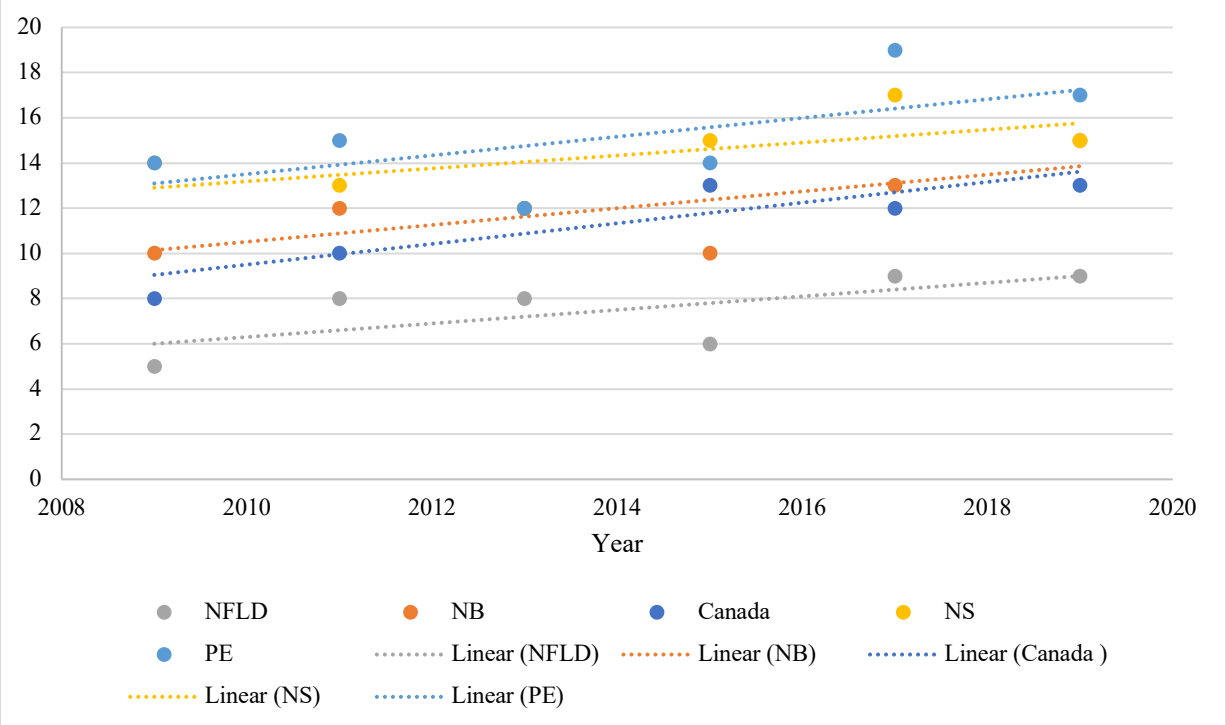


Figure 9. Percentage of households in each province that had access to a municipal composting or organics program but did not use it from 2009 to 2019.

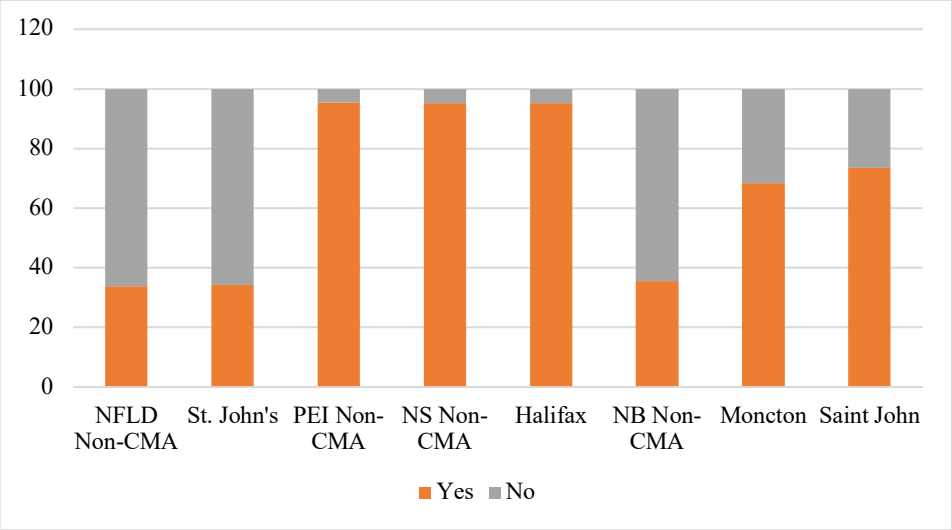


Figure 10. The percentage of households who did and did not compost kitchen waste divided provincially by central metropolitan areas and non-CMAs (HES 2015).

The next variable that was considered was whether households in CMAs were more or less likely to compost their kitchen waste than those in non-CMAs. Figure 10 shows the households that did and did not compost kitchen waste divided provincially by central metropolitan areas and non-CMAs. PEI is the only Atlantic province that doesn't have a CMA by definition of a population of more than 100,000 but was still included for comparison to the other provinces. NFLD and NS showed no difference between the CMA and non-CMAs. However, NS had a much higher percentage with of 95% of households composting kitchen waste in both Halifax and non-CMAs compared to NFLD which had just 34% in each area. PEI had a similarly high response to NS with of 96% of households composting, but again, this encompasses all households within the survey. NB showed the most change with only 36% of households composting kitchen waste in non-CMAs compared to 68% and 74% in Moncton and Saint John respectively. This large jump may be attributed to the accessibility to curbside composting programs in those cities compared to the other areas of the province.

Figure 11 looks at how the type of dwelling impacts the percentage of households that are composting kitchen waste in each province. All the provinces showed a decrease in composting for dwelling type two which is apartments. Comparing the differences between apartment households and all other dwellings NB had the biggest difference with just 21% of apartment dwellers composting kitchen waste, 31% less than other dwellers. Subsequently, NFLD had a 27% difference with only 8% of apartment dwellers composting. NS had a 17% difference but had 80% of apartment dwellers composting. Lastly, PEI only had a 5% difference between type 1 dwellings and apartments with 96% and 91% respectively composting kitchen waste.

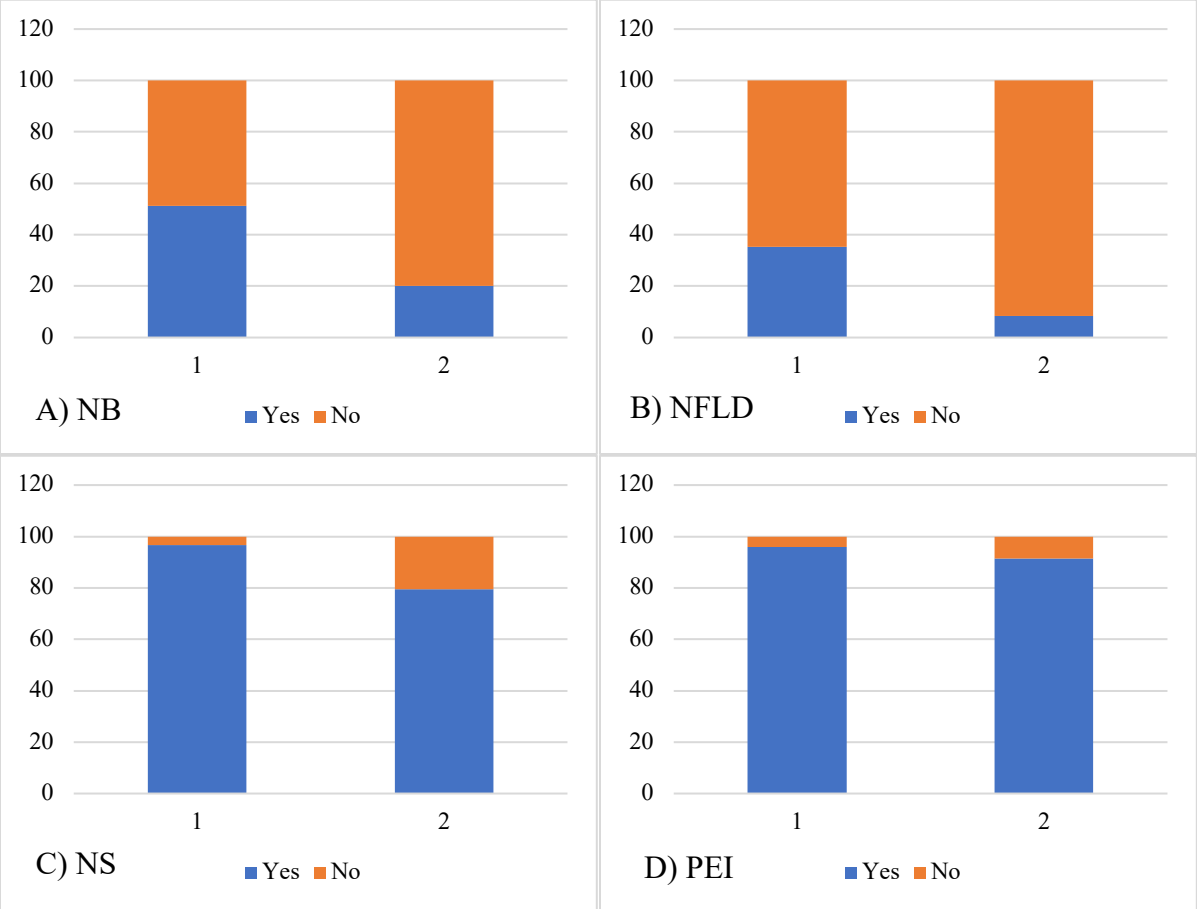


Figure 11. Percentage of households who did and did not compost kitchen waste divided into dwelling type. Dwelling type one is all dwelling other than apartments. Dwelling type two is low- or high-rise apartments (HES, 2015).

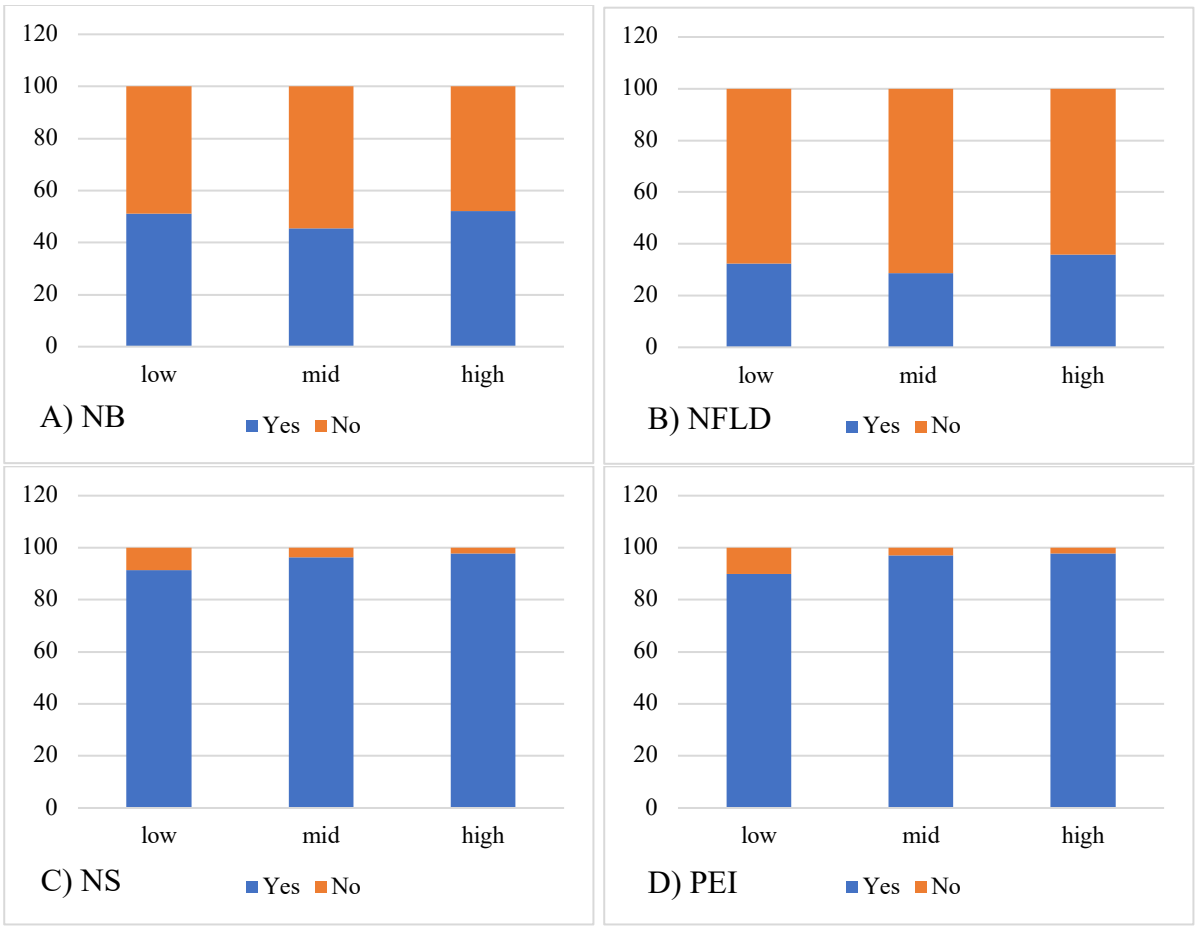


Figure 12. Percentage of households who did and did not compost kitchen waste divided by annual household income. Low household income is less than $40,000, mid household income is between $40,000 and $80,000 and high household is income is more than $80,000. (HES 2015)

The final variable that was considered for this study of the HES was household income and composting of kitchen waste, as shown in Figure 12. NFLD and NB both had a slight decrease in composting at the mid-income households while having similar percentages for low- and high-income households. NS and PEI showed a slight increase in households composting kitchen waste with each increase in income level. Overall, there was no significant change in composting behaviour between income levels for each respective province.

Discussion

One of the limiting factors for furthering organic waste diversion is data. There is limited data available for how much waste is being diverted for each of the provinces but equally concerning there is limited data available for how much is going to landfills. You cannot manage what you do not measure. Even though we can see how many households have access to diversion programs, and the amount of waste being diverted it is only through waste audits and data reporting on the landfilled waste that we can get a true idea of the diversion rate. Nova Scotia is considered the best province for diverting organic waste however through waste audits they have performed they found that organics were still the largest component by weight entering landfills (DivertNS, 2018). Although more than 90% of households claim to participate in composting there is no guarantee that they are using programs perfectly and could still be sending some of their waste to landfill. Furthermore, there is a need for transparency on methods and sources of data used in organic waste diversion reports and studies. A 2021 study on the state of organic waste management in Canada by the Environmental Research and Education Foundation explored the differences in data available on organic waste being diverted. The amount of organic waste being diverted found in their study, compared to that reported by the Compost Council of Canada and Statistics Canada varied on the scale of thousands to hundreds of thousands of tonnes (EREF, 2021). Without transparent data collection and methodologies, it is challenging to know where these variations have arisen. The province of Ontario releases annual reports on the amount of residential waste being disposed of and diverted through the Resource Productivity and Recovery Authority. These reports have allowed for more in-depth studies to be done on the impact of various interventions such as curbside collection, pay-as-you-throw, etc. If other provinces followed suit with similar data being recorded and published it

would be possible to do more comprehensive studies on the factors influencing organic waste diversion (Treadwell et al., 2018).

NS and PEI have historically had the most participation in composting through collection programs. Comparing their waste management systems one reason for the increased participation could be attributed to both provinces having a mandatory diversion of organic waste through legislated landfill bans. Landfill bans for organic waste are currently a topic of discussion in many provinces across Canada. In Atlantic Canada, NFLD has also noted their intention to implement a similar landfill ban and in NB the Green Party has called for a provincial landfill ban however, the provincial government has never expressed this intention. Although landfill bans have been successful tools for waste diversion, they are typically introduced alongside other interventions. Things like EPR regulations, procurement policies, waste reduction goals, and educational programs on composting can help yield the most benefits from a landfill ban (CCME, 2021). Additionally, there need to be effective methods for residents and businesses to recycle their waste and safeguards in place to minimize illegal dumping of the banned waste once a landfill ban is in place. The last consideration for the implementation of landfill bans is ensuring that there is a market for the end-product. For these reasons a landfill ban introduced in isolation from other policies or programs will likely not be as successful as one developed with complementary programs.

One of the ways that PEI and NS have diverted organic waste from landfill is through having a curbside collection of all streams of waste. This includes both provinces offering a curbside collection of kitchen waste across the entirety of each province. NB has had some regions implement curbside pickup, but these have been centred around more populated areas in Moncton, and Saint John. This access to curbside pickup could be one reason why Moncton and

Saint John had a much higher percentage of households that composted kitchen waste compared to non-CMA areas of the province (Figure 10). One reason moving forward with organic waste collection in NB and NFLD may be more challenging compared to PEI and NS is their much lower population density. Collection, infrastructure, and transportation costs for rural areas can be much higher than in more densely populated areas. This may limit the potential of taking the same province-wide approach that PEI did. However, they may look to NS where the approach to waste collection and management is regional and relies on collaboration between the province, regional authorities, and municipalities. The Dillon Consulting report on organic waste completed for NFLD modelled their results based on the current and desired curbside waste collection. This report noted that the cost for residential curbside collection remained relatively consistent regardless of whether an organics management system is established (GNFLD, 2014). NB and NFLD should continue to explore the potential of expanding existing curbside programs or creating a curbside collection for organic waste as an opportunity for more diversion. Multiple studies on the factors influencing household waste diversion indicate inconvenience as a disincentive and convenience and accessibility as motivators (Pickering, 2020, Treadwell et al., 2018). Regular curbside collection, in a municipality-provided bin, is in most cases perceived to be the most convenient option for composting.

End-user knowledge and understanding of composting are essential parts of successful waste management programs. A lot of places that have implemented compost or other recycling programs note the challenge of getting residents to sort waste properly and thus there is a need to educate residents. In Atlantic Canada, management for the recycling program in Southeastern NB was considering ending the program unless residents got better at separating their waste (CBC, 2013). Education is not only important for teaching people how to sort their waste but

also for why separating and diverting waste is important. A study conducted in the Niagara region of Ontario found that residents separated organic waste primarily because of the perceived environmental benefits (Pickering, 2020). Whether it is a new program just implemented or an old program, education surrounding sorting waste is an ongoing need. Education also carries over to backyard composting and teaching residents how they could implement composting on their own. Three of the Atlantic provinces offered some form of information or guidance on backyard composting through provincial sources. Additionally, some regions and municipalities within those provinces added to this guidance and had additional programs such as offering reduced-cost composters.

One of the ultimate goals for organics diversion is that you can retain maximum value for the waste product and this stream of waste could be viewed as an economic resource. It will be important for both governments and industries to recognize the potential value of organic waste as a resource. Compost is not only a valuable nutrient source for soil health and plant growth, but organic waste diversion industries create jobs and economic growth. The CCME developed guidelines for composting products. This included a grading system to ensure the safety of compost for public health and the environment but also to ensure the best use for compost based on quality. All Atlantic provinces use these guidelines to grade and market compost. Most of the compost produced in Atlantic provinces is sold to be used primarily for agriculture and landscaping (EREF, 2021). However, concerns over the quality of the compost are common due to poor sorting and contaminates of plastic and glass. NS has had challenges with municipalities having excess amounts of composting piling up. Farmers are not always interested in compost even at no cost because of the poor quality and amount of contaminants (CBC, 2016). PEI has also had challenges with industry confidence in the compost produced at its composting plant

(CBC, 2011). Again, this relates to issues of sorting. Unfortunately, with the increasing use of biodegradable plastic products, issues with sorting and contaminates will continue.

Various motivators drive individuals to participate in organic waste diversion programs. One of the most important motivators is an individual's knowledge and intent to reduce the environmental impact that organic waste has when going to landfill. Many individuals have a positive attitude towards participating in organic waste diversion due to their perception of the environmental benefits and its role in mitigating climate change and creating a more sustainable future. For others, participation comes down to convenience and available infrastructure (bins, regular collection, etc.) this ease of access makes it just as easy and accessible as the alternative. Another component of participation is the existing social norms or pressure, if it is normal for other members of the household or the community to separate their organic waste others might feel the need to also participate. This could explain why Nova Scotia found that clear bags motivated people to separate waste as there was social pressure on collectors and others to see how well waste was sorted. On the contrary, some of the reasons that disincentivize participation are smell, lack of time, forgetfulness, inconvenience, not understanding why the change is necessary and limited knowledge of climate change and other environmental issues. To progress organic waste diversion in Atlantic Canada it would be valuable for any of the provinces to study what is motivating the households that do compost their kitchen waste to participate. Is it simply just having a curbside program and that just comes down to convenience? Or is it more dependent on the knowledge of the benefits of diverting waste, or some combination of both? Conversely, looking at the data from the HES there is a consistently increasing number of households that have access to programs but choose not to use them. It will be important to understand why they are not participating. Some households may not participate as they are

utilizing backyard composting. However, others could have various other reasons such as smell or inconvenience of separating food waste.

The intent of looking at data from the HES was to explore the possible demographic and socio-economic factors and behaviours of composting at a household level. One area that data on organic waste diversion from sources such as Statistics Canada lacks is backyard composting. This falls outside of the scope of the diversion reports and even at the provincial levels isn't observed through waste audits or reports as this waste is never processed through the waste management system. The HES was able to provide perspective on how many households in Atlantic Canada were utilizing backyard composting. Observing how many households were backyard composting in NB and NFLD where there is not a widespread collection of organic waste was particularly interesting. It was important to understand if the curbside collection should be recommended for these provinces or if the diversion rates were artificially low due to the lack of reporting on backyard composting. Ultimately, it does not appear that backyard compost can compete with the efficiency of curbside collection for influencing diversion rate. Households are likely selective with what waste they compost in backyard bins due to smell, space restrictions or lengthy degradation time. Backyard composting was trending down in both NB and NFLD throughout this study but interestingly increasing in PEI and NS. Therefore, backyard composting could be an asset to use in combination with curbside composting to lessen the quantity heading to facilities, especially in places like NS where composting facilities are reaching max capacities.

The composting in CMA versus non-CMAs of the Atlantic provinces was used to gain a general observation of the potential difference between rural and urban areas. The household food waste perceptions and behaviours of rural households have not been studied in the same

way urban areas have. There are unique challenges for infrastructure and transportation issues for waste management in rural areas. Additionally, many residents in rural areas are more likely to own land or livestock and may already divert some waste on their property. A study conducted in the state of Vermont, a largely rural state, indicated that a majority of residents would be interested in some type of curbside program but were unwilling to pay additionally for the program (Niles, 2020). There need to be more comprehensive studies on the cost and feasibility of organic waste collection programs for rural areas of NB and NFLD.

It has long been understood that apartments and multi-resident dwellings have lower diversion rates than single-family homes. This was observed in the HES for all provinces in Atlantic Canada. Apartment dwellers usually have limited space and lack control over the necessary infrastructure for organic waste management, such as compost bins and separate collection systems. Making it difficult for residents to sort and dispose of organic waste properly. Additionally, apartments are often occupied by renters who may not feel motivated to invest in long-term environmental initiatives or feel the sense of responsibility to separate waste properly. In Atlantic Canada, it is not uncommon for multi-resident buildings to fall outside municipal waste collection systems and rely on private waste collection. This often means all streams of waste are collected together and there is no separation for waste to be diverted. In contrast, homeowners typically have more space, greater autonomy, and a greater sense of ownership over their property, which makes it easier for them to establish and maintain organic waste diversion systems. Overall, while apartment residents may want to divert organic waste, the lack of infrastructure and space makes it more challenging to achieve the same level of success as single-family homes.

The last demographic factor that was observed in this study was income level. There were no significant changes in composting behaviour and income in Atlantic Canada in this study, however, other studies have noted that the greater the income, the greater the likelihood that the household composted (Statistics Canada, 2013). There are a few considerations to account for why higher-income households may be more likely to compost. Firstly, higher income households are more likely to own rather than rent, therefore, having more space and resources to compost. Lower-income households may lack the time and effort required to compost due to other essential daily activities. Overall, the combination of economic, logistical, and informational barriers may limit the likelihood of low-income households participating in composting activities.

The following are some of the areas that need to be addressed to progress organic waste diversion in Atlantic Canada. Firstly, there is still room to determine what the feasibility and cost would be for developing infrastructure in rural areas of NB and NFLD. Secondly, understanding the motivation for composting behaviours and practices at the household level. Lastly, to identify areas where organic waste is still going to landfill whether it be from apartments, households incorrectly sorting, or households choosing to withhold from using a program and determine how these "leaks" can be addressed. Beyond increasing waste diversion in Atlantic Canada there are some broader questions regarding organic waste management that are not yet fully understood. For example, the relationship between food waste and accessible compost programming. Separating food waste could make identifying areas to target food waste reduction easier. However, on the contrary, does having easily accessible, convenient waste diversion make residents more likely to throw-away food as they perceive it to be environmentally friendly? There also remain to be a lot of questions regarding bioplastics and the management and

consumer understanding of these products. Until they are regulated better in Canada it could prove to be a challenge for compost facilities to sort out these products and other contaminates to produce high quality compost.

Summary of Opportunities

1. **More Comprehensive Data on Waste Diversion and Disposal:**
   More comprehensive and available data on waste diversion and disposal will allow a better understanding of the factors that influence composting behavior. Consistent and regular measurement could allow research on the effectiveness of different organic diversion programs. By having access to better data on waste diversion, municipalities can identify areas where improvement is needed and tailor their programs accordingly.

2. **Learning from Other Jurisdictions:**
   Organic waste management is not a new practice, and areas across Canada and Europe have been diverting organic waste for many decades. This allows NB and NFLD to learn from the experiences of other jurisdictions and identify best practices that can be applied to their own programs. Lessons can be learned from NS and PEI and other areas who have had successful diversion of organic waste. However, an integrated view of all waste diversion activities within the local context is important for successful change in waste management. This is particularly relevant in the context of rural areas, where unique challenges may exist.

3. **Exploring Options Beyond Organics Waste Diversion:**
   All areas of Atlantic Canada can explore options beyond just organic waste diversion through recycling but also strategies to reduce food waste. Municipalities can educate households, restaurants, and grocery stores on the importance of reducing food waste and explore opportunities to divert food that is still edible.

4. **Pursuing Curbside Collection for Organic Waste:**
   NB and NFLD should continue to pursue options for expansion or creation of curbside collection for organic waste to increase waste diversion. Curbside collection makes it easier for households to participate in organic waste diversion programs and can increase participation and diversion rates.

5. **Introducing a Landfill Ban:**
   NB should consider introducing a legislated landfill ban and NFLD should continue to pursue this option. A landfill ban can serve as a strong incentive for municipalities and households to participate in organic waste diversion programs. This can reduce the amount of organic waste that ends up in landfills, which can reduce greenhouse gas emissions and extend the lifespan of existing landfill sites.

6. **Researching Educational Resources:**
   Further research is needed on educational resources and how to educate the importance of composting organic waste and how to sort properly. Effective educational resources can increase participation rates and reduce contamination rates in organic waste diversion programs.

7. **Addressing Funding and Resource Issues:**
   NFLD in particular has shown interest in introducing programs for organic waste management but faces issues of funding and resources to implement and maintain. A landfill ban can be an opportunity to hold the provincial government accountable for supporting efforts. Or by taking examples from NS where Divert NS has been able to fund innovation and expansion of organic waste diversion programs. By addressing funding and resource issues, municipalities can ensure that organic waste diversion programs are sustainable over the long term.

8. **Understanding Motivations and Disincentives:**
   It is important to study what is motivating or disincentivizing participation in organic waste diversion programs. By understanding the barriers to participation, municipalities can tailor their programs to address these issues and increase participation rates. This can result in more effective diversion of organic waste and more sustainable waste management practices.

Conclusions

In conclusion, diverting organic waste from landfills has countless environmental, economic, and social benefits. If done well, organic waste collection programs and backyard composting can help move us toward a more circular economy. In Atlantic Canada, there is a notable difference in diversion rates between provinces. NS and PEI have both implemented landfill bans on organic waste and have province-wide curbside collection. This has contributed to their success in yielding high diversion rates around 50% for organic waste in addition to over 90% of households indicating they compost kitchen waste in the HES. NB has had more moderate success and aligns closely with the national response for composting based on the HES. NFLD has limited organics diversion but has expressed and demonstrated intent to progress organic waste diversion as a priority.

Overall, successful waste diversion requires a multi-faceted approach, including a combination of policies, infrastructure, education and outreach initiatives, and a strong commitment from both the government and the public. Landfill bans can help hold provincial governments accountable for the success of diversion programs. In addition, curbside collection programs offer convenience for households and have been utilized effectively in many urban areas to divert waste. Diverting waste in rural areas is less studied and should be explored further to determine the best way to approach the lack of infrastructure and transportation of waste. Demographic factors, such as household type and urban versus rural residence, have also been found to impact composting behaviour. Addressing these factors can help to improve diversion rates and ensure that all members of the community can participate in waste diversion efforts.

To facilitate progress towards a more sustainable and circular economy, there is a need for better reporting of waste data and waste audits to understand the motivation and disincentives for participating in organic waste diversion. By integrating these opportunities and considerations into waste diversion efforts, Atlantic Canada can continue to make progress toward a more environmentally conscious future. With ongoing commitment and collaboration from all stakeholders, we can build a more resilient and sustainable region for generations to come.

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Appendix

Appendix A – List of Acronyms

AD - Anaerobic Digestion
CCME - Canadian Council of Ministers of the Environment
CMA - Census metropolitan area
GHG - Greenhouse Gas
HES - Households and the Environment Survey
IWMC - Island Waste Management Corporation
MMSB - Multi-materials stewardship board
NB - New Brunswick
NFLD - Newfoundland and Labrador
NS - Nova Scotia
OECD - Organisation for Economic Co-operation and Development
PEI - Prince Edward Island

Appendix B – HES Data

Number of Households that responded to the HES						
	2009	2011	2013	2015	2017	2019
NB	568	782	893	525	588	692
NFLD	476	612	610	389	425	404
NS	584	738	856	850	805	785
PEI	294	257	309	264	295	263

Composted Either Kitchen or Yard Waste (Percentage of households)							
	2009	2011	2013	2015	2017	2019	Average
Canada	61	61	64	69	72	76	67
NB	63	58	61	69	64	63	63
NFLD	48	43	51	56	47	56	50
NS	93	94	97	94	94	92	94
PEI	99	96	97	94	96	96	96

Composted Kitchen Waste (Percentage of Households)							
	2009	2011	2013	2015	2017	2019	Average
Canada	43	45	47	52	56	62	51
NB	41	43	44	50	52	49	47
NFLD	26	27	29	33	29	34	30
NS	91	92	96	93	92	90	92
PEI	97	95	97	93	92	95	95

Kitchen waste collected by city or private company (Percentage of Households)							
	2009	2011	2013	2015	2017	2019	Average
Canada	55	60	65	71	70	75	66
NB	68	59	61	62	64	65	63
NFLD		15		22	26	32	24
NS	85	87	85	88	80	80	84
PEI	95	94	91	94	89	86	92

Kitchen waste put in compost bin, pile, or garden (Percentage of Households)							
	2009	2011	2013	2015	2017	2019	Average
Canada	49	41	39	38	35	30	39
NB	33	40	40	45	38	36	39
NFLD	78	81	77	75	70	61	74
NS	21	23	20	25	31	29	25
PEI	13	11	16	18	28	18	17

Had access to municipal composting or organics collection program for kitchen and/or yard waste but did not use it							
	2009	2011	2013	2015	2017	2019	Average
Canada	8	10	12	13	12	13	11
NB	10	12	12	10	13	15	12
NFLD	5	8	8	6	9	9	8
NS	14	13	12	15	17	15	14
PEI	14	15	12	14	19	17	15

Percentage of Households in 2015 who did and did not compost kitchen waste divided by CMAs and Non-CMA								
Province	NFLD		PEI	NS		NB		
Census Metropolitan Area	NFLD Non-CMA	St. John's	PEI Non-CMA	NS Non-CMA	Halifax	NB Non-CMA	Moncton	Saint John
Past yr: compost kitchen waste								
Yes	34	34	96	95	95	36	68	74
No	66	66	5	5	5	65	32	26
N=	245	143	264	599	248	332	98	91

Percentage of Households in 2015 that composted kitchen waste divided by dwelling type								
Province	NFLD		PEI		NS		NB	
Type of dwelling: grouped	1	2	1	2	1	2	1	2
Past yr: compost kitchen waste								
Yes	35	8	96	91	97	80	51	20
No	65	92	4	9	3	21	49	80
N=	360	12	215	35	735	78	464	40

Percentage of households in 2015 that composted kitchen waste divided by income												
Province	NFLD			PEI			NS			NB		
Household income	low	mid	high	low	mid	high	low	mid	high	low	mid	high
Past yr: compost kitchen waste												
Yes	33	29	36	90	97	98	91	96	98	51	46	52
No	68	71	64	10	3	2	9	4	2	49	55	48
N=	77	104	134	59	70	91	207	241	236	139	143	146

Appendix C – Addressing Comments from Research Proposal

Overall, most of the comments I received on my research proposal from both supervisor, Nic Rivers and second reader, Luc Juillet surrounded the feasibility of my research question which was "What are the different organic waste diversion policies and programs in place in the Atlantic Canadian provinces and what ones work best at diverting organic waste?" After doing further research and assessing the data I had available I ended up adjusting my research question to reflect the following: "Why are organics waste diversion rates significantly different across the Atlantic Canadian provinces and what are the barriers and opportunities for progressing diversion in the region?"

Based on this shift to my research question and methodology my research was more focused on qualitative data to compare provincial approaches to organic waste management rather than a purely quantitative study. I believe the initial research question from my proposal is still valid and would be an interesting study, however, I recognized it would not be feasible in the scope of this MRP. Although different from my initial proposal I think the discussion I was able to create with my MRP sets the stage for furthering organic waste management in Atlantic Canada.