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Waste Reduction in Public School Cafeterias Through Sorting and Diversion: An Analysis of Three Southern Maine Schools

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ABSTRACT

Solid waste is a serious environmental problem in the modern world. School cafeterias are one source of food and packaging waste that must be dealt with. Reducing the amount of cafeteria waste disposed of as trash through source reduction, recycling, and composting can not only improve environmental outcomes but also teach students about sustainability and save schools money. Social practice theory provides some factors that may be helpful to examine school cafeteria waste reduction programs. Using these factors, this thesis first examines school waste reduction programs in articles from academic databases, and then in three case study elementary schools in Southern Maine. Waste audits at each of the three schools reveal that there are major differences in how effectively waste is sorted and the types and quantity of waste generated per student. Overall waste diversion was measured at 69% or greater at all schools, although recycling sorting accuracy varied from 90% to 44%. Non-food waste generation rates varied from 16g to 53g per student per day and including food went as high as 148g per day. Finally, interviews with four staff members at each school followed by online surveys supply additional details and opinions on the waste reduction programs. Embracing key people to drive the program on the ground, simplifying the waste stream, and having somebody at the bins to help students sort emerge as concrete sources of program success. These seem to indicate the importance of institutional context and interaction in the creation of a "practice" of waste sorting in schools. There was also an emphasis on making sure students and staff were adequately trained and knowledgeable about the system to use it effectively, exemplifying the importance of knowledge. While there are still varying amounts and kinds of work to be done at all three schools to make these waste reduction programs as successful as they can possibly be, they have a major impact even in their current state.

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INTRODUCTION

Solid waste management is a significant environmental challenge in the modern world. Over the past century, the material "throughput" of societies, particularly industrialized societies including the United States, has increased dramatically for a variety of reasons such as mass production, increased incomes, marketing, and the development of single-use products (Strasser, 1999). This has led to waste production of approximately two kilograms per capita per day in the United States in 2012 (UNEP, 2016). While this has declined slightly since peaking in 2000, a total of 164 million metric tons of municipal solid waste is deposited annually in landfills or disposed of via other non-reuse systems like incineration. Another 87 million tons is diverted annually through recycling and composting (UNEP, 2016). Municipal solid waste presents a challenge compared with industrial waste in that it mixes a wide variety of materials from diverse sources, all of which must be dealt with together and disposed of in a way that is safe considering even the more damaging or toxic materials which may be present (Rootes, 2009). In the United States, this disposal is most commonly done in landfills, which accept 82 percent of non-recycled or composted municipal solid waste in the country (US EPA, 2014). These present their own environmental issues including groundwater contamination, air pollution, and land use (Moy et al., 2008) as well as political and environmental justice concerns regarding where landfills are sited (Martuzzi et al., 2010).

Food waste can comprise a significant component of the waste stream, and brings its own set of environmental challenges. Wasted food represents wasted resources put into its production and a social ill in a world where many people do not have enough to eat (UNEP, 2016). "Food waste" can be many things. It is defined by the United Nations Food and Agriculture Organization as "wholesome edible material intended for human consumption, arising at any point in the FSC [food supply chain] that is instead discarded, lost, degraded or consumed by pests" (FAO, 1981). Other definitions include Stuart's (2009) addition of food that could have been consumed by humans that is instead fed to animals or otherwise diverted from the human food supply chain. In this thesis I use the term "food waste" in the FAO definition applied within a cafeteria setting to represent food that was served or could have been served, but was not eaten. Other terms

like “compost” and “organics” refer to food waste as well as inedible portions of food such as fruit peels. I use these terms regardless of the eventual use of the material, if it is landfilled, burned for energy, bio-digested, or composted. This is because in a cafeteria setting the relevant options are to separate this material for re-use or leave it mixed with other waste as “trash”. In the United States, the USDA estimates that in 2010 133 billion pounds of food - or 31% of the total food produced - was not consumed (Buzby et al., 2014). When food must be disposed of in landfills, its decomposition in anaerobic conditions contributes to the production of methane, a potent greenhouse gas (Cheng & Hu, 2010). Despite these issues, and despite the fact that organic matter can be recycled by composting, the United States, sends approximately 97% of its food waste to landfills or similar disposal sites (UNEP, 2016).

There is also a large food-related waste stream that is not food itself. Packaging and single use serviceware like paper plates and plastic cutlery can dramatically increase the waste generated by food systems. Since World War II the variety of packaging materials, their use for branding, and their quantity has increased many times over (Strasser, 1999). Packaging has value in a globalized food system in that it allows food to be processed in one location and safely and efficiently shipped to consumers. It can help prevent spoilage or damage, which would otherwise result in more wasted food. However, food packaging also contributes in a significant way to the municipal solid waste stream (Marsh & Bugusu, 2007). Packaging (including both food packaging and other packaging as food packaging alone is not broken out in EPA figures) made up 76.7 million tons of municipal solid waste in 2006, or approximately 31% of all municipal solid waste produced that year (Marsh & Bugusu, 2007).

Institutional food service in cafeteria settings is one area that generates both food and food-related wastes that must be disposed of in volume (Wilkie et al., 2015). Studies have shown that meals served through the national school lunch program may end up wasting 20-50% of the total food served (Wilkie et al., 2015). Public school cafeterias are one food service location that present their own unique waste management opportunities and challenges. Students are more supervised than the general public, and eat in cafeterias daily. This supervision and consistency could potentially allow for better waste separation outcomes in schools than other cafeterias. On the other hand, schools are

resource-limited environments where staff have many competing demands on their time. Students also may not be interested in yet another task to complete (Simon, 2001). In this context, there has been an effort towards establishing more environmentally, and potentially economically, sustainable waste management practices in schools and their cafeterias (McKenzie & Smith, 1999).

School cafeteria waste reduction can provide positive environmental, economic, and educational benefits for schools and communities. It can also be difficult due to a variety of factors affecting schools, including constrained resources, limited time, competing priorities, and the challenge of altering an established way of doing things. In order to justify the effort expended on making changes to school cafeteria waste practices, I begin with an overview of the environmental, economic, and educational impacts of cafeteria waste reduction drawing on existing research into waste management and school waste reduction practices.

Solid waste, even non-hazardous waste like food and packaging that is generated in a cafeteria, has adverse environmental consequences. Final (non-reuse) disposal strategies most commonly used for waste in the United States include landfilling (53.8% of all municipal solid waste in 2012) and waste to energy plants that burn trash to produce electricity (11.7% of municipal solid waste in 2012) (US EPA, 2014).

The U.S. EPA has developed a waste hierarchy that places source reduction and material reuse as the most desirable method for dealing with waste, followed by recycling and composting, then waste to energy and finally treatment and disposal (Figure 1.1; US EPA, 2017b). Specifically for food waste, there is a separate hierarchy that specifies again, that source reduction is the environmentally best option for dealing with food waste, followed by feeding people, then animals, reuse in industrial processes, composting, and then landfilling or incineration (Figure 1.2; US EPA, 2017a).

The most desirable waste management option according to the waste hierarchy (US EPA, 2017b), not to produce waste at all, is known as source reduction. In a school cafeteria setting source reduction can take multiple forms, including washable serving trays and cutlery, preparing the proper amount of food, and allowing students to choose

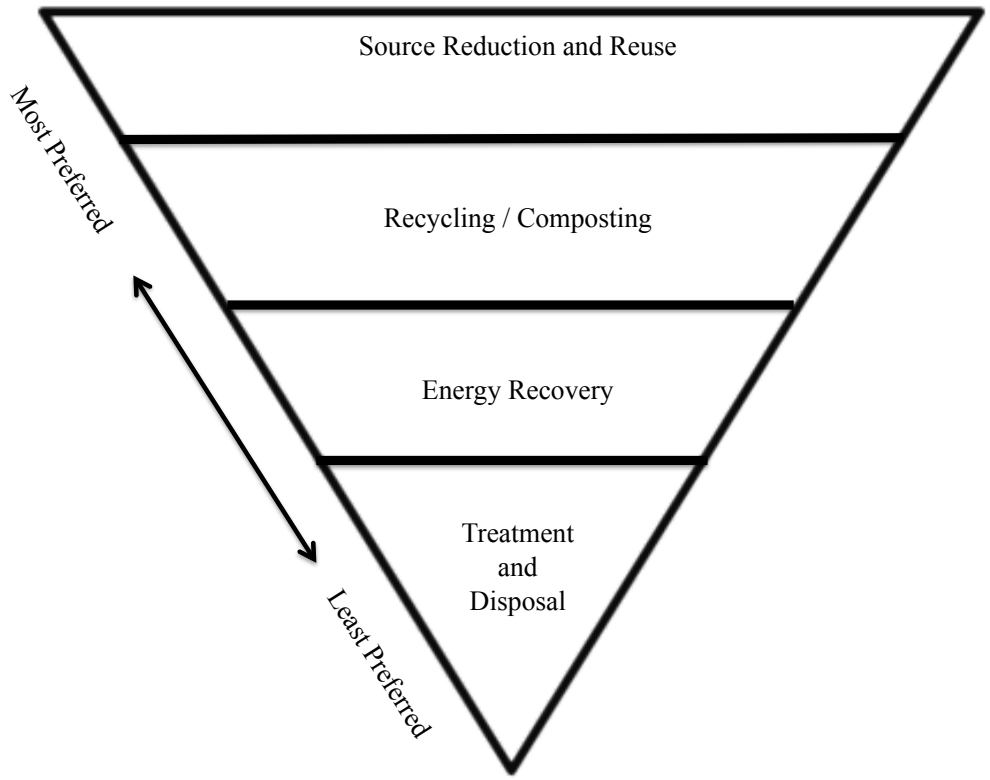

Figure 1.1: U.S. EPA waste management hierarchy (US EPA, 2014b).

the foods and quantity thereof that they take rather than forcing all students to take all foods regardless of their intention to eat them (Berry & Acheson, 2017). In some cafeterias the concept of a share-table, where students can place unwanted packaged food or fruit for other students to take, has been applied to successfully reduce food waste (Berry & Acheson, 2017). From an environmental standpoint, all these methods curtail cafeteria food waste production at the source and drastically reduce, or eliminate, resource use and pollution both from manufacturing and from disposal of the material not used (US EPA, 2017b).

Recycling allows material to be used again, preventing the need for disposal and reducing energy and raw material inputs for new products (US EPA, 2015). While the reduction in energy and resource consumption resulting from recycling varies by material type, net greenhouse gas reductions can range from 60% for aluminum cans to 15% for mixed paper (US EPA, 2015). Overall, however, life-cycle analysis indicate that

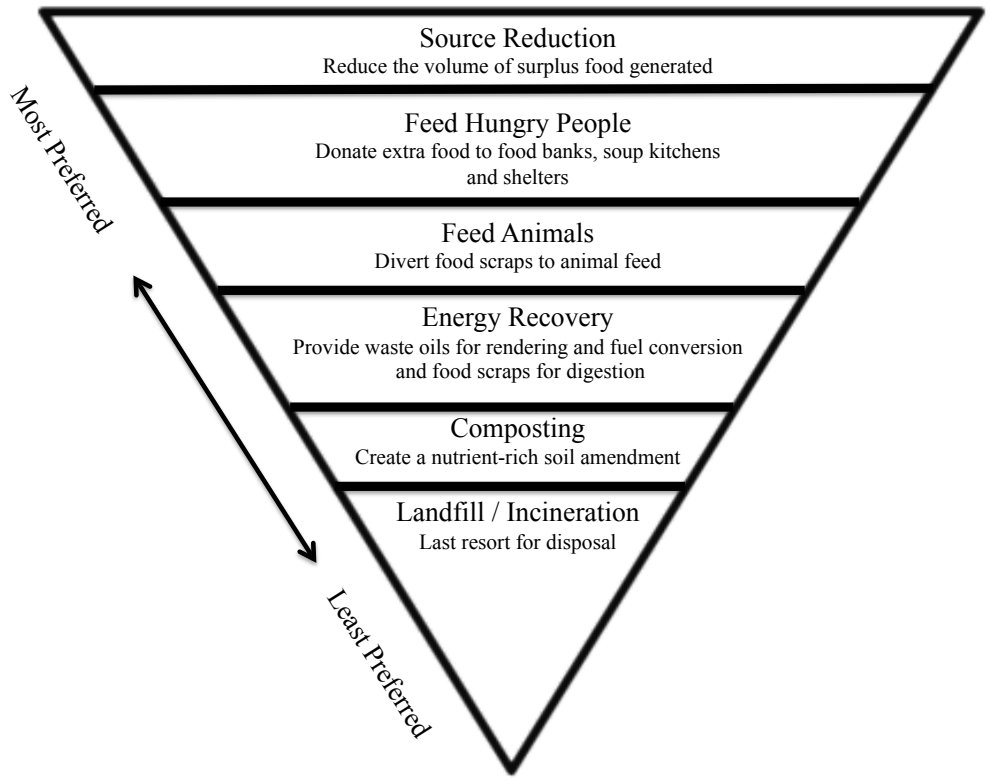

Figure 1.2: U.S. EPA food recovery hierarchy (US EPA, 2017a).

recycling is environmentally preferable to landfills in almost all cases and is overall preferable to waste to energy systems when accounting for energy consumption, pollution, and resource use (Björklund & Finnveden, 2005). In the 1960s and 1970s recycling was primarily driven by activists as an educational and community-building tool. It was a concrete action people could take against the damages of consumerism and a throwaway society. Early recycling emphasized community effort and volunteer engagement (Lounsbury, 2005). The educational and engagement component is still valuable today (Derksen & Gartrell, 2017), especially in schools (Clark, 2013; Evans et al., 2012). However, recycling has also become a major for-profit industry, improving its reach, efficiency, and real environmental impact, but potentially reducing its role as an activist activity (Lounsbury, 2005). The ability of recycling to provide cost savings through the market system makes it easier to implement and can multiply its benefits.

Composting, while less advantageous than source reduction or use of food to feed humans or animals, is frequently the only non-disposal option to deal with post-consumer

food waste. Waste from plates cannot be re-used by humans in a sanitary manner in a cafeteria setting, feeding animals requires very precise sorting and a relationship with animal owners or caretakers, and anaerobic digestion requires adequate facilities that may not exist in all areas. Organic material, including food, releases methane from landfills as it decomposes anaerobically, contributing to climate change in a much greater way than the carbon dioxide released during aerobic decomposition (Lundie & Peters, 2005). Further, burning food in waste to energy plants is often inefficient because of its high water content. This means that food contributes relatively little energy to the waste to energy process, but does produce carbon and particulate emissions (Chaya & Gheewala, 2007). Compost, therefore is a choice that allows cafeterias to dispose of food and paper such as napkins in a more sustainable way by converting them into a carbon-rich soil amendment that recycles the nutrients contained in the food. At an industrial scale, composting food waste can also reduce greenhouse gas emissions compared to landfilling (Levis & Barlaz, 2011).

Schools can spend significant amounts of money on waste management, depending on local conditions, and cafeterias can create over 100g of total waste per student per day (Wilkie et al., 2015) A common arrangement is that schools pay a set fee for a given number of weekly trash pickups, plus a tipping fee per ton of waste. For example, Charleston County schools in South Carolina report that their waste reduction program saves $1,300 per school per year for every weekday they avoid needing a trash pickup, among other benefits of the program (Clark, 2013). Composting companies may provide free pickup to institutional customers because they will make money selling the finished compost (e.g. Ramsay, 2008; Szczepanski, 2017). In order to realize savings, however, schools must pay attention to how they pay for disposal and adjust that method accordingly as waste volume decreases (Skumatz et al., 2014). A survey of Michigan Schools found that 40% of districts reported cost savings associated with their waste reduction programs, and 50% said costs remained the same or that they did not know if it saved money or not. The authors calculated that almost all schools would pay between $116 and $1,132 more per month without their school wide waste reduction programs (Skumatz et al., 2014).

In addition to the direct environmental and economic benefits of reducing waste to be landfilled, schools can use well-designed waste reduction efforts as a teaching tool. Environmental behaviors, including recycling, have the potential to cause "spillover" effects whereby participation in one behavior for the purpose of improving the environment (rather than a self-centered motivation like receiving compensation for doing so) can make an individual more likely to participate in other environmental behaviors (Evans et al., 2012). This can be especially important for schools where children are learning behaviors that they are likely to carry with them throughout their lives (Llargues et al., 2011). Not only can students be positively influenced to engage in pro-environmental behaviors, but can also be positive environmental influences on the rest of their families, introducing concepts of sustainability that they learn outside the home (Istead & Shapiro, 2014). This has been seen specifically with recycling programs in schools: the managers of a local water park near Charleston County schools have noted students explaining the park's food scrap separation system to their parents. The source of that knowledge on how to separate waste was believed to be the local school waste reduction program (Clark, 2013).

Why More Research

While lists of best practices and implementation techniques have been published (e.g. Schumpert & Dietz, 2005; Ward et al., 2014) and waste reduction initiatives are frequently reported on in popular media (e.g. Ansloiv, 2008; Ramsay, 2008; Bradley, 2015) there have been relatively few academic studies that attempt to assess a program years after it has begun. Studies like Wilkie et al. (2015) have quantified sorting in schools, and behavior is sometimes evaluated by looking at bin placement's effect on separation (e.g. Chong et al., 2015). What appear to be lacking are comprehensive studies that explicitly attempt to analyze school waste reduction programs in depth and in light of schools' context as educational institutions that serve children in an environment of limited resources.

In this thesis I examine an example of school-based cafeteria waste reduction efforts at three southern Maine elementary schools that all use a similar sorting station

model to reduce cafeteria waste. The three schools are Longfellow Elementary and Reiche Elementary in Portland, which implemented the program after Portland piloted it in 2012, and Falmouth Elementary in the town of Falmouth where it began in 2011. Chapter one begins with a review of relevant theory on institutionalized behavior and change, including portions of social practice theory, to contextualize the case study findings, and a brief summary of other school waste reduction programs reported on by articles in scholarly databases. Chapter two analyzes waste audits conducted at each school to capture a snapshot of how accurately waste is sorted and presents the available information on waste disposal volume. Chapter three expands on the waste audit analysis using interviews with interested staff at each of the three elementary schools. These interviews focus on the staff members' experiences with the program, particularly what they view as successful and challenging about it, and attempt to draw out what has been important in getting the program where it is today.

This research provides empirical examples of successes and challenges facing cafeteria waste reduction programs in public elementary schools as well as ideas on needed improvements from the people working directly with the programs on a daily basis. While the results do not exactly mirror the opportunities and challenges at other public and private schools, they provide a point of reference for program development, implementation, and improvement. This study aims to facilitate sharing of knowledge and experience between schools to give change agents additional context for their work.

CHAPTER 1: THEORETICAL BASIS FOR CHANGES LEADING TO WASTE REDUCTION IN SCHOOLS

Introduction

Solid waste management is a significant environmental challenge in the modern world. Over the past century, the material "throughput" of societies, particularly industrialized societies including the United States, has increased dramatically for a variety of reasons such as mass production, increased incomes, marketing, and the development of single-use products (Strasser, 1999). This has led to waste production of approximately two kilograms per capita per day in the United States in 2012 (UNEP, 2016). While this has declined slightly since peaking in 2000, a total of 164 metric million tons annually of municipal solid waste is deposited in landfills or disposed of via other non-reuse systems like incineration. Another 87 million metric tons is diverted annually through recycling and composting (UNEP, 2016). Despite the fact that organic matter can be recycled by composting, a natural process known to and used by humans for thousands of years, the United States disposes of 97% in landfills or other non-reuse systems (UNEP, 2016).

Institutional food service in cafeteria settings is one area that generates both food and food-related wastes that must be disposed of in significant volumes (Wilkie et al., 2015). Studies have shown that meals served through the national school lunch program often end up wasting 20-50% of the total food served (Wilkie et al., 2015). Public school cafeterias are one food service location that present their own unique waste management opportunities and challenges.

Waste disposal is not typically something most people give a lot of thought to, whether in a cafeteria or otherwise. It is simply a habitual action to accomplish their goal of ridding themselves of unwanted material. Klöckner & Verplanken (2012) define habits as "cognitive structures that automatically determine future behavior by linking specific situational cues to behavioral patterns." These patterns can be explored under a theoretical lens as practice theory. After discussing practice theory and its implications for environmental behavior, this section reviews some aspects of institutions and institutional change that fit with the practice theory model and will help ground the theory in concrete behaviors related to waste reduction.

Studies of behavior change in environmental contexts frequently focus on the behavior itself, using the institutional context only as a location to implement the study (e.g. Ansloiv, 2008; Cutter-Mackenzie, 2010). There is also a strong literature on institutional change and how it is implemented (e.g. Gortner et al., 1987; Burke, 2017) This leaves a need for studies examining the institutional changes that are in play alongside and as part of individual behavior change when institutions, like schools and their food service programs, want to implement pro-environmental changes like waste reduction.

In order to more effectively analyze the opportunities and challenges of school cafeteria waste reduction I first use social practice theory to identify a unit of change analysis and then examine theories of how that change can come about in organizations generally as well as specific manifestations of change that can be applied to school cafeteria waste reduction.

Practice Theory

Under the umbrella of cultural theory, practice theory takes the approach that the smallest analysis unit of human behavior and interaction is a "practice." Reckwitz (2002) defines a practice as "a routinized type of behavior which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge." This places habitual behavior in a larger social and personal context and gives practice theory the "capacity to describe important features of the world we inhabit as something that is routinely made and remade in practice using tools, discourse, and our bodies" (Nicolini, 2012).

Unlike other common theories of behavior, such as Ajzen's (1991) theory of planned behavior, practice theory removes the focus from the individual, and their values, beliefs, and preferences, choosing instead to emphasize interactions, knowledge, repeated motions, and social models (Bones, 2001). For example, practice theory integrates the idea of a technology (the physical thing) and its use. That use involves how people plan their projects incorporating its presence, how they physically interact with it on a routine basis, and how it changes their view of their work (Feldman & Orlikowski, 2011). Given

that practices combine explicit actions, interactions, and social contexts, they involve a certain amount of shared understanding, or as Collins (2001) puts it *tacit knowledge*. Tacit knowledge is a context-based understanding of how to behave in a given circumstance. It is not simply knowledge of the "rules" but an understanding of what the expected consequences of multiple actions, routine or actively considered, will be. For example, a bicyclist might exchange a glance with a driver that allows him or her to feel safe crossing an intersection, but that interaction involves tacit knowledge of the rules of the road (and their enforcement), social norms of drivers, the bicyclist's own confidence in his or her biking skill, and the ability to interpret facial expressions within their cultural context (Collins, 2001). In this case the practice of crossing the intersection on a bicycle is influenced by a broad array of tacit knowledge. Another major tenant of practice theory is that everyday actions matter. They produce and reproduce structures that are important features of our lives and have impacts on the broader social order (Feldman & Orlikowski, 2011; Nicolini, 2012). Practices are also "taken for granted and engrained in the natural order of things" (Nicolini, 2012), making their study a useful way to uncover why behaviors do or do not change.

For the study of environmental initiatives, specifically waste reduction and waste reduction in schools, practice theory suggests some fundamental variables to investigate:

- **Actions:** Fundamentally practice theory is about repeated actions (whether physical, mental, emotional, etc.) and their development in a given context (Reckwitz, 2002)
- **Institutional context:** Practices are carried out within a social and institutional context (Reckwitz, 2002)
- **Interactions between people:** Practice theory emphasizes how an individual interacts and engages in repeated behavior (Bones, 2001)
- **Knowledge**: Practice theory includes the importance of knowledge, particularly tacit knowledge (Collins, 2001)

Waste disposal and reduction fit this method of analyzing behavior precisely because it they are small, repeated actions that occur in wide-ranging social contexts that stretch from the materials an individual has access to (and therefore must dispose of), the type and placement of receptacles in public and private spaces, and the broader

environmental, economic, or ethical considerations a person may have regarding the disposal of waste.

Hypothesized Characteristics of Practice Theory in the Waste Reduction and Environmental Change Literature

Past studies of waste management for environmental goals support the hypothesis that the above factors matter. Waste reduction can be viewed as a socio-technical transition along the lines of Shove & Walker's (2010) use of practice theory to examine green transitions more generally. For example, a workplace waste audit by "green champions" allowed them to expose the previously hidden results of everyday practice (Hargreaves, 2011). These same champions reported feeling uncomfortable attempting to change behavior after the audit, a feeling the author attributes to being the ones to expose and challenge an existing practice, which complicates their interaction with fellow employees. They had to move outside the comfort and security that established practices provide and attempt to consciously implement a new one, including establishing a new set of tacit knowledge (Hargreaves, 2011).

In a 2010 study in one West Coast city, researchers found that infrastructure and bin placement, as well as lack of precise knowledge of recyclable materials was what prevented recycling from becoming normative at a school. The students already valued recycling, but did not see it as easily doable, preventing it from becoming a practice (Prestin & Pearce, 2010). The institutional context and knowledge were not available to establish it as one.

Social norms, habits, and practices may be particularly important in pro-environmental behavior because a person's history and habit of engaging in a given behavior may influence their likelihood to do so again independently of conscious decisions or values (Hing Lo, 2015). This supports the hypothesis that knowledge and actions help establish practices. Cialdini's (2003) distinction between descriptive norms, which are demonstrated actions implying their acceptability, and injunctive norms, which are direct social approval/disapproval, can be useful to understand this phenomenon and integrate it with human interaction. For example an office may post information saying that 75% of employees turn off lights when they leave to show that saving energy is a

descriptive norm and hopefully create a new practice among the other 25%. An injunctive norm in the same situation could be employees making a point to mention turning off the lights around a colleague who does not do so routinely (Ruepert, et al., 2015). This focus on practice theory is not to say internal factors do not play a role in determining behavior, and there are studies demonstrating that they do (e.g., Izagirre-Olaizola et al. 2015), but that social practice does matter as part of explaining behavior and its change.

Institutions can be defined as "performance scripts that provide stable decisions for chronically repeated activity sequences, deviations from which are counteracted by sanctions or are costly in some manner" (Jepperson, 1991). The implementation of these "performance scripts" could also be looked at as "practices," as they are individual repeated actions and pieces of shared knowledge that help make up the institution. Institutions are also seen as providers of "stability and persistence" by Garud et al. (2007) who also note how "institutional arrangements confer legitimacy" in part because people know what to expect from them. These institutional factors help solidify actions and knowledge, as suggested by practice theory. If behaviors are too defined by top-down management by an institution, however, to the point that a person feels they have no autonomy in their environmental decision-making the fact that they engage in pro-environmental behavior may not strengthen their desire to continue engaging in that behavior (Ruepert et al., 2015).

Further support for waste reduction as a practice rather than a reasoned choice comes from Flagg & Bates' (2016) finding that there was no significant relationship between university students' tested knowledge of local recycling guidelines (which would enable them to participate in campus waste reduction) and any tested measures of environmental awareness or engagement. They conclude that recycling is a "normative" activity that is only marginally impacted by environmental concerns for most participants (Flagg & Bates, 2016). On the surface this provides evidence against knowledge as a key factor in establishing practice, but at the same time it confirms that knowledge of social norms, which could be considered part of the tacit knowledge involved in practices, is very important.

Other Factors in the Literature

Besides the ideas already established from practice theory, the literature around waste reduction and environmental behavior change suggests some other factors that may be important but do not fall into the categories already identified. These include barriers to participation, effective interventions, and monitoring and evaluation. Low barriers to participation are key in almost any recycling program (Chong et al., 2015; McKenzie-Mohr & Smith, 1999; Prestin & Pearce, 2010). As McKenzie-Mohr and Smith (1999) conclude: "sustainable activities that are inconvenient typically have low participation rates." Locating recycling bins in more convenient areas, such as classrooms, rather than only in common spaces has been shown to increase their use, demonstrating a concrete example of this principle (O'Connor & Lerman, 2010).

Some authors focus on interventions as a path to environmentally beneficial outcomes. Two relatively passive forms of interventions to change practices are informational and instructional interventions (Ones & Dilchert, 2013). These focus on teaching people why and how they should change their behavior, with the hope that it will eventually become a practice. Other interventions target emotions and motivation (Levis & Barlaz, 2011). Commitment, asking people to publicly or personally commit to a change, is also frequently considered a highly effective behavior change intervention (Lokhorst et al., 2013). Interventions are temporary; they are a means to achieve a shift in practice, where the change becomes relatively permanent.

Cutter-Mackenzie (2010) asserts that a new waste reduction program, like any environmental initiative, should be monitored and analyzed over time to determine its impact and if actions are actually changing outcomes. Without analysis program organizers have no way of knowing if the desired results are being achieved and if practices are changing as hoped. While waste reduction efforts can have real environmental and educational benefits, it is important to consider if they are truly engaging in what Laszlo and Zhexembayeva (2011) call "embedded sustainability" or if they are an example of "bolted on sustainability efforts that were the norm in the business world in the 1990's and early 2000's (Laszlo & Zhexembayeva, 2011). Analysis and follow-up can help determine if this is the case or if a program is truly making a difference.

Methods

Working from practice theory as a model for behavior that emphasizes institutional context, this chapter introduces theories of institutional change as they are seen in publications relating to school waste reduction. The purpose is to introduce actual cases of school programs to provide context for the theoretical elements described above and the case studies that follow.

Search Methods

I analyzed publications found in the *Environment Complete* and *GreenFILE* databases from both academic and industry sources using the keywords "cafeteria recycling", "cafeteria composting", "cafeteria waste reduction", "school waste reduction", "school composting", and "school recycling." I included all articles from those searches that dealt explicitly with specific K-12 schools (not colleges or universities and not general guidelines on how to start a program). I recorded information, when available, about when and how the program began, what is working well, what is challenging, key individuals involved, and organizational structures that allow it to function (Appendix A).

Data

School waste reduction is a field with relatively few formal studies, and far more examples of school waste reduction programs are published in news format than as rigorous academic studies. Using environment-focused academic databases, my search terms returned 28 news articles and only 1 scholarly article based on a conference (Appendix A). This brief review of school waste reduction publications from two databases is not intended to be exhaustive, nor a representative sample of school programs. The very limited sample size prevents it from being either. It is a sample of programs to analyze drawn from a known reputable source. This method of database search and recording data categories as a means to summarize a literature is similar to the approach taken by Franche et al. (2005), although on a smaller scale so as to give

examples rather than review the entire field. The categories of data I attempted to collect from each article are detailed in Appendix A. Considering that the sample consists of news articles, often only a few paragraphs long, not all information was available for each article; therefore, a lack of information about a given variable does not signify the absence of that variable.

Analysis

I begin with descriptive findings on the characteristics of the programs reviewed, including the origins of the programs, their successes, key institutional and person-based factors enabling those successes, and challenges they face. In the discussion I look into how the following principals from practice theory apply to the results:

- **Actions:** Fundamentally practice theory is about repeated actions (whether physical, mental, emotional, etc.) and their development in a given context (Reckwitz, 2002)
- **Institutional context:** Practices are carried out within a social and structural context (Reckwitz, 2002)
- **Interactions between people:** Practice theory emphasizes how an individual interacts and engages in repeated behavior rather than on their internal motivations (Bones, 2001)
- **Knowledge**: Practice theory includes the importance of knowledge, particularly tacit knowledge (Collins, 2001)

Results

Among the 29 articles in the final sample, seven were announcing new (launched within the past 6 months) programs, and 13 more documented a successful first year or pilot program. This leaves relatively few studies of long-term successes or challenges in school waste reduction. Only five articles discussed programs at least three years old. The 29 articles refer to over 162 schools participating. It was sometimes clear that the article referred to more than one school, but did not give a specific number, meaning the total number of schools was more than 162. Organizational levels varied from individual schools in 16 of the cases to districts or parts of districts with up to 35 schools. Schools

were located in 19 U.S. states plus one in England and one with an unknown location in the United States (Figure 1.1).

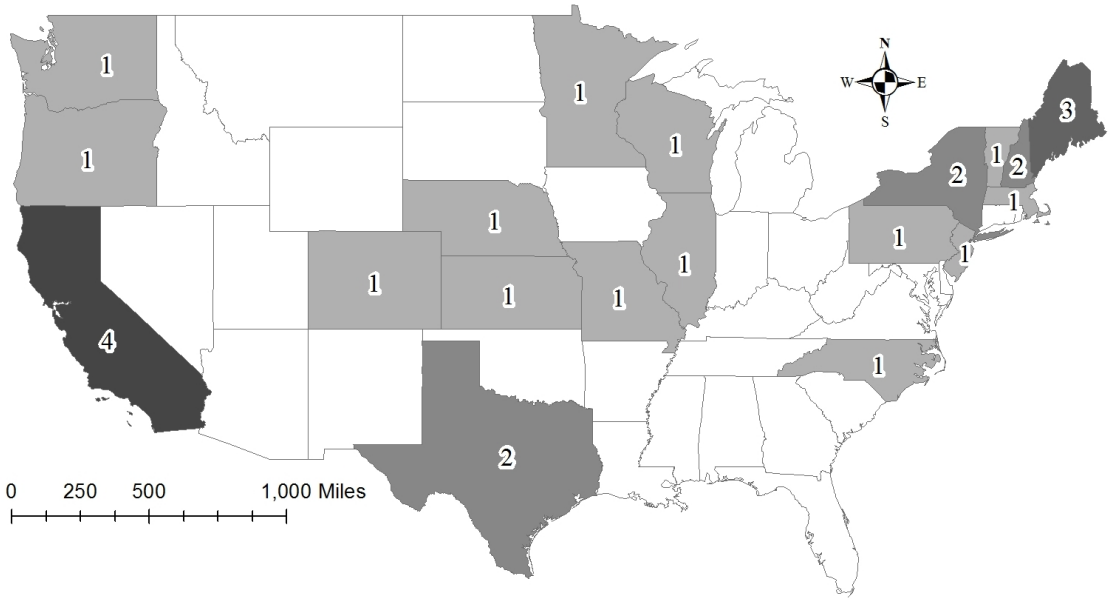

Figure 1.1. Locations of the 29 waste reduction programs analyzed. Numbers represent the number of programs reported in articles for each state. Not pictured: One program in England and one with an unknown location in the United States (Appendix A).

There were many different types of programs represented. Twenty-five of the articles discussed waste reduction that included the cafeteria. The remainder were primarily recycling programs for paper and other products used throughout the school, although many articles that included cafeteria programs also mentioned waste reduction efforts in other parts of the school. Composting programs were the most common, with 24 articles discussing them. There were also 12 recycling programs, seven of which overlapped with composting programs. The two articles including source reduction projects paired them with composting programs.

Origins

Programs began for a variety of reasons. The most common reason to start a program was cited as a waste audit showing that a large portion of the waste stream could be composted or recycled, with five articles mentioning that catalyst. The next most common reasons, with four articles citing each, were a law or government entity

requiring or offering assistance in waste reduction, and student initiative for sustainability.

Program Successes

Program successes included waste reduction and student engagement. Over two thirds of the articles, 22 out of the 29, mentioned a reduction in trash volume as a result of the program (Table 1.1), and 14 of those presented specific figures regarding waste or budgetary savings. Five articles recorded reductions in cafeteria waste of over 70% after beginning recycling and composting programs, including three reporting savings of 90%. This was the most frequently cited benefit. However, 7 articles also cited an increase in student engagement with environmental and waste issues as a result of their program, and three specifically mentioned cost savings, including two cases that reduced the number of weekly trash pickups the school(s) needed (Table 1.1). One article also mentioned benefits of using compost for a school garden.

Key Enabling Factors

Programs were initiated and sustained by a variety of people and outside partners. Teachers were the most frequent champions of programs, with their involvement mentioned by 11 articles. Students were similarly important, with 10 articles including them. Student involvement varied; a kindergartner wrote a letter to the principal about recycling with help from his mother, high school students started a program as their senior project, and green team members worked with a teacher. Nine articles cited administrators as key contributors to waste reduction success and five cited custodians. Three cited food service staff and two school or district sustainability coordinators. Outside partners were mentioned eight times and included five parents and one each of an NGO, government agency, and for-profit compost company.

Organizational factors present at the schools helped make programs work. In the programs reported on by seven of the articles, materials or services, such as bins or collection, were donated to make the program financially viable at least during a trial period. Six articles also mentioned students doing at least some of the work, whether monitoring bins, bringing material to a compost pile, or publicizing the program. One

program found that waste needed to be placed in different locations on the curb so that the hauler knew what was trash and what was recycling, while another found that recycling bins needed to be available throughout the school, and yet another that compost, trash, and recycling all needed to be located together. Although they can be expensive, two articles reported that schools found using compost bin liners prevented complaints about odor and made removal easier.

Interventions made to start programs included signs directing students how to sort (3 articles), a school wide assembly (1 article), and peer educators visiting classrooms to conduct bilingual trainings (1 article). Twelve articles also mentioned including the waste reduction program in the curriculum in some way, making it a teaching tool.

Table 1.1. Most common program successes reported about waste reduction programs in studied articles

Program success	Number articles	State/Country	Program type
Reduced waste	22	CA, CO, IL, KS, MA, ME, MN, NC, NE, NH, NY, PA, TX, WA, WI, England, Unknown	Composting, Recycling, Recycling/Composting
Student engagement with environmental issues	7	CO, ME, NC, NJ, NY, WI, OR	Composting, Recycling/Composting
Integration into the curriculum	3	CA, MO, NH	Composting
Save money	3	MA, MN, MO	Composting, Recycling
Reduced trash pickups	2	CA, MN	Composting, Recycling

Challenges

Eight articles emphasized how waste reduction in schools can be challenging, with a variety of reasons why (Table 1.2). The most prominent issue was a lack of sorting at some level. This included one program that found that students only sorted waste when a monitor was physically sitting at the bins (Kadleck, 2015a) and another where waste was sorted by students but mixed up when placed on the curb for collection (Ward et al.,

2012). Regarding cost, a program was temporarily shut down due to an increase in compost hauling fees brought about because the compost company was losing money on transporting the waste (Szczepanski, 2017). The cost of compost bin liners or "biobags" was also mentioned by two of the articles citing cost as an obstacle. Other challenges included difficulties getting people to accept a new systematic program after many smaller efforts had tried and failed to implement recycling on an individual scale at the same school.

Table 1.2: Most common problems reported with waste reduction programs in reviewed articles.

Program challenge	Number articles	State/Country	Program type
Diverted waste mixed with trash	4	NH, NJ, WA, Unknown	Composting, Recycling, Recycling/Composting
Cost	2	CO, OR	Composting, Recycling/Composting
Storing material for pickup	1	NC	Composting
Overflowing bins	1	England	Recycling

Discussion

This review suggests that the factors identified from practice theory: actions, institutional context, interactions between people, and knowledge have varying degrees of importance in different programs. Additionally, this sample of relatively young programs indicates that interventions are being used and that evaluation and monitoring allow a program's success or lack thereof to be assessed.

The set of programs reviewed does not offer a perfect sample of all school waste reduction programs, but it does provide a base of examples that can illustrate situations in which institutional changes can occur (or not) and to see how these attempts at change play out in the real world. The dominance of composting programs is likely because many of the articles came from the composting-focused trade magazine, *BioCycle.* The heavy skew toward news, rather than scholarly, articles likely produced the bias toward

one year old programs, because one year is a convenient time for a news story to talk about a program after it is up and running. Even in this relatively small sample, the fact that well over 162 schools were represented shows that waste reduction is a concern in a wide variety of schools and geographic locations (Figure 1.1).

Programs in the Context of Practice Theory

Schools are institutions, embedded within the larger institutions of school district and the public sector. Jepperson's (1991) definition of institutions as "performance scripts" implies that schools both have the power to compel individuals involved (particularly students, but also teachers, administrators and other staff) to engage or not engage in a behavior like waste reduction. The other side of that is that is difficult to change those "performance scripts," in this case meaning how waste is disposed of. Until such "performance scripts" are changed, a deviation from them, in this case composting or recycling, is seen as "costly in some manner" (Jepperson, 1991). The implementation of these "performance scripts" could also be looked at as "practices," as they are individual repeated actions and pieces of shared knowledge that help make up the institution. The fact that "institutions focus on continuity" (Garud et al., 2007) can in part explain some of the challenges faced by schools in the articles analyzed. Contamination, the most frequently mentioned issue, is likely a result of people continuing to use the same patterns (practices) of waste disposal that they did before separation became possible. This may be because not sorting is initially faster or because it does not require additional knowledge. As practice theory suggests (Bones, 2001), knowledge of how to use the system as well as knowledge that sorting is a social expectation (knowledge as a part of practice) are both likely to influence the enactment of waste disposal practice as an everyday action. Without knowledge of how to use the system (which can be taught) sorting will not become a practice, however, knowledge alone is not enough, as suggested by the other factors identified including actions, interactions, and context.

Knowledge of existing practices played a role when such knowledge became available after a waste audit showed a shocking amount of waste at many of the schools. When people became aware of the results of current practice, it encouraged change. These changes, as indicated by the cases examined, do not come easily. In the case of

schools, the challenges appear to be in spreading the daily practice of environmentally friendly waste disposal, not in arriving at the idea.

In order for change to be successful in schools, support from the administration is usually necessary (Bradley, 2015). This would be part of the institutional context that also plays out in interactions between administrators and others at the school. The articles cited administrators as key program drivers. There were also direct attempts to influence administrators, such as writing a letter to the principle (Waste 360 Staff, 2016).

Two high school seniors who started a program had to sit by the bins every lunch period in order to prevent contamination (Kadleck, 2015a). The action to change waste disposal habits had not yet become a practice even though the knowledge and institutional context were present, as evidenced by correct sorting when interacting with the two seniors through their presence. In one case a recycling program lacked legitimacy because it was compared to the string of failed programs that came before it, leading to an ingrained sense that recycling could not work even though the champions of the current program believed differently (Kadleck, 2015b). This is an example of only portions of the practice changing. The actions (waste sorting) were not habitual nor was the social expectation to engage in them present.

Experiments have shown success when combining a prompt that addresses the knowledge aspect of practice with a model of the action through interaction with the modeling person (e.g. Sussman et al., 2013). Sussman et al. (2013) also found that combining written prompts with behavior models significantly increased composting in a school cafeteria from 12.5% of waste to 42%. Importantly, they continued to observe the improvement even after the behavior models were removed. This validates the strategies employed by Biocycle (2009) and Ansloiv (2008) to have bin monitors or "bin buddies" who modeled proper sorting, combined with signage.

Another consideration is employee and student autonomy in environmental decision-making. While this might be seen as negative in some ways (people will choose not to engage in waste reduction, for example) it can also lead to more support over time (Ones & Dilchert, 2013). The issue of inability to choose to reduce waste due to the kinds of materials used in packaging and a lack of disposal options could have led to student action in the form of environmental clubs and other such organizations. In 10 of the

programs students, often as environmental clubs and in collaboration with teachers, pushed for institutional infrastructure that allowed for waste reduction.

Additional Factors From the Literature

Particularly in schools where there are many competing demands for student and staff time, sustainability activities are unlikely to be successful unless they are easy and well-integrated into the school day (Kress & Elias, 2013). The articles reviewed did not identify many ways schools lowered barriers to participation other than ensuring trash, recycling and compost bins were clustered (Hayes, 2013), and located throughout the school (Tales, 2013). As indicated by a mix-up where recyclable and non-recyclable trash was placed side-by-side on the curb (Ward et al., 2012) it may also be necessary to simply make sure infrastructure, such as collection bins, signs, and hauling plans, are in place and functioning property (Preston & Pierce, 2010). If waste reduction is seen as a shift in practices, lowering barriers facilitates the adoption of the new practice during the phase when it is not yet automatic. As seen above when students did not pay attention when others were not physically present, an easier system might improve the number who would not need that presence. It may also be the case that barriers need to be lowered to a certain extent (such as having sufficient bins located together and in useful locations) which, once reached, becomes sufficiently convenient that focus should shift to creating a new practice.

Passive interventions in the form of a school-wide assembly to announce the new program (Block, 2000), bilingual trainings for classmates in individual classes (BioCycle, 2016) and signs detailing what to put in each bin were revealed in the literature review, showing that they are at least attempted. While emotions and motivation based interventions were not explicitly mentioned in the articles, it seems likely that at least for some students the information from the waste audits was sufficient to provide motivation. Commitment motivation was not present in the articles analyzed.

At least 14 of the programs profiled performed some form of analysis, as they provided numerical or percentage reductions in waste or cost. The dramatic nature of the waste reduction, frequently over 70%, shows that these programs can in fact be effective. Measuring their success helps make the case to expand them so that they become

systematic rather than isolated cases. Some of these programs are likely demonstrating the "embedded sustainability" described by Laszlo & Zhexembayeva (2011), while others may not be. Combining composting and recycling with source reduction, as is done in two of the programs analyzed is a form of embedded sustainability, as it looks at the entire waste process and seeks to follow the waste reduction hierarchy (US EPA, 2017b). A less waste-oriented culture is also likely in schools that incorporate their composting programs into the curriculum and engage students in the process as 12 articles mentioned. In some school districts only a select few schools participate, showing evidence that waste reduction is programmatic and not necessarily something the entire district is committed to.

This analysis of a small sample of 29 school waste reduction programs provided evidence and context for the use of practice theory to look at such programs. However, the small sample size and inconsistent data reporting methods mean it should be seen as illustrative rather than definitive or a source for concrete numbers. Articles were likely slanted by the fact that many appeared in a compost industry trade publication and by the fact that most programs were one year old or less. Given the number of schools in the United States, it is impossible that 29 articles come close to estimating the extent of waste reduction efforts nationwide. Further analyses could seek a more representative sample of programs to quantity efforts and outcomes nationwide.

Conclusions

Reviewing a sample of published accounts of school waste reduction efforts reveals that institutional factors predicted by practice theory and the literature to impact their functioning do in fact play a role.

School cafeterias present both opportunities and challenges when reducing waste. They produce large quantities of material that can potentially be eliminated or diverted, resulting in environmental and operational benefits. They are also, however, part of institutions with very limited resources and time and such programs therefore must be very well thought out and efficiently run in order to be effective. In the following chapters I analyze three specific cafeteria waste reduction programs at elementary schools in Southern Maine.

CHAPTER 2: SORTING AND DISPOSAL ANALISIS THROUGH WASTE AUDITS

Introduction

Solid waste is a serious environmental concern in the modern world (Rootes, 2009). In the United States, 164 million metric tons of municipal solid waste is deposited in landfills or disposed of via other non-reuse systems like incineration every year (UNEP, 2016). Another 87 million tons is diverted annually through recycling and composting (UNEP, 2016). This implies a solid waste generation rate of approximately 2kg per person per day.

Schools, like other large institutions, produce large quantities of solid waste that must be managed and disposed of. One major source of waste in schools is cafeterias, where students eat lunch (and often breakfast as well) daily. Mean cafeteria waste was measured at between 50g and 137g per student per day by Wilkie et al. (2015). This waste includes both packaging/serving material and uneaten food. Food waste is compostable, and much of the remaining waste is made up of paper, cardboard, plastic, metal, and other recyclable materials (Wilkie et al. 2015). Implementing a system to capture those materials and reduce landfilled waste not only benefits the environment in the form of reduced waste but, as seen in the introduction, also helps teach students environmentally friendly habits and can reduce trash hauling costs to schools (Evans et al., 2012; Skumatz et al. 2014)

In the analysis of news articles relating to school waste reduction in chapter 1, the most common reason (16% of programs, most did not give a reason) why the program was started was that the results of a waste audit indicated a large proportion of recyclable and/or compostable material in the waste stream that was being landfilled. A waste audit is a method of researching waste by sorting the waste generated in a particular facility over a specified period of time. It categorizes and quantifies the waste stream in order to produce data that can be used for education, program implementation, or program assessment.

A 2001 study of all waste generated on the University of British Columbia, Columbia, campus was designed to comprehensively assess materials generated and their quantity across space and time on the campus. This led to conclusions that about 70% of

the easily divertible waste was organic material and recommendations to look into the feasibility of a composting program (Felder et al., 2001). A similar audit at University of Northern British Columbia found that 70% of total waste could be diverted (Smyth et al., 2010). The previously mentioned studies characterize waste a higher education institutions, but there are few published examples in public K-12 schools such as the audits conducted by Wilkie et al. (2015).

This chapter contributes to the waste audit literature in elementary schools by assessing the existing waste reduction programs at three public elementary schools in Southern Maine using one-day waste audits to analyze the programs as advocated by McKenzie & Smith (1999). It attempts to answer the questions:

- How is waste sorted in each school's cafeteria?
- What waste and how much is being generated in each cafeteria?
- Are there differences between schools in either waste sorting practices or waste generation rates?

Methods

I conducted waste audits at three elementary schools in southern Maine: Falmouth, Longfellow, and Reiche elementary schools (Figure 2.1). These schools represent a range of urban to suburban locations, and larger versus smaller school districts. They also include a range of socioeconomic conditions and levels of funding (Table 2.1). These variations mean that the results can both be compared to a wider variety of schools around the country (rural schools are not included in this sample, which makes it a closer match for Southern Maine conditions than for the state as a whole) but also that care should be taken to consider when differing contexts contribute to how their waste reduction programs function and that some parameters studied may be overridden by these contextual differences. Considering these limitations, the three case studies do allow for a comparison of three programs that use a similar method for waste reduction in a relatively small geographic area (Figure 2.1) and the differences between the schools mean that the study is able to potentially see more methods of running waste reduction programs under different conditions.

Study Locations

Falmouth Elementary School is a K-5 elementary school that is the only public elementary school serving the suburban town of Falmouth, Maine. It has a student population of approximately 925, making it among the largest elementary schools in the state. The school was recently built to LEED standards and is the only school in this study with a dedicated cafeteria space and its own kitchen to prepare lunches. Approximately 48% of the student body receives school lunch on a given day and 7% qualify for free or reduced price lunch due to family income. I audited waste from all students in grades 1,2,3 and 5.

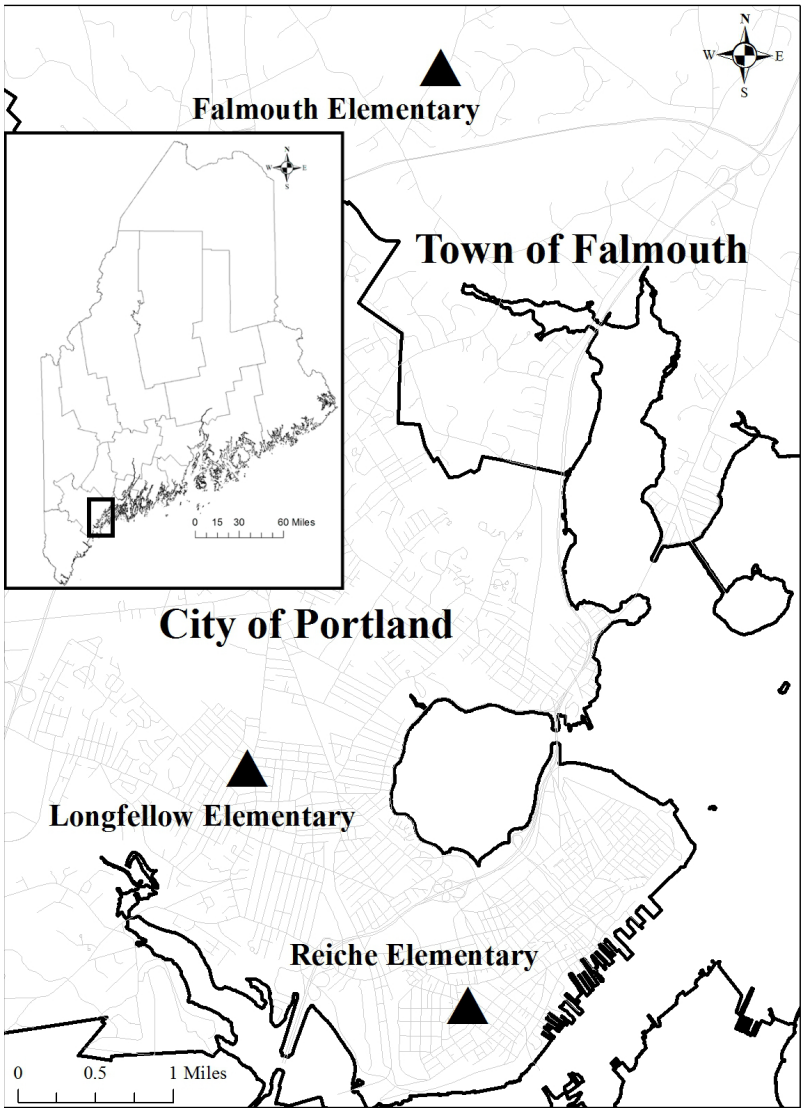

Figure 2.1. Locations of case study schools.

Longfellow Elementary School is a K-5 elementary school that is part of the Portland Public Schools in Portland Maine. It serves a primarily residential area in the Deering Center neighborhood of Portland. Its student population is 325. The school does not have a dedicated cafeteria or kitchen, so grades K,1,3, and 4 eat lunch in the gymnasium while grades 2 and 5 eat in their classrooms. Approximately 26% of students eat school lunch on a given day and 25% qualify for free or reduced price lunch due to family income. Food is delivered daily from a school district central kitchen in individual serving packages. I audited all waste for students in grades K,1, 3, and 5.

Reiche Elementary School is a pre-K-5 elementary school that is part of the Portland Public Schools in Portland Maine. It serves an urban residential neighborhood on the Portland peninsula. Its student population is 404. The school does not have a dedicated cafeteria or kitchen, so students eat lunch in an open auditorium space. Approximately 70% of students eat school lunch on a given day and 77% qualify for free or reduced price lunch due to family income, although the school provides free lunches to all students if they wish. As with Longfellow, food is delivered daily from a central kitchen in individual packages. I audited all waste from students in grades 2 and 5.

Waste disposal in the Greater Portland area, where all three schools are located, is generally accomplished by either municipal or private haulers delivering trash and recyclables to EcoMaine, a regional non-profit waste management organization. Trash is burned in a waste to energy plant to generate electricity, with the ash landfilled nearby. Single stream recyclables are sorted in an automated plant and sold in bulk. EcoMaine's website contains promotional materials demonstrating recyclable and non-recyclable wastes, with the goal of zero contamination (EcoMaine, 2017). The recycling plant operates best with 7% or less contamination by volume in incoming recyclable materials, although it can handle slightly more than that and 15-23% is the industry standard (K. Venhuizen, pers. comm., 26 February 2018) In this analysis all totals are presented as weight, not volume, so percent contamination is not directly comparable to this 7% standard. EcoMaine will reject loads of recycling that are too heavily contaminated, sending them to the waste to energy plant instead (K. Venhuizen, pers. comm., 26 February 2018). Smaller private composting companies that pick up directly from the schools handle the food waste.

Table 2.1. Summary of schools where interviews were conducted

	Falmouth	Longfellow	Reiche
Location	Falmouth, ME	Portland, ME	Portland, ME
Grades	K-5	K-5	Pre K-5
Students at school	925	340	404
Approx. % hot lunch	49%	26%	70%
% Free/Reduced lunch	7%	25%	77%
District spending/student (2017)	$18,690	$16,580	$16,580
Kitchen on site	Yes	No	No

Procedure

The audits were organized with help from interested school employees and the custodians working in the lunchrooms. Based on the availability of space and collection logistics, I selected grades to audit at each school. I ensured a balance of ages by making sure that for every grade K-2 that was audited, one grade 3-5 was also audited.

I sorted the waste from the recycling and trash bins into three categories: recyclable (all three schools use single stream recycling through EcoMaine, and EcoMaine's published recycling list was used to determine recyclable material (EcoMaine, 2017)), trash (non-recyclable and non-food), and food waste. Any liquid remaining in containers was poured off, and the difference in starting weight and the cumulative weight of the sorted components was assumed to be liquid. All waste was weighed in plastic trash bags to the nearest 0.5g. I also separated the two most common items in the recycling bin and the two most common recyclable items in the trash bin, and weighed each.

Finally I weighed the material in the compost bin at Longfellow and Reiche without sorting it due to logistical constraints and cleanliness concerns. Falmouth uses a different compost procedure that includes mixing their liquid waste (milk and juice) with the compost meaning it was not possible to remove from the tote and would not have been comparable to the other schools' numbers.

Results

All three schools diverted waste from the regular trash that would otherwise have been burned in EcoMaine's waste to energy plant (table 2.2). A breakdown of the raw quantities of waste in each bin by school is shown in table 2.3.

Table 2.2. Actual percentages of waste diverted from the trash stream, after accounting for recycling contamination at each school audited.

	Falmouth	Longfellow	Reiche
Reduction in waste not including organics bin	53%	35%	33%
Reduction in waste including organics bin	*Not Measured	67%	70%

Table 2.3. Summary of total waste generated by audited lunches at each school.

	Falmouth	Longfellow	Reiche
Grades Audited	1,2,3,5	k,1,3,4	2,5
Date of Audit	1/8/18	1/24/18	2/6/18
Total trash bin (g)	3956.5	2429.5	4155.0
Total recycle bin (g)	5627.0	9250.0	3657.0
Total food bin (g)	*not measured	11323.5	10086.0

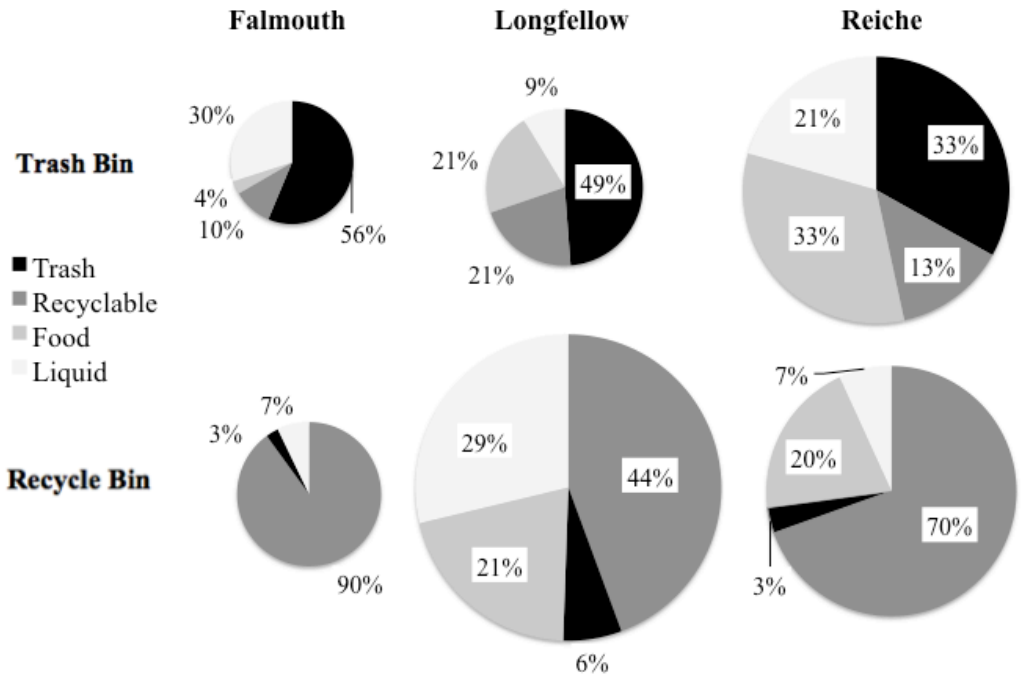

Figure 2.2. Percentage of the waste in each bin that is trash, recyclable, food, or liquid.

Sorting Accuracy

The quantity of recyclable material compared with non-recyclable material present in the recycling bins at each school varied widely. The same is true of the trash bins (Figure 2.2). Falmouth had the overall most accurate sorting, with only 10% contamination by weight in the recycle bin (and no food in that bin, although some milk) (Figure 2.2). Falmouth's trash was also the most accurately sorted, with 56% of the material in the trash bin actually being trash and 44% being recyclable or compostable. Longfellow had the least accurate overall recycling, with 56% contamination by weight. Almost 1/3 of the recycle bin weight (29%) was liquid contamination, and another 21% was made up of compostable organics. Longfellow's trash was similar to Falmouth's, with 49% accurate material and 51% recyclable or compostable material. At Reiche, the situation was the reverse of Longfellow, with more accurate recycling (only 30% contamination, 70% of the material should be there), and a trash bin with trash as only 33% of its contents, the rest being recyclable or compostable. Most of the recycling contamination at Reiche (20% of the bin weight) was compostable food waste, with

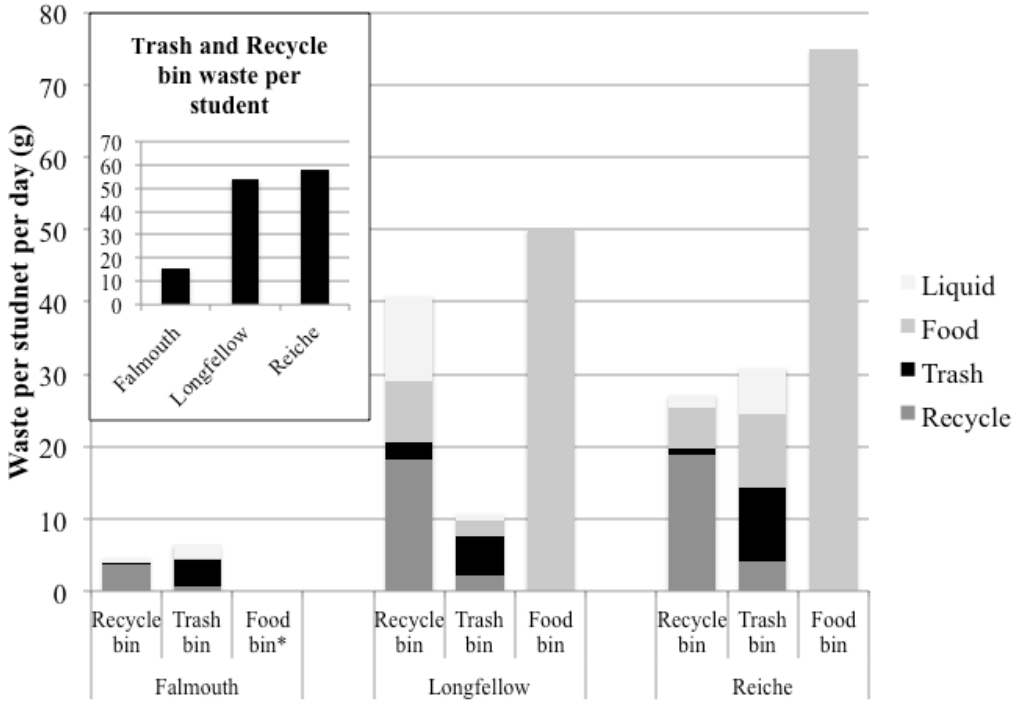

Figure 2.3. Measured quantity of waste by type in each bin at each school in grams per student. Insert shows total waste per student in the trash and recycle bins only.

relatively less liquid and trash (Figure 2.3). At both schools where organic waste in the compost bin was measured (Longfellow and Reiche), approximately equal proportions of the total organic waste was captured (82% at Longfellow and 83% at Reiche).

At Falmouth the most common recyclable item to be misplaced was plastic yogurt containers and the most common item in the recycle bin was milk cartons. In fact no milk cartons were found in the trash there. At Longfellow the most frequently misplaced recyclable item was cardboard serving boxes and the most common recycled item milk cartons. At Reiche the reverse was true, with milk cartons being the most frequently misplaced and serving boxes the most commonly recycled.

Waste Generation

Quantities and types of waste generated per student varied widely among the three schools. For this section all reported quantities are per student unless otherwise specified. Falmouth had by far the lowest total non-food waste generation (Figure 2.3 insert). The two other schools have a major source of waste not present at Falmouth in the cardboard

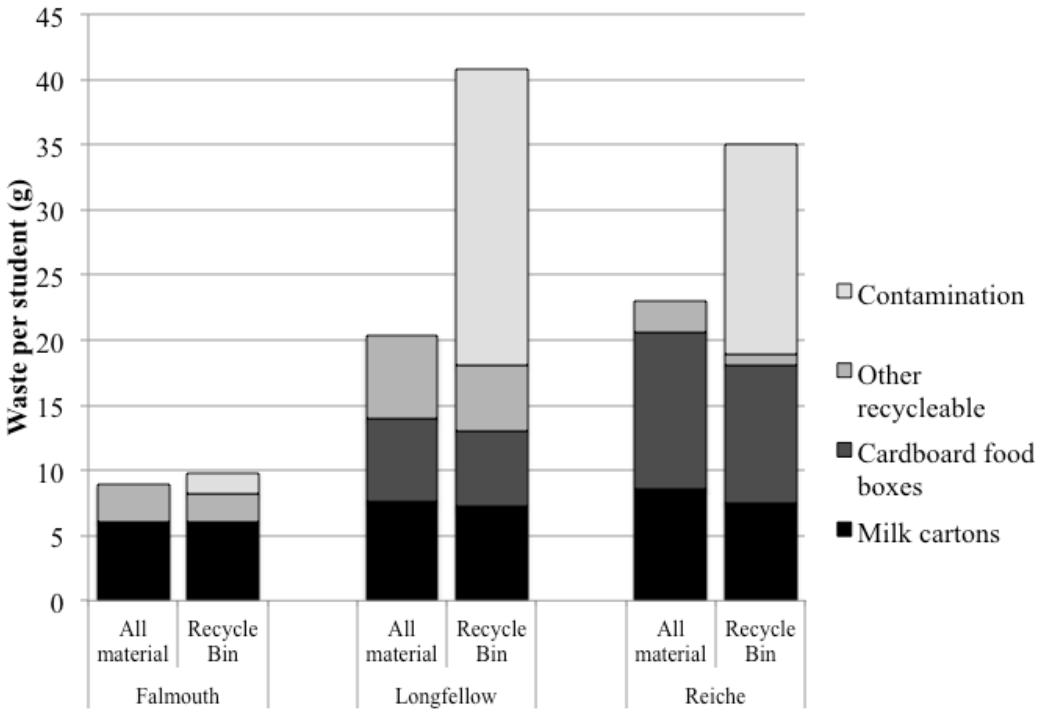

Figure 2.4. Breakdown of recyclable material that was produced and that was placed in the recycling bin at each school.

serving boxes used to transport the school lunch meals. At Longfellow these accounted for 12% of total waste and 14% of the recycle bin (Figure 2.4), while at Reiche they were 21% of the total waste and 39% of the (less contaminated than Longfellow) recycle bin (Figure 2.4). Food waste generation, at the two schools measured, showed wide variation. Longfellow produced 61g of food waste across all bins compared to Reiche's 91g per student. In both cases this accounted for over half the total waste produced per student (Table 2.4).

Table 2.4. Total waste per student at each school in grams across only the recycle and trash bins and across all bins.

	Falmouth	Longfellow	Reiche
Total waste per student no food (g)	16	52	58
Total waste per student (g)	*not measured	113	149

Discussion

All three schools are sending less waste to be burned in the EcoMaine waste to energy plant than they would have been without this program. They are moving material up the waste hierarchy (US EPA, 2017b) and the food recovery hierarchy (US EPA, 2017a). By that measure the programs are successful in improving the environmental outcome. The results do, however, indicate that more could be done and that there are major differences between schools.

Overall reductions in trash sent to the waste to energy plant (after accounting for contamination which will presumably be sorted out at the recycling center) was in line with numbers reported in news articles examined in Chapter 1. Block (2000) reported that the Wichita Kansas school district reduced their waste 70%, closely matching the 67% and 70% (respectively) achieved by Longfellow and Reiche. While Falmouth's organic waste was not measured, it is likely overall diversion was even higher than the other two schools because of a higher non-food diversion rate and much smaller amount of food in both the trash and recycling bins. This lines up with reports like Biocycle (2012) where waste was reduced approximately 80% and Kadleck (2015b) where waste was reduced 90%.

Sorting

This study's sorting results are weight based rather than volume based, making them not directly comparable to EcoMaine's maximum contamination level for recyclables. However, it is possible to estimate based on the types of material present. Falmouth almost certainly falls under the 7% by volume contamination threshold, given that it had only 10% contamination by weight, of which seven percentage points were made up of liquids, by far the densest type of contamination compared with food or trash. At Longfellow the fact that less than half the weight in the recycle bin was recyclable material means that it is unlikely the load would meet the 7% threshold, given that trash, which likely has similar volume to recycling, makes up 6% of the bin before accounting for substantial amounts of food and liquid. This does not necessarily mean EcoMaine rejects Longfellow's recycling, as cafeteria waste is mixed with paper and other recyclables from classrooms and offices. Reiche's cafeteria waste likely also goes above the 7% threshold, but may be under the 15-23% operational maximum for contamination depending on the exact density of the food and recycling waste.

Longfellow and Reiche's opposite issues (Longfellow has more contamination in the recycling bin, Reiche has more recyclables in the trash) are not exactly equivalent. Due to the possibility of recyclables being rejected for too much contamination, Reiche's situation is probably the more desirable of the two. Considering the quantity of food and liquid waste in the recycling bin at Longfellow, emphasizing that containers need to be empty before they are recycled may help reduce contamination. If students are going to dispose of all their waste in one bin, it is better for that to be the trash so that those who sort accurately can be sure they are contributing to real reductions through recycling.

One factor to consider in the sorting accuracy between Falmouth and the two Portland schools is the variety of materials students are presented with. Falmouth students with school lunch (almost half of students) receive their food directly on a washable tray with metal utensils, meaning they only need to recycle their milk carton and dump any remaining food in the compost bin. By contrast both Portland schools serve hot lunch in packaging meaning that the plastic utensils and box lid must be placed in the trash, any extra food in the compost and the box itself in the recycling along with

the milk carton. This sorting process took visibly longer in my personal observation at both schools than it did at Falmouth. There is a possibility this packaging and subsequent sorting could decrease in the future as preliminary renovation plans at Longfellow tentatively include an on-site kitchen.

Again relating to materials, most of the recycling bin material was hot lunch related (milk cartons and (in Portland) food boxes. While this is the most common material (it is not only most common in the recycle bin but also as an error in the trash bin) the relative lack of cold lunch recyclables being accurately sorted may reflect explanations of the waste sorting systems that rely more on individual items like milk cartons rather than reflecting students' knowledge of recyclable materials more broadly (e.g. all rigid plastic, paper, cardboard, etc.)

Waste Generation

Considering all waste generated per student, regardless of whether or not it was sorted correctly, the schools display some interesting similarities and differences. Total quantities of waste generated are similar to those identified by Wilkie et al. (2015), which found mean waste generation rates from 50.5g to 137g per student per day. Reiche's total is slightly higher while Longfellow's is within the range on the upper end. Food waste generation at similar rates to Longfellow or Reiche would put Falmouth in the lower to middle of the Wilkie et al. (2015) figures. Food waste at the two schools measured was, like in that study, the largest source of waste by weight. At Longfellow, food waste fell within the range that Wilkie et al (2015) found of 47-58% of waste. However, food accounted for an even higher proportion of total waste (61%) at Reiche.

There is a major (61g vs. 91g) difference in food waste per student between Longfellow and Reiche. Note that this was a one-day study and that more data points are necessary to fully determine if this difference is as large as it appears. A possible contributing factor is that on the day of the audit at Reiche some students were served frozen vegetables that had not been property re-heated (they were still frozen) leading many students to understandably throw them away uneaten. Another possible explanation for the difference in food waste is that approximately 70% of students at Reiche eat school lunch daily compared to only 26% at Longfellow. Studies have found that

between 20-50% of items served in school lunches may go to waste (Marlette et al., 2005; Smith & Cunningham-Sabo, 2014) which is likely more food than is wasted from lunches brought from home. This would imply that the almost 3 times higher consumption of school lunch would increase per student average food waste at Reiche compared to Longfellow.

Longfellow and Reiche produced around 3.5 times as much non-food waste per student as Falmouth. As mentioned before, this likely has to do with the larger amount of packaging the school meals require and the fact that more liquid was retained in the waste at the Portland schools (less was put in the appropriate bucket which was not measured as part of this analysis at any of the schools). Falmouth also uses washable cutlery, which may also be a factor compared to the disposable cutlery at the other two schools. This difference in packaging comes from the fact that Falmouth, being the only elementary school in its district, cooks food on site compared with the need for packaging to deliver food to the Portland Schools.

An interesting if inconclusive comparison between hot and cold lunch at Reiche and Longfellow can be made if one assumes that similar proportions of food are wasted (regardless of which bin it is sorted into) at each school. Solving the difference between total waste generation and proportion of hot lunch students as a system of equations yields a waste generation rate of 173g per student for hot lunch and 91g per student for cold lunch. As noted before, this could be affected by the day the data were collected. This implies that possible ways to reduce waste at the source include reducing packaging and wasted food in hot lunches. Berry & Acheson (2017) include a variety of ways to reduce food waste in school lunches including allowing students more choice and using solutions like share tables to avoid wasting unwanted food.

Considering that this study is a snapshot in time rather than consistent data collection over a number of days and weeks, its comparisons are not statistically testable. This leaves open the possibility of variation due to the specific days chosen, such as the kinds of food served, as well as random variation. Both sorting and waste production may have also been influenced by factors beyond the scope of this study such as the financial resources available to each school and its students' prior exposure to conepts like recycling and composting at home. Analyzing schools with very similar socioeconomic

and surrounding contexts could show more clearly how programs are different independently of those conditions. In order to give more definitive conclusions future studies could conduct audits on multiple days of the week over a period of time involving all grade levels. Another limitation is the inability to capture Falmouth's compost bin material, which could be solved with better study design to avoid mixing food waste from the sample lunches with food from unsampled lunches. It would also benefit the completeness of the results to directly measure the liquid found in all locations, trash, recycling, and the liquids bucket. In this study trash and recycling liquid was measured only indirectly and the liquid bucket not at all.

The most important takeaway from this waste audit is that all three schools have managed to divert waste that would have otherwise been sent to the waste to energy plant, moving their disposal practices up the waste hierarchy (US EPA, 2017b). Falmouth is achieving a very high rate of sorting accuracy, leaving their options to further improve the program mostly in the realm of source reduction, and keeping a few recyclables and some food out of the trash. The two Portland schools both have the possibility to improve sorting in a relatively significant way, but are still diverting well over half their waste. Anything that simplifies the waste stream (such as kitchen facilities that reduce the need for packaging) would likely help improve sorting as well.

This audit confirmed that the sometimes drastic waste reduction numbers cited in the literature (e.g. Biocycle, 2012; Block, 2000) can be achieved by schools in Maine using existing programs and that food waste is a huge and divertible portion of the cafeteria waste stream. While sorting may not have fully become a practice among all students, it appears to have among enough to result in reductions. The studied programs are already providing environmental benefits and have the potential to continue improving.

CHAPTER 3: STAFF PERSPECTIVES ON WASTE REDUCTION AT THREE SOUTHERN MAINE SCHOOLS

Introduction

Solid waste is a serious environmental concern in the modern world (Strasser, 1999). In the United States, 164 million metric tons annually of municipal solid waste is deposited in landfills or disposed of via other non-reuse systems like incineration (UNEP, 2016). Another 87 million metric tons is diverted annually through recycling and composting (UNEP, 2016). This implies a solid waste generation rate of approximately 2kg per person per day (UNEP, 2016). The environmental impacts of solid waste disposal range from land use to air and water pollution (Singh et al., 2014), and wasted resources (Hall et al., 2009).

Schools, like other large institutions, produce large quantities of solid waste that must be managed and disposed of. One major source of waste in schools is their cafeterias, where students eat lunch daily (and often breakfast as well). Cafeteria waste has been estimated at 51g to 137g per student per day by Wilkie et al. (2015). This waste includes both packaging/serving material and uneaten food. Food waste is compostable, and much of the remaining material is made up of paper, cardboard, plastic, metal, and other recyclable materials (Wilkie et al., 2015). As shown in chapter 1, implementing a system to capture those materials and reduce landfilled waste not only benefits the environment in the form of reduced waste but also by teaching students environmentally friendly habits and can reduce trash hauling costs for schools. Implementation of such waste reduction programs, however, is not always easy or simple, and involves considerations ranging from educating students and lunch aids to hauling logistics and budgetary sustainability.

This chapter analyzes three existing waste reduction programs at elementary schools in Southern Maine through the perspectives of four staff members at each school. The analysis centers on the question: How do staff members at individual schools see institutional and programmatic factors influencing the perceived success (or lack thereof) in the cafeteria waste reduction program? Using interviews and online surveys, this chapter places the three case study schools' waste reduction programs in the context of

the ideas from practice theory identified in Chapter 1: Actions, institutional context, interactions between people, and knowledge.

Theory

Under the umbrella of cultural theory, practice theory takes the approach that the smallest analysis unit of human behavior and interaction is a "practice". Reckwitz (2002) defines a practice as "a routinized type of behavior which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge." This places habitual behavior in a larger social and personal context. It gives practice theory the "capacity to describe important features of the world we inhabit as something that is routinely made and remade in practice using tools, discourse, and our bodies" (Nicolini, 2012). While practice theory was not developed specifically to explain behavior in young children, such as those in elementary school, it seems to be applicable because if anything younger students are less likely than adults to actively think about their behavior around something like waste sorting, which implies the importance of habitual ways of doing like practices.

Chapter 1 identifies four elements that may impact the outcomes of school waste reduction programs derived from practice theory:

- **Actions:** Fundamentally practice theory is about repeated actions (whether physical, mental, emotional, etc.) and their development in a given context (Reckwitz, 2002)
- **Institutional context:** Practices are carried out within a social and structural context (Reckwitz, 2002)
- **Interactions between people:** Practice theory emphasizes how an individual interacts and engages in repeated behavior rather than on their internal motivations (Bones, 2001)
- **Knowledge**: Practice theory includes the importance of knowledge, particularly tacit knowledge (Collins, 2001)

As seen in chapter 2, these programs have led to reductions in waste. However, they are not perfect. A more qualitative look at the programs is a way to seek out patterns in how people view them and identify possible reasons why certain schools experience varied success in different areas of the programs. These interviews aim to identify aspects of the programs' histories and current operations that could be causes of the successes and challenges noted in chapter 2 as well as successes and challenges that go beyond simple waste reduction and into the social and institutional context of the schools.

Methods

Study Locations

I conducted interviews in the three case study schools where I conducted the waste audits detailed in Chapter 2 (Table 3.1).

Table 3.1. Summary of schools where interviews were conducted

	Falmouth	**Longfellow**	**Reiche**
Location	Falmouth, ME	Portland, ME	Portland, ME
Grades	K-5	K-5	Pre K-5
Students at school	925	340	404
Approx. % hot lunch	49%	26%	70%
% Free/Reduced lunch	7%	25%	77%
District spending/student (2017)	$18,690	$16,580	$16,580
Kitchen on site	Yes	No	No

The specific schools were chosen because they had a staff member (who became the point person for this study) who attended a school waste reduction event hosted by two parents who had been instrumental in starting Portland's waste reduction program in the spring of 2015.

Interviewee Selection

In order to assess the current condition of the waste reduction programs from the perspective of staff members at each school I solicited the opinions of four staff members through interviews followed by online surveys. Each of the point people mentioned above agreed to assist with the study and recommended colleagues with an interest in the program. All those suggested colleagues contacted agreed to participate. I made sure to

include at least one person who works in the cafeteria as a lunch aid and at least one teacher at each school. I intended to interview staff members who were invested in the program in some way, whether through personal interest or the requirements of their job, and therefore the interviews are not a representative sample of opinions among all staff at the school. This was intended to generate the most relevant information by speaking with people who have a lot to say about the program.

Data Gathering

Each of the four staff members at each school was given a short interview and follow-up online survey. These data gathering instruments were approved by the Institutional Review Board at Colby College. The interviews consisted of short (5-10 minute) in person conversations concerning the general history and status of the program from the respondent's perspective and knowledge (Appendix B). I recorded the interviews (with the interviewee's permission) and transcribed them for analysis. This was followed by an electronic survey distributed by email which asked the respondent to identify positive and challenging aspects of the program as well as important people involved in it among other short answer and multiple choice questions (Appendix C).

Rating Individual Program Components

The online survey asked respondents to rate five areas of the program as "needs improvement" "moderately good" or "very good" (Appendix C, question 6). Each of these areas matches with one of the four principles from practice theory (two of them were combined into "institutional context"). These responses were converted to a 0-2 scale (0=needs improvement, 1=moderately good, 2=very good) for responses to the survey prompts related to each practice theory area (Actions=student follow through on sorting, Institutional context=administration support for program + program operation, Interactions between people=lunchroom staff support for student sorting, Knowledge=student knowledge of how to sort) and averaged across the four staff member surveys at each school.

Results

Origins

Each of the schools' waste reduction programs has evolved over time and this was demonstrated in the interviews. At Falmouth there had been a desire among a few teachers to implement waste reduction, and one teacher even wrote and received a grant from EcoMaine to help with start-up costs, but the program never took off at a large scale until the opening of Falmouth's new LEED certified elementary school. As one employee put it, the new school was "a logical time to start." As the new school opened, a private compost company worked with one very involved teacher to create a system to collect the school's waste. That teacher secured a grant from the Falmouth Education Foundation to pay for the first 1.5 years of compost pickup. After that time, the teacher was able to convince the school board to renegotiate the trash-hauling contract due to reduced waste and use the savings to pay for compost pickup in the long term. Even before the waste reduction initiative, the food service department had been using washable trays and cutlery to serve school lunches.

Longfellow's waste reduction program was also desired by a small group of teachers and staff that worked on plans that proved difficult to implement. At the time almost all students ate lunch in their classrooms, meaning waste was highly distributed, and food was served on polystyrene trays which EcoMaine does not accept for recycling (EcoMaine, 2017). Things moved more quickly after the Waste Reduction Group, a group of parents, teachers, and other stakeholders from the entire Portland Public Schools district were able to implement a waste reduction plan on the district level. All schools, including Longfellow, received bins, compost pickups, and volunteer assistance during the early stages. There was also a switch to compostable paper trays and eventually washable plastic ones. This program, however, proved challenging and respondents reported that it only really took off under the new Vice Principal, who wrote a grant to EcoMaine in the fall of 2015 for new bins and better signage. The new bins and signs, combined with moving to a system where four grades eat in the gym which better centralizes the waste has made the program work better in recent years.

Reiche's history is similar to Longfellow's. There was a concerned teacher with a green team of students who tried to expand recycling, but no formal centralized system in

the lunchroom, and they used the same polystyrene trays that were used in all Portland Schools. When the Waste Reduction Group's plan came to Reiche it started off well with lots of educational efforts including videos put together by concerned staff and a "magic dot" system designed to reward good sorting at the end of lunch. One teacher reported that students "were getting all of this attention from all of these grown ups and all these visitors […] and then obviously all that excitement died down." Since then student sorting has reportedly decreased and there has been recognition among staff of how much work it takes to keep the system functioning properly.

Positive Aspects Of Cafeteria Waste Reduction Programs

When asked about positive aspects of the waste reduction programs a large majority (9 of the 12 interviewees) included reduced waste as one of the top two positive aspects of the program, making this the most common answer. The exception to this trend was Reiche, where only 2 of the 4 respondents cited reduced waste and three cited teaching students about recycling and composting. Teaching students about waste reduction or other comments around awareness of recycling/composting or the importance of waste was the next most common positive aspect, with 8 of 12 interviewees citing this example.

When asked to rank which of the positive aspects of the program they considered most important, however, only 2 respondents, one at each Falmouth and Reiche, cited reduced waste. Responses to what was most important were distributed, with two others citing student involvement in the process and two more claiming teaching recycling was most important. No other answers had more than one mention as most important.

Challenges and Improvements

Interviewees reported a wide variety of challenges, with less similarity than among positive comments. One respondent at each school stated that it was difficult to educate students about the system. Two respondents at Falmouth and one at Reiche reported staff engagement as a challenge. Three (all at Reiche) mentioned that the system only works well when there is a teacher present at the bins supervising, and two of those respondents considered this the most important challenge.

Ideas for improving the system centered on education and monitoring. Six respondents (including all four at Longfellow) mentioned training or educating students and/or staff. One person at Longfellow thought it would be a good idea to expand the lunch helpers program where students who finish eating early volunteer to help their peers sort waste. Similarly, at Reiche there were suggestions for a "recycling buddy" system or asking for outside volunteers to help monitor the bins. Another suggestion was to move waste reduction beyond the cafeteria and make sure every classroom had three bins, one each for trash, recycling, and compost.

Key People in Waste Reduction Programs

All three schools appeared to have a key individual who was the primary driver of positive change, supported by many others. At Falmouth and Reiche that person was a teacher (cited by all four respondents at Falmouth and 3/4 at Reiche), while at Longfellow it was an administrator (cited by all four respondents). These people were considered by their colleagues to have played an important role in getting the program going, often by serving as a point person or organizer. Two respondents at Reiche also considered administration important. Students, lunch aids, and custodians were mentioned 3 times each as important players. Custodians were mentioned at both the Portland schools (twice at Reiche), but not at Falmouth; nor did anyone at Falmouth cite administrators. Outside organizations were considered important for all schools. In Portland this included the Waste Reduction Group mentioned once at each school, and for Falmouth it was EcoMaine and their compost hauling company. Two respondents also cited parent teacher organizations (PTOs).

During interviews there were references from interviewees at all three schools to the schools' broader communities and those communities' impact on the program. At Falmouth one teacher said that they hear from families frequently that their children are correcting the rest of the family's waste sorting or convincing their parents to sign up for curbside composting. A teacher at Longfellow mentioned that the school is located in an environmentally conscious neighborhood and so many of the kids also "get it at home." Conversely, teachers and lunch aids at Reiche pointed out that many of their students live in multi-unit buildings and that fewer families likely recycle or compost at home (until

recently larger apartment buildings were not required to even provide recycling pickup in Portland). They also noted that relatively more frequent turnover in the student body compared to other schools in the district means they cannot simply teach the system to students once when they are young.

a.

b.

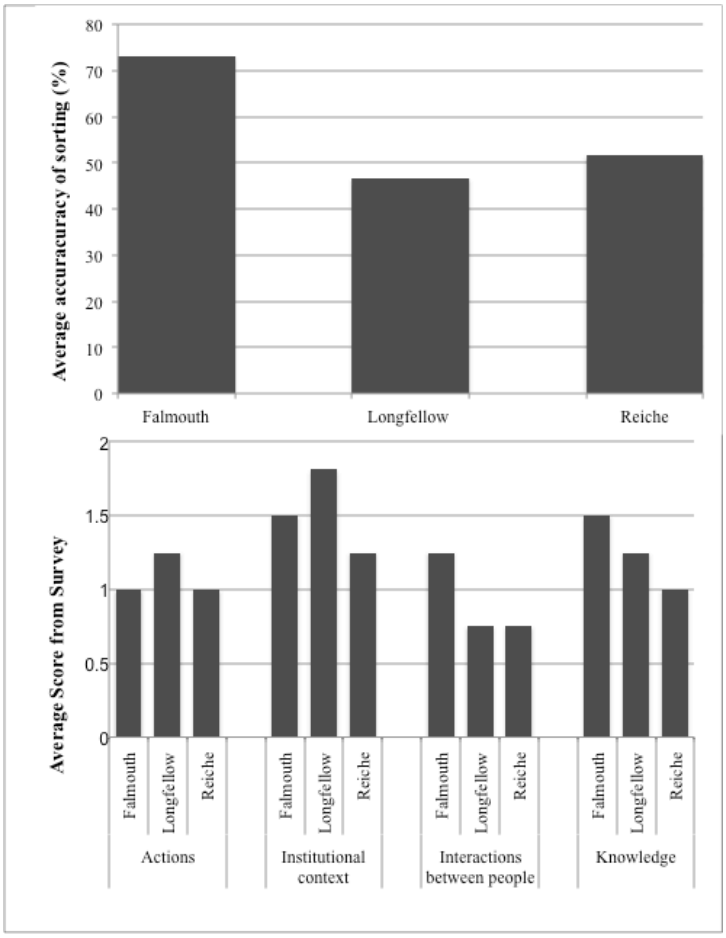

Figure 3.1. (a) Average of the percentage of accurately sorted waste in both the recycling and trash bins at each school (Chapter 2). (b) Average score on 0-2 scale (0=needs improvement, 1=moderately good, 2=very good) for responses to survey prompts related to each practice theory area (Actions=student follow through on sorting, Institutional context=administration support for program + program operation, Interactions between people=lunchroom staff support for student sorting, Knowledge=student knowledge of how to sort).

Table 3.2. Quotes relating to the four elements of practice theory used in this analysis from each school.

	Falmouth	Longfellow	Reiche
Actions	"I mean even are kindergarteners 5 years old are separating things out so I would say overall it's pretty successful"	"Students are actively involved in finding ways to recycle"	"Ideally it would be a habit it doesn't have to be exciting it would just have be a habit but it's not ingrained in everyone yet"
Institutional Context	"It's pretty cut and dry for an adult or even the older kids even if they hadn't gone through the younger grades it's a pretty simple system to figure out"	"We also moved to a slightly different model of doing lunch where we had all but two classes per lunch wave in the gym [...] so then it was a little bit more centralized to make the recycling a little bit easier"	"You have students who come from homes who have a trash sorting that's functional already [...] and if you work with kids who come from other countries or who have a lot of trauma in their homes [...] those students need a lot more help in understanding"
Interactions between people	"A huge part are those staff who are in the cafeteria who are really following through and making sure the kids are composting and helping to train them"	"In the beginning of the year I think it is very important for kids to help out other kids to show them how it works especially with the younger kids so older kids are helping younger kids"	"I was also made available to be at the recycling center for lunches so it all worked beautifully it was great and since then about a month a couple of months ago I got pulled out of the lunch room"
Knowledge	"I have been out in the school garden with my class during gardening lessons and garbage to Garden comes to pick up the compost [...] you've got this amazing composting lesson so seeing that happen is pretty powerful and sometimes the garbage to Garden person will even tell us exactly what is going on"	"It's not just the milk carton goes into the recycling but why does a milk carton go in there and trying to develop the concept of what kind of things are recyclable and what kinds of things are not recyclable"	"We might have explained to them but now those kids are in the 5th grade so I don't know about the second graders I don't know about them that's a good idea maybe I should explain to them why they need to do this"

Relation to Practice Theory

Interviewees gave some insight into how the elements of practice theory used in this study played out in the schools (Table 3.2). Figure 3.1 compares the average percentage of accurate sorted waste at each school (Chapter 2) to the average rating given by staff members to a program component that corresponds to the areas of practice theory identified previously. The two practice theory components with scores that most closely follow the sorting accuracy of their respective schools are "Interactions between people" and "Knowledge." The quotes (Table 3.2) are intended to illustrate generally how those areas apply to school waste reduction as well as give examples of opinions at each school.

Interviewees' Overall Impressions of the Programs

When asked if there was anything their colleagues would say, survey respondents provided some general impressions of the program that were supported in the interviews. At Falmouth one person responded with "everyone is on board now." While that may not be entirely the case, as it was mentioned in an interview that some staff do not take it seriously enough, it seems to be generally true. Lunch aids monitor the bins every day and that is included in job descriptions when hiring new people who will have those duties. There was also a comment from a teacher that the "cafeteria staff really follow through."

At Longfellow the same question was answered with "Needs monitoring by adults all year long." This response matches a general feeling that the program is effective, but that there is work still to be done. For example interviewees said that it is reducing waste but not all the staff buy in, or that the fifth grade teachers need to bring up waste sorting in their "town meeting" with the entire grade every six or seven weeks.

The general comments at Reiche are that people are tired of working with too few resources and feel disconnected from the system. This matches with the fact that it was "left up to lunch aids and custodians" according to one teacher, and that the "amount of intervention is unsustainable" according to another.

Discussion

Each program's origins appear to play a role in how it is functioning and how people feel about it. Unlike many of the articles analyzed in Chapter 1, none of the three schools began their program as a result of a waste audited they conducted. All three had teachers or other staff members who had been interested in waste reduction for some time but were not able to implement a program on the scale that exists now until some event like the opening of a new school, alliances with local composters, or a district wide initiative, provided the opportunity. Similarly to Kadleck (2015a) in Chapter 1, both Falmouth and Longfellow relied at one point or another on outside grants to help begin their programs. Falmouth provides a clear indication of the value of grants as a way to prove that cost savings will result, as it gave the involved teacher the opportunity to show real data on how much trash was reduced and how that savings could cover costs temporarily covered by the grant. Longfellow's grant covered one-time costs to obtain better bins. These examples imply that there is a role for outside grant-making organizations that wish to help reduce waste, and that the amounts of money do not need to be huge. The grant amounts ranged from the hundreds of dollars up to $1,500. One major difference in the beginnings of the programs was the influence of the Waste Reduction Group as an outside catalyst in the two Portland Schools. This group helped create the district scale context, such as replacing polystyrene trays and setting up compost collection, that enabled the individual schools to more successfully implement waste reduction plans.

General perceptions of the program at Falmouth were, if anything, slightly less positive than the results of the waste audit in Chapter 2 indicate. While it was the only school where someone said, "everyone is on board" there were still concerns among some interviewees about how on board all the staff really were. People indicated that students knew how to sort and for the most part did it well, which is substantiated by the waste audit. Interviewees strongly emphasized the teaching aspect of the program, which may be reflected in the comments about how well students know how to sort. It is also worth noting that unlike either of the Portland schools, Falmouth has a lunch aid at the station helping students sort every day, and it is part of the job description for new lunch aids. This also represents a difference in financial resources, when there are sufficient

lunch aids in the cafeteria to have one person help with sorting and still enough others to supervise the students generally and deal with issues.

Longfellow appeared to have a slightly more positive view of its recycling program than Reiche overall, although with more qualification than Falmouth. This could have to do with the slower start to the program and subsequent improvements in recent years under new leadership from an involved administrator. If anything, students seem overly enthusiastic about recycling, putting things in the recycle bin that do not belong there, or at least not emptying their food and milk containers before recycling them. This is potentially more of an issue than Reiche's lower recycling rate because of the risk of creating overly contaminated recycling loads.

Reiche respondents seemed to primarily (not always) indicate a feeling that the program could be good if it had more resources but that they had tried and were tired of trying. This could have something to do with the huge amount of effort that went into the program at the beginning with lots of interventions to teach students. That level of intervention was unsustainable and now that sorting is not quite as good as they were during the height of the intervention people see the program as less successful. While there are certainly improvements that could be made, there is also significant success; over half the waste is being diverting according to the waste audit in Chapter 2, and the recycling contamination level in that audit was lower than Longfellow's.

Viewing Programs Through Practice Theory

The fact that waste is being reduced, as evidenced by how many people mentioned this as a program benefit and by the audits in Chapter 2, shows some change in actions by students. Many of them are clearly separating their trash. At the same time we can see that not everyone has adopted the action of sorting waste as a practice. One lunch aid gave the example that she had the kids pre-sort the trash on their trays before they went up to the bins, but now that those students have different lunch aids only a few of them continue to do that pre-sorting. This implies that for those few it became a practice, although the others may still sort at the bins.

The two areas of practice theory identified in Chapter 1 that have average scores from the surveys that most closely match the average sorting accuracy are "Interactions

between people" and "Knowledge" (Figure 3.1). This is not a statistical analysis, but the similarity of those two areas to the sorting accuracy observed in Chapter 2 implies that improving student understanding of how to sort (knowledge) and staff support for students (interactions between people) has the possibility to improve the programs. This matches with suggestions given in the surveys for improvements. It is also possible that focusing on institutional context at the level of the waste reduction program made that category look less connected to program success because it excluded broader contextual factors like overall level of resources available and waste sorting as a practice in the community where the school is located. This can be seen when a Reiche staff member points out that some of their students "get" recycling at home and others need more support (Table 3.2).

Knowledge is a complicated issue with these programs. Knowledge of how to sort among students was both praised and challenged by interviewees. The most common suggested means of improving the programs was to teach students and staff more about what and how to recycle, but at the same time, at least at Falmouth and Longfellow, there were comments suggesting most students already knew where to sort things. Some of this knowledge may come from the fact that those schools' surrounding neighborhoods, according to survey respondents, generally tend to participate in recycling and composting at home, something that may be less the case for Reiche. Knowledge of how to sort is a baseline, but more importantly, according to practice theory (Collins, 2001), is the tacit knowledge of how to do what is expected, in this case reduce waste. That level of tacit knowledge may differ between students and staff and could help explain some of the difference in sorting. If people do not really believe it is expected of them (it may be stated, but is not an unthinking norm), they may not try to do the sorting, particularly if they are still slightly unsure of how to do it properly.

The programs at all three schools show value for institutional context, even if it does not map directly onto how staff see the program. Key individuals who supported the program came out clearly in the surveys at all three schools, reinforcing the same finding in Chapter 1 that point people on the ground are a major part of a supportive context. Another element of context that makes the actions easier to turn into practices is the type of waste generated by the school lunches. Particularly at Falmouth and Reiche, where

half or more of the students eat school lunch, the difference in packaging means that sorting is dramatically easier at Falmouth, likely contributing to its perceived and measured success. One interesting aspect of context is that at Longfellow respondents cited the addition of new bins and better signs as a turning point for the program, but at both Falmouth and Reiche there are almost no signs at all. This difference could have something to do with differing patterns of explicit and tacit program knowledge in each location.

Interactions also seem to be important across all programs, and impressions of them mirror sorting results. Falmouth, where there is almost always an adult to interact with at the sorting station, is very successful. Respondents at Longfellow and Reiche also implied that the program was more successful when a monitor was at the bins (Table 3.2) and suggested improvements such as having kids act as recycling helpers or buddies or bringing in volunteers to help supervise. Interactions may be particularly important given that only one school (Longfellow) had physical signs directing students what to put in each bin, the others relied on student knowledge and the help of somebody at the bins. This interaction matches with what is seen in Figure 3.1 and is supported by the interviews (Table 3.2). This is similar to the experience of the two student program founders in New Hampshire who found that the program only worked well when they sat at the bins and interacted, directly or through their presence, with their peers at the end of lunch (Kadleck, 2015a).

This study is intended to provide an overview of some factors that may impact schools' waste reduction programs through the opinions of staff. There were only four staff members interviewed at each school, meaning that some views may not be fully represented. In order to increase the diversity of opinions and ability to determine consensus it would be helpful to expand the sample size. There would also be value in talking with students to elicit their thoughts directly. With an expanded sample it would be helpful to standardize the proportion of respondents by either involvement with the program or position at the school. Further analysis could look into the actual budgetary impact of these programs at each school, particularly in Portland where none of the respondents mentioned costs or savings. The effect of institutional context as en element of practice theory may have also been muted in this study due to the focus on waste

reduction programs directly rather than broader contexts like overall level of resources or staffing at each school, students' family incomes, availability of recycling and composting services at home, or students learning English. Any of these variables may have had a larger or smaller role in the programs and would be something to analyze further with more information.

Reducing barriers to engage in a behavior, interventions, and program analysis were three additional factors potentially leading to program success identified in Chapter 1. There was some evidence of attempts to reduce barriers, particularly surrounding signage and bins at Longfellow. Most of the other effects would better be classified as interventions. All the schools had interventions in the beginning, and Reiche in particular emphasized a wide variety of attempts including the gold dot strategy, videos, and information cards on tables. Falmouth teachers mentioned making it a priority to educate their own classes every year and that when the program launched there was a major school-wide push to educate students using a game show activity. Very little analysis was mentioned, other than early in the Falmouth program when a teacher needed to quantify waste reduction to convince the school district to change the waste hauling contracts and make composting a permanent addition to the waste system. This was apparently successful; the district approved funding to continue the program.

Conclusions and Key Takeaways

This analysis is only beginning to gain a general understanding of how the waste reduction programs at these schools are functioning and an attempt to derive reasons why that is the case. There is a need for ongoing analysis to make sure the programs continue to produce benefits and to test the success of interventions. Involving students in some of this analysis could also be a way to further learning about waste, as many respondents claimed this was an important benefit of the program. Practice theory appears to have a use to study school waste reduction because it allows a combination of factors that impact the creation of an unconscious action to be studied together. Embracing key people to drive the program on the ground, simplifying the waste stream, and having somebody at the bins to help students sort emerge as concrete sources of program success. These seem to indicate the importance of institutional context and interaction in the creation of a

"practice" of waste sorting in schools. There was also an emphasis on making sure students and staff were adequately trained and knowledgeable about the system to use it effectively, exemplifying the importance of knowledge.

These three schools do not represent all cases around the country, but do provide evidence that three schools operating in different contexts are able to achieve waste reductions in line with, or even better than, those seen around the country in news articles. Together, these studies suggest that cafeteria waste reduction can be converted into a practice in a variety of settings and that there are both broad and school specific forms of successes and challenges. Reducing waste is clearly a goal of these programs, but they can also be used to reinforce teaching about environmental issues and save schools money. More resources, like lunch aids to monitor sorting, make implementation easier, but there are also creative solutions that require fewer resources, for example student volunteers helping their peers.

While there are still varying amounts and kinds of work to be done at all three schools to make these waste reduction programs as successful as they can possibly be, they have a major impact even in their current state. The percentage reductions in waste, likely well over half at all schools (Chapter 2), and the fact that waste reduction was the most commonly cited benefit of the programs shows that they do have an impact even when they are not perfect. There are committed and engaged staff and students at each school and hope that these efforts will accelerate in the future.

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APPENDIX A

Sources used to review school waste reduction programs.

Source	State	Start year	# Schools	Program	Cafeteria?	Benefits	% Reduction	Challenges	People driving program	Organizational factors	How did it start	Key lessons
Anslow, S. (2007). Setting up a recycling system at school. In Business, 16–18.	OR	2007	1	composting	Y	student engagement,		cost was originally seen as prohibitive, biobags are expensive	principle	principle buy in student green team clear signage and container color		
Biocycle. (1995, August). Collecting organics from schools. BioCycle, 24.	NH	1995	3	composting	Y						help from the governor's recycling program	
Biocycle. (2007). Schools champion organics recycling. BioCycle, 20.	MN	2006	35	composting	Y	5x week pickup of trash to 2-3x, savings of $4900						
Biocycle. (2009). Composting at zero waste school. BioCycle, 12.	IL	2008	1	recycling, composting, source reduction	Y	90% food residuals diversion, 5x increase in recycling	90			student "bin buddies" to capture recycling in more of the school		
Biocycle. (2016). High school steps up to waste reduction. BioCycle.	TX	2016	1	composting, recycling	Y	over 33% increase in recycling	33		teachers, students	students in different classes trained others bilingually, built display boards	student led waste audit, found 82% was recyclable	

										(construction tech), picked up recyclable (occupational prep)		
Biocycle. (2012). School composting success. BioCycle, 10–11.	NY	2012	1	composting	Y	450lbs/day waste reduction, 80% less cafeteria trash	80		custodians, food service, teachers	hauling serveries were donated by private company		
Block, D. (2000). School district supplies organics to commercial composter. BioCycle.	KS		15	composting	Y	70% reduction in cafeteria waste	70			students are the ones moving material use bags to prevent odor		
Bradley, A. L. (2015). Food scraps composting at schools. BioCycle, 29–32.	VT	2014	4	composting	Y				environmental club, teachers. head custodian, student volunteers, principal, facilities director	school wants a community garden, so will make own compost	VT universal recycling law	
Cooper, R. (2015, May). Composting pilot expands in North Carolina school district. BioCycle, 32–36.	NC	2012	25	composting	Y	student engagement, less waste		raccoons attacked food, so they put clips on the outdoor bins, hard to document waste reduction and fiscal savings hard to convince	teachers, cafeteria staff, custodians	liners prevent odor		need to record savings, both trash and financial to keep and expand program

								schools to participate				
Dubois, P., & Ramey, P. (2006, February). Practical model for school organics recovery. BioCycle, 36–37.	WA	2005	22	composting	Y	waste reduced 90%	90	avoiding contamination in organics bins	district facilities manager, principals	top down support from district with principals able to adapt it to their own school's circumstances partnership with county and waste hauler every effort is made to get the custodian whatever they need	district facilities manager convinced district to do it after county introduced reduced organics tipping fees	avoid having anyone blindsided by new program
Farrell, M. (1997, June). Recycling cafeteria food residuals. BioCycle, 82–84.	ME	1992	1	composting	Y				PTO parents, 5th grade students	students do all the work	PTO applied for grant	
Flammer, R. (2015). School district rolls out food waste reduction. BioCycle, 79–81.	CA	2014	8	composting	Y	40-70lbs daily staff decide if unserved food can be donated, used as animal feed, or composted learning benefits used in classes			teacher, special needs high school students in technical program, district	integrated into technical education program	working with country composting consultant	
Goodwin, B. (2000,	NY	1995	1	composting,	Y	students are			parent	custodian built	custodians	

December). School models composting for the community. BioCycle, 38–40.				recycling		engaged, less waste, students bringing the idea of composting home			volunteers, students composting coordinator, custodian	table where students and staff sort food waste. community is small and close community garden (2/3 for school, 1/3 for community members who volunteer to help with school composting.	conducted waste audit, to support school board's goal of cutting waste disposal costs	
Hayes, P. E. (2013). School recycling lessons. BioCycle, 40–43.	NJ	mult iple	>1	recycling, composting	Y	student engagement,		materials being mixed back together, teachers say it will not work	teachers, custodians, students	students collect recyclables bins are clustered	waste audit	teamwork, insider makes change. commitment, academic content standard, local law, children lean what they live, teaching opportunities, custodial and kitchen staff
In Business. (2006). Student composting programs build on success of working models. In Business, 4.	CA		3	composting	Y	reduce 500 tons of residuals per year						
Kadleck, C. (2015b, April). Nebraska	NE	2015	1	composting	Y	90% reduction in	90		sustainability coordinator			

school succeeds in composting most of its food waste. Waste 360, 1.						cafeteria trash, students doing a good job sorting						
Kadleck, C. (2015a). Two enterprising N.H. teens created a school composting program. Here's how they did it. Waste 360, 1.	NH	2014	1	composting	Y	waste was reduced, students learned about working on thesis projects		students not separating, needing to sit by bins to monitor	two students for senior project	got $2500 grant for liners and compost pickup	senior project	would have started with elementary school because it is easier
Peters, H. (2007). Nature club helps to launch a recycling drive. Environmental Education, (Spring), 28.	England		2	recycling	N	recycling workshops waste reduction		recycling bins are overflowing	teacher, nature team students			
Ramsay, D. (2008). Cafeteria composting in Southern Maine. BioCycle, (April), 25–27.	ME	2007	1	composting, source reduction	Y	has spread to other schools, reduced waste leadership training students lean values connecting behavior to end results		recycling did not work, but milk cartons could be composted	fourth grade student, supportive principal	principle willing to have student initiated programs	student wanted to do something and kept pushing even when traditional recycling did not work	students can initiate multiple ways to make a program work successful programs can be models for others.
Satkofsky. (2001). Missouri school operates and in-vessel composter. BioCycle, (November), 30–31.	MO	2001	1	composting	Y	students separating with 90% accuracy, integrating into curriculum,			biology teacher, food service director	knowledgeable food service director received grant for much of the cost (~66%)		

						positive financial impact from compost sales (on campus operation)						
Schubert, G. (2001, September). Kids for composting on the Oneida Nation reservation. BioCycle, 66–67.	WI	1999	1	composting,	Y	community engagement, waste diversion, improved garden			partnership between school and tribal gov.	there is a compost manager who supervises children the students bring the compost out themselves, and weigh it.	waste audit	
Solid Waste Report (2009). Recycling at Stockton, Calif., elementary school cuts waste stream by 20%. Solid Waste Report, 7.	CA		1	recycling	Y	20% reduction in waste, 90% of polystyrene trays recycled saved money cutting waste collection from 5 to 4 days/week	20			partnership with nearby manufacturing plant to accept trays that usually can not be recycled		
Szczepanski, M. (2016, October). Travon grant of republic services ramps up recycling efforts in the L.A. unified school district. Waste 360, 1.	CA		>1	recycling	N	more than doubled recycling, more stable, less work for staff		no resources to implement, in the past there had been short-term programs that did not last	outside company, and their municipal relationships manager	company provides employees to work alongside school employees until they understand the process, and checks up on		need to make sure the process is clear and set up for the long term, with ongoing support.

										them 2-3 times a year		
Szczepanski, M. (2017). Colorado middle school aims to save its composting program. Waste 360, 1.	CO	2011	1	composting, recycling	Y	built and environmental culture at school, saved 20-30 thousand pounds of food waste		cost	environment focused class run every semester	aiming to find a new partner		
Tales, D. (2013). Recycling pays off in Brockton, MA schools by saving $90,000.Solid Waste Report, 4–5.	MA	2013	>1	recycling	N	saving $90,000 a year			director of office of operations	place recycling bins in every classroom	seeing savings from a pilot recycling program	
Verespej, M. (2012, August). Maine school district drops PS lunch trays. Plastics News, 1.	ME	2010	16	composting, recycling	Y	eliminate 450,000 polystyrene trays			superintendent	understanding that the savings on waste hauling would be used to pay for recyclable/ compostable trays		
Ward, M. N., Wells, B., & Diyamandoglu, V. (2012). Developing a recycling plan for an elementary school. 27th International Conference on Solid Waste Technology and Management, 431–443.	Unknown	Unknown	1	recycling	N	very little contamination, more recycling occurring		recyclables mixed with trash after sorting, difficult for "outsiders" to cause internal change	outside volunteers	physical separation of waste when placed outside for pickup,	waste audit revealed problem	need to build internal awareness and ability to keep program running within the school
Waste 360 Staff.	TX	2015	1	composting,	Y	sustainability			students,		waste audit	

(2016b, October). Austin high school gains national attention for recycling and composting efforts. Waste 360, 1.				recycling		effort helped bring community together and improve academic performance			teachers, keep Austin beautiful (outside NGO)		found 82% of trash could be recycled	
Waste 360 Staff. (2016a). Moscow kindergartener gets school to expand recycling program. Waste 360, 1.	PA	Unknown	1	recycling	N	paper is recycled			kindergartner and his mother, teacher, principle		kindergartener and his mother wrote a letter	

APPENDIX B

Interview script given to school staff members:

1. I am hoping to talk about the cafeteria recycling, composting and waste reduction project that has been going on for the past few years. My senior thesis at Colby College involves looking at the program today, specifically here at (name of school) to see how the program developed, how it is functioning, and what could potentially be improved. Would you be willing to have me record this interview? Neither the recording nor the transcript will be shared other than short, non-identifying quotes, and your name will not be used in any public product. You will be identified only as (position) at (name of school). If you would prefer not to be recorded I can take notes on our conversation. Before we begin if you would please read through this informed consent form and sign if you agree. I am happy to answer any questions

2. Can you briefly describe, from your perspective, two or three key points in the timeline of how the cafeteria waste reduction program came to be at (name of school) and how it got where it is today?

3. What is your overall impression of the program's performance?

4. Is there anything else you think would be important for me to know about the waste reduction program, particularly as it functions specifically at (name of school)?

Consent form to be interviewed:

Consent Form
Colby College Environmental Studies Program

Title of the Study: Waste reduction in public school cafeterias through sorting and diversion: an analysis of three southern Maine schools

Researcher Name: Jeremy Ravenelle (jpravene@olby.edu)

The general purpose of this research is identify options for maintaining and improving the outcomes of cafeteria waste reduction programs in Portland and in public schools generally. Participants in this study will be asked to provide their opinions and perspective on the waste reduction program at the school where they are employed.

Informed consent is required by Colby College for any person participating in a College-sponsored research study. This study has been approved by the College's Institutional Review Board for Research with Human Subjects.

I hereby give my consent to be the subject of this research study. I acknowledge that the researcher has provided me with:

A. An explanation of the study's general purpose and procedure.
B. Answers to any questions I have asked about the study procedure.

I understand that:

A. My participation in this study will take approximately 10 minutes in person with a follow-up by email expected to take approximately 20 minutes.
B. No unusual risks are anticipated as a result of participating in this
C. The potential benefits of this study include contributing to our understanding of school waste reduction programs and helping further the environmental and educational goals of this program.
D. I will not be compensated for participating in this study.
E. My participation is voluntary, and I may withdraw my consent and discontinue participation in the study at any time. My refusal to participate will not result in any penalty.
F. All data collected for this study will be kept confidential. The data will be stored in a secure location, and reports will identify me only by the broad category of my employment (eg. administrator, teacher, lunch aid, custodian)

Consent to record:

I *agree / do not agree* (circle one) to be voice recorded as part of this research study, and to have these recordings confidentially studied by the researcher.

_____ _____

Signature Date

APPENDIX C

Survey sent to participating school staff members:

This survey is a follow-up to our conversation in person to expand on your thoughts about the program. Thank you for your time and participation.

Please attempt to provide some detail (e.g. a sentence or two per question rather than a single word). Feel free to take more space if you have more to say.

Your participation in this section is expected to take approximately 20 minutes, if you feel it you are going significantly over that time frame, feel free to write shorter answers.

Your name (will not be included in the final report, for identification purposes only)

1.Would you be able to give two positive aspects of the program (this can be waste reduction results, learning opportunities, or anything else you think is positive)?

2. In your opinion, which of the two things you listed above do you think is the most valuable?

3. Would you be able to give two challenges the program faces or has faced (this can be waste reduction results, organization, support, infrastructure, or anything else that has been challenging)?

4. In your opinion, which of the two things you listed above do you think is the most important challenge the program has faced or is facing?

5. In your opinion, what is one thing that could or should be improved to make the program more successful for students, faculty, staff, and/or the environmental outcome?

6. For each statement, please check if you feel it is "Very good," "moderately good," or "in need of improvement"

Student understanding of how to sort
Student follow through of sorting during lunch
Lunchroom staff support of students' sorting
Administration support for the program
Program organization (bins, signs, storage, collection schedules)
Student understanding of how to sort
Student follow through of sorting during lunch
Lunchroom staff support of students' sorting
Administration support for the program

Program organization (bins, signs, storage, collection schedules)

7. Can you briefly mention any key people who have played a major role in getting this program going and/or sustaining it? Please refer to people by their professional position rather than name to protect privacy.

☐

8. Has there been a major event or issue that caused a serious problem in the program or put it at risk of not continuing?

☐

9. Is there anything you think your colleagues would say about this program that you have not already mentioned?

☐