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# Household-level dynamics of food waste production and related beliefs, attitudes, and behaviours in a municipality in Southwestern Ontario

## Abstract

It has been estimated that Canadians waste $27 billion of food annually, and that half of that waste occurs at the household level (Gooch et al 2010). There are social, environmental, and economic implications for this scale of food waste, and source separation of organic waste is an increasingly common municipal intervention. There is relatively little research that assesses the dynamics of household food waste (particularly in Canada). The purpose of this study is to combine observations of organic, recyclable, and garbage waste production rates to survey results of food waste-related beliefs, attitudes, and behaviours at the household level in a mid-sized municipality in Ontario. Waste weights and surveys were obtained from 68 households in the summer of 2013. The results of this study indicate multiple relationships between food waste production and household shopping practices, food preparation behaviours, household waste management practices, and food-related attitudes, beliefs, and lifestyles. Notably, we observed that food awareness, waste awareness, family lifestyles, and convenience lifestyles were related to food waste production. We conclude that it is important to understand the diversity of factors that can influence food wasting behaviours at the household level in order to design waste management systems and policies to reduce food waste.

## Keywords

Food waste; household; survey; weight measures; Canada

**Highlights**

- We combined household waste stream weights with survey data.
- We examine relationships between waste and food-related practices and beliefs.
- Families and large households produced more total waste, but less waste per capita.
- Food awareness and waste awareness were related to reduced food waste.
- Convenience lifestyles were differentially associated with food waste.

## 1.0 Introduction

The Food and Agriculture Organization recently reported that the world wastes 1.3 billion tonnes of food annually, with an associated cost of $750 billion (FAO 2013). Canadians waste $27 billion of food annually: the equivalent of 40% of all food produced, and 2% of our GDP. Half of that waste occurs at the household level (Gooch et al 2010), with an average cost of $28 in wasted food per week for each Canadian household (Martin 2012). Studies from the United Kingdom suggest that about 60% of food waste at the household level can be considered "avoidable" (Quested et al 2013), and it can be surmised that up to a 60% reduction in food waste is therefore possible at the household level. There is currently little research on the dynamics of household level food wasting, despite the importance of understanding the issue at this scale.

High levels of food waste exacerbate environmental impacts such as greenhouse gas emissions (Dorward 2012, Gentil et al 2011), nutrient loss (Forkes 2007), and the inefficient use of resources, including farm land (FAO 2013, Kummu et al 2012), energy, water, and fuel used for food production (Cuéllar and Webber 2010). In addition, the US EPA (2013) estimates that over one-fifth of the waste contained in municipal landfills consists of food waste. Municipal composting systems that divert source-separated organics from landfills may mitigate the environmental impacts of food waste by recapturing nutrients (and energy in anaerobic digestion systems); however, such systems may be more expensive than landfilling (Levis et al 2010), and

there is currently little political pressure from senior levels of government to develop municipal composting programs. Additional economic costs of food waste are borne by the individual households, suppliers, and producers who dispose of avoidable food remnants at different points in the food supply chain. The social implications of food waste are related to food security, and reducing waste has been identified as a key component of strategies to feed a future global population of 9 million people (Godfray et al 2010, Parfitt et al 2010). Food waste is also problematic in the context of increasing social inequality, where the unequal distribution of resources results in almost 900,000 Canadians accessing food banks each month (Food Banks Canada 2012; see also Papargyropoulou et al 2014). The environmental, economic, and social implications of wasted food reveal the substantial policy-relevance of this issue.

*1.1 Study context*

Considering the importance of food waste management to effective municipal service provision, the reduction of waste treatment and landfill costs, broader economic efficiency, social equity, and environmental conservation, it is surprising that there is little research that systematically assesses the factors that influence food wasting and waste disposal at the household / consumer level. There is some research on waste in other parts of the food chain in Canada and abroad (e.g. production, manufacturing, distribution, and retail: Darlington and Rahimifard 2006, Gooch et al 2010, Kaipia et al 2013, Maxime et al 2006, Mena et al 2011, Schliephake et al 2009). Nonetheless, academic observers have commented on the lack of household-level research on food waste (Sonesson et al 2005, Stefan et al 2013) as well as the policy need for these types of data (Abdulla et al 2013, Langley et al 2010). In particular, the regional specificity of food systems,

waste management systems, and cultural norms with regard to food necessitates place-based and geographically-sensitive analyses.

A research focus on the household unit and individual consumer behaviours has the potential to devolve into "blam[ing] the consumer" (Evans 2011), and so it is imperative to understand householders' behaviours in a broader context of systemic factors (e.g waste management systems, local government capacities and priorities, etc.) and cultural factors, such as the "throwaway society" (Evans 2012), the pervasive "out of sight, out of mind" attitude toward waste (de Coverly et al 2008) that is common in Canadian society, and various other institutional and cultural factors that can influence individual environmental beliefs and behaviours (e.g. Shove 2010). As argued by Bulkley and Gregson (2009), "…waste policy has to cross the threshold, to open up the black box that is the household and engage with household practices, rather than continue with furthering end-of-pipe approaches which impose rafts of new practices on households from the outside" (p.930). Such investigations have the potential to inform understandings of household-level food wasting behaviours, and to also allow for the development of targeted place-specific policy interventions.

Waste audits are regularly undertaken as a part of municipal waste management planning, but these tend to be weight-based audits rather than composition audits (where waste would be sorted into its constituent parts), the sample sizes are often small, the audit results are often unpublished, and the data are rarely cross-referenced with demographic or social data. There is therefore little publicly-available data available on the composition and amount of food waste produced in different food systems (Buzby and Hyman 2012, Lebersorger and Schneider 2011, Lundqvist et al 2008, Parfitt et al 2010). Most systemic studies that quantify food waste rely on estimates and aggregate data collected at municipal or even national levels, and do not directly

measure household food waste. For example, baseline data on amounts of food waste generated by different sectors have recently been estimated in Europe based on EUROSTAT data (Monier et al 2010), and Oelofse and Nahman (2013) estimate South Africa's food waste using FAO data. Sonesson et al (2005) conducted a study of Swedish food waste at the household level, but relied on self-reports of food waste via diaries. Koivupuro et al (2012) also used food diaries and related food waste produced by households to 22 socio-demographic, attitudinal and behavioural variables. However, self-reported mechanisms tend to underestimate waste quantities (Chung 2008), and so may limit the comparison of waste production with social variables. Unpublished analysis from the WRAP studies in the UK indicates that self-report of food waste via diary methods underestimated waste production by approximately 40% (Quested et al 2011). The extensive WRAP food waste studies do draw on both self-report and observational data (Quested et al 2013, Ventour 2008), and while they effectively describe local dynamics of food waste production at the household level, they do not discuss the statistical significance of relationships between waste measurements and survey data.

We are unaware of any other study that statistically connects third-party measures of household-level food waste production to qualitative survey data on attitudes, beliefs, and household practices. Our results may therefore provide new insight to household food wasting dynamics, particularly in Canada.

## 2.0 Material and methods

Given that there is little publicly-available data available on the composition and amount of food waste produced in different food systems, our objective in this research project is to achieve

a more detailed understanding of the factors that influence food wasting at the household/consumer scale in a municipality in Ontario, Canada.

In the summer of 2013, we carried out a study to assess the dynamics of food waste in three similar neighbourhoods in a mid-sized community in Southwestern Ontario. The municipality offers weekly source-separated organics collection for households, in addition to weekly source-separated recyclables collection, bi-weekly residual waste collection, and semi-annual yard-waste collection. While the source-separated organics stream is intended primarily for food wastes, pet waste, soiled paper, and limited amounts of yard waste are also accepted in this stream. The neighbourhoods we sampled were using transparent coloured bags (clear, green, and blue) for waste collection, although the city is in the process of moving from bag collection to the use of carts. The municipality is also active in providing educational content on waste management topics through their website, the distribution of informational material to households, and participation in community events.

In collaboration with the municipality, we weighed source-separated organics, recyclables, and residual garbage placed at the curb on municipal collection days by 222 households . At the time of sampling, the municipality collected garbage every other week, while recyclables and organic wastes were collected every week. We sampled the households on two subsequent garbage collection days (i.e. biweekly). All resultant weights were standardized and averaged to reflect the equivalent of a 7 day weighing period (e.g. our calculations accounted for the collection of 14 days of garbage on each collection date, but only 7 days of recycling and organics), which we refer to below as weekly averages. We conducted door-to-door surveys with 61 of the households included in the audit, speaking with the person most responsible for food shopping and cooking. All households included in the audit were approached for participation in the study by way of a letter

and visits to the home. We provided a small monetary incentive to respondents who completed the survey. Our final sample represents a survey response rate of 31%. Our survey assessed a number of variables, including perceptions of the municipal waste management system, shopping and cooking practices, self-reported waste behaviours, environmental beliefs, and socio-demographic characteristics.

Limitations of our study included the focus on waste put out for collection; we were unable to observe food waste that was disposed of by other means in the household (e.g. sink garburators, home composters, feeding food waste to animals). Furthermore, the organics collection stream in the study city does accept some non-food materials, including limited amounts of yard waste, pet waste, and soiled paper products. We also were not able to assess the amount of food waste placed in the garbage or recycling streams using this methodology. For these reasons, the weights of the source-separated organics stream do not represent a full or exclusive accounting of food waste produced in the home. The weight data we collected may also have been impacted by climactic factors on collection day (e.g. rain could have made the bags heavier). Another limitation is based in our relatively small survey sample of 61 households, which is not representative of the socio-demographic diversity of the study city as a whole. Rather, this sample of neighbourhoods was chosen to capture single-family homes, and to avoid areas of high residential turnover (i.e. student neighbourhoods). Furthermore, our small sample size has limited the power of our statistical analysis, thus restricting us to bivariate analyses of the survey results (we were unable to observe any significant multivariate relationships).

## 3.0 Results

### *3.1 Household demographics*

The household study was conducted in suburban areas of the city typified by single-family dwellings. Respondents reported an average household size of 3.3 people (median = 3 people), and an average of one child in the household under the age of 18 (median = 0). The vast majority (97%) owned their homes, and only 3% were renting. Similarly, 95% of respondents did not have roommates or tenants. On average, survey respondents had lived in the municipality for 21 years (median = 15 years), and 16% had lived in a community with a food waste collection system before moving to the municipality. Driving was the major mode of transportation for travelling to the grocery store (97%), and 3% walked (no other mode of transportation was listed as a primary means of travelling to buy food). Most of our respondents were female (70%), 77% were born in Canada, and the age range is depicted below in Table 1.

Table 1: Ages of survey respondents

| Age range | Percentage of respondents |
|---|---|
| 20-29 years | 10 |
| 30-39 years | 23 |
| 40-49 years | 25 |
| 50-59 years | 18 |
| 60 years and older | 25 |

*3.2 Household waste production and management*

On average, surveyed households put out 31.2 kg of waste for collection every week, including an average of 12.5 kg of source-separated organic waste, 11.6 kg of recyclables, and 7.1 kg of residual garbage. The average waste produced per capita in these households was 4.2 kg of organic waste, 3.8 kg of recyclables, and 2.2 kg of residual garbage, for a total of 10.2 kg per person per week.

It is important to note that household waste generation varied greatly in our sample, and that the above averages are not necessarily representative of norms or trends. Figure 1 depicts the diversity of per capita organic waste production among the surveyed households, arranged from

highest weekly production of organic waste to lowest. This graph demonstrates persistent variability, and no clusters of common organic waste production values are evident in our sample. We contend that it is important to understand the sources of this diversity in order to effectively design policy and program interventions that target food waste reduction.

[Insert Figure 1 here]

Figure 1: Per capita weekly organic waste collected at curbside, organized by rank

We asked householders how they disposed of food waste in their homes. All respondents indicated that they used the "green bag" system to source separate their organic wastes. Although the local waste management bylaw requires source separation of garbage, recyclables and organics, 39% of respondents admitted that they also disposed of some of their food waste in the garbage stream, and 12% disposed of food wastes in the sewage system through garburators or by pouring organic matter into sink drains or toilets. Some reused food wastes within their households: 13% used backyard composters, and 20% fed domestic or wild animals with food scraps. We did not observe a relationship between organic waste production rates and composting or feeding animals, although it may be that the small percentage of respondents engaging in these behaviours has limited our ability to detect such trends.

Fifteen percent of respondents took some of their food waste directly to a landfill or transfer station, despite having access to the organic collection system at home. These results indicate that estimates of food waste generation based on the weight of green bags put out for organic waste collection underestimate the amount of food that is wasted within households. We did not find a statistical relationship between the amount of organic waste put out for collection and use of the garbage stream to dispose of food waste (i.e. those households reporting that they put food waste

in the garbage did not put out less organic waste for collection on average), suggesting that those who used the garbage stream for food disposal may have generated more total food waste than other households (some of which went unobserved and un-weighed in the garbage stream).

Overall, 71% of respondents agreed (somewhat or strongly) that the municipal waste management program was effective and easy to use. Survey participants were also asked about their perceptions of household food waste management practices. Ninety seven percent of the respondents said that the green bag system was very or somewhat convenient, compared to 81% who described food waste reduction or avoidance as convenient, and 33% who found home-based composting convenient. Perceptions of convenience are likely a reflection of both the user-friendliness of the system in question (i.e. green bags, reduction, home composting), as well as the individual's commitment to engaging in the behaviour. All respondents to the survey agreed (either strongly or somewhat) that they properly sorted their food waste into the green bin.

The primary complaints with respect to the green bag system were the following: mess or nuisance (16%), availability and cost of green bags (8%), collection service problems (5%), and concerns about impending changes to the green bag system (5%). The most common concern (mess or nuisance) may be inherent to organic waste management, whether it is source separated or combined with other waste streams (e.g. coffee grounds could lead to messy leakage whether placed in a green bag for source-separated organics collection or a clear/black garbage bag).

When asked about the potential for household food waste reduction, 65% agreed (strongly or somewhat) that they could reduce the amount of waste that they produced, while 29% disagreed (strongly or somewhat) and 8% remained neutral. These results may indicate an acknowledgement of wasteful food behaviours within the household, or alternatively a sense of capacity to change household behaviours. Koivupuro et al (2012) observed in Finland that households that expected

to be able to reduce their waste tended to produce more food waste, suggesting that a perceived ability to reduce is reflective of high waste production.

Figure 2 shows the types of food wastes that respondents reported generating in their households. The graph indicates that "trim or inedible portions from food preparation" were the most commonly reported types of waste, suggesting that most householders perceived a substantial portion of their routine food waste to be unavoidable. Other common categories included spoiled food and food that had reached its best before date, indicating an awareness of food waste caused by not using otherwise edible products in a timely manner. Food that households tried and did not like and over-preparation of food (e.g. burning) contributed less frequently (but not uncommonly) to household food waste.

[Insert Figure 2 here]

Figure 2: Types and frequencies of food wastes

Respondents were asked how they identified when food was ready to be thrown out. Most respondents used multiple approaches to decide when to discard food, as depicted in Figure 3.

[Insert Figure 3 here]

Figure 3: Criteria used to determine when food became waste (multiple responses allowed)

The most common criterion for disposal was the appearance of food, followed by its smell and whether it had passed its best before date. The only statistically significant relationship between individual strategies for identifying food waste and amount of organic waste generated in the household was that those who discarded food after it had been in the fridge for a certain number

of days produced more organic wastes on average than other households (Mann-Whitney test: $p = 0.019$). We also found that those who produced greater amounts of residual garbage waste in their homes were more likely to report discarding food after it had been in the fridge for a certain number of days (Mann-Whitney test: $p = 0.033$), discarding spoiled food (Kruskal-Wallis test: $p = 0.039$; Jonckheere-Terpstra test: $p = 0.012$), and discarding food beyond its best before date (Kruskal-Wallis test for difference: $p = 0.005$; Jonckheere-Terpstra test for trend: $p = 0.025$), suggesting that households using these criteria may discard of such foods in the garbage stream, possibly while still within the container.

We hypothesized that those who used more criteria to identify food waste would be more conscientious and aware of food waste, and would therefore waste less overall. Surprisingly, we observed that the number of different strategies used to identify food waste was positively correlated with the amount of organic waste produced by a household on average ($p = 0.025$), as well as the number of food waste types (e.g. trim, past its best before dates, etc.) produced within a household ($p = 0.020$). It appears that households that used more criteria for identifying food waste had more occasion and rationale to classify food as waste, and thus put more food into the organic waste stream. In other words, those who were choosier about the edibility of their food wasted more, whereas those who focused on one ultimate indicator of food edibility wasted less.

We asked respondents to consider their food wasting in broader contexts, both in comparison to others in their social circles (neighbours, family, and friends) and compared to their own past and future projected behaviours. The most common response when comparing household behaviours to others was a perception that they produced the same amount of food waste (41%), while 25% believed they produced somewhat or much less, and only 15% thought they produced somewhat more (none reported that they produced much more food waste than others in their

circles, and 20% did not know). There appeared to be a reluctance to identify oneself as someone who produces more food waste than others in their social circle. Furthermore, a lack of regular exposure to the food waste of others may allow for respondents' persistent self-perception as producing similar or less food waste than other households. A similar trend emerged when asking householders to project their relative rates of food waste generation 5 years in the future: no one projected that they would waste much more food, only 13% projected that they would waste somewhat more, 46% anticipated similar amounts of food waste generation, and 40% anticipated that they would waste somewhat or much less food than they currently did.

Trends in respondents' analysis of their past food waste production suggest why some may have projected somewhat more food waste production in the future. When compared to their own past behaviours, 35% reported that they produced somewhat or much more waste in the past, 28% produced the same, and 38% produced less or much less in the past. Bivariate analysis indicates that those who perceived that they produced less waste in the past were more likely to have children at the time of survey (Chi-square: $p = 0.039$), suggesting that changes related with family lifestyle may have influenced their rates of food waste generation. In this vein, households who anticipated an increase in their food waste generation 5 years into the future may have predicted that their families would expand in that time.

*3.3 Food shopping and preparation habits*

Households spent an average of $171.50 per week on groceries (or $53.05 per capita). They also indicated that they spent an average of $51.75 per week ($16.96 per capita) on non-grocery food per week (i.e. money spent on take out, restaurants, etc.). We observed positive correlations between the amount of money per capita that households routinely spent on groceries

and both the amount of organics waste generated per capita ($p = 0.013$) and the total weight of all three streams of waste per capita ($p = 0.028$). In other words, households that spent more money on groceries per person also tended to produce more organic and total waste per person in their household.

We observed internal consistency with reports of amounts of money spent on eating out: those who reported that they more frequently ate food prepared outside the home also reported that they spent more money on non-grocery food per capita (Kruskal-Wallis: $p = 0.000$; Jonckheere-Terpstra: $p = 0.000$), while those who cooked from scratch more often spent less money per capita on non-grocery food (Kruskal-Wallis: $p = 0.039$; Jonckheere-Terpstra: $p = 0.011$). As noted above, those households spending the most money on grocery food per capita produced higher amounts of organic waste per capita; interestingly, household spending on non-grocery foods was also positively correlated with per capita generation of organic waste ($p = 0.039$). We also observed a correlation between the amount of money spent per capita on non-grocery foods and that spent on grocery foods ($p = 0.000$), indicating a cluster of households who purchase large amounts of both groceries and take-out foods, and who likely waste food as a result of over-purchasing groceries and / or non-grocery foods.

When asked about their food shopping habits, 53% of respondents said they shopped for groceries once a week, 39% shopped multiple times a week, and 8% shopped less than once a week. As shown in Figure 4, most respondents relied on grocery stores as primary shopping sites, although other retail options often supplemented grocery store purchases (multiple responses were allowed).

[Insert Figure 4 here]

Figure 4: Usual sources of grocery purchases

We asked respondents about their food shopping habits: 82% of respondents regularly (and 7% sometimes) shopped with a list, 82% of respondents regularly (and 12% sometimes) checked their food inventory before going shopping, 66% regularly (and 16% sometimes) reviewed flyers before shopping, 39% regularly (and 36% sometimes) planned meals in advance of shopping, and 28% regularly (and 13% sometimes) shopped for food according to a budget. There are therefore some habits (including using a list and checking food inventory) that were fairly common among respondents, whereas more detailed food planning behaviours (such as menu planning and food budgeting) were less common.

We asked respondents about the connections between their shopping behaviours and food waste. Eight-two percent of respondents agreed (strongly or somewhat) that they were able to buy the correct amount of food for their household on a regular basis; 15% were neutral on this question, and only 4% disagreed. A similar question revealed that only 12% reported that they often bought too much food, and no respondents said that they always bought too much food when shopping. These results indicate that surveyed households generally did not perceive their food purchasing behaviours as problematic in terms of over- or under-provisioning. Although 34% of respondents often or always bought food that was on sale or otherwise discounted and another 41% sometimes did so, few respondents reported that they wasted food that they bought on sale (72% never or infrequently wasted this food; 26% sometimes wasted sale food, and only 2% often wasted sale food).

Respondents were asked about their food preparation habits. Most households (93%) reported that they often or always cooked from scratch (prompt: “at least two ingredients combined”). The frequency of reported home cooking is mirrored by low rates of reported reliance

on pre-packaged meals and ordering take-out food, and eating in restaurants / cafeterias / fast food outlets. Similarly, most (71%) households reported that they often or always ate leftovers.

With respect to food storage, most (62%) respondents reported using one refrigerator, while 36% used two and 2% used three. Including the freezer attached to most refrigerators, most households (54%) used two freezers for storing food, while 36% used one and 10% used three or four freezers. We asked respondents about how full their fridges were: 59% said their fridge was quite or very full, 38% said somewhat full, and 2% said their fridge was empty. Despite the fullness of their fridges, most respondents (59%) said they could see all of the food in their fridge, while 31% could somewhat see their food and only 10% said they could not. We hypothesized that households with full refrigerators (and particularly those who could not see all of the food in their refrigerators) would produce more food waste, but this relationship was not apparent in the data. However, we suspect that responses could be influenced by the amount of time since the household last shopped for groceries (which we did not assess). Otherwise, it may also be that the relatively small sample size of our survey may have limited our ability to detect this relationship, and so we encourage further investigation of this question.

Survey respondents were also asked about more general aspects of their food habits. A substantial proportion (44%) reported that someone in their household was on a special diet (e.g. vegetarian, diabetic, food allergies, etc.), indicating a high level of dietary conscientiousness among surveyed households. Supporting this inference, 64% of respondents reported that they regularly reviewed the nutrition labels on packaged foods, and 28% did so sometimes. Eight percent of respondents regularly bought organic food, and 38% sometimes bought organic food. More than half (51%) of respondents canned, froze, or otherwise preserved excess foods, and 38% had a vegetable garden at home. These results suggest that a substantial proportion of survey

respondents had cultivated a sense of food awareness based on the provenance or contents of the food that they bought or grew. We discuss the relationship between food awareness and food waste awareness in section 3.5 below.

*3.4 Beliefs, practices, and attitudes regarding waste and food*

When asked about recycling practices (as an indicator of general waste awareness), 98% of respondents agreed with the statement that they recycled all of their recyclables at home, and 83% recycled regularly outside the home as well. We also asked about the guilt that respondents felt associated with different wasting behaviours: 63% felt guilt about buying food or other products that came with a lot of packaging, 56% felt guilty about producing "a lot of garbage (non-recyclable waste)," while 38% felt guilty about producing a lot of recyclabes. Interestingly, the most guilt-inducing practice was wasting food (85% of respondents agreed that this behaviour made them feel guilty). We asked a series of questions to assess the nature of the responsibility that people associate with food waste, and while many agreed that food waste was an environmental (68%) or economic (72%) problem, the most common response was that food waste is a social problem (83% of respondents agreed with this statement).

We asked survey respondents their opinion of whose responsibility it is to reduce food waste (multiple responses were allowed, but all responses were ranked). Overwhelmingly, respondents felt that individuals were responsible for reduing food waste (74% ranked this as the #1 option, and an additional 21% ranked individuals as their #2-4 response). Other actors identified as bearing responsibility for food waste included food manufacturers (#1 option for 13%, and #2-4 option for 58%), stores (#1 option for 3%, and #2-4 option for 55%), government (#1 option for 3% and #2-4 option for 35%), and farmers (#1 option for 2%, and #2-4 option for 7% of

respondents). Restaurants and food marketers were also identified as bearing some responsibility for food wate reduction by one respondent each.

When asked about what activities or interventions would help respondents to reduce food waste in their household (up to two responses accepted), 30% said meal planning, 11% indicated a need to change household preferences and food habits, and 9% suggested that different packaging options were necessary at retail. Ideas raised by 5% or less of respondents included eating leftovers, improving household organization, improved education about food waste, buying less food, preserving food better, buying food that lasts longer, improved proximity to grocery stores, cooking more, changes to the municipal food waste collection system, and eating out more often to reduce food wasted in the home. Interestingly, 38% of respondents could not provide any suggestions for what would help with household food waste reduction. Considering the strong perception of indivuals as bearing primary responsibility for reducing food waste, the common lack of ideas for reducing food waste indicates a tension for householders. While they believe they are responsible for reducing food waste, many of them do not know what types of interventions would enable food waste reduction in their homes.

*3.5 Bivariate analyses – life stages and lifestyles*

We observed clusters of bivariate relationships that describe distinctive lifestyles and attitudes that influenced wasting behaviours. There may be some overlap among these groups in terms of individual respondents, but our interpretation is that these clusters describe patterns in the aggregate data. The clusters suggest that, although the volume of waste produced by different households may be similar, the attitudes, behaviours, and contexts that lead to waste production may be distinct.

3.5.1 Family lifestyle and large households:

The data suggest that households with children faced limitations of time and money, and that these constraints impacted their wasting behaviours. Overall, households with children produced more total waste from all three waste streams (Mann-Whitney: $p = 0.001$). However, these same households produced less total waste per capita, suggesting that the rate of waste production was lower for children than for adults in these households (Mann-Whitney: $p = 0.005$). Households with children also produced more types of waste (e.g. spoiled food, food no one wanted to eat any more, over-prepared/burned food) than other households on average (Mann-Whitney: $p = 0.002$). As noted in Section 3.2, households with children were cognizant of a change in their waste production over time (likely associated with a shift toward a family lifestyle), and were more likely to report that that they produced more waste than they did five years previous (Chi-square: $p = 0.039$). Perhaps because of their awareness of the recent increase in their waste production, households with more children tended to express more guilt about producing high volumes of garbage (Kruskal-Wallis: $p = 0.005$; Jonckheere-Terpstra: $p = 0.001$).

On average, households with children spent more total money on groceries than those without children (Mann-Whitney: $p=0.000$), and were more conscientious about how that spending occurred. Households with more children were more likely to plan or sometimes plan meals before shopping (Kruskal-Wallis: $p = 0.044$; Jonckheere-Terpstra: $p = 0.014$), and to check food inventory before shopping (Kruskal-Wallis: $p = 0.022$; Jonckheere-Terpstra: $p = 0.044$). Households with more children were also more likely to do their main grocery shopping at big box stores (Mann-Whitney: $p = 0.015$), perhaps suggesting a concern among families for cost effectiveness or a desire for the convenience of one-stop shopping.

Some of the trends associated with family lifestyle were also observed among larger households more generally; some of these were households with children under 18, while some included adult children or other adult household members. Household size was positively correlated with total waste weight ($p = 0.000$), including all three streams of garbage ($p = 0.020$), recycling ($p = 0.003$), and organics ($p = 0.002$). Similar to the family dynamics described in this section, household size was negatively correlated with per capita amounts of total waste ($p = 0.001$), including per capita amounts of recyclables ($p = 0.013$) and organics ($p = 0.001$), suggesting economies of scale may exist with respect to the recycling and organic streams of household waste production. On average, bigger households expressed more guilt about producing a lot of garbage (Kruskal-Wallis: $p = 0.001$; Jonckheere-Terpstra: $p = 0.000$) and buying products with a lot of packaging than other households (Kruskal-Wallis: $p = 0.033$; Jonckheere-Terpstra: $p = 0.011$), suggesting a higher visibility of packaging waste in these households with more people. Those who felt guilty about both packaging waste (Kruskal-Wallis: $p = 0.033$; Jonckheere-Terpstra: $p = 0.013$) and overall waste generation (Kruskal-Wallis: $p = 0.013$; Jonckheere-Terpstra: $p = 0.002$) tended to spend more total money on groceries than other households, as would occur in larger households. There is also an indication of convenience-oriented waste management strategies in larger households, as they were more likely than small households to report that they disposed of food waste in the garbage stream (rather than the organics stream; Mann-Whitney: $p = 0.032$).

3.5.2 Food awareness:

People who demonstrated conscientiousness in their eating habits tended to effectively manage food waste in their households. Respondents with a person on a special diet in their household (such as vegetarians or those with restrictions due to diabetes or other health concerns)

were more likely to see food waste reduction as a very convenient household strategy (Chi-square: $p = 0.034$). Respondents with a person on a special diet in their household were also more likely to have a vegetable/fruit garden (Chi-square: $p=0.039$), and those with vegetable/fruit gardens tended to produce less waste than others on average (Mann-Whitney: $p = 0.040$). Those who more frequently read nutrition labels on the food they purchased produced less organic waste overall (Kruskal-Wallis: $p = 0.031$; Jonckheere-Terpstra: $p = 0.008$) and less organic waste per capita (Kruskal-Wallis: $p = 0.013$; Jonckheere-Terpstra: $p = 0.015$) in their households. We created a composite food awareness index including variables such as special diets, food gardens, and reading of nutrition labels. Those with a lower level of food awareness as measured by this index tended to eat out at restaurants more often than those with high food awareness (Kruskal-Wallis: $p = 0.048$; Jonckheere-Terpstra: $p = 0.012$), and tended to feel confident that they could reduce their food waste in their homes (Kruskal-Wallis: $p = 0.000$; Jonckheere-Terpstra: $p = 0.000$). As discussed in Section 3.2, we hypothesize that the expression of the potential to reduce food waste is an indication of the respondent's awareness of excessive food waste production in their home, and that those with stronger food awareness had already reduced household food waste as much as they believed possible.

3.5.3 Waste awareness:

Conscientiousness about waste and its impacts was also connected to lower rates of waste production. For example, households that expressed more guilt around producing high volumes of garbage produced less total waste per capita (Kruskal-Wallis: $p = 0.042$; Jonckheere-Terpstra: $p = 0.011$), and less organic stream waste in particular (Kruskal-Wallis: $p = 0.031$; Jonckheere-Terpstra: $p = 0.008$). We also observed that those who more strongly agreed with the statement

"Food waste is a social problem" produced fewer types of food waste (Kruskal-Wallis: $p = 0.046$; Jonckheere-Terpstra: $p = 0.013$).

We observed reduced waste production in households that exhibited effective food management. For example, households that reported that they did not waste excess food bought on sale tended to produce fewer types of food waste overall (Kruskal-Wallis: $p = 0.024$; Jonckheere-Terpstra: $p = 0.008$). Fewer types of waste were also produced in households that infrequently threw away food that had reached its best before date (Mann-Whitney: $p = 0.036$). Lower rates of garbage (Mann-Whitney: $p = 0.033$) and organic waste (Mann-Whitney: $p = 0.019$) were produced by those who avoided throwing away food based on the length of time it had been in the fridge. These behaviours suggest that effective household food management strategies (including conscientious purchasing and assessments of food spoilage that are more nuanced than simply number of days in the fridge or best before dates) can result in reduced wasting of food and other materials.

3.5.4 Convenience lifestyles:

We observed clusters of convenience-based lifestyles that were associated with low waste awareness and particular waste production patterns. Those who spent more money eating out at restaurants believed that they generated more waste than others (Kruskal-Wallis: $p = 0.003$; Jonckheere-Terpstra: $p = 0.003$); however, they produced less recyclable waste (Kruskal-Wallis: $p = 0.001$; Jonckheere-Terpstra: $p = 0.001$) and less total waste (Kruskal-Wallis: $p = 0.026$; Jonckheere-Terpstra: $p = 0.016$) than other households, suggesting a disconnect between their perception and reality of household waste production. In terms of organic waste, those who spent more money eating out were more likely to believe that they could reduce food waste in their home

(Kruskal-Wallis: $p = 0.005$; Jonckheere-Terpstra: $p = 0.001$), suggesting a perceived surfeit of unnecessary food waste. In this case, the respondents' perceptions appear more founded, as the amount of money a household spent on non-grocery food (such as on restaurants, cafeterias, fast food, and take out) was positively correlated with the amount of organic waste produced in these households ($p = 0.039$). We hypothesize that while these households ate out frequently, they were still purchasing food with the intention of eating it at home, and ended up wasting this food more often than other households. This conjecture is supported by our observation that those who ate out most frequently did not spend significantly less money on groceries per capita than other households ($p = 0.472$); in fact, amount of money spent on eating out per capita was positively correlated with the amount of money households spent on groceries per capita ($p = 0.000$). We also observed that those who more frequently generated spoiled food waste also spent more money on groceries than other households (Kruskal-Wallis: $p = 0.033$; Jonckheere-Terpstra: $p = 0.004$), and so may have been routinely overestimating and over-purchasing the amount of food that their household would consume at home. Interestingly, we observed that those households that spent the most money per capita on eating out expressed lower levels of guilt for wasting food than those who spent less money on food consumed outside of the home (Kruskall-Wallis: $p = 0.040$; Jonckheere-Terpstra: $p = 0.012$). These households that most heavily rely on food prepared outside of the home therefore may have the capacity to reduce household food waste, although this may not be a priority for them.

A distinct version of the relationship between convenience lifestyles and waste behaviour was observed among those who relied more often on pre-packaged foods (as opposed to convenience strategies based on eating out): these households tended to produce less organic waste than other households (Kruskal-Wallis: $p = 0.039$; Jonckheere-Terpstra: $p = 0.011$), likely due to

less trim and other waste created through food preparation, as well as controlled portion sizes in prepared foods and less over-preparation due to ease of cooking/reheating. It is important to note that although we did not observe high rates of food waste in these households, lifestyles based on the consumption of processed food products may be implicated in food waste higher up the food value chain at mass-processing and packaging sites. This issue therefore merits more attention, and we encourage further research on the distribution of food waste throughout the value chain.

## 4.0 Discussion

### *4.1 Household waste production and management*

Our study observed average weekly household organic waste production of 4.2 kg per capita (or 218.4 kg per capita annually). A report from Statistics Canada (2009) estimated post-retail food waste (a proxy for household food waste) at 183 kg / per person for 2007. While our results are similar in scale to the Statistics Canada data, the households in our study produced close to 20% more organic waste than the Canadian average from 6 years earlier. We offer four potential explanations for this disconnect. First, it is possible that our results indicate an upward trend in food waste between 2009 and 2013; second, our sample (a relatively affluent and suburban group) may have produced more waste than the Canadian average; third, there may be seasonal reasons for our observations of high food waste production during summer months when fresh produce is more readily available, and households may be entertaining more often; and fourth, it may be that Statistics Canada estimates do not adequately reflect the actual amounts of organic waste produced at the household level.

It is also notable that the per capita amounts of food waste we observed at the household level were substantially higher than per capita estimates from the US (Buzby and Hyman 2012:

estimating 129 kg of per capita consumer food waste in 2008) and from the European Union (Monier et al 2010: estimating 76 kg of per capita food waste in 2006), as well as food diary studies from the UK (Langley et al 2010 observed 0.14 kg per capita weekly food waste sent to landfill in an unspecified year of study, or 51.1 kg per year), and Finland (Koivupuro et al 2012: 23 kg per capita of avoidable food waste in 2010). The WRAP studies suggest that individuals produce 70 kg of avoidable waste per year in the UK (Ventour 2008); considering the finding from other WRAP studies that 60% of household food waste is avoidable (Quested et al 2013), this would indicate that total avoidable and unavoidable food waste at the household level total approximately 117 kg per person each year. Our findings of 217.4 kg of food waste per year may indicate a more wasteful Canadian populace, but may also support the importance of third-party direct observation of food waste practices (as opposed to the national-level estimates or self-report mechanisms used in the above-cited studies).

We observed great variability of waste production among our sample. Bulkley and Gregson's (2009) description of the "lumpiness" of waste production may provide insight to this observation. Because events like birthday parties and other non-daily occurrences can lead to "spill-over" waste, it may be difficult to capture homogenous and consistent measures of waste on any given week, even among similar households. We chose to measure waste over a two week period and to calculate weekly averages of waste streams in order to minimize the variability in our samples, although our results persist in demonstrating a degree of lumpiness.

Our respondents reported strong uptake of the municipal organics system, although they also used multiple alternative and/or complementary systems to manage food waste (including composting, feeding inedible food to animals, and using the sewage or garbage systems to clandestinely dispose of food waste). Despite the high rate of system use, there were some

complaints about the messiness and logistics of the municipal organics collection system. Some of these complaints were made in anticipation of the municipality's shift from a clear bag collection system for all three streams to a cart collection system, which necessitates storage and cleaning of more permanent containers. It will be important for the municipality to revisit these concerns as households transition to the cart system.

When asked about the types of food waste produced in the home, the most commonly reported waste was trim from food preparation (ostensibly unavoidable waste), followed by spoiled foods. Less common but not insubstantial sources of waste were foods no one in the household liked and food that had reached its best before date. The least reported type of food waste was over-prepared (e.g. burned) foods. It is germane to note that reports of commonness of different types of waste produced in the household are not an indicator of the amount of waste of that type (for example, frequently producing trim does not necessarily indicate a high amount of food waste). Self-report of these types of food waste were likely influenced by moral norms surrounding different types of food waste, and so these results may be indicative of perceived social acceptability of different types of food waste. Moral ordering would explain the prominence of trim (unavoidable waste) as a response. A similar question in the WRAP studies (Ventour 2008) focused on different types of avoidable waste, finding that food left on the plate and "out of date" foods were the most frequently reported reasons for wasting food, followed by an unappealing appearance and different types of spoilage.

We were surprised by the finding that the number of different criteria that householders used to decide when food became waste was positively correlated with the amount of organic waste that they produced. We had hypothesized that more cursory investigations of edibility would lead to less discriminate disposal, but rather found that more extensive food waste detection

strategies led to more organic waste production in the household. In other words, when people used multiple methods to detect food waste, they found more waste. Those respondents who used fewer criteria commonly relied on indicators such as smell or appearance; less interactive indicators such as best before dates and number of days in the fridge were usually not the sole measures that these respondents used to detect food waste. Our interpretation of these findings is that those with a more narrow and specific definition of food waste tended to discard of less organic material. We believe this observation makes an important contribution to our understanding of the household dynamics of food waste, with implications for policy and program interventions. In particular, education around meaningful indicators of food spoilage may assist householders in quickly and accurately identifying spoiled foods.

Despite the diversity of food waste behaviours, habits, and self-perceptions reported in the survey, it is notable that 65% of respondents agreed that they could reduce the amount of food waste they produced. This is a particularly interesting observation given that most people described their food waste production as relatively similar to others in their social circles. We remark that households wasted different types of food for different reasons, yet most respondents believed they could be wasting less.

### *4.2 Food shopping and preparation habits*

The Statistics Canada Survey of Household Spending 2012 (published in 2014) reports that on average, Canadian households spent $7,739 in 2012 on food expenditures (including food purchased at stores and restaurants), or $148.83 per week. In comparison, survey respondents reported an average weekly spending of $171.50 on groceries, and an additional $51.75 on non-grocery food (including take out and restaurant food), for a total of $223.25 average weekly

spending on food. Per capita, households spent $53.05 per week on groceries and $16.96 per capita on non-grocery food, for a total of $70.01 on food expenditures. The average household size in the Statistics Canada sample was 2.48, compared to an average household size of 3.3 in our sample. Because of differential spending on food for children and adults, a direct comparison between our results and the Statistics Canada data (which is not demographically disaggregated) would not be statistically meaningful. However, our average household size was 33% larger than that of the Statistics Canada sample, and the food spending of the households in our sample was 50% higher than the national average. These findings support our earlier hypothesis that our survey population was not characteristic of the national average, and was likely more affluent (and therefore more prone to both spending and wasting).

Overall, survey respondents indicated prudence when shopping for their groceries (e.g. shopping with lists, checking flyers). Despite exercising forethought, only 28% of respondents shopped for food according to a budget, and 34% often or always bought food that was on sale (again supporting our supposition that this is a relatively affluent sample). Other studies have either indicated that shopping for food on special leads to increased food waste by encouraging over-purchasing (Cox et al 2010), or that households concerned with finding low food prices produced less avoidable waste (Koivupuro et al 2012). Our survey results suggest that wasting sale food was not a common occurrence (only 2% of respondents said that they often waste sale food). We interpret this diversity of observations to be reflective of socio-economic differences between the study populations, and so encourage comparative research that better establishes the differential use of sale food in households of distinct socio-economic backgrounds.

In our survey, 93% of respondents claimed that they often or always cooked from scratch. Because of the lack of diversity in these responses, we were not able to observe many relationships

between home cooking and other food and waste behaviours. The prompt for this question defined cooking from scratch as putting together at least two ingredients; in this vein, boiling dried pasta and adding a can of pre-prepared sauce would qualify as cooking from scratch. It may be that our results over-estimate the amount of home food preparation and engagement with cooking in our sample households. Additionally, it is less morally desirable to self-describe as someone who does not cook, but relies on pre-packaged foods, and so the self-report mechanism for this behaviour may also have led to overestimation of home cooking.

*4.3 Beliefs, practices, and attitudes regarding waste and food*

We observed that survey respondents generally expressed an environmental consciousness through their beliefs and reported behaviours, and that guilt was associated with a number of wasting behaviours. These guilt-associations resonate with the predominance of the framing of responsibility for reducing food waste primarily at the individual-level. Our results suggest that food waste is an important issue for householders, and that they primarily understood food waste as a social issue (although a majority also perceived food waste as an enviornmental and economic issue). It is possible that the social framing of food waste is particular to the context of our study community where organic waste is diverted from the waste stream for composting: in the context of systemic reuse of food waste, it is possible that respondents are less concerned with negative environmental outcomes associated with the household production of organic waste. Comparisons with other studies of attitudes toward food waste reveal both similarities and differences. Quested et al (2011) note that economic savings were the most common motivator for reducing food waste in the WRAP studies (75% reported “A great deal” or “A fair amount”), followed by a desire for efficient home management (68%). Guilt and health concerns were also reported as important

motivators for reducing food waste (55% each) in this UK study, followed by environmental motivations (50%) and concern for food shortages elsewhere (44%). Stefan et al (2013) also observed that moral attitudes (including guilt about wasting food) were an important contributor to waste-reducing planning and shopping routines in a self-report study of food waste behaviours in Romania. These findings indicate the importance of understanding people's place-based and value-based relationships with food when planning communication and educational initiatives around food waste.

*4.4 Bivariate analyses – life stages and lifestyles*

Our bivariate analyses revealed thematic clusters of beliefs and behaviours that suggest the importance of life stages and lifestyles to food waste production. We observed that families and large households produced more total waste, but less waste per capita in all three streams. These results are supported by similar observations in the UK (Quested et al 2013, Ventour 2008) and Finland (Koivupuro et al 2012). We also observed that these households spent more money on groceries, planned their food shopping in advance, and tended to frequent big-box stores. While these households did express guilt and concern about their changing food waste patterns (i.e. more types of food waste and more total waste), we suggest that families and large households likely faced time and logistical constraints in trying to reduce food waste.

Two clusters of beliefs and practices associated with lower food waste production in our study included food awareness and waste awareness. These observations are also substantiated by other studies: as noted in Section 4.3, the WRAP studies in the UK revealed that healthy eating was identified as a motivation for reducing food waste (Quested et al 2013), thus suggesting that conscientiousness around food can be related to food waste reduction. Because fresh, healthy foods

like vegetables and fruit have shorter lifespans, high volumes of food waste may be reflective of a household's intention to eat healthy foods gone awry. Prioritizing the use of these foods before they spoil could lead to reduced organic waste and increased consumption of fresh produce. With respect to waste awareness, the WRAP studies found that households who regularly recycled also wasted less food than other households (Ventour 2008; although it is unclear whether this was a statistically significant difference). In order to encourage positive attitudes toward household waste management, it is important that residents continue to perceive the source-separated waste collection system as easy to use and convenient: Ghani et al (2013) found that positive attitudes toward waste separation were a significant predictor of intention to perform waste separation tasks among university employees in Malaysia. Based on focus groups in Norway, Refsgaard and Magnussen (2009) found that the presence of an organics collection system itself can engender positive attitudes toward food waste recycling, along with belief in the significant impacts of such a system, how user-friendly the system is, and price incentives.

Two different patterns of convenience-oriented food waste behaviour were apparent in our data. There were those households who ate out more than other households, but who spent statistically similar amounts of money on groceries per capita compared to other households. Those households who spent more money eating out produced more organic waste than other households, leading to our hypothesis that these households are allowing groceries and/or leftovers to spoil in favour of meal options that are more spontaneous or convenient than cooking. We also observed households that relied more on pre-packaged foods - a behaviour associated with less organic waste at the household level (although likely more waste at the food processing stage). Ganglebauer et al's (2013) qualitative work in Austria and the UK highlights the time constraints that some respondents associated with shopping for and preparing healthy meals; lifestyles busy

with work, unplanned social opportunities and leisure impeded conscientious food planning and preparation, and sometimes led to buying more food than was needed or intended.

## 5.0 Conclusions

Our results have revealed a number of relationships between food waste production and household shopping practices, food preparation habits, use of waste management systems, and food-related attitudes, beliefs, and lifestyles in this particular location. Notably, we have observed that food awareness, waste awareness, family lifestyles, and convenience lifestyles can influence household food wasting behaviours in distinct ways. While our results are place-based, we believe that they have implications for understanding food wasting at the household more broadly, and that this study reveals the generalizable importance of understanding householders' lifestyles, attitudes, habits, and institutional contexts. Our results support the observation made by Quested et al (2011) in discussing the WRAP studies: "The generation of food waste is not a behaviour in itself, but results from the interaction of multiple behaviours relating to planning, shopping, storage, preparation and consumption of food... Indeed, by the time food is thrown away, the opportunity to prevent that food from becoming waste has often passed" (p.463).

We have observed that there are social, cultural, economic, and institutional factors that may influence household food waste practices. These factors touch down differently in each household, and so there is no single strategy or intervention that can meaningfully address the diverse constraints and challenges that prevent household food waste reduction across a municipality. Our study suggests that there are multiple policy levers that could impact distinct aspects of food waste practices at the household level. For example, education and skill-building could prove useful to those who believe that individuals are responsible for reducing household

waste, but do not know how to do so themselves; institutional changes to food waste collection systems can ensure that they remain user-friendly for those who are committed to source-separation in their households, but who face constraints due to time and opportunity costs; and cultural changes that engender food and waste awareness may dissuade waste-intensive convenience lifestyles. Furthermore, our results highlight that for most householders, food waste is primarily a social issue, and not just an environmental or economic issue. These results suggest the importance of using social messaging in educational and promotional materials designed to reduce household food waste (e.g. invoking the health implications of wasting nutritious produce, or alluding to connections between food waste and community food security).

Our findings suggest that waste management policies should not focus solely on end-of-pipe solutions that seek to minimize food waste at the household level. Rather, food waste policy must consider the constellation of factors that influence household food wasting, including storage and cooking practices within the household, the implications of retail packaging and marketing choices for food purchasing decisions, the connections between restaurant / take-out dining and food waste produced in the home, and the influence of municipal waste collection system design on household wasting behaviours. In the case of the study municipality, the regulatory framework restricts local policy and planning to service provision, enforcement, and educational initiatives; it is clear that more senior levels of government must become involved in food waste policy for multi-sectoral change to occur. Our future research priorities are to continue to build our sample of household observations and surveys in order to better assess the statistical relationships between behaviours, attitudes, beliefs, and waste generation rates. We aim to observe a more diverse range of households in future work in order to observe variability between single- and multi-household dwellings, among other socio-economic differences. We also plan to re-sample

the households observed in this study after the collection system shifts from bags to carts in order to assess the influence of the format of the collection system on waste production rates. Finally, household-level composition audits of all three waste streams will provide more detailed observations of the types of food waste produced in the study households, the amounts of food waste placed in the garbage and recycling streams, as well as the ratio of avoidable to unavoidable food waste in these households.

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