Title
Everyday Transformations of Food to Waste: What and Why Food is Discarded in U.S. Households

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Publication Date
2019

Peer reviewed|Thesis/dissertation

Everyday Transformations of Food to Waste: What and Why Food is Discarded in U.S. Households

By

Laura Christine Moreno

A dissertation submitted in partial satisfaction of the
requirements for the degree of
Doctor of Philosophy
in
Energy and Resources
in the
Graduate Division
of the
University of California, Berkeley

Committee in charge:

Professor Alastair Iles, Chair
Professor Isha Ray
Professor Matthew Potts

Summer 2019

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Abstract

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Recent headlines have called food waste "the world's dumbest problem," often pointing out that consumers are responsible for the majority of it in the United States. Edible food is discarded while there is continuing food insecurity and hunger. Discarding food is also associated with environmental, economic, and social costs. However, the characterization of this problem as dumb or simple fails to acknowledge that its causes are complex and inextricably linked to the structure of our food system, our relationships with food, and the demands of everyday life. My dissertation centers around why people discard edible food in households in the United States by focusing on various aspects of how they plan, shop, prepare, store, cook, eat, and discard food.

The aim of this dissertation is to augment the current dearth of information about causal mechanisms and determinants of consumer-level food waste and to interrogate how definitions of edibility influence household-level research. The central finding is that the behaviors associated with the production of wasted food in households are complex and diverse including a wide range of structural, social, cultural, technological, symbolic, and material factors. Understanding these factors and how they interact are key to identifying interventions that will effectively reduce the amount of wasted food.

Chapter one explores the concept of edibility as a sociocultural construct rather than a fixed feature of a food item. Increasingly, food waste measurement, research, and policy seek to differentiate between edible food and associated inedible parts, acknowledging different underlying causes for discard and different preferred solutions for managing the materials. Given the varying views of edibility within and across cultures, there is no single definition that is widely accepted. Specifically, this paper evaluates how different definitions of "edibility" influence outcomes of food waste measurement at the household level. Using kitchen diary data from households in Denver and New York City, four definitions of edibility were applied to food waste generation data. Based on the varying definitions, we found that the percentage of total food waste considered edible ranged from 52% to 71%. We also found that the top ten lists of most wasted edible food items changed based on the definition. The findings suggest that the definition of edibility does

matter in terms of defining the extent of the problem, identifying hot spots for intervention, and tracking progress over time. We contend that edibility should be consistently and transparently defined, but also that how we define edibility should be considered in the context of policy and intervention goals.

In chapter two, we explore behaviors hypothesized to be linked to lower levels of edible food being discarded in households, such as meal planning and freezing foods. Using a Natural Resources Defense Council (NRDC) dataset from over 400 households in Denver and New York City, this chapter employs exploratory factor analysis and regression models to explore whether these behaviors are correlated with edible food waste generation. Weight-based food waste generation data from kitchen diaries were coupled with surveys that assessed frequency of participation in behaviors. After analyzing patterns of participation in twenty food waste-related behaviors, we identified three clusters representing "suites" of behavior: maximizing the consumption of already obtained food, meal and shopping planning, and minimizing overages from purchasing and cooking. The maximization factor was the only suite of behaviors found to have a statistically significant correlation with the generation of edible food waste, with greater participation in these behaviors associated with lower levels of wasted food. Although planning behaviors were not correlated, we contend that this does not mean that these behaviors are not important. Rather, we identify the potential intervening factors that could explain the lack of correlation. This chapter highlights the concept that participation in certain behaviors may have variable outcomes over time within and between households. Understanding these nuances with regard to how these behaviors are enacted within the priorities and contexts of everyday life is important to ensuring that suggested interventions are effective in reducing wasted food.

Finally, chapter three qualitatively explores how food becomes waste by focusing on the broader relationships households have with food. Open-ended interviews with 52 households in Oregon, Washington, and California were used to identify five key benefits associated with food that were linked to its non-consumption: pleasure/enjoyment, comfort, self-identity, convenience, and "good" food. I found that these benefits were sometimes realized through the consumption of food items that directly or indirectly resulted in the non-consumption of other food items (e.g. eating out instead of eating a planned meal to treat oneself during times of high stress); and were sometimes realized even if the food providing the benefit went unconsumed (e.g. stockpiling food items to feel more secure about access to food). Using theories of practice for the underlying theoretical foundation, I found that households participate in value negotiations, weighing costs and benefits, to maximize utility or satisfaction from food. These value negotiations include the intertwined household costs of money and time and lead to either the consumption or discard of food. Overall, this chapter illustrates why focusing solely on financial benefits of reducing wasted food may not be an effective lever for changing behavior.

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ACKNOWLEDGEMENTS

Someone once said to me that ERG might not have been my "natural" home in terms of topic, but it *was* home in terms of my intellectual temperament. This epitomizes my experience and my appreciation for ERG – for all of the people that make ERG what it is. I may not have been studying a topic common to many, but I was allowed and encouraged to explore any discipline, method, or theory. Nobody ever told me to stop talking trash. Instead, they curiously asked me questions and made confessions of their food waste "sins." I will miss the infectious spirit of ERG – dedicated to making change, passionate about equity, but with laughter, some yummy food, and friendship.

Special thanks to my committee -- Alastair Iles, Matthew Potts, and Isha Ray for all of the support you have given me over the years. You endlessly inspire me with your passion, research, and kindness. Thank you for giving me critical feedback to help me become a better researcher! Your generosity will not be forgotten. Special shout out to Alastair! Without you as my advisor, my time at ERG would not have been the same.

To Kay Burns, I am not sure how to adequately acknowledge your impact on me and the entire ERG community. Your unwavering support – from registering for classes to chatting about life to being a shoulder to cry on – was invaluable. Thank you for being a constant light in the sometimes overwhelming and stressful parts of grad school. You are the best!

Thank you to the ERG faculty. Each of you has had a long-lasting impact on me. I will always be grateful to Duncan Callaway for being the one who first encouraged me to undertake qualitative research, which might be surprising to some since he is a power systems engineer. Thanks to David Anthoff who gave me the single nicest and most critical piece of feedback regarding my presentation style – that my presentation "was like a good NPR episode." I always chuckle when I think of that and remind myself that I need to add more academic rigor into my presentations and storytelling. Thank you to Isha Ray for many things, but specific thanks for creating the Water Group (now WG+) and accepting us "outsiders." The intellectual community and support system that you have created is unmatched. Thanks to Margaret Torn for all of your critical feedback and great questions during masters and PhD seminars! Also thanks to Dan Kammen for his support of the ERG community, his humor, and generosity. And, last but not least, thank you to John Harte who generously provided me with a place to sit and finish my dissertation in Hilgard Hall. While this may seem small to some, it made the world of difference!

Thank you to Arpad Horvath, Wendi Gosliner, and Jennifer Wolch. I have learned so much from all of you and can never thank you enough for the support. I appreciate all of the guidance, mentorship, and support that you have given me. Thanks also to Roni Neff and Brian Roe, who are my inspirations in the world of wasted food!

My time at ERG has been both everything I imagined it would be and nothing like I expected. Just like I expected, I have had the incredible ability to learn and study what I

enjoy. Unlike I envisioned, ERGies became family (*#ergiesforlife*). I am forever indebted to all of you for your warmth, smarts, and humor.

A shout out to my cohort (*newbies2013*)! Before I met you all, I was already impressed and inspired by everything you had accomplished. And, it was love at first sight. You are a truly magical group of people. From day one we created silly, serious, and lifelong memories. I have learned so much from each of you and consider you all family. Special thanks to those of us who chose the PhD life: Kripa Jagannathan, Nikky Avila, Noah Kittner, Chris Hyun, Vero Jacome, and AP Avrin. You were my rocks, my co-conspirators, my study buddies, and so much more. From tears to belly laughs, we have so many memories that I cherish and can't wait to make many more.

To the quals, then dissertation, now life accountability group – Laney Siegner, Jess Goddard, and Cecilia Springer – you are simply the best accountability group anyone could ask for. From stickers to video chats to writing retreats with amazing food to shared spreadsheets, you made the difficult times much more bearable. You inspired me and made me work harder and smarter. To my other informal accountability buddies, Hayley and Angel, we are doctors now! Without my suite of accountability people, this would not have been possible.

An especially trashy thanks to the ladies that always inspired and encouraged me. Through your passion, dedication, and kindness, I was able to turn my interest in digging through trash into a fulfilling and fun career. Who knew?! Lisa Bauer, Timonie Hood, Saskia van Gendt, Eileen Sheehan, Nora Goldstein, Darby Hoover, and Christa McDermott -- thank you so much for your support. You are all inspirations.

To my parents, this is for you too. You have empowered me at every step of the way – allowed me to follow my own path even when you thought my keen interest in trash was a little strange. Thank you for everything that you have given me, which I am sure is more than I will ever know. To the rest of my family, I cannot express enough gratitude for your love and care throughout the years! Love you all so much!

Thanks to my family of friends for putting up with me and my constant talk of food waste! Special shout out to Rebecca Sandidge and Thao Tran, who started out as colleagues at Cal and became close friends. To Thao, I am forever in awe of your intelligence, passion, and determination. You cut up foods, managed giant spreadsheets, and always listened to my wacky ideas with a smile. Jill, Omar, Kate, and Mary – thanks for being my sounding boards and my never-ending support system.

To Joshua Dean, I don't know how to thank you enough! Your love, support, humor, and compassion were invaluable as I embarked on the unknown path of pursuing a PhD. From the stressful moments to the days of overwhelming joy, you were there for me. Thanks for letting me take pictures of your food and use you as an (un)willing participant in my mini home science experiments.

Last, but certainly not least, I would like to thank the financial supporters of the research that appears in this dissertation. Thank you to the Rosalie M. Stern Fellowship, National Science Foundation Graduate Research Fellowship Program, National Science

Foundation (Grant #EAR-1739676), Berkeley Food Institute, University of California Nutrition Policy Institute, the Energy and Resources Group, Seattle Public Utilities, and Alameda County Waste Management Authority. Special thank you to the Natural Resources Defense Council for providing the dataset that was used in two of the three chapters.

INTRODUCTION

GLOBAL IMPACTS OF FOOD LOSS AND WASTE

The global food system is viewed as problematic in many aspects related to environmental sustainability, human health, equity, and social impacts. This includes continuing food insecurity and hunger, increasing prevalence of diet-related diseases, and degradation of environmental resources (Pothukuchi & Kaufman, 1999; Raja, Morgan, & Hall, 2017). The issue of food loss and waste (FLW) has gained international attention because it is linked to all of these issues. Wasting food results in the loss of resources such as energy and water, as well as pollution associated with the lifecycle of food production. Additionally, the disposal of food in landfills results in methane emissions, a powerful greenhouse gas (Conrad et al., 2018; Food and Agriculture Organization (FAO), 2013; Hall, Guo, Dore, & Chow, 2009; Spiker, Hiza, Siddiqi, & Neff, 2017).

While the exact amount of global FLW is debated (Bellemare, Çakir, Peterson, Novak, & Rudi, 2017; Xue et al., 2017), it is estimated that one-third of edible food, intended for human consumption, is lost or wasted (Gustavsson, Cederberg, & Sonesson, 2011). Depending on the source, estimates of FLW in the United States range from 38.4 to 104 million tons per year (Buzby, Farah-Wells, & Hyman, 2014; Gustavsson et al., 2011; Hall et al., 2009; ReFED, 2016; U.S. Environmental Protection Agency, 2018). In other terms, producing food that is never consumed is estimated to account for 25% of U.S. freshwater use and 4% of U.S. oil consumption (Hall et al., 2009). Annual greenhouse gas emissions from the lifecycle of uneaten edible food (excluding land use change) are estimated to range from 700 to 900 kg CO2e per capita in North America and Oceania (Food and Agriculture Organization (FAO), 2013). Thus, the potential to reduce the environmental impacts of food through reduction of waste is high.

FOOD RECOVERY HIERARCHY: INCREASING FOCUS ON PREVENTION

While the issue of FLW has been on the policy agenda of many governments for decades, previous work primarily focused on the management of food waste and its diversion from landfills due to its contribution to the total amount of waste by weight and its associated methane emissions (Papargyropoulou, Lozano, K. Steinberger, Wright, & Ujang, 2014). However, with increasing attention, the dialogue around wasted food has gone beyond landfills to the resources (e.g. fertilizer, water, energy) that are embodied in the food that goes uneaten (Food and Agriculture Organization (FAO), 2013). As a result, a more holistic approach to reducing food waste has been promoted through the Food Recovery Hierarchy (see **figure 1**). The hierarchy preferentially organizes options to manage food waste with source reduction or prevention and food donation as the most preferred techniques (Papargyropoulou et al., 2014; U.S. Environmental Protection Agency, n.d.) given their goal of maximizing the amount of food that is eaten by people, instead of discarded. Recovering safe, edible food to redistribute to people in need is seen as a key benefit associated with strategies to reduce the amount of wasted food (Papargyropoulou et al., 2014). The next set of options, referred to as "diversion," includes feeding animals as the most preferable followed by anaerobic digestion and composting. The least

preferable options, considered "disposal," are landfilling and incinerating the food materials which are linked to the most environmental degradation compared to other options (Papargyropoulou et al., 2014; U.S. Environmental Protection Agency, n.d.).

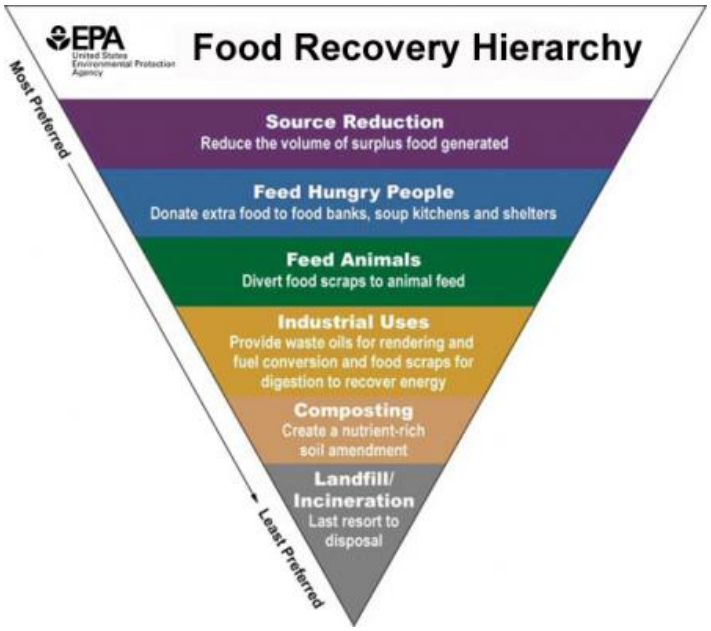

Figure 1. Food Recovery Hierarchy. Illustrates the multiple ways to reduce, divert, and dispose of food waste in preferential order from most preferred (top) to least preferred (bottom). (Source: U.S. Environmental Protection Agency, n.d.)

Given the promise of source reduction to mitigate environmental impacts while making more food available to feed people, there are an increasing number of efforts to prevent food from being discarded to any end-of-life destination. At the consumer level, a majority of the food that is discarded is considered edible (Gillick & Quested, 2018; Hoover & Moreno, 2017a), or could have been eaten, thus many efforts focus on preventing wasted food through technological and behavioral change. Food waste prevention techniques include minimizing purchasing to only buy what can be used or maximizing use of all parts of a food. It is estimated that the potential greenhouse gas emissions reduction from prevention are eight times greater than the potential reduction from composting (Quested, Marsh, Stunell, & Parry, 2013). Due to the significant contribution of food waste to climate change and its link to hunger mitigation, the United Nations established Sustainable Development Goal 12.3.1 which set a goal to reduce or prevent the amount of food wasted by retailers and consumers by 50% by 2030. Many countries, including the United States, followed suit and set national goals in line with SDG 12.3.1 (Food and Agriculture Organization (FAO), 2019; Lipinski et al., 2017).

OVERALL AIM OF DISSERTATION

From my perspective, there are three major challenges to shifting the focus from diversion to a more holistic, prevention-oriented approach to reducing wasted food: 1)

Lack of research identifying the diverse and complex causal mechanisms of the non-consumption of food; 2) Most established metrics for success in policy and practice are for *diversion* and are not easily translated to prevention; and 3) There is a need to reconcile the many definitions of FLW, including how edibility is defined and measured. Together, these three challenges represent major knowledge gaps related to the design, implementation, and tracking of evidence-based interventions.

The overall goal of this thesis is to help fill some of these gaps by incorporating direct weight-based measurement into the analysis of food waste amounts as well as using open-ended interviews to provide a "thick" description of behaviors and other factors related to discarding food. Specifically, I augment the current dearth of information on what types of food, how much, and why food is wasted in households in the United States. My long-term goal is to contribute to a more robust and holistic understanding of how food is wasted to aid in the creation of evidence-based policies and other interventions.

In addition, I contend that the concept and measurement of FLW are in the process of being re-negotiated as new policies call for new definitions related to wasted food (e.g. California Senate Bill 1383 defining "edible food"), with emerging calls for standardization of existing definitions (e.g. FUSIONS and the international Food Loss and Waste Accounting and Reporting Standard), and through the development of new methods for measuring wasted food in more detail and with greater accuracy (e.g. Remote Food Photography Method™ for measuring plate waste). It is therefore timely for my research to not only provide analysis using direct measurement, but to also analyze the definitions of wasted food and how it is measured and researched in terms of the rhetorical, analytical, ethical and policy implications.

HOUSEHOLDS: A MAJOR SOURCE OF WASTED FOOD

It is generally agreed that consumers are the largest generators of food waste in the United States compared to other stages in the food supply chain (Buzby et al., 2014; Gustavsson et al., 2011; ReFED, 2016). Within the consumer level, which includes restaurants and other consumer-facing businesses, households are the largest contributors. A 2016 study by ReFED estimated that 43% of all food wasted in the United States was generated in households (ReFED, 2016), and a similar trend was found in the European Union, with 53% attributed to households (Stenmarck, Jensen, Quested, & Moates, 2016). Given their large contribution to FLW, consumers and household members are frequently targeted by governments, NGOs and researchers for intervention to change consumer behavior and promote new technologies in order to prevent the generation of wasted food (Hebrok & Boks, 2017; Schanes, Dobernig, & Gözet, 2018). Consumer education campaigns to provide information on the issue and suggestions for changing behaviors are the dominant intervention strategy (e.g. Save the Food) (Hebrok & Heidenstrøm, 2019).

Even though households are estimated to be the largest contributor to wasted food along the supply chain, they are difficult to target for measurement or intervention, especially

with regard to food waste prevention. In addition to the sheer number of households that contribute to food waste, Quested et al (2013) explains that understanding how much and why food is wasted in households is complex for a number of reasons: 1) Wasting food is not a single behavior, but rather a series of multiple interacting activities often separated in time, space, and concept; 2) Behaviors related to discarding food are often strongly rooted in habit or routine; 3) Food waste behaviors are performed within the context and priorities of everyday life; and 4) For the general public, there are strong conceptual links between waste and other food-related issues such as nutrition and food safety (Quested et al., 2013).

Reviews on consumer-level food waste have identified the literature as being fragmented, with scarce evidence of causal mechanisms underlying the behaviors that result in discarded food. Other critiques include that the literature tends to overlook sociocultural factors, excessively emphasizes changes at the individual consumer level, and is more focused on generating knowledge of the problem than identifying and testing solutions (Hebrok & Boks, 2017; Reynolds et al., 2019; Roodhuyzen, Luning, Fogliano, & Steenbekkers, 2017; Schanes et al., 2018). Based on a systematic review of existing literature on consumer level food waste, Schanes et al (2018) identified the need for a coherent and systematic policy framework that empowers changes all along the food supply chain, and not just at the individual consumer level (Schanes et al., 2018). More qualitative research is needed to better understand the nuances and complexity of behavior and their interactions with contextual factors (Hebrok & Boks, 2017; Roodhuyzen et al., 2017). Overall, behaviors related to discarding food in households are complex, diverse, and require a wide range of quantitative and qualitative research methods to understand them within the broader sociocultural context, as part of the food system, and in context with priorities of everyday life.

EXISTING METHODOLOGIES: QUANTIFYING THE AMOUNT OF WASTED FOOD

Common methods used to quantify the amount of food wasted at the individual or household level include measurement through: waste composition studies, which involve researchers collecting waste material, separating it into categories, and weighing it; kitchen diaries in which household members record what and how much food is wasted, sometimes in addition to other information; surveys used to approximate food waste generation by asking respondents to estimate the amount of food they discard; and statistical modeling, often using proxy data (Moreno, Lazell, Mavrakis, & Li, in press; Roodhuyzen et al., 2017). Waste composition studies and kitchen diaries are both considered direct measurement, while surveys and statistical modeling are characterized as indirect measurement. Both waste composition studies and kitchen diaries use weight-based measurement, though kitchen diaries can also employ other methods for quantification including volume-based measurement and approximations (e.g. handfuls or servings) (Moreno et al., in press). Weight-based measurement is preferred as it improves accuracy and allows for easier comparability (Hanson et al., n.d.-a; Hebrok & Boks, 2017). Due to the difficulty of gathering FLW data, indirect measurement is also used to estimate FLW. For example, Hall et al (2009) estimate food waste in the U.S. using an energy balance model that simulates metabolic intake (Hall et al., 2009).

Directly measuring wasted food can be difficult due to resource constraints, access to food materials, and sampling and self-reporting biases. In studies of household-level food waste, kitchen diaries have an underreporting rate of approximately 40% when compared to results from waste composition analyses (Hoover & Moreno, 2017a; Oregon Department of Environmental Quality, 2019; Quested, Parry, Easteal, & Swannell, 2011). Another related but distinct challenge of food waste measurement, especially methods relying on surveys or other recall methods, is that people tend to underestimate how much they discard (Neff, Spiker, & Truant, 2015). Waste composition studies are also limited in quantifying wasted food because they generally only measure items that are placed in the trash or organic materials bin collected at the curbside. They generally do not capture food items discarded in other destinations such as drain disposal, backyard composting, and feeding pets/animals (Moreno et al., in press). While no specific methodology has yet to predominate as the most trusted for household-level measurement, direct measurement relying on weight-based methods is considered "best practice."

EXISTING METHODOLOGIES: UNDERSTANDING WHY FOOD IS DISCARDED IN HOUSEHOLDS

Wasting food is a not just an issue of waste. It is a food issue, thus behaviors of interest go beyond the final act of discard. In understanding why consumers waste food, it is critical to contextualize actions of discard within the larger relationship that people have with food. A variety of qualitative and quantitative methods are used by researchers including surveys, focus groups, interviews, and ethnography (Hebrok & Boks, 2017; Roodhuyzen et al., 2017; Schanes et al., 2018). Compared to quantitative approaches, qualitative methods offer a more expansive approach that enhances understanding of how behaviors are interconnected and impacted by context. They allow the researcher to contextualize values, attitudes, and beliefs within the society and culture in which food waste occurs in order to provide a more nuanced account of behavior (Hebrok & Boks, 2017; Roodhuyzen et al., 2017).

Most research on consumer-level food waste utilizes either a psychology-oriented or a sociology-oriented theoretical approach (Schanes et al., 2018). Approaches from psychology, including the Theory of Planned Behavior (e.g. Romani, Grappi, Bagozzi, & Barone, 2018; Stancu, Haugaard, & Lähteenmäki, 2016) and Value-Norm-Belief Theory (e.g. Farr-Wharton, Foth, & Choi, 2014), generally aim to identify mechanisms and factors that either promote or impede reduction of food waste by individuals, often focusing on intention as the primary predictor of behavior. These approaches are criticized for overlooking the known gap between intentions and actual behavior. They are also criticized for failing to appropriately describe behavioral outcomes by focusing excessively on individuals without adequate consideration of context and sociocultural factors (Hargreaves, 2011; Schanes et al., 2018).

Approaching the issue of wasting food from a sociological perspective, as a social phenomenon rather than an individual phenomenon, may more accurately illuminate the

drivers of and solutions to food waste. Theories of practice are one set of dominant sociological theories utilized to understand routine or habitual behaviors (Hargreaves, 2011), including issues of water and energy use (e.g. Hand & Shove, 2007; Shove, 2003) and consumer food waste (e.g. Evans, 2012; Ganglbauer, Fitzpatrick, & Comber, 2013). In this set of theories, it is acknowledged that individuals operate within a broader interwoven framework of structural, social, economic, cultural, and material factors (Evans, 2012; Hargreaves, 2011). In a foundational paper exploring food waste from a sociological perspective, Evans (2012) describes wasting food as a mundane consequence of social relationships with food. While this framing can overcome the intention-behavior gap of psychology-based theories, it can be difficult to quantify or model. Psychology-oriented theories, on the other hand, are generally more amenable to quantification yet constrained in their ability to understand and explain the complexities of individuals operating within larger contexts.

Based partially on the work of Quested et al (2013), behaviors of interest in terms of discarding food, or precursor behaviors, can be categorized into six activities plus the final act of discard (see **figure 2**): planning, shopping, preparing, storing, cooking, and eating. Discard can occur as part of or after any of the six activities. Understanding each of these precursor behaviors in relation to each other and the act of discarding food is important to understanding the phenomena of wasted food. These behaviors are not always undertaken in a linear fashion and each may be separated in space and time. As noted previously, many of these behaviors are routinized or habitual, meaning that they are done without much thought on a regular basis. As a result, these behaviors may be less "visible" to people as they act them out (Quested et al., 2013). Additionally, there is significant diversity in how people relate to food, the context of everyday life in which they make decisions related to food and waste, and how sociocultural norms impact these behaviors (Evans, 2012; Quested et al., 2013; Southerton & Yates, 2015). Understanding how all of these factors and contexts come together and change over time is essential to understanding how and why people discard edible food.

Figure 2. Food cycle: Precursor behaviors to discarding food. Food can be discarded at any point and behaviors are interrelated.

Consumers, through their actual behaviors as well as perceived desires, influence choices associated with waste that are made all along the supply chain (e.g. retail aesthetic standards or date labeling) (Aschemann-Witzel, de Hooge, & Normann, 2016). Similarly, upstream policies and decisions related to food production, manufacturing, distribution, packaging, marketing, and promotion structure consumers' environments and shape their food consumption and waste-related behaviors (Quested et al., 2013). Thus it is important to consider the food supply chain holistically, rather than in isolation, to support understanding of the ways in which actors and actions at each level of the supply chain affect waste at other levels (Institute of Medicine and National Research Council, 2015). As a result of these complexities, developing policies or creating interventions to effectively reduce wasted food in households is reliant on a holistic understanding of the practice of wasting food, including precursor behaviors.

In light of the research gaps, each chapter of this thesis addresses a specific question related to the complex and diverse factors associated with discarding food in households. A prerequisite to identifying how much and what food is discarded is to understand "what is food?" In chapter one, we explore how the differences in researcher-defined conceptions of edibility influence the understanding of wasted food by applying multiple definitions to real-world data. Using data from households in Denver and New York City, chapter two identifies suites of behaviors related to food waste prevention and tests their correlation with edible food waste generation. With a focus on planning, we highlight the variable impact that participation in behaviors, such as meal planning, have on food discards in households. Chapter three further explores how households negotiate whether to consume or discard food in households. Using open-ended interviews, I identify benefits of food that directly or indirectly result in its non-consumption. Together, these chapters provide evidence that some of the assumptions made about our relationships with food, including how we define food, need to be further interrogated to ensure we are capturing the diversity and nuance of perceptions and behaviors. Specifically, these chapters illuminate how our broader relationships with food are crucial to understanding how food is transformed to waste in households, further illustrating that food waste is a "food issue," not just a waste issue.

CONCEPTUAL FRAMEWORK

The following terminology and conceptual framework are used to clarify the meaning of "wasted food" used in this thesis and to structure the remaining chapters. Each chapter explores factors identified within the framework, ranging from narrow topics of edibility in chapter one to broader explorations in chapter three of how the benefits we derive from food contribute to its discard.

TERMINOLOGY: DEFINING FOOD LOSS AND WASTE

One of the main reasons why estimates for the quantity of food discarded vary is the lack of convergence around a single definition for FLW. Definitions differ in terms of inclusion of: various stages of the food supply chain, inedible parts, and various discard destinations or end-of-life options (Bellemare et al., 2017; Spang et al., in press). The challenge of multiple definitions of FLW being in use has been identified as one of the major issues for food waste research. Differing definitions make comparisons between various studies difficult, add complexity to tracking progress against regional, national, and international goals, and make clearly communicating results to various stakeholders difficult (Bellemare et al., 2017; Hanson et al., n.d.-a; Spang et al., in press). To help address this issue, a multi-country group based out of the European Union, Food Use for Social Innovation by Optimising Waste Prevention Strategies (FUSIONS), undertook a study to identify current definitions in use and suggest a new, universal definition (Östergren et al., 2014). Following this framework, this dissertation uses the following definitions and terminology throughout:

> **Food Waste:** Any food or beverage, and associated inedible parts, intended for human consumption and removed from the food supply chain to be recovered or disposed (including composted, anaerobically digested, disposed to sewer, landfilled, incinerated, and fed to animals). This does not include food that is eaten by people, thus recovery for food donation is excluded from the definition.
>
> **Wasted Food:** A subset of food waste that only includes the portion of food materials considered edible. In this thesis, "edible food waste" or "edible portion of food waste" may also be used.
>
> **Edibility:** Refers to whether the food item or portion of a food item could have been eaten, rather than safe to eat at the time of disposal. For instance, a moldy pizza is not safe to eat at the time of disposal, but is still considered edible.

One notable difference is that discarding food intended for consumption by humans to pets or wildlife by households is considered part of the definition of food waste for the purposes of this thesis, but it is excluded by FUSIONS. The main reasoning behind its exclusion from the FUSIONS definition is that the food remains part of the supply chain

when it is fed to animals (Östergren et al., 2014). I contend that this is true for stages of the food supply chain that divert discarded food to pig or cows, but is not applicable for discarding food to pets or wildlife as happens in households.

CONCEPTUAL FRAMEWORK: THEORETICAL UNDERPINNINGS

Theories of practice are based in sociology and provide the theoretical foundation for the conceptual framework created as part of this thesis to illustrate the key factors related to the discard of edible food in households. Theories of practice emphasize materiality, symbolism, and the embedded nature of practices within social and power relations (Hargreaves, 2011; Reckwitz, 2002; Warde, 2005). Individuals are viewed as "skilled agents" who partake in daily, routinized actions that allow them to better understand their worlds and develop their identity. By understanding how individuals perceive themselves and their experiences, it allows researchers to better grasp why practices develop and how they change (Hargreaves, 2011). Additionally, de-centering the individual allows for practices to be conceptualized as a combination of factors, rather than solely a result of volitional behaviors (Warde, 2005).

Practices are the primary unit of analysis within theories of practice and are generally defined as a series of repeated actions that are enacted together. When conducting research, the researcher collects information on the "doings" and "sayings" associated with a specific performance, or enactment of a behavior. In this case, the performances of interest are discarding food and associated actions. Discarding food should be considered a "bundle of practices" including behaviors related to the provisioning, preparation, and consumption of food, in addition to its eventual discard. Understanding each of the precursor behaviors by itself and in relation to each other is critical to understanding how food is transformed into waste by households (Hargreaves, 2011; Southerton & Yates, 2015).

By understanding both how and what the participant perceived of the performance (sayings) in addition to what actually happened (doings), the researcher can identify patterns and themes related to that practice or behavior (Reckwitz, 2002; Schatzki, 1996). A practice is comprised of three general elements which include factors within and beyond the individual, but are all influenced by the social world: 1) bodily and mental activities, including emotion and symbolism; 2) things and their use; and 3) knowledge and understanding (Hargreaves, 2011; Reckwitz, 2002). Understanding these elements and how they change with time and context are critical to understanding routinized, everyday behaviors.

CONCEPTUAL FRAMEWORK: DISCARDING FOOD AS A PRACTICE

The conceptual framework shown in **figure 3** illustrates the key factors that determine whether food is consumed or discarded: structural, economic, and policy factors; priorities and factors of everyday life; bundles of food practices; and food type and characteristics. Based partially on the work of Quested et al (2013) and theories of practice, the parts of the framework come together to form the major factors of a practice,

in this case, discarding food. The circles are concentric to illustrate that some factors, as represented by outer circles (e.g. structural factors), have widespread impacts that influence factors within the inner circles (e.g. bundles of food practices).

The outermost ring of the conceptual framework is "structural, economic, and policy factors" which include technologies, policies, and broad sociocultural contexts that influence how a person interacts with food and waste. Influential factors within this ring include: systems of food provisioning, for instance the structure of the retail food supply chain (e.g. Lee, 2018; Soma, 2019); conventions of date labeling and food safety (e.g. Watson & Meah, 2012); nutritionalization of the food system (e.g. Dixon, 2009); and food prices (e.g. Ericksen, 2008). Other influential factors within this ring include the waste management infrastructure and policies, economic and social systems for reinforcing inequity, and the structure of the larger food supply chain (Evans, 2012; Hebrok & Boks, 2017; Quested et al., 2013; Roodhuyzen et al., 2017). Generally, these factors have broad international, national, and regional influences that impact the other three rings. For example, concerns of food safety and healthy eating shape whether food is characterized as good enough to eat. The structure of the food system impacts whether food is characterized as "good" and "bad," influencing decisions to discard it. Important food system factors include the prevalence of cold storage technologies, government regulations, and cultural conventions around healthy eating. For instance, poultry products that are sold unrefrigerated in some countries would likely be considered unsafe to eat in countries where cold storage is dominant across the entire food supply chain.

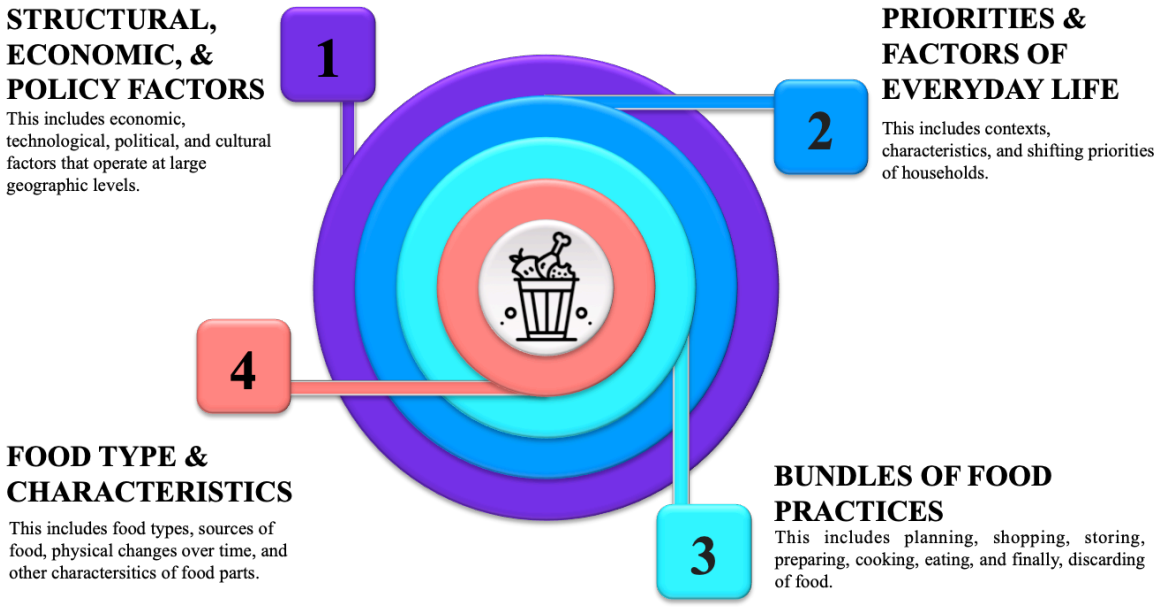

Figure 3. Conceptual framework for wasting food in households. Each ring represents a major set of factors that influence what and how food is discarded in households. Factors in each of these rings may change across geography, differ between individuals, or vary over time within and among households.

The second outermost ring is "priorities and factors of everyday life" representing contexts, shifting priorities, and other characteristics of a household that influence the enactment of their everyday lives. Excluding priorities and factors solely related to food,

which are included in the third ring, this set of factors includes: good provider identity, or expressing love and care to loved ones by providing goods and services to them (e.g. Barone, Grappi, & Romani, 2019; Graham-Rowe, Jessop, & Sparks, 2014); time scarcity and convenience, including participation in behaviors that shift or save time (e.g. Setti, Banchelli, Falasconi, Segrè, & Vittuari, 2018); saving money and time-money value (e.g. Koivupuro et al., 2012); social relationships with family, friends, and housemates (e.g. Evans, 2012); and households characteristics, including household composition, presence of children, and other sociodemographic factors (e.g. Evans, 2012; Parizeau, von Massow, & Martin, 2015; Quested & Luzecka, 2014). This set of factors greatly influence how households interact with food and can change within households over short and long periods of time. Shifting factors can have significant influences on the consumption of food and the generation of wasted food. For example, life stressors or feelings of time scarcity shape how a household provisions and interacts with food. During stressful weeks, households may eat out more frequently or forego planned meals due to convenience or comfort. However, these behaviors are also influenced by factors in the outer ring, including access to the restaurants or cultural conventions about self-gifting during times of high stress.

The next ring, third from the outside, is "bundles of food practices" which represents everyday behaviors and actions related to food. Comprised of the precursor behaviors or actions associated with the food cycle, this set of factors can also shift rapidly within a household. For instance, a household may grow a majority of their produce during the Summer and Fall months but rely on the supermarket for the rest of the year. This change in provisioning may influence what foods are eaten by the household as well as what food items or parts go unconsumed. Households have noted, for example, that they are more likely to eat all parts of produce, even if it is considered potentially inedible, from their garden compared to the grocery store. Key themes within this set of factors include: delayed disposal, or storing foods prior to disposal instead of disposing of them immediately (e.g. Evans, 2012); participation in meal and shopping planning (e.g. Stefan, van Herpen, Tudoran, & Lähteenmäki, 2013); enjoyment or self-gifting derived from interactions with food (e.g. Evans, 2012); and knowledge and skills, including proper food storage (e.g. Farr-Wharton et al., 2014; Quested & Luzecka, 2014; von Kameke & Fischer, 2018). Each of the behaviors considered in the bundle of food practices is influenced by the outer rings. For example, systems of provision for food, including retail markets, impact household level food waste by influencing how people partake in food behaviors (Lee, 2018; Soma, 2019). Soma (2019) illustrates this by finding that the concept of shopping and meal planning is based on the premise that the consumer has a supermarket experience. If shoppers are purchasing from traditional markets or other sources that may not predictably have a stock of food items, then planning behaviors like making a shopping list or meal planning are not as viable as in contexts where supermarket shopping is the norm.

The innermost ring represents factors associated with "food type and characteristics" of a food item that influence whether and how it is discarded. This includes physical properties of food item, including physical changes that happen over time. It also includes the values given to food, such as monetary and moral values (Mavrakis, 2014).

For example, some people express greater levels of guilt for discarding meat and fish items in comparison to vegetable-based items due to the "loss of life." Other key themes within this ring include: edibility including the perception of edibility (e.g. Nicholes, Quested, Reynolds, Gillick, & Parry, 2019); and healthy foods, including over-provisioning of vegetables due to aspirations to eat healthier (e.g. Quested & Luzecka, 2014). How people interact with food, and thus how it is discarded, is shaped by the material and symbolic nature of food items.

The factors represented in the conceptual framework: 1) are not static and may change across geography, differ between individuals, or vary over time within and among households; 2) should be considered in the context of how all rings come together and interact as a whole; and 3) are impacted by multiple elements including symbolic and material influences. In line with the components of a practice identified in theories of practice, the following elements or factor influences should be considered: 1) meaning - including symbolism, values, and identity; 2) materiality - including physical objects, systems, and technologies; 3) competencies - know-how and knowledge; and 4) temporality - ordering and sequencing of everyday life (Ellegård, 1999; Hand et al., 2005; Hargreaves, 2011; Shove, 2003). For example, understanding the discard of meat products may include: moral values associated with the "loss of life" (meaning); the type of meat and how meat items are stored (materiality); knowledge of how to elongate the shelf life of meat products (competencies); and household availability of time to properly store and cook items (temporality).

STRUCTURE OF THE REMAINING CHAPTERS

All of the remaining chapters explore at least one factor or component of the conceptual framework and aim to clarify the role of various factors and components in the generation of wasted food. ***Chapter One*** explores the definition of edibility and how that influences estimations of food waste generation at the household level. This chapter is based on the premise that edibility is a socially constructed concept instead of being an innate characteristic of a food item. The perception of edibility is influenced by a variety of factors, including the material nature of the food item, transformations and treatments associated with preparing food items, government and corporate standards and definitions for food, and preferences of individuals (Gillick & Quested, 2018; Hanson et al., n.d.-a; Nicholes et al., 2019; Roe, 2006). Through the conceptual framework, understanding edibility incorporates components of meaning (e.g. emotions associated with consuming certain food parts, such as feelings responsibility from using all parts of items or disgust about eating particular parts), know-how (e.g. cooking skills to prepare different parts of food), materiality (e.g. physical characteristics of foods), and temporality (e.g. how food changes over time). Perceptions of edibility influence the understanding of wasted food in two ways. Firstly, if something is considered edible, it is more likely to be consumed than items that are considered inedible, thus the sometimes-changing perceptions of edibility influence how much food is discarded. Secondly, most research targeting the prevention of wasted food only considers the edible portion; therefore, the researcher's definition of edibility shapes their understanding of what is "wasted food?" Chapter One specifically examines the concept of edibility to explore the impact of various researcher

definitions of edibility on the outcome of household food waste measurement results. While it does not directly relate to consumer behavior, it indirectly influences how wasted food is conceptualized and studied.

Chapter Two uses directly-measured kitchen diary data coupled with survey data from households in Denver and New York City to cluster behaviors associated with food waste prevention and correlate the clusters with the generation of edible food waste. Specifically, this chapter focuses on a variety of behaviors included within "bundles of food practices," the second innermost ring of the conceptual framework. Using polychoric factor analysis, three "suites" of behaviors were identified: shopping and meal planning, maximizing consumption of already purchased items, and minimizing overages from provisioning and cooking. Using regression analysis, the relationship between the generation of edible food waste at the household level and participation in these suites of behavior was tested. Finding that only the suite of behaviors related to maximizing consumption was correlated with the generation of wasted food, this chapter explores how the various factors and components within the conceptual framework explain these results. Purported by some to be important determinants of wasted food (Setti et al., 2018; Stefan et al., 2013), this chapter explores how participation in planning behaviors can lead to variable "success" within and between households based on changing contexts and priorities of everyday life. Understanding the success of planning in reducing wasted food incorporates components of meaning (e.g. expressing good provider identity by over-provisioning food), know-how (e.g. ability to plan and estimate stock correctly); materiality (e.g. physical characteristics of foods); and temporality (e.g. shifting stressors and responsibility; time scarcity).

Based on open-ended interviews of over fifty households in Oregon, Washington, and California, ***Chapter Three*** explores a specific aspect of the component of "meaning." Specifically, this chapter identifies five practical and symbolic benefits that people derive from food that are directly or indirectly related to its non-consumption or discard. These benefits can be derived from any interactions with food within the "bundles of food practices" and are mediated by the other sets of factors. It was found that these benefits are considered during value negotiations, in which households seek to maximize utility, or satisfaction from food, by comparing costs of time and money with potential benefits. These value negotiations determine whether food is consumed or discarded (Furst, Connors, Bisogni, Sobal, & Falk, 1996; Jabs & Devine, 2006). Benefits associated with the non-consumption of food relate to other conceptual framework components of know-how (e.g. ability to store food properly thus elongate its lifespan), materiality (e.g. household composition; physical characteristics of foods including whether they are considered healthy), and temporality (e.g. shifting stressors and responsibility; time scarcity).

As a whole, these chapters illustrate that describing the social phenomenon of wasted food in households is complex. It requires an understanding of the nuanced and variable nature of behaviors over time and between contexts, including the diversity of relationships people have with food. Wasting food cannot be understood without understanding how people interact with food within the priorities of everyday life. Instead of framing the issue of wasting food as a problem of careless, lazy, or unknowing

individuals, we must understand the complex nature of how people perceive food and interact with it to understand how that food becomes waste.

CHAPTER 1

Chapter 1 is included here with the permission of my co-authors, Thao Tran and Dr. Matthew Potts. Human subjects approval was obtained for this project from UC Berkeley's Institutional Review Board, Protocol # 2017-06-10053, entitled "Household Level Food Waste in the U.S.".

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1. CONSIDER A BROCCOLI STALK: DOES EDIBILITY MATTER IN HOUSEHOLD FOOD WASTE MEASUREMENT?

1.1. INTRODUCTION

Do you eat the broccoli stalk? The apple core or the apple peel? Do you peel your potatoes and carrots? Do you eat chicken skin or use your bacon grease? Or, do you consider these items to be inedible? While the concept of edibility is seemingly straight-forward, what is and is not considered edible varies widely within and between cultures (Gillick & Quested, 2018; Hanson et al., n.d.-a; Papargyropoulou et al., 2014). These examples of food parts with debated edibility may seem like small details in studying and intervening in the generation of food waste, however, we argue that categorization of food parts as "edible" or "inedible" has a potentially significant impact on household level measurement of wasted food.

Historically, the focus of food waste management has been on diverting materials from landfills with an emphasis on methane emissions and landfill space (Papargyropoulou et al., 2014). In the United States in 2015, discarded food accounted for 22% of municipal solid waste reaching landfills (U.S. Environmental Protection Agency, 2018). Policies to address the issue of food waste have tended to focus on diversion to composting or anaerobic digestion, where the type of food item, including its edibility, is of little importance. However, there is increasing acknowledgement that the environmental and social impacts of discarded food go beyond its impact when disposed in landfills (Food and Agriculture Organization (FAO), 2013; Papargyropoulou et al., 2014).

It was estimated that one-third of edible food produced globally was lost or wasted (Gustavsson et al., 2011). Globally, this results in a carbon footprint of approximately 3.3 Gts of CO2e per year, not accounting for emissions from land use change (Food and Agriculture Organization (FAO), 2013). All of the resources that go into producing, processing, and transporting, and storing food, including water, energy pesticides, and fertilizers, are essentially wasted if the food goes uneaten These upstream resource impacts outweigh those associated with disposal (Food and Agriculture Organization (FAO), 2013; Salemdeeb, Font Vivanco, Al-Tabbaa, & zu Ermgassen, 2017). For these reasons, in addition to links to hunger alleviation, the issue of food loss and waste (FLW) at all parts of the food supply chain, including the consumer level, has gained increasing international attention.

In recent years, there has been a shift in the focus of policy and programs to maximize the amount of food that is consumed by humans or animals and minimize any discarded food, whether diverted from disposal or not (Papargyropoulou et al., 2014). This is exemplified in Sustainable Development Goal 12.3.1 to reduce food waste at the retail and consumer levels by 50% by 2030 (Food and Agriculture Organization (FAO), 2019). Initiatives and policy focusing on prevention of wasted food tend to target foods containing 'edible' parts, which are considered 'avoidable' (Hanson et al., n.d.-a; Papargyropoulou et al., 2014). Aside from avoidability, it is also acknowledged that food items with edible portions have different causal mechanisms for becoming waste than inedible parts alone (e.g. whole banana vs. banana peel) (Hanson et al., n.d.-a). While goals, measurement, and programs are created in terms of edible wasted food, there is not a widely agreed-upon definition of edibility (Gillick & Quested, 2018).

There are many definitions for FLW and some, including those of the United States Department of Agriculture (USDA) and the United Nations Food and Agriculture Organization (FAO), only include the edible portion of food items, thus excluding the associated inedible parts from estimates of FLW (Buzby et al., 2014; Gustavsson et al., 2011). Using fresh broccoli as an example illustrates the potential impact of categorizations of edibility. According to the USDA Loss-Adjusted Food Availability (LAFA) dataset, approximately 6.1 pounds per person per year of fresh broccoli were available for consumption, but not necessarily eaten, at the consumer-level in the United States in 2017. USDA also provides a loss rate at the consumer level, estimating that 12% of that available broccoli is discarded, or goes uneaten for some reason, by consumers/eaters in households and restaurants (USDA Economic Research Service, 2018). If the broccoli stalk is considered *edible*, approximately 119,000 tons of broccoli would be considered lost or wasted in the U.S. (assuming a population of 325.7 million people in 2017). The USDA estimates that a broccoli stalk accounts for 39% of the total item (United States Department of Agriculture, 2018), thus if the stalk is considered *inedible*, only about 73,000 tons of broccoli would be considered as lost or wasted.

While this example illustrates the potential of differing definitions of edibility to significantly influence FLW estimates at the national level, it is not well established what the impact of edibility is across multiple food types and at the household level. We contend that the definition of edibility impacts household food waste measurement and is important for describing the extent of the food waste problem, identifying areas for targeted interventions, and tracking progress towards goals aimed at reducing wasted food.

1.1.1 *Household-Level food waste*

In the United States, a study by ReFED estimated that 43% of food waste is generated in households (ReFED, 2016). Another study, by the USDA, estimated that 21% of the available food supply is lost or wasted at the consumer-level, which includes households (Buzby et al., 2014). Similar trends have been found in Europe and other developed countries (Gustavsson et al., 2011; Stenmarck et al., 2016). Given the large amount of wasted food generated in households, measurement studies have been undertaken to estimate what, how much, where, and why food is discarded; to identify 'hot spots' or areas for targeted interventions; and to set baselines and quantify the results of

interventions (Buzby et al., 2014; Gillick & Quested, 2018; Roodhuyzen et al., 2017; Stenmarck et al., 2016).

1.1.2 *DEFINING EDIBILITY*

There are varying definitions of edibility based on a set of sociocultural, structural, technological, and other factors. This variation happens within and across geographic borders and cultures, making a widely agreed upon and universal definition of edibility difficult. The international Food Loss and Waste Accounting and Reporting Standard acknowledges the variable nature of edibility, but also advocates for consistent definitions across studies whenever feasible to allow for comparability (Hanson et al., n.d.-a). It is important to note that the term "edibility" is often used when considering food donation or rescue. "Rescuable" food, however, must be safe and healthy to eat when it is donated. For the purposes of this paper, we define "edibility" not in terms of rescuability, but in terms of whether it *could* have been eaten, even if it was moldy or rotten when it was discarded. Food suitable for rescue may also contain parts that we would consider "inedible" in this paper (e.g. apples are donated to food banks as whole apples, not only "edible" parts).

Using ingestibility or digestibility as the criteria for edibility is not feasible because essentially all food materials could be made into something that is digestible with enough processing or technological innovation (Gillick & Quested, 2018). Additionally, many items considered inedible by people are safe to eat, but are not eaten due to cultural or personal preference. For instance, citrus rinds are safe to eat and eaten by some (e.g. preserved lemons), but many people consider them inedible. In lieu of an existing framework of edibility, the Waste and Resources Action Programme (WRAP) identified potential methods for categorizing food items or portions of a food item as edible or inedible. They also note that none of these methods are 'objective' and can be difficult to apply to household-level research. The two methods are: 1) using whether a product is sold or not as a rule of thumb for determining edibility; and 2) creating a definition based on cultural norms of what is typically eaten in that geographic location (Gillick & Quested, 2018).

Relatively little attention has been paid to the impact of the definition of edibility on measurement outcomes at the household level. Notably, WRAP recently completed a national survey in the UK to understand what parts of foods are usually eaten and what parts are perceived as inedible. The findings were then used to help WRAP delineate between food and associated inedible parts in their measurement (Gillick & Quested, 2018; Nicholes et al., 2019). To the authors' knowledge, there has not been a paper exploring differences in the quantitative impacts of different definitions of edibility on measurement. However, in a similar vein, WRAP re-calculated household food waste estimates and impacts based on a change in how food waste was categorized. They changed from a scale of avoidability (unavoidable, potentially avoidable, avoidable) to edibility (edible, associated inedible parts) to conform to international standards for food waste measurement. They found that the most wasted food items, environmental impacts, and costs of food waste did have some differences between "avoidable" and "edible" categories (Gillick & Quested, 2018), thus suggesting how food is categorized in terms of edibility may have an impact on measurement outcomes.

Edibility not only plays an important role in estimates of FLW, but also understanding what portion of wasted food can be managed with prevention programs. In this paper, we interrogate the potential impact of different definitions of edibility on household food waste measurement outcomes and discuss how these might influence policy and interventions related to reducing FLW. To do this, we analyzed multiple definitions of edibility, two that are widely used and two created as part of the study. The definitions were then quantitatively applied to approximately 500 weeklong kitchen diaries and the results were compared. We find that definitions of edibility can differ significantly by specific food type and those differences impact the results of household level food waste measurement, and thus how it is problematized.

1.2. MATERIALS AND METHODS

We compared multiple definitions of edibility to understand: 1) the maximum difference between two definitions of edibility by comparing two 'extreme' definitions, one that includes most parts as edible and another that characterizes the least number of parts as inedible; 2) the difference between two widely-used definitions from the U.S. and U.K. and how they compare to our extreme definitions; and 3) how the identification of edibility by participants in a kitchen diary study compared to the other four definitions. In addition to comparing the four definitions, we also explored the variable impact of these definitions on real-world household measurement data (week-long kitchen diaries in Denver and New York City). **Table 1** summarizes the steps of the analysis described in the following sections.

Phases	**1) Creation & Application of Definitions of Inedibility**	**2) Quantitative Comparison of Definitions**	**3) Application of Definitions to Real-World Data**
Analyses	● Created and/or applied all definitions of edibility for standardized food items with potential inedible parts in the kitchen diaries ● Qualitatively compared differences in definitions	● Compared proportion of food items considered inedible by definition, including correlation of differences with: ○ Food types ○ Size ○ Purchasing differences ● Compared estimates of refuse percentage in USDA NNDSR to estimate using USDA definition with study measurement	● Applied quantitative definitions to 489 kitchen diaries and compared outcomes, including: ○ Ratio of edible to inedible parts ○ Top 10 lists of most wasted edible food types ○ Breakdown of wasted edible food by loss reason and discard destination ○ Household-level impacts

Table 1. Summary of Methods. The data sources used were: USDA National Nutrient Database for Standard Reference (NNDSR), WRAP Household Food Waste Restated, kitchen diaries from households in New York City and Denver, and study measurement of 69 individual food items.

1.2.1. DETERMINING FOOD ITEMS TO BE ANALYZED

To facilitate comparisons between the four definitions, we generated a list of specific food items commonly discarded in US households. The food items included in this list were determined by the foods reported in kitchen diaries from 545 households in Denver and New York City collected during late 2016 and early 2017 as part of a study by the Natural Resources Defense Council (NRDC). Participants recorded a food description,

weight (in ounces), state of food (e.g. inedible parts, cooked, whole), loss reason, and discard destination for all food and beverages they discarded for one week. More information on the study can be found in the original NRDC study reports and technical appendices (Hoover & Moreno, 2017a, 2017b). Using NRDC's raw kitchen diary data, 56 households were excluded from the analysis due to missing data or clear errors in weight measurements.

Each of the 13,962 kitchen diary entries was given a standardized food name based on the description provided by the respondent, such as "apple." After creation of a list of 246 food items, which can be found in the appendix 1, all items without inedible parts were removed from the list. Cooked items such as lasagna and burritos, as well as beverages, were removed from the list as they were assumed to always be edible. The resulting list of food types with potential inedible parts was used as the basis to compare the four definitions of edibility.

1.2.2. CREATING AND APPLYING DEFINITIONS OF EDIBILITY

We created two new definitions; "restrictive" and "inclusive," to better represent the spectrum of edibility. The restrictive definition includes the most amount of parts as inedible and the inclusive definition includes the fewest parts as inedible. For example, the restrictive definition for edibility of an apple considers all parts but the flesh to be inedible. The inclusive definition considers the apple's peel, core, and flesh to all be edible, while the seeds and stem are considered associated inedible parts. When creating the two definitions, items were considered "always inedible" if they were largely considered unsafe to eat (e.g. rhubarb leaves) or are generally considered inedible without prominent examples of edible uses in the United States (e.g. egg shells and bones). We considered items to be "potentially edible," even if they could be argued to be inedible, if they are safe to eat and there are established examples of their use among some consumers. For instance, smooth melon rinds, like watermelons, are considered potentially edible because they are generally considered safe to eat and pickling watermelon rinds is a practice employed by some households in the U.S. The inclusive definition was created to include all potentially edible items given the tremendous variation in what is considered edible in our culturally diverse society. Definitions used by the United States Department of Agriculture (USDA) in their National Nutrient Database for Standard Reference (NNDSR) and the UK Waste and Resources Action Programme (WRAP) were chosen as the two widely used definitions. A summary of all definitions can be found in **table 2.**

In order to compare the various definitions, all food items were split into parts. For example, an apple was split into stem, seeds, core, peel, and flesh. We then determined whether each food part was considered edible or inedible under each definition (for a detailed list, see appendix 1). Items considered edible under one definition but inedible under another were considered 'potentially edible.' We identified trends by qualitatively comparing which items were considered edible and inedible under each of the definitions: inclusive, restrictive, USDA, and WRAP.

In order to compare definitions, we needed to first make them compatible with each other. Refuse descriptions and how food items were split up by food part were not

consistent across established definitions. The description of the food parts considered inedible under USDA and WRAP definitions often differed from each other, requiring assumptions to standardize them with our definitions (see all definitions and assumptions by food type in appendix 1). For instance, the NNDSR describes the refuse of potatoes as "parings and trimmings" (United States Department of Agriculture, 2018), while WRAP described the inedible parts as "sprouts" (Gillick & Quested, 2018). For the paper, we divided potatoes into peels, eyes/sprouts, and flesh. It was assumed that the NNDSR description translated to peel and eyes. For some food items, descriptions of inedible parts were not provided by USDA and/or WRAP. For those items, we assumed the classification of parts as inedible based on how similar items were treated.

Definition Name	Definition Description	Notes
Inclusive	Considers the *most* number of food parts as edible. Together with the 'restrictive' definition, represents the spectrum of edibility.	Definition developed by authors
Restrictive	Considers the *least* number of food parts as edible. Together with the 'inclusive' definition, represents the spectrum of edibility.	Definition developed by authors
USDA	The USDA's National Nutrient Database for Standard Reference (NNDSR) provides information on nutritional content of almost 8,000 individual food items. Provides description and quantitative estimate for portion of food items considered 'refuse' (United States Department of Agriculture, 2018).	Sometimes the refuse percentage is broken down by food part while for other items it is provided as an aggregate percentage
WRAP	Based on the 2018 update of WRAP's classification of commonly wasted food items into food and associated inedible parts (Gillick & Quested, 2018).	No quantitative estimates of inedibility provided.
Respondent- Chosen	In the kitchen diaries, respondents were asked to indicate the state of the food item (inedible parts, prepared, cooked, or whole) and why the food was discarded (including an option for inedible parts). If food was indicated to be an inedible part, it was considered inedible for this definition.	Only included in comparisons using kitchen diary data A small number of items were not considered inedible if the respondents indicated the state was "inedible parts" but the reason for loss was "moldy/spoiled."

Table 2. Summary of definitions used for comparisons.

1.2.3. QUANTITATIVE COMPARISON OF DEFINITIONS

To convert total weight of the item into edible and inedible parts under each definition, we created conversion factors for each measured food item. These factors estimated the proportion of the food item that is considered inedible under each definition (more detailed information in section 1.2.3.1.). For example, as shown in **figure 4**, we estimated the proportions for each part of an apple as follows: stem (<1%), seeds (<1%), core (8%), peel (10%), and flesh (80%) based on study measurement. Proportions were then combined for each definition to provide a conversion factor for the proportion considered *inedible* under that definition. A summary table comparing all definitions qualitatively and quantitatively can be found in the appendix 1.

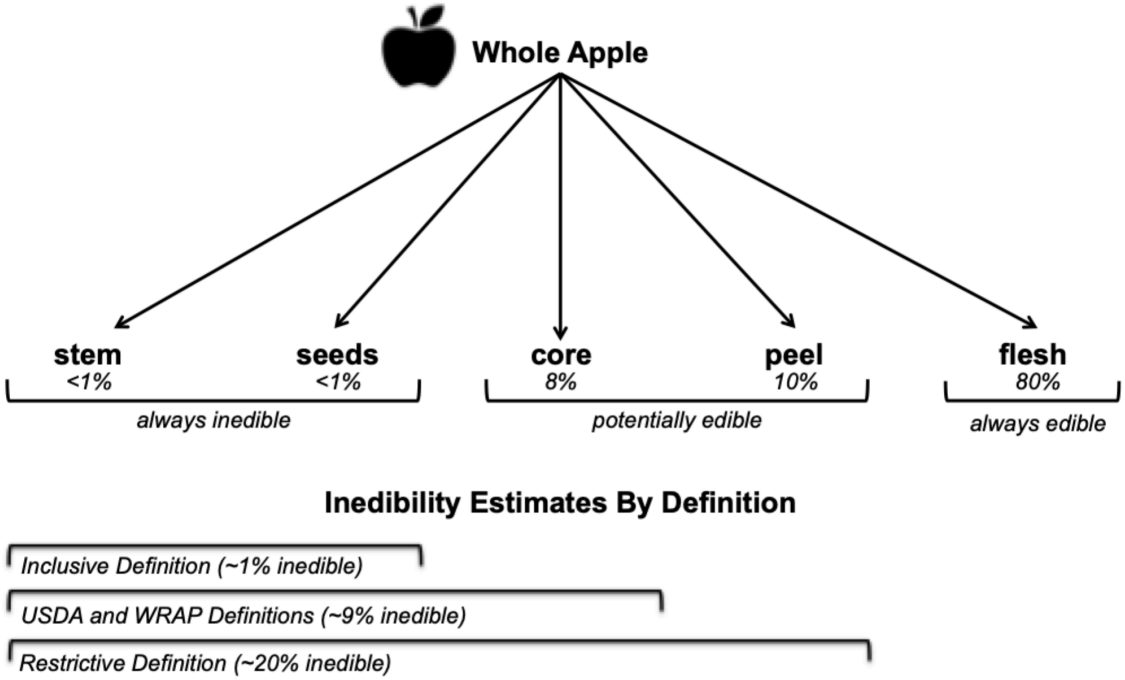

Figure 4. Example of study measurement results and application to definitions. Percentages may not add to 100% due to rounding.

In order to analyze differences by definitions, the maximum range of inedibility was determined by comparing the inclusive and the restrictive definitions. Additionally, we also explored the differences between the widely used definitions, USDA and WRAP. Trends were found by correlating differences in inedibility estimates with characteristics of the food items, including variation in size (coefficient of variation of initial weights of measured food items), variation in purchasing options (dichotomous variable indicating whether items have major differences in how they are purchased, such as carrots being purchased with and without tops), and food type (e.g. fruit, vegetable, meat, fish, and other). When correlating the differences with food characteristics, we used two-tailed t-tests for exploring purchasing differences, ANOVA for correlating with food types, and simple linear regression for correlating size. The outcome variable for the tests was the difference in proportions considered inedible between definitions and all statistical tests used a 95% significance level.

It should be noted that some differences exist between refuse assumptions found in USDA's NNDSR and their Loss-Adjusted Food Availability (LAFA) dataset. For simplicity, we consistently use estimates from the NNDSR. WRAP does not publicly provide quantitative estimates for edibility.

1.2.3.1. Measuring Food items by part

In order to quantitatively compare the definitions using conversion factors, weight-based data was needed for each food item by part. Neither USDA nor WRAP consistently

provide quantitative information by food part, so measurement was undertaken for a portion of the food items.

All kitchen diary entries were coded to indicate whether they were a mixture of edible and inedible parts under any of the definitions of edibility, called 'mixed edibility.' All entries of mixed edibility of the same standardized food name were summed to determine a combined mixed weight. If the combined mixed weight of a food type was less than 20 ounces in total, or 0.2% of all items of mixed edibility by weight, it was excluded from measurement. Food types with a combined mixed weight of less than 20 ounces were considered to be negligible in terms of contribution to overall weight. Measurement data provided estimates of the proportion of total food item by weight that each part comprised for the 69 food items above the exclusion threshold, while assumptions using available USDA estimates from the NNDSR were used for less commonly discarded items.

Each of the 69 food items were separated into parts twelve times, with three repetitions completed by four different team members. The output of the measurement was the average proportion each food part contributed to the whole food item, by weight. Team members divided items into parts as instructed, to correspond with food parts used in definitions. All items were divided into parts as a raw item except for meats, fish, and chestnuts, which were oven roasted. For each item, the size, location of purchase, starting weight (grams) and weights of each food part were recorded. Additionally, pictures were taken at each stage.

To account for the heterogeneity in food shapes and sizes across and within different stores, we procured items from four different stores representing two major national supermarkets, a large local grocery, and a small local grocery, whenever possible. Additionally, a small, medium, and large version of each item were purchased from each store with size determined given what was available for purchase. While team members were given specific instructions on how to separate the food items by part, we recognize that different people have different preparation techniques or perceptions based on their cultural backgrounds that may contribute to differences in how they separate foods into parts. To account for this heterogeneity, team members represented a variety of ethnicities and national origins.

Some food descriptions provided by kitchen diary respondents were exceedingly broad (e.g. "peppers" or "beef"). For those categories, three items that represent common types of food items in that category were chosen based on items of that type most commonly specified in kitchen diary responses. For example, for "peppers," a bell pepper, jalapeno, and poblano represented the category because many households individually reported these. Averaging the results from the three representative food items, we created conversion factors for these broad categories.

1.2.4. APPLICATIONS OF DEFINITIONS TO REAL-WORLD DATA

In order to determine the impact of each definition on real-world data, we applied conversion factors to the 489 kitchen diaries splitting the weight of food items into edible and associated inedible parts. Each entry of potential or mixed edibility in the kitchen diary was coded to indicate which food parts were included in each entry (e.g. core/stem/seed was coded for entries where those parts of the apple were indicated as present). We created a conversion factor for each of these codes for each definition using study measurement to determine the proportion of inedible parts. For instance, under the WRAP, USDA, and restrictive definitions, the core, stem, and seed of apples are all considered inedible, thus a conversion factor of 1 (or 100%) is assigned to entries coded core/stem/seed. For the inclusive definition, the core is considered edible, thus a conversion factor of 0.10 (or 10%) is assigned under that definition for seeds and stem only.

For items that were excluded from measurement, a measured item was used as a proxy, whenever feasible. For instance, parsley was used as a proxy for cilantro, which was unmeasured. If no suitable proxy could be identified, the quantitative estimates from USDA were used to estimate breakdown by food part, which were used to calculate the conversion factors.

Additionally, USDA's quantitative estimates for refuse percentages provided in the NNDSR were compared to the USDA conversion factors generated using study measurement. Conversion factors were created using quantitative estimates found in USDA's NNDSR. When NNDSR refuse estimates were given by part, they were directly used to create a conversion factor representing USDA's own quantitative estimates. If the estimate was given in aggregate for multiple food parts, it was split up using the average proportions found in study measurement.

1.2.4.1. COMPARING KITCHEN DIARY RESULTS

After all of the conversion factors were applied, total food waste generation (pounds) was divided into edible and inedible components. A ratio of edible to inedible parts was created for each individual household and as an aggregate for all households. These were compared for each definition and compared to respondent-indicated inedibility.

Considering only the edible portions of discarded food in aggregate (by weight) for each definition, we identified the following hot spots: 1) top 10 most wasted food items by food type; 2) breakdown by loss reasons as stated by respondents; and 3) breakdown by discard destinations as stated by respondents.

The impact of definitions on individual households was analyzed to determine whether they were homogeneously or heterogeneously impacted by changes in definition. To do this, two comparison were made: 1) inclusive versus restrictive definitions; and 2) USDA versus WRAP definitions. We used simple linear regressions to determine if total edible food waste generation by household was correlated between the two definitions in each comparison.

1.3. RESULTS

Below, we describe the qualitative and quantitative differences between definitions followed by how the definitions impact findings from the kitchen diaries (see **table 5** for a summary of main results). For the qualitative and quantitative comparisons in Sections 1.3.1 and 1.3.2, we only analyzed the 69 food items that were included in study measurement: inclusive, restrictive, WRAP, and USDA definitions. Both measured and non-measured items were included when applying definitions to the kitchen diaries. The respondent-chosen indication of inedibility was also compared to the other four definitions.

1.3.1. QUALITATIVE COMPARISON OF DEFINITIONS

Of the 69 measured food items, seven items (10%) had consistent definitions across all four definitions, indicating that most items have at least one part that can be considered either edible or inedible. Items with universal classifications across our definitions included avocado, egg, and bananas - items with inedible parts that are widely accepted as inedible.

When only comparing the widely used definitions, USDA and WRAP, 39 items (57%) were consistent between these definitions. We found that the main differences in how edibility is characterized between USDA and WRAP were for the following parts: peels for some vegetables including carrots, cucumbers, and potatoes; stalks and stems for stalky vegetables, including broccoli and cauliflower, and mushrooms; core and outer leaves for cabbages and lettuces; and fat for red meat. In most of these instances (27 of 30 items), USDA has a more restrictive definition of edibility, meaning more parts were considered inedible.

1.3.2. QUALITATIVE COMPARISON OF DEFINITIONS

The quantitative estimate for refuse percentage provided in the USDA NNDSR was compared to estimates for USDA's definition using study measurement. When comparing these estimates, 19 (28%) of items had a greater than 10% difference between the two, with an approximately even split in terms of which one had the higher estimates. A two-tailed t-test comparing items with and without purchasing differences (e.g. carrots can be purchased with our without tops) was statistically significant ($t = 2.5$; $df = 67$; $p = .014$). On average, items with purchasing differences (e.g. carrots) have higher estimates of inedibility from study measurement compared to USDA NNDSR. Items without purchasing differences, on average, had lower estimates of inedibility for study measurement compared to USDA NNDSR. ANOVA by food type was significant ($F=17.13$; $df = 68$; $p = <0.01$). Specifically, fish were found to have significantly higher estimates for inedibility from the USDA NNDSR compared to study measurement. No correlation was found between the product size and the difference between estimates from NNSDR and study measurement for the USDA definition ($t = -0.68$; $df = 68$; $p = 0.50$).

For simplicity, only the USDA definition using study measurement is presented in the remaining results, omitting the USDA NNDSR quantitative estimates. While there were

differences in estimates at the level of individual food items, the macro-level results for both USDA quantitative estimates were the same when applied to the kitchen diary.

1.3.2.1. SPECTRUM OF INEDIBILITY: COMPARING RESTRICTIVE VERSUS INCLUSIVE DEFINITIONS

The restrictive and inclusive definitions were designed to represent the spectrum of edibility that is culturally appropriate for the United States. Of the 69 food items, 8 items (12%) had the same estimated proportion of inedibility, 11 items (16%) had differences of 10% or less, 23 items (33%) had differences between 11% and 20% and 27 (39%) had differences of 21% or more. The items with the largest differences were citrus items due to the categorization of rinds as edible in the inclusive definition and inner membranes as inedible in the restrictive definition. As expected, the restrictive definition has a higher estimate for the proportion of inedibility for all items. See **figure 5** for the food items that have the largest ranges of edibility as defined by the restrictive and inclusive definitions.

The percentage difference between the quantitative estimates of inedibility for the restrictive and inclusive definitions was not significantly correlated with differences in purchase conditions ($t = -0.20$; $df = 67$; $p = 0.84$), product size ($t=0.40$; $df = 68$; $p = 0.69$), or food type ($F = 2.39$, $df = 68$; $p = 0.06$). Due to the lack of correlation, the divergence in estimates of inedibility is primarily attributable to the differences in definition itself and not characteristics of the food items.

1.3.2.2. WIDELY-USED DEFINITIONS: COMPARING USDA VERSUS WRAP DEFINITIONS

When comparing the USDA and WRAP definitions, we found that 41 items (59%) had the same estimated proportion of inedibility, 10 items (14%) had differences of 10% or less, 13 items (19%) had differences between 11% and 20% and 5 (7%) had differences of 21% or more. The items with the largest differences were stalky vegetables such as broccoli and cauliflower, due to inclusion of stalks as edible in the WRAP definition, and red meat because of the inclusion of fat as edible in the WRAP definition. Grapefruit is also on the list because the USDA definition considers the tough inner membranes as inedible. See **figure 5** for the list of food items with the largest differences in quantitative estimates of inedibility between the USDA and WRAP definitions. The USDA definition has a higher estimate for the proportion of inedibility than the WRAP definition for all food items in figure 5.

The percentage difference between the quantitative estimates of inedibility for the USDA and WRAP definitions was correlated with purchasing differences ($t = -3.0$; $df = 67$; $p < 0.01$). On average, both items with and without purchasing differences have higher estimates of inedibility under the USDA definition. Items with purchasing differences diverge more between USDA and WRAP definitions. The percentage difference between USDA and WRAP definitions were not significantly correlated with product size ($t=1.20$; $df = 68$; $p = 0.24$) or food type ($F = 0.79$; $df = 68$; $p = 0.54$)

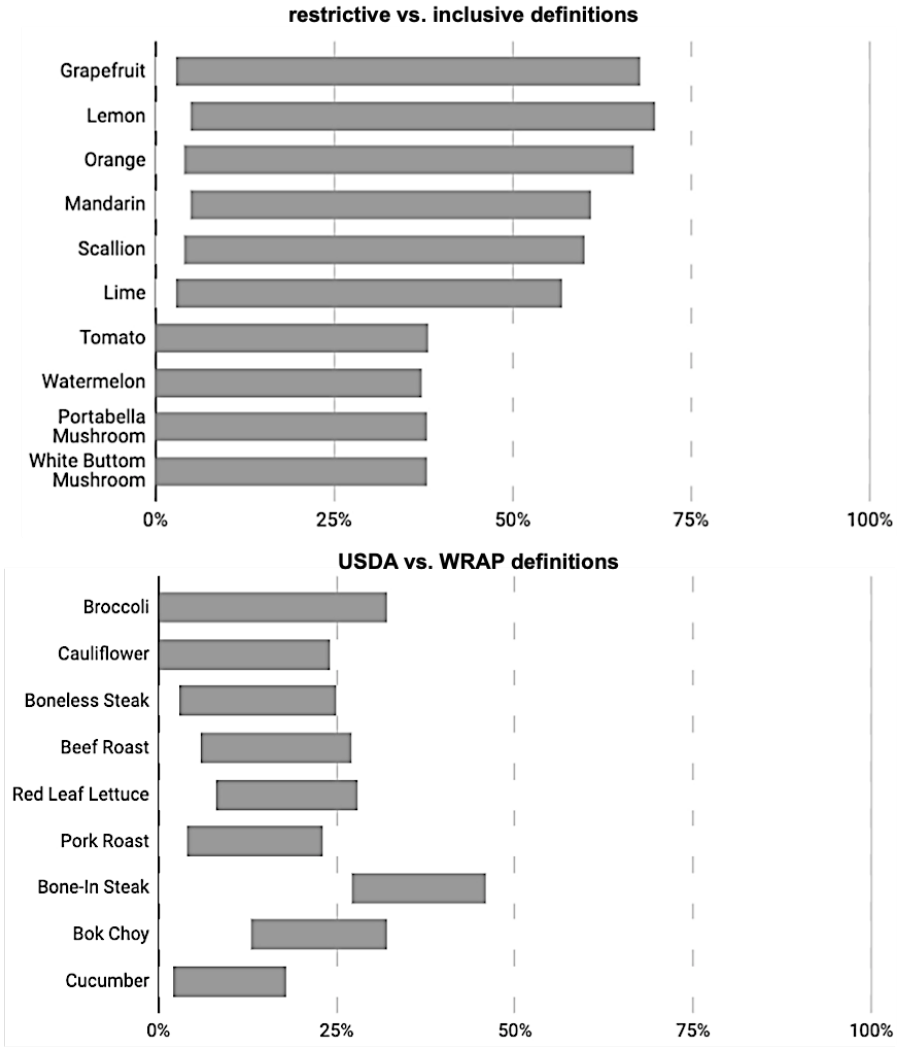

Figure 5. Top 10 largest ranges of inedibility restrictive vs. inclusive definitions (top) and USDA vs. WRAP definitions (bottom). Gray bars display the proportion of total food item, by weight, that is considered inedible. In the bottom diagram, the WRAP definition always has the lower estimate of inedibility. For example, in the top comparison, estimates of inedibility for grapefruit range from 3% (inclusive) to 68% (restrictive).

1.3.3. APPLICATION TO REAL-WORLD DATA

To appraise the definitions against household data, we used analyses common in food waste research: aggregate-level results of total wasted food broken down by edibility, top 10 lists of most discarded edible food types, breakdown by loss reason and discard destination for the edible portion, and household-level estimates of edible wasted food. Results for each analysis were compared between definitions, including the respondent indication of edibility.

1.3.3.1. AGGREGATE LEVEL ANALYSES

Total food waste generation was broken down into edible and inedible parts for all households for each definition, including the respondent-chosen indication (see **figure 6**). As expected, the restrictive and inclusive definitions have the lowest (52%) and highest (71%) estimates for proportion of total that was edible, respectively. The USDA and the respondent-chosen indication of edibility both had estimates of 55% for edible wasted food and WRAP had a higher estimate of 63%.

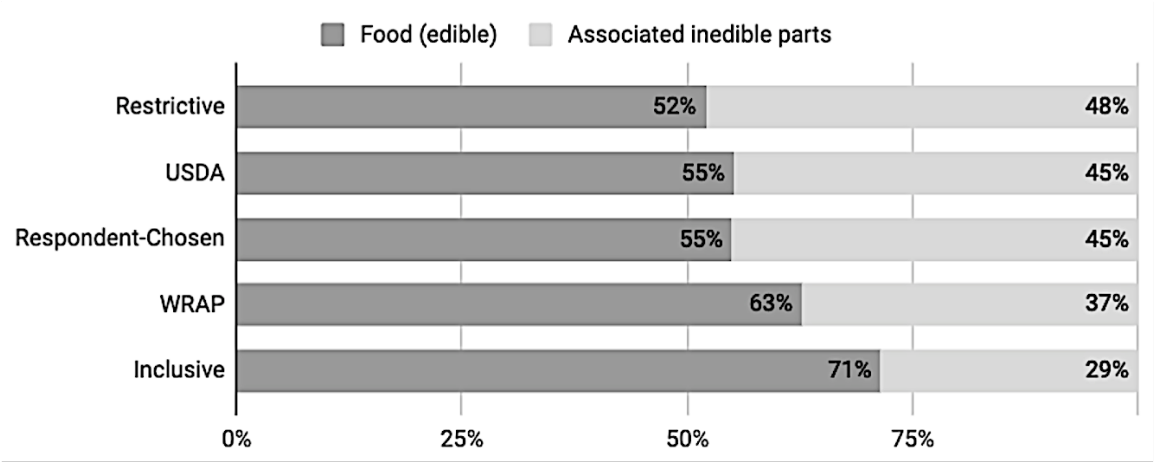

Figure 6. Breakdown of total food waste by food (edible) and associated inedible parts for each definition of edibility, including respondent-chosen indication of edibility. All estimates, except the respondent-chosen indication, were based off of study measurement.

In total, approximately 2,948 pounds of food and associated inedible parts from 489 households were recorded in the kitchen diaries as discarded over the period of one week. Comparing the estimates of edible wasted food using the inclusive and restrictive definitions, there was a difference of 572 pounds, translating into a 1.2 pounds per household per week difference. Comparing the USDA and WRAP definitions, the difference is 221 pounds of edible wasted food, translating into a 0.5 pounds per household per week difference.

When comparing the inclusive with restrictive definition and the WRAP definition with USDA, we identified the food items responsible for the largest changes in the proportion of food considered edible. The magnitude of the difference between estimates of edibility by definition (by weight) is a function of both the proportion of the item considered inedible under each definition and the frequency that the food item appears in the kitchen diaries. When comparing the inclusive and restrictive definitions, oranges, apples, lemons, broccoli, cauliflower, and potatoes were the food items that accounted for the largest difference in the estimates of edible wasted food. Broccoli, cauliflower, potato, cucumber, carrot, and lettuce were the top food items when comparing the USDA and WRAP definitions. The top 10 food items with the largest differences in estimated edible weight between definitions account for approximately half of the total edible weight differences. This indicates that a relatively small number of food items accounted for a majority of the differences.

Only considering the edible portion, or wasted food, **table 3** shows the breakdowns by loss reason for all definitions, including the respondent indication. Even though the breakdown by loss reason only includes edible parts, 'inedible parts' is still a loss reason because items that were not considered inedible in the definitions *were* considered inedible by the respondents. As such, the respondent-chosen indication is the only definition with no edible food items considered as inedible parts. Approximately 5% of edible wasted food was considered inedible by respondents under the restrictive definition while 25% was considered inedible under the inclusive definition. Notably, the USDA definition resulted in 8% of edible food discarded because it was considered inedible, while the WRAP definition had 17% discarded as inedible parts. The largest changes in other loss reasons between definitions were 'moldy/spoiled', 'don't want as leftovers,' and 'left out too long' though the changes were relatively small by percentage.

Loss Reason	Inclusive	Restrictive	USDA	WRAP	Respondent-Chosen
Moldy/Spoiled	25%	31%	30%	27%	34%
Inedible Parts	25%	5%	8%	17%	0%
Don't Want as Leftovers	13%	18%	17%	15%	17%
Left Out Too Long	9%	12%	11%	10%	12%
Past Date Label	7%	9%	9%	8%	9%
Too Little to Save	6%	8%	8%	7%	8%
Don't Like Taste	5%	7%	7%	6%	7%
Improperly Cooked	1%	1%	1%	1%	1%
Other/Blank	9%	11%	11%	10%	13%

Table 3. Breakdown of edible wasted food by loss reason for each definition of edibility, including respondent-chosen indication of edibility. Estimates derived from weeklong kitchen diaries in New York City and Denver. May not add to 100% due to rounding.

The breakdown by discard destination, shown in **table 4**, shows very few changes as a result of changing definitions. The largest, but relatively small, differences are for compost and drain disposal as discard destinations.

Discard Destination	Inclusive	Restrictive	USDA	WRAP	Respondent-Chosen
Trash	53%	53%	53%	53%	53%
Compost	27%	21%	24%	26%	23%
Drain Disposal	15%	20%	19%	17%	19%
Fed to Animals	2%	2%	2%	2%	2%
Blank/Other	3%	4%	3%	3%	5%

Table 4. Breakdown of edible wasted food by discard destination for each definition of edibility, including respondent-chosen indication of edibility. Estimates derived from weeklong kitchen diaries in New York City and Denver. May not add to 100% due to rounding.

1.3.3.2. TOP 10 LISTS

We created lists of the top 10 most wasted edible food subtypes for each of the four definitions, in addition to the respondent-chosen indication (for a full list of food subtypes, see appendix 1). 'Other' food categories, which are comprised of items that did not fit in other categories, were excluded. The trends were relatively similar when 'other' categories were included. **Figure 7** shows the frequency that food subtypes appeared in the top 10 lists, out of five possible times. Coffee, dairy milk, bread, soup, grains, and noodle dishes appeared on all of the lists. Bread was the top wasted edible food subtype on all lists except for the inclusive definition, where it ranked second. Additionally, soup and dairy milk were in the top five food subtypes for all definitions. Citrus only appeared in the inclusive list, but was the top most wasted edible food subtype on that list.

The USDA definition and respondent-chosen indication of edibility have the same estimate for aggregate amount of edible discarded food compared to inedible portions. However, the food items included in the estimates are somewhat different. When edibility was indicated by the respondents, some items always considered edible in the definitions were considered inedible, including bread and pizza crusts. When comparing the top lists of edible foods, red meat and tubers are on the respondent-chosen list, but not on the USDA list.

Comparing USDA and WRAP top 10 lists, the majority of food subtypes are similar. However the USDA top 10 list includes fruits and fruit beverages while the WRAP list instead includes stalky vegetables, tubers, and red meat. This finding aligns with the findings that broccoli, cauliflower, potatoes, and beef are some of the items that account for the largest differences between USDA and WRAP's estimates of wasted food.

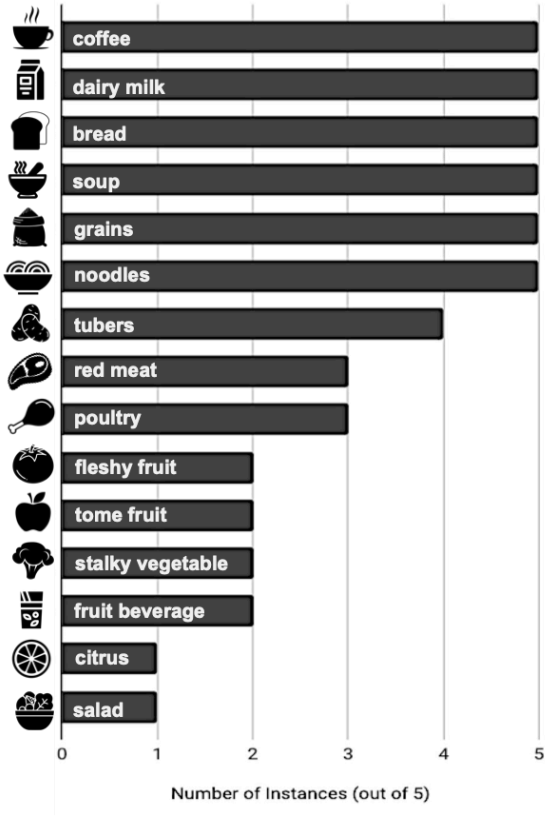

Figure 7. Frequency of appearance in top 10 lists of most discarded edible food subtypes. Top 10 lists were created for inclusive, restrictive, USDA, WRAP, and respondent-chosen definitions. Gray bars represent the number of times a food type appears on top 10 wasted edible food lists (out of five).

1.3.3.3. HOUSEHOLD-LEVEL ANALYSIS

To determine whether the different definitions impact estimates of edible wasted food at the household level in a heterogeneous or homogeneous fashion, we ran simple linear

regression between: 1) the restrictive and inclusive definition; and 2) the USDA and WRAP definition. Both regression analyses showed a statistically significant relationship between the two definitions with the restrictive/inclusive comparison having a coefficient of 0.85 ($t=70.8$; $df = 488$; $p < 0.01$), indicating that, on average, household level edible wasted food as defined by the restrictive definition is predicted to be 85% of that found under the inclusive definition. The USDA/WRAP comparison results in a coefficient of 0.95 ($t=113.09$; $df = 488$, $p < 0.01$), indicating that, on average, household level edible wasted food as defined by the USDA definition is predicted to be 95% of that found under the WRAP definition. These findings indicate that changing definitions has a relatively homogenous impact on households.

Phases	**1) Qualitative Comparisons of Definitions**	**2) Quantitative Comparisons of Definitions**	**3) Application of Definitions to Real-World Data**
Results	• Only 7 of 69 (10%) of food items had the same definition of edibility across all definitions • The same 7 food items (10%) above were also ones with the same definitions between inclusive and restrictive. • More than half (57%) of items had the same definition between USDA and WRAP	• On average, USDA definition results in higher estimates of inedibility compared to WRAP with the largest differences in stalky vegetables and red meats • On average, the largest potential differences, as represented by comparing inclusive and restrictive definitions, are in citrus and stalky vegetables.	• At the aggregate level, the proportion of edible wasted food compared to total food waste ranges from 71% (inclusive) to 52% (restrictive). The USDA definition resulted in a 55% estimate while the WRAP definition resulted 63%. • There were a number of changes to top 10 lists for most wasted food types and breakdown of loss reasons based on definitions. Breakdown by disposal destination remained fairly constant with definitions. • At the household level, edible food waste generation estimates differed between definitions somewhat homogeneously. This indicates that changing definitions has a relatively homogenous impact on households.

Table 5. Summary of Results. The data sources used were: USDA National Nutrient Database for Standard Reference (NNDSR), WRAP Household Food Waste Restated, kitchen diaries from households in New York City and Denver, and study measurement of 69 individual food items.

1.4. DISCUSSION

The adage "you can't manage what you don't measure" is frequently used to encourage investment in measurement. Viewed as a necessary part of policy and interventions, measurement helps to define the extent of the problem, identify hot spots, and track progress over time. However, it must also be acknowledged that what and how you measure impacts what and how you manage (Espeland & Sauder, 2007). Seemingly small details of measurement have the potential to both highlight and trivialize certain aspects of an issue, thus altering the findings. In the case of household food waste measurement, this paper highlights the role of edibility in influencing key results that shape what policy and interventions are chosen and how they might be tracked over time.

One of the primary difficulties in creating a widely agreed upon definition of edibility is the diversity of perceptions within and across cultures. Given this, it is not reasonable to propose the use of a universal definition of edibility. However, this paper illustrates that what is considered edible and inedible should be carefully considered in the context of measurement, interventions, and policy. While the point of this paper was not to provide a value judgment on the definitions of either USDA or WRAP, these two widely used definitions illustrate real differences in how edibility is conceived and how those conceptions impact the results of measurement.

When "defining edibility," assigning quantitative estimates is a second important step after determining the qualitative descriptions of edibility. Quantitative conversion factors by food part are needed to estimate the proportions of the food items considered edible and inedible. Our research did not find publicly available quantitative data consistently reporting food items by food part that would allow for estimations of multiple definitions of edibility, although USDA NNDSR does report this for some food items. Additionally, information on proportions determined to be inedible were often unclear and did not identify sources of the numbers. An example is the estimate in the USDA NNDSR that 25% of raw potatoes are considered "refuse" described as "parings and trimmings" (United States Department of Agriculture, 2018). To remedy these challenges, we performed our own measurement on the 69 most wasted food items of mixed edibility, capturing how parts are excised in practice and how heterogeneity of food items in terms of size and purchasing options impacts estimates. This step is important because both the qualitative definition of edibility and its quantitative estimate greatly influence the proportion of a given food item that is considered edible.

Our study compared four definitions of edibility, two created as part of the study and two widely used definitions, to understand their impact on the findings of household food waste measurement. We hypothesized that the definition of edibility would alter measurement findings. Translating definitions of edibility into quantitative conversion factors and applying them to actual household data confirms our hypothesis that the definition of edibility influences: 1) estimating the magnitude of the problem of wasted food at the household level; 2) the identification of hot spots for policy and intervention (e.g. top wasted food items); and 3) the accuracy of tracking progress over time.

1.4.1. WHAT'S IN AND WHAT'S OUT?: DEFINING THE EXTENT OF THE PROBLEM

How edibility is defined impacts how the scope of the food waste problem is bounded, thus influencing estimates of how much edible food is discarded. Edibility is especially important when the definition of "food waste" only includes the edible portion of all discarded foods, because inedible portions are essentially rendered "invisible." However, it is also of increasing importance as more policy and interventions focus on the edible portion of food waste to target for prevention and redistribution (e.g. California's Senate Bill 1383) (Lara, 2016), particularly given the nuanced differences between "edibility" and "food suitable for rescue," or "rescuability".

Figure 8 (panel a) illustrates how the definition of edibility shapes the boundaries of what is considered edible food waste or wasted food. The outer box represents the total

amount of food and associated inedible parts discarded while the inner white boxes represent categorizations of the amount of edible wasted food as determined by each definition. The largest white box, for the inclusive definition, considers the largest proportion of food waste to be edible, followed by WRAP, then USDA, then the restrictive definition (with the least amount considered edible). The gray area represents food parts that are considered inedible in all definitions.

In terms of weight, the percent difference between the estimate of edible wasted food under the inclusive and restrictive definitions is about 30%, while the percent difference between the USDA and WRAP definitions is approximately 14%. In terms of average household-level generation of wasted food, the difference between inclusive and restrictive estimates was over one pound of edible food discarded per household per week. Comparing USDA and WRAP, the difference was almost one-half pounds per household per week. These relatively large differences illustrate that the definition of edibility is not trivial in terms of estimating the amount of edible wasted food in aggregate.

1.4.2. WHERE SHOULD INTERVENTIONS BE TARGETED?: IDENTIFYING HOT SPOTS

In addition to impacting aggregate-level estimates of food waste, the definition of edibility also impacts what areas are targeted as hot spots for intervention by policy or programs. The impacts of differing definitions of edibility have a relatively significant impact on measures such as breakdown by edibility, top lists of wasted foods, and breakdown by loss reasons. We found that the impacts on discard destinations and household-level measures were less significant, but further investigation should be done to better understand these impacts.

In terms of the most wasted edible food items, the inclusion or exclusion of food parts as edible, especially for commonly eaten items, can change the lists of the most wasted foods at the household level, thus altering where policy and consumer campaign efforts might be focused to reduce wasted food. Comparing the WRAP and USDA lists of top wasted food types reveals how each list prioritizes certain food types differently: whereas the USDA version emphasizes fruits, the WRAP version suggests stalky vegetables and tubers are more significant. While both food types are likely important for reducing wasted food overall, this specific example indicates the potential power of definitions of edibility to narrow attention too much.

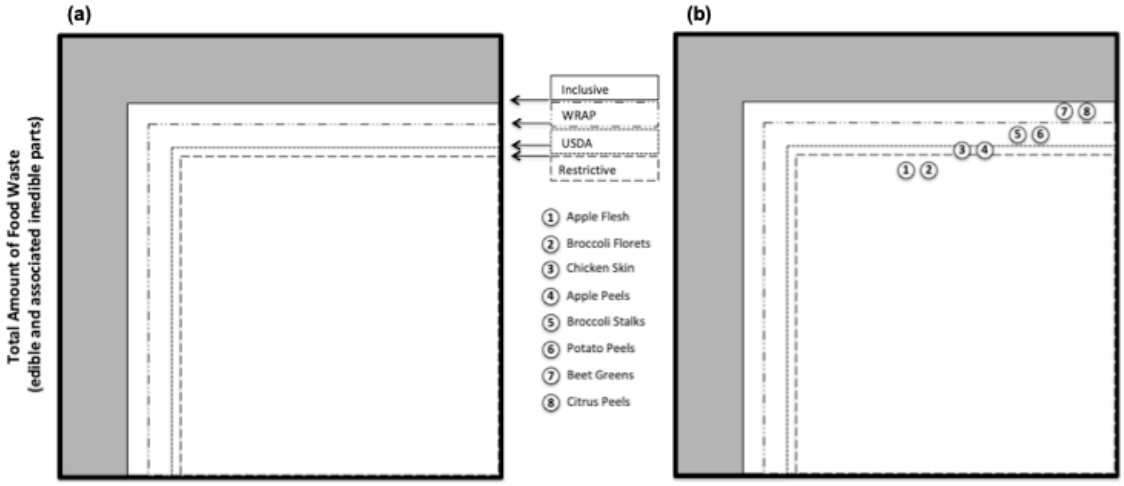

Figure 8. Edible or inedible? Illustration of boundaries of edibility in terms of food waste. (a) All discarded food, including edible and associated inedible parts are included within the large black box. The white area inside each box represents the theoretical proportion that is considered edible under each definition. The area outside of those boxes represents food materials considered inedible by those definitions, thus potentially excluded from their definitions of "wasted food." The gray area represents food parts considered inedible by all definitions. (b) Food parts (indicated by a circle with a number) are placed within the box representing the definition where they are first considered edible. Items are also considered edible in definitions in surrounding boxes, but inedible in inner boxes. Items in the innermost box are considered edible by all definitions. For example, apple peels (4) are considered edible by USDA, WRAP, and the inclusive definitions, but not the restrictive one.

Figure 8 (panel b) also illustrates how definitions include or exclude certain parts of food items in the definition of edible wasted food. For example, if broccoli stalks (item #5 in figure 8) are characterized as an inedible part, as they are by the USDA and restrictive definitions, they are not considered wasted food. Additionally, when only the edible portion is considered 'food waste', the broccoli stalk would be effectively omitted from a characterization of food waste. However, under the WRAP and inclusive definitions of edibility, the broccoli stalk is considered edible and would thus be included.

As illustrated in the figure, neither of the widely used definitions, USDA or WRAP, captures all items that people might consider edible. For programs or characterizations of food waste that primarily consider the edible portion, neither definition captures the entire realm of what might be targeted for reduction. This gap in definition is important because prominent information and awareness campaigns targeting both consumers/eaters and consumer-facing businesses focus on reducing the discard of food items that are considered inedible by some people. For example, the Save The Food campaign in the United States has an entire section of their website dedicated to encourage people to eat more parts of food items, including broccoli stalks, cauliflower leaves, cilantro stems, and cheese rinds (Ad Council, n.d.). Additionally, a 2017 report by the World Wildlife Fund (WWF) provided guidance to the hospitality sector to reduce wasted food in their operations. The report included yield ranking tool based on the proportion of commonly-used fruits and vegetables that are typically considered edible (Pearson & McBride, 2017). The characterization of edibility used by WWF most closely aligns with this study's inclusive definition, with the WWF definitions sometimes including more parts as edible than even our definition.

Given that information and awareness campaigns are a major tool being used to reduce the amount of wasted food, it would be advantageous to better align food items that are being targeted with definitions of edibility. For instance, if reducing food parts like broccoli stalks is being targeted by interventions or policies, it should be included within the boundaries of what is considered wasted food.

Relatedly, there is a large diversity of perceptions within the United States of what is considered inedible by consumer/eaters. This is illustrated in the breakdown of edible wasted food by loss reasons (**table 3**), which shows that not even the restrictive definition of edibility captures all items that respondents indicated as inedible. Items that were considered edible under all definitions, including pizza and bread crusts, were indicated as 'inedible' by some respondents. Under the widely used definitions, USDA and WRAP, we found that between 17% and 8%, respectively, of 'edible' food items were considered inedible by the respondents. In addition to showing that no definition included in this analysis fully encompasses all inedible parts as indicated by respondents, this also indicates that encouraging people to eat food items they might consider inedible is likely part of the solution to reduce wasted food.

1.4.3. HAS PROGRESS BEEN MADE?: TRACKING CHANGES OVER TIME

Ensuring that the definitions of edibility are transparent and consistent across comparative studies is important to ensuring that tracking progress over time is reflective of actual changes and not an artifact of changes in measurement. This is not only important for estimating aggregate-level changes but also changes in terms of specific food items. For example, if the information and awareness campaigns described in the previous section successfully decrease the number of parts that are considered inedible under the edibility definition being used (e.g. broccoli stalk discards under the USDA or restrictive definition), this would not technically contribute to reducing edible food. This is especially important for definitions of food waste that only include the edible portions of food items. Reporting reductions that are not 'included' in the definitions could cause 'over-reporting' of reductions since they would be outside of the boundaries of what is being considered as wasted food or edible food waste.

Using the same definition of edibility is important when comparing measurement across time and geographies -- for instance, comparing wasted food before and after interventions, or estimating reductions from specific actions. If different definitions of edibility are used to evaluate the change in edible food waste generation over time, the definition change on its own could falsely suggest that the amount of wasted food has increased or decreased.

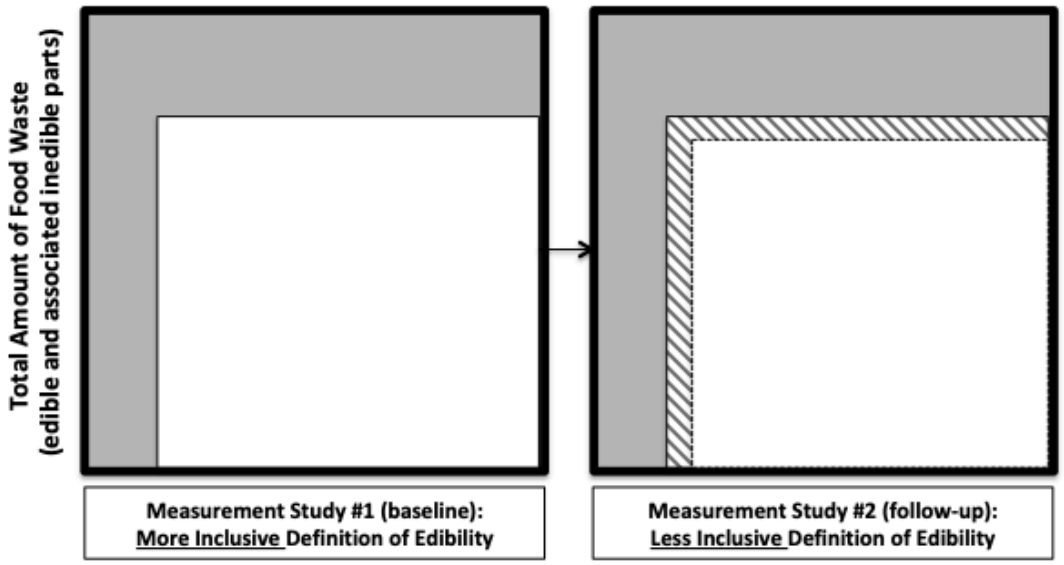

Figure 9. Tracking progress: Impact of inconsistent definitions of edibility. The leftmost box represents baseline measurement using a more inclusive definition of edibility (solid line), for instance, the WRAP definition. The rightmost box represents follow-up measurement to track progress using a more restrictive definition of edibility, for instance, the USDA definition. Based only on changing the definition of edibility, it appears that the amount of edible food has decreased. White areas are considered edible. Gray areas are considered inedible.

This is illustrated in **figure 9** by showing that the use of a more inclusive definition of edibility in the baseline measurement followed by the use of a less inclusive definition for the follow-up measurement would show a decrease in edible food waste simply as a result of the definitional change. Using the kitchen diary data as an example, there would be a 12% 'reduction' in wasted food simply by changing from the WRAP to the USDA definition of edibility. This magnitude of difference is significant in that a 12% reduction is the same magnitude of reductions that would be expected from successful interventions. This illustrates that a consistent definition of edibility is necessary to ensure that changes in the quantity of wasted food are based upon actual changes in consumer practices and not definitional changes.

1.5. CONCLUSION

Edibility is an important construct for food waste measurement. Given the relatively wide range of perceptions on what is and is not edible, there is a wide range of definitions of edibility that could be and are used. This wide range results differences in outputs of measurement based solely on the definition of edibility used. The largest differences were found in aggregate-level estimates of wasted food, lists of top wasted edible foods, and breakdowns by loss reasons. While this paper focused on the impact of the definition of edibility on household-level food waste measurement, it is likely that the definition also has impacts on other stages of the FSC or when considering all FLW across the FSC.

There has been a suggestion to standardize the definition of edibility and claims that inedible parts should be based on what is 'usually' eaten by members of the group being studied (Gillick & Quested, 2018). Our study suggests that it may also be important to base the definition on the goals of what is being targeted by FLW prevention programs.

Thus, we propose that the definition of edibility should reflect the purpose of the measurement and include any food parts that are being targeted by food waste prevention campaigns and policies as edible. For instance, if broccoli stalks are going to be targeted by consumer education campaigns to increase their consumption, then they should be included in the definition of edible wasted food. Inclusion in the definition will reduce the risk of 'over-reporting' progress and ensure that they are captured in the problematization of wasted food.

When considering edibility in measurement, it is also important to be transparent about how it is defined. It is imperative to ensure that measurement results are comparable or able to be easily manipulated for comparison. A potential solution is to create a standard, potentially as part of the existing international Reporting and Accounting Standard, to create a more consistent and rigorous accounting of how edibility is defined to ensure transparency and accountability.

CHAPTER 2

Chapter 2 is included here with the permission of my co-author, Dr. Matthew Potts. Human subjects approval was obtained for this project from UC Berkeley's Institutional Review Board, Protocol # 2017-06-10053, entitled "Household Level Food Waste in the U.S.".

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2. IS MORE PLANNING BETTER PLANNING? "SUITES" OF BEHAVIORS AND THEIR CONTRIBUTION TO THE GENERATION OF WASTED FOOD

2.1. INTRODUCTION

Given the estimate that one-third of all edible food produced globally goes uneaten (Gustavsson et al., 2011), there is an increasing focus on reducing the amount of food that is discarded. In the United States, it is estimated that 25% of freshwater consumed (Hall et al., 2009), in addition to other resources, including energy, labor, and fertilizers are used to produce food that is lost or wasted. Methane, a potent greenhouse gas, is generated from food disposed in landfills in addition to greenhouse gas emissions resulting from the production of uneaten food (Food and Agriculture Organization (FAO), 2013; Hall et al., 2009). While large quantities of edible food are being discarded, it is projected that more food will be needed to feed a growing and more affluent global population as well as eliminate food insecurity and hunger (Smil, 2004). Considered a superior alternative to food waste diversion options such as composting, source reduction prevents food from becoming waste in the first place, maximizing the amount that is eaten (Bernstad Saraiva Schott & Andersson, 2015; Papargyropoulou et al., 2014).

In the United States, it was estimated that over 40% of total food waste is discarded by households (ReFED, 2016). Similar trends have been found in the European Union, with an estimated 53% of food waste attributed to households (Stenmarck et al., 2016). To promote food waste prevention, changing consumer behavior has been one of the most commonly cited approaches. However, there is relatively sparse evidence of underlying causal mechanisms of consumer-level food waste that could be used to inform the design of specific interventions (Hebrok & Boks, 2017; Hebrok & Heidenstrøm, 2019; Roodhuyzen et al., 2017; Schanes et al., 2018). To fill this knowledge gap and inform the design of evidence-based interventions, research is increasingly focused on identifying the determinants of wasted food generated at the consumer-level.

A majority of this research uses an underlying behavioral theory that is either based in psychology (e.g. theory of planned behavior) or sociology (e.g. theories of practice). Psychology-based analyses tend to use quantitative methods and focus on correlations between frequency of participation in certain behaviors and wasted food. Sociology-based analyses focus more on interactions between contexts, materials, meaning, and

temporality and how they lead to the routinized discard of edible food. These analyses tend to be qualitative and provide a more nuanced perspective of behaviors related to wasting food, considering shifting priorities in the context of everyday life (Schanes et al., 2018). Much of the research to understand the determinants of wasted food or to identify behaviors for intervention has focused on the enactment of specific behaviors, such as using a shopping list, meal planning, and freezing food to extend its shelf life. These behaviors are hypothesized to be associated with lower levels of wasted food and are the focus of both research and consumer education campaigns, such as Save The Food (Ad Council, n.d.; Roodhuyzen et al., 2017). Behaviors related to planning, shopping, storage, preparation, cooking, and eating are targeted to help consumers more closely match the amount of food they provision with consumption by either reducing purchasing or increasing consumption over time.

While behaviors, such as properly storing food or checking food inventory prior to shopping, are considered best practices to reduce wasted food, there is relatively sparse evidence linking these behaviors with food waste generation (Schanes et al., 2018). Much of the research correlating behaviors with food waste generation is based on survey questions that ask people to approximate how much food they waste on average, creating issues of cognitive recall (Moreno et al., in press; Thompson & Subar, 2001) or use questions as proxies to estimate higher and lower wasters. These methods have been shown to be unreliable in producing quantitative estimates of wasted food (Quested et al., 2013). In Neff et al (2015), it was found that people tend to underestimate how much food they discard and may also overestimate their participation in behaviors linked to reducing wasted food. It was found that almost 75% of respondents believed they wasted less food than the average American. Additionally, around 60% of respondents indicated that one of their motivations to reduce wasted food was guilt related to wasting in general (Neff et al., 2015). In addition to cognitive issues with estimation, regular underestimation may be a result of wasting food being considered an undesirable behavior or it being a routinized and sometimes "invisible" part of everyday life.

2.1.1. A FOCUS ON PLANNING

Shopping and meal planning behaviors are considered some of the most promising behaviors to change in terms of food waste prevention (Abeliotis, Lasaridi, & Chroni, 2014; Diaz-Ruiz, Costa-Font, & Gil, 2018; Setti et al., 2018). Save The Food, a consumer education campaign to inform the general public about food waste in the United States, dedicates a whole section of its website to planning (Ad Council, n.d.). The planning behaviors that tend to be considered are making a shopping list, sticking to only items on the shopping list, including quantities needed on the shopping list, planning meals multiple days beforehand, and checking inventory of food items prior to shopping (Roodhuyzen et al., 2017; Schanes et al., 2018).

Planning behaviors have been explored in both quantitative and qualitative literature as important factors when considering how much food households purchase, and thus eventually discard. A summary of key literature relating planning behaviors to wasted food can be found in **table 6**. In much of the quantitative literature, there is an implicit assumption that more frequent participation in planning behaviors inherently reduces over-purchasing and thus wasted food (e.g. Diaz-Ruiz et al., 2018; Schmidt & Matthies,

2018). Qualitative literature tends to provide a more varied perspective of planning and identifies several modes in which increased levels of meal and shopping planning do not result in less discarded food. This can be a result of shifting priorities and stressors inhibiting plans from being successfully implemented or people intentionally planning to purchase more than they can consume in a given amount of time (Evans, 2012; Hebrok & Heidenstrøm, 2019).

Overall, there is mixed evidence about the correlation between planning behaviors and the generation of wasted food. A number of studies find a correlation between higher frequency of participation in planning behaviors and lower quantities of edible wasted food, however most do not find statistically significant evidence. There are other studies that focus on planning behaviors, but not through the lens of wasted food, including how grocery lists are created and used (Bassett, Beagan, & Chapman, 2008); how preshopping factors drive unplanned purchasing (Bell, Corsten, & Knox, 2011); and how distorted estimates of inventory can lead to overstocking or running out of stock in a household (Chandon & Wansink, 2006).

Evaluating the influence of behaviors and other determinants requires estimates of edible food waste generation. Direct measurement, generally in the form of kitchen diaries and waste composition analyses, are considered to be less biased than self-reported approximations or proxies using survey questions. Weight-based measurement is considered the best option for collecting information on the quantity of wasted food (Hanson et al., n.d.-b; Moreno et al., in press), however, some kitchen diary studies use other estimation techniques based on counts, volume, or other approximates, like handfuls (e.g. Romani et al., 2018). Both kitchen diaries and waste composition analyses have their limitations. Waste composition studies generally only collect information on wasted food collected in the municipal solid waste stream, thus exclude discard destinations of drain disposal, backyard composting, and feeding animals. Unlike waste composition analyses, kitchen diaries can be used to collect information on all discard destinations. However, underreporting is a known issue with kitchen diaries due to omissions of waste items as a result of forgetting, difficulties coordinating all household members to record, not wanting to be seen as wasteful, and changing the behavior of the household members (Moreno et al., in press).

Author(s)	Summary of relationship	Link to wasted food?*	Methods summary	Measurement method	Behavioral theory
A. Literature using quantitative methods					
Survey-based estimations (used survey questions to estimate the amount of food wasted, generally using surveys)					
Diaz-Ruiz et al, 2018	Purchasing behaviors, including planning, were correlated with less wasted food.	–	Online and paper survey (n=418). Structural equation modeling.	Proxy	none
Romani et al, 2018	Lack of planning for domestic food prep was found to be the most significant barrier to reducing wasted food.	–	Online survey (n=456). Cluster analysis and structural equation modeling.	Approximation	Theory of Planned Behavior (TPB)
Schmidt and Matthies, 2018	Planning behaviors were not correlated significantly with amount of wasted food.	/	Online survey (n=402). Cluster and regression analyses.	Approximation	none
Setti et al, 2018	Always making a shopping list was correlated with less wasted food.	-/	3-year online survey (n = 1706, 1518, and 1502, respectively). Path analysis.	Approximation	none
Stancu et al, 2016	Planning routines indirectly impacted amount of wasted food and were strongly associated with household skills.	/	Online survey (n=1062). Structural equation modeling.	Approximation	TPB
Stefan et al, 2013	Planning and shopping routines predicted avoidable food waste.	–	Online survey (n =244). Structural equation modeling.	Approximation	TPB
Visschers et al, 2016	Planning habits were not correlated significantly with amount of wasted food.	/	Mail survey (n = 796). Tobit analysis.	Approximation	TPB
Direct measurement (used directly measured data, generally from kitchen diaries or waste composition analyses, to estimate wasted food)					
Koivupuro et al, 2012	Participation in planning behaviors not correlated significantly with the amount of wasted food.	/	Online survey and kitchen diary (n=380).	Kitchen diary (weight-based)	none
Parizeau et al, 2015	Participation in planning behaviors not correlated with amount of wasted food. Meal planning was highest suggested practice to reduce wasted food.	/	In-person survey (n = 61) with waste composition study.	Waste composition analysis (weight-based)	none
Quested and Luzecka, 2014	Moderate evidence that meal planning was linked to wasted food. Meal planning strongly linked with amount of food that was discarded because it was "not used in time."	–/	Surveys combined with either kitchen diary or waste composition study. Generalized linear modeling.	Two different data sets: kitchen diaries and waste composition analysis (data recorded as weight, volume, handfuls, etc.)	none
Romani et al, 2018	Households that received interventions had less avoidable wasted food after they read the article on planning.	–	Intervention study using kitchen diary (n =210). Solomon four group design.	Kitchen diary (data recorded as weight, volume, handfuls, etc.)	TPB

B. Literature using qualitative methods					
Evans, 2012	Planning was often disrupted by the other priorities and stressors of everyday life. Sometimes, planning led to more wasted food, while other times it resulted in less. Overpurchasing was sometimes planned and not simply a result of lack of planning.	/	Quasi-ethnography including interviews and shop-alongs, (n = 19).	n/a	Theories of practice
Farr-Wharton et al, 2014	Lack of predictability prevented people from following through with their food plans.	/	Open-ended interviews (n=12) and participant observation (n=6).	n/a	Value –belief-norm theory
Ganglbauer et al, 2013	More planning did not always result in less waste. Linked to predictability.	/	Quasi-ethnography including fridge cams, home tours, and interviews.	n/a	Theories of practice
Hebrok and Heidenstrom, 2019	Long-term planning sometimes reduced flexibility, thus resulting in more wasted food. Those who practiced more flexible or shorter-term planning were able to adjust to unexpected events.	/	At-home visits including short interviews and photo documenting (n = 26).	n/a	Theories of practice
Romani et al, 2018	Lack of purchase and meal planning was cited as one of the major barriers to reducing wasted food.	–	Critical incident technique survey (n=514).	n/a	TPB
Soma, 2019	Shopping and meal planning behaviors were seen as ways to reduce wasted food and were linked to competency and food literacy. This idea of "good" planning is centered on a supermarket experience for purchasing food.	/	In-person surveys (n=323) and semi-structured interviews (n=21).	n/a	Theories of practice

Table 6. Quantitative and qualitative literature relating shopping and meal planning behaviors to the generation of wasted food in households.

* [1]symbol legend: + more planning, more wasted food; – more planning, less wasted food; /no statistically significant relationship or mixed relationship.

This research explored the relationships between individual behaviors promoted for food waste reduction and connected these behaviors with measured food waste estimates using week-long kitchen diaries coupled with surveys. Using polychoric factor analysis, we analyzed twenty behaviors associated with food waste prevention. Our hypothesis was that *people do not participate individually in behaviors; rather they participate in "suites" of behaviors.* In other words, there are "patterns" where participation in one behavior makes you more likely to also participate in others. We specifically hypothesized that behaviors related to planning would cluster given the results of previous literature. Behaviors clustered into three "suites" and only one of the three, representing behaviors associated with maximizing the consumption of already purchased foods, was significantly correlated with the generation of wasted food. Meal and shopping planning behaviors *were not* correlated with the generation of edible wasted food, however we contend that this does not necessarily indicate that planning behaviors

are not important determinants. In order to test possible explanations for the lack of correlation, we conducted additional analyses, including how perceptions of edibility influenced the correlation between planning and wasted food generation. We conclude with a discussion of potential explanations based on findings of other literature, discuss whether the explanations are supported by the findings of this research, and argue that understanding the intervening factors between planning and wasted food is critical to designing effective planning interventions.

2.2. METHODS

2.2.1. DATA SOURCES: SURVEYS AND KITCHEN DIARIES

We used raw data provided by the Natural Resources Defense Council (NRDC) to link food waste behaviors with generation of wasted food in households in Denver and New York City. Collected in 2016/2017 with the objective of better understanding what, how much, and why food was discarded in households, the NRDC data set includes responses from surveys and weeklong kitchen diaries. For the kitchen diary, participants were asked to weigh and track all of their discarded food for one week using a provided scale. In an online survey, participants were asked a series of questions assessing their attitudes and knowledge about food waste, and exploring the contexts, relationships, and behaviors related to food and waste that may contribute to the generation of wasted food. Unlike most research linking behaviors with the generation of edible wasted food, the NRDC dataset provided weight-based estimates of food waste generation. To the best of the authors' knowledge, it is the largest data set in the United States combining weight-based estimates of household food waste generation with household characteristics, demographics, attitudes, behaviors, and knowledge related to food and waste.

Participants were recruited using clustered random sampling, where houses or census tracts were randomly chosen. Households within the census tract or within the block surrounding the randomly chosen household were recruited door-to-door. Given limitations in access, a majority of respondents lived in single-family homes or multi-family dwellings with less than 10 units. Respondents were given a digital kitchen scale and compensated for their participation. Additionally, they were given a guide with detailed instructions and frequently asked questions about the study process. Additionally, participant support was available via phone, email, and text for the duration of the study. 545 households in Denver and New York City completed the NRDC study, resulting in a completion rate of approximately 55%. More information on the study undertaken by NRDC can be found in the final report and technical appendices (Hoover & Moreno, 2017a, 2017b). 390 households that fully completed both the kitchen and the survey were included in this analysis. Households were excluded if they did not fully complete the kitchen diary, there were obvious errors in recording food discarded, or if the respondent missed one survey question used in this analysis.

Using a paper kitchen diary, participants were asked to provide a description of every food and beverage item that they discarded over the period of one week, including a weight estimate for each item (in ounces) using the provided digital kitchen scale. Respondents were also asked to record the reason they discarded the food (inedible parts,

moldy/spoiled, past date label, improper cooking, left food out for too long, too little to save, doesn't taste good, don't want as leftovers, or other) and the state of the food item at the time of disposal (whole, prepared, cooked, or inedible parts). The kitchen diaries were used to estimate edible food waste generation (pounds per household per week) including food and beverages discarded to the trash or compost (backyard or curbside), fed to animals, and disposed down the drain. Kitchen diary entries were coded to indicate what proportion of the food material was edible and associated inedible parts. Breakdowns by part for food items, created as part of chapter one (see appendix 1), were used to create quantitative conversion factors approximating the proportion of total food discarded that was edible, as recorded in the kitchen diary. See appendix 2 for more information on the definition of edibility used for this project.

For the purposes of this analysis, twenty survey questions were considered, which gauged participation in behaviors associated with food waste prevention (see **figure 10** for frequency tables of all twenty survey questions). The inclusion of these specific behavioral questions was based on previous literature hypothesizing them as important variables (see **table 6** for a partial list of literature). All but one of the survey questions was based on one of two five-point Likert scales: a) agree, somewhat agree, neither agree nor disagree, disagree somewhat, and disagree; and b) always, often, sometimes, rarely, never. One survey question was based on a three-point scale for level of fullness of the refrigerator. For the analysis, all of the responses to these questions were re-coded from 1 to 5 (except for refrigerator fullness which was coded 1 to 3), so that the larger number indicated more frequent participation in behaviors that were hypothesized to *decrease* the amount of edible food discarded. Survey responses were also used to capture five household characteristics: city of residence, household size, presence of children, full-time employment of all household members (as a proxy for time available), and annual household income (see **table 7** for a summary of household characteristics). Other demographic factors that represented characteristics of the survey respondents, as opposed to the household, were not included because the unit of analysis for our study was the household.

2.2.2. DATA ANALYSIS

Analyses were conducted using Stata/IC 15. To test the hypothesis that people participate in "clusters" of behaviors, we employed exploratory polychoric factor analysis. This method allows for the use of both ordinal and dichotomous variables in the same analysis (Holgado–Tello, Chacón–Moscoso, Barbero–García, & Vila–Abad, 2010). Based on the results of the preliminary factor analysis, factors with an eigenvalue greater than one were chosen for inclusion in the final analysis. The resulting matrix was then rotated using the quartimax rotation with Kaiser normalization. Using this rotated solution, the final factors were then identified and defined. Variables with factor loadings of greater than 0.4 in absolute value were considered to be loaded onto a specific factor (Matsunaga, 2010). After each of the factors was identified, a factor score was generated for each factor by household.

In order to test for relationships between frequency of participation in behaviors and the generation of edible wasted food by households, we used ordinary least squares regression. Edible food waste generation (pounds per household per week), as determined

by the kitchen diaries, was used as the outcome variable. The explanatory variables for food waste prevention behaviors were represented by the factor scores for the three factors identified in the previous analysis. In addition to the factor scores, variables that did not load onto any factor and household characteristics were also included in the regression. Variables that did not load onto any factor were coded into two dummy variables per behavior. For Likert-scale variables, the responses coded 1 and 2 (e.g. agree and somewhat agree) were combined as well as the responses coded 4 and 5, with the neutral response (3) as the reference group. Household characteristics of income, household size, city of residence, presence of children, and employment were also included. Specifically, a dichotomous variable indicating whether all adult members of the household were employed full-time was used as a proxy for time availability.

For the main analysis, the study definition of edibility was used. For a secondary analysis, the categorization of edibility indicated by the participants in the kitchen diary was used to determine the outcome variable of edible wasted food (pounds per household per week). For a tertiary analysis, a new outcome variable was created to estimate a subset of edible food waste generation from the kitchen diaries, only including the food that was discarded for reasons that could theoretically have been prevented from better planning: moldy/spoiled and past date label. The other loss reasons for discarding edible food that were not considered preventable by better shopping and meal planning were improper cooking, leaving food out for too long, too little to save, doesn't taste food, don't want as leftovers, and other.

We used a 5% level to determine statistical significance and denote the p-value and coefficient for all variables in the tables. However, we will also interpret the meanings of all values within the 95% confidence interval (Amrhein, Greenland, & McShane, 2019) for variables with a p-value of .10 or less. Our initial regression analysis showed that the model violated the assumption of homoscedasticity. The mean residual size increased as the mean increased. To adjust for the violation, the regression model was re-run using robust standard errors.

2.3. RESULTS

2.3.1. DESCRIPTIVE STATISTICS

For the 390 households included in this analysis, the mean total food waste generated was 5.9 pounds per household per week, with New York City having an average of 5.8 pounds and Denver with an average of 6.1 pounds per household per week. A subset of total, the mean *edible* food waste generated was 3.8 pounds per household per week, again with New York having a lower mean estimate (3.7 pounds) than Denver (4.1 pounds). For edible wasted food, the minimum value was no discarded edible food in a week period while the maximum was 23.4 pounds for a household during the week they recorded their kitchen diary. The standard deviation was 3.6 pounds per household per week.

Frequency tables for all twenty survey questions gauging frequency of participation in behaviors related to food waste prevention are presented in **figure 10.** Notably, a majority of respondents indicated relatively high levels of participation in behaviors associated

with food waste prevention, especially behaviors related to shopping and meal planning. Additionally, household characteristics, used as the control variables for regression, are presented in **table 7**.

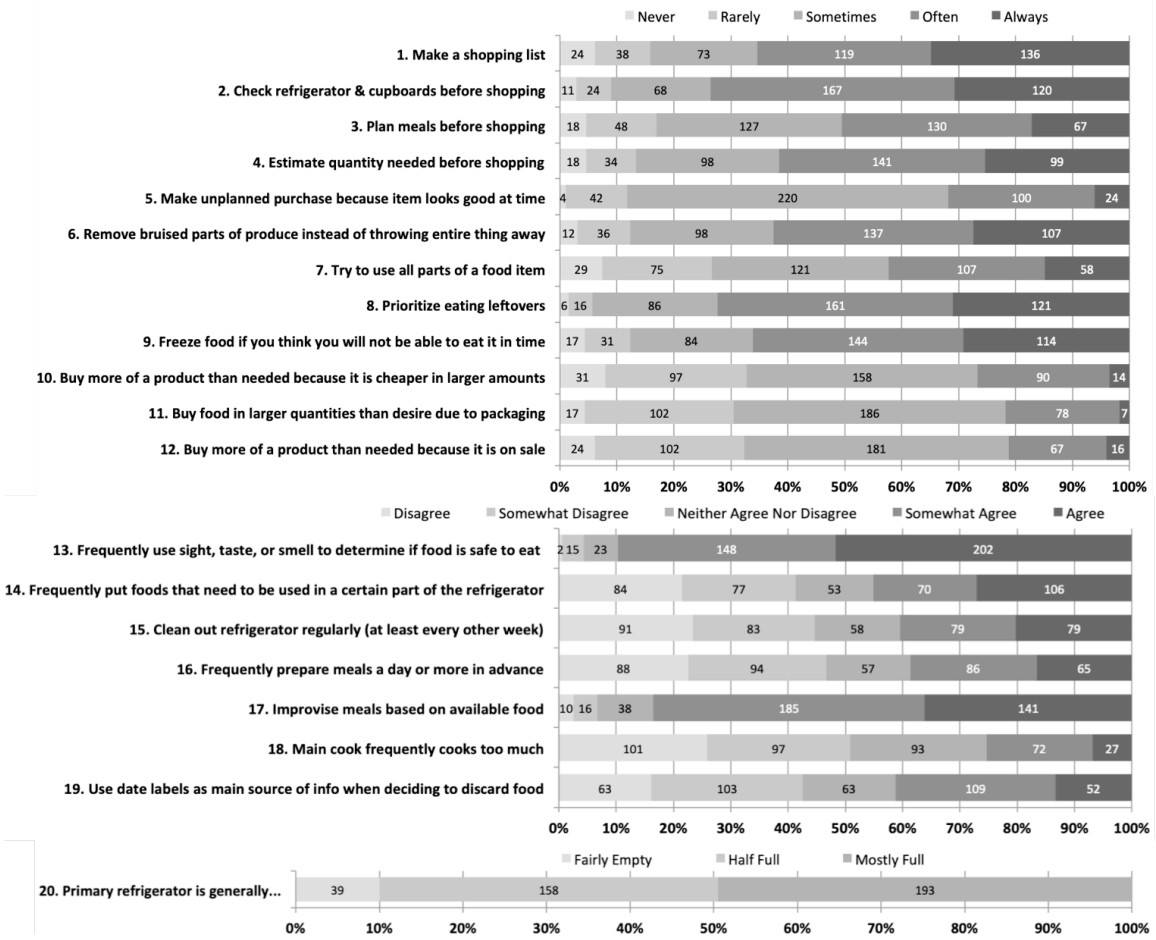

Figure 10. Frequencies of responses for twenty behaviors included in factor analysis. Out of 390 total responses.

Variable	Category	#	%
City of Residence	Denver	145	37%
	New York City	245	63%
Household Size (persons)	1	91	23%
	2	125	32%
	3	76	19%
	4	68	17%
	5 or more	30	8%
Children Present in Household (ages 17 and under)	No	266	68%
	Yes	124	32%
Household Income	Less than $45,000 (Low)	97	25%
	$45,001-$95,000 (Middle)	107	27%
	More than $95,001 (High)	186	48%
All Adults Employed Full-Time	No	183	47%
	Yes	207	53%

Table 7. Frequency Table for Household Characteristics (Control Variables).

2.3.2. FACTOR ANALYSIS

The polychoric factor analysis of the twenty behavioral questions resulted in three clusters: Factor 1 - behaviors related to planning for shopping and meals including making a shopping list and meal planning; Factor 2 - behaviors related to maximizing consumption of food that has already been acquired such as using all parts of food items and prioritizing eating leftovers; and Factor 3 - behaviors that represented minimizing overages, including avoiding over-purchasing and cooking more food than desired. **Figure 11** shows the 14 behaviors that loaded onto the three identified factors. Any columns that exceed the loading value threshold of 0.4, represented by the red horizontal line, are considered to load onto that factor. For example, factor 1 had six variables that loaded onto it as shown by the six black columns on the left-hand side of figure 11, each representing single behaviors. See appendix 2 for detailed information on the results of the factor analysis including eigenvalues, loading factors by behavior, and a list of variables that did not load onto any factor.

After identifying the factors and estimating the factors scores, we conducted a regression analysis. Results for this model are presented in **table 8**. Only Factor 1 was statistically significant at the 95% level. On average, higher levels of participation in activities in the maximization factor resulted in lower levels of edible food discarded in households, controlling for all other variables ($t = -2.2$, $p = 0.03$). The planning factor (Factor 2) was not statistically significant and the coefficient was close to zero with the confidence interval ranging from -0.31 to 0.44 indicating that both positive and negative values may be equally plausible ($t = 0.33$, $p = 0.75$). Factor 3, minimizing overages, had a positive coefficient of 0.31 potentially indicating a relationship of increased edible wasted food with increased participation in these behaviors ($t = 1.5$, $p = 0.14$). The confidence interval was skewed towards a positive value.

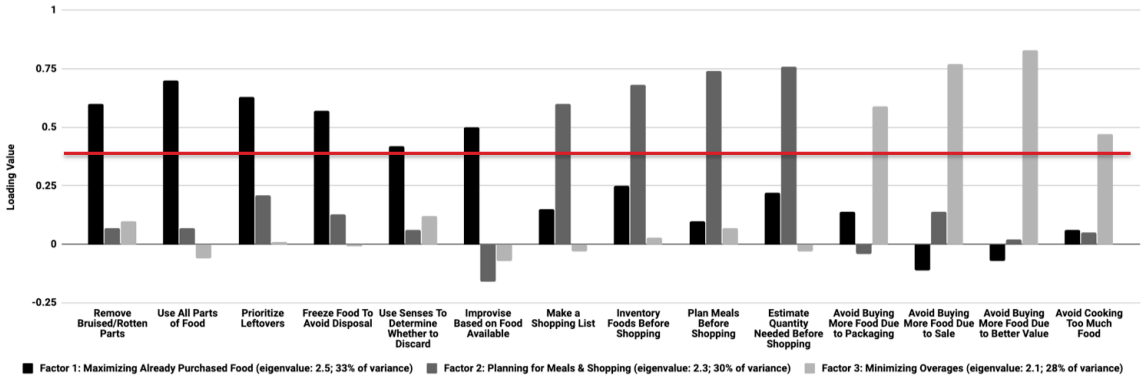

Figure 11. Rotated factor loadings for 14 behaviors related to food waste prevention. Variables that did not load onto any factor were omitted from this figure. The horizontal red line is at 0.4, representing the threshold for a variable to be considered loaded onto a factor.

Most of the variables for the behaviors that did not load onto any of the factors were not statistically significant. Agreement with the statement that generally the household's refrigerator was mostly full was associated with higher levels of edible wasted food compared to households whose refrigerator was generally half full, controlling for all other variables ($t = 2.7$, $p < 0.01$). The coefficients for the set of variables relating to refrigerator fullness were significant ($F(2, 368) = 6.5$, $p < 0.01$). As expected, households with full refrigerators were associated with higher levels of edible wasted food while households with mostly empty refrigerators were associated with lower levels of wasted food ($t = -1.8$, $p = 0.08$). Notably, one other dummy variable had a p-value of less than 0.1. Agreement with the statement that date labels were used as the primary source of information when deciding whether to discard food had a confidence interval of -0.20 to 2.2 indicating that there is a likelihood that agreement with this statement is associated with higher levels of edible wasted food, on average ($t = 1.7$, $p = 0.10$).

Of the variables for household characteristics, only household size and city of residence were statistically significant. Controlling for all other variables, household size had a significant effect on mean edible food waste generation ($t = 3.3$, $p < 0.01$). For every increase in household size of one person, mean edible food waste generation was estimated to increase by 0.59 pounds per household per week (95% CI: 0.25 to 0.94). Controlling for all other variables, the city of residence had a statistically significant effect on edible food waste generation ($t = -2.6$, $p = 0.01$). On average, households in New York City were estimated to have a lower mean edible food waste amount by 0.94 pounds per week compared to households in Denver (95% CI: -1.7 to -0.23).

Variable	Coeff (Robust Std. Err.)	95% Confidence Interval		t-value	p-value
Factor 1 (Maximizing)*	-0.60 (.27)	-1.13	-0.06	-2.19	0.03
Factor 2 (Planning)	0.06 (0.19)	-0.32	0.44	0.33	0.75
Factor 3 (Minimizing)	0.31 (0.21)	-0.11	0.73	1.46	0.14
Clean Out Fridge Regularly					
- Agree/Somewhat Agree	-0.71(0.45)	-1.60	0.18	-1.56	0.12
- Disagree/Somewhat Disagree	-0.18 (0.41)	-0.98	0.62	-0.44	0.66
Use Date Labels as Main Source of Info					
- Agree/Somewhat Agree	1.02 (0.62)	-0.20	2.23	1.65	0.10
- Disagree/Somewhat Disagree	-0.73 (0.42)	-0.90	0.76	-0.17	0.86
Put Items That Need to be Eaten in Certain Part of Refrigerator					
- Agree/Somewhat Agree	-0.48 (0.50)	-1.46	0.50	-0.96	0.34
- Disagree/Somewhat Disagree	-0.21 (0.39)	-0.97	0.55	-0.54	0.59
Make Unplanned Purchases Because Something Looks Good					
- Always/Often	0.90 (0.75)	-0.58	2.38	1.20	0.23
- Rarely/Never	-0.02 (0.36)	-0.73	0.69	-0.04	0.97
Prepare Meals In Advance					
- Agree/Somewhat Agree	-0.11 (0.49)	-1.07	0.85	-0.23	0.82
- Disagree/Somewhat Disagree	-0.61 (0.50)	-1.58	0.36	-1.23	0.22
Refrigerator is generally…*					
- Mostly full*	1.08 (0.39)	0.30	1.85	2.73	<0.01
- Fairly Empty	-0.83 (0.47)	-1.75	0.10	-1.76	0.08
Children Living in Household	1.09 (0.58)	-0.06	2.24	1.86	0.06
Household Size (persons)*	0.59 (0.18)	0.24	0.94	3.34	<0.01
New York City*	-0.94 (0.36)	-1.66	-0.23	-2.59	0.01
Full-Time Employment	-0.15 (0.37)	-0.88	0.58	-0.41	0.68
Income					
- Low (less than $45k)	0.15 (0.54)	-0.92	1.22	0.27	0.79
- High (more than $95k)	0.07 (0.36)	-0.64	0.78	0.20	0.84
Intercept*	3.80 (1.67)	0.52	7.08	2.28	0.02

*Statistically significant at the 95% confidence level
* *R-squared = .22, degrees of freedom: 368

Table 8. Primary Regression Model Results. For model run with robust standard errors.

To explore plausible explanations for the lack of correlation between planning behaviors and edible wasted food, we re-ran the model two more times to test whether different interpretations of the outcome variable for wasted food would change the results. The first rerun estimated wasted food *based on how the respondents characterized edibility in*

the kitchen diary, rather than relying on the study definition. For the most part, the results were the same as above in terms of the magnitude, directionality, and statistical significance of the variables. Two variables became statistically significant, the dichotomous variable for presence of children as well as the dummy variable indicating agreement that the household regularly cleans out their refrigerator. The second rerun estimated the amount of wasted food for the *subset of discarded food items that theoretically could have been prevented by better meal and shopping planning.* The results from this model were somewhat different, however, the relationships between planning behaviors and the outcome variable were not statistically significant. Notably, the maximizing behaviors were no longer statistically significant in this third model, but the behaviors associated with minimizing overages did become statistically significant. Tables showing model results are presented in appendix 2 (tables a2-3 and a2-4). Given that the main purpose of the additional analyses was to determine if different conceptions of "wasted food" were correlated with planning behaviors, the results are not presented in detail here because neither had a statistically significant correlation between planning behaviors and edible wasted food.

2.4. DISCUSSION

As hypothesized, individual behaviors clustered indicating that there are patterns of participation among them. However, it was surprising to find that only one of the suites of behaviors was correlated with lower quantities of edible wasted food by households. Following a general discussion of the results, we delve into a detailed explanation of the relationship between planning behaviors and wasted food. We explore potential explanations for why there is essentially no correlation of wasted food with frequency of participation in shopping and meal planning behaviors. We conclude that there is a need for improved metrics related to planning behaviors that go beyond frequency of participation and for further, more nuanced explorations to identify which interventions related to planning are likely to be most successful in reducing wasted food.

Results of the factor analysis identified three clusters of individual behaviors associated with food waste prevention, which has potential implications for influencing consumer behavior. Instead of focusing on promoting behaviors individually, it might be advantageous to promote them together as "suites" of behavior, since people are already participating in them jointly. Additionally, given that the function of factor analysis is to identify underlying latent variables, we suggest that these suites may not only be linked in terms of frequency of participation, but in terms of how the behaviors are perceived by consumers. Understanding these similarities could help to more effectively communicate with consumers about further adopting these behaviors. More research is needed to further explore the behaviors that did not load onto any factor, to see if they cluster with any behaviors not included in this analysis, such as storage behaviors.

The main regression analysis showed that only Factor 1 has a negative coefficient and is statistically significant, meaning that higher participation in maximizing behaviors was associated with lower amounts of wasted food. Based on the direction of the relationship and its statistical significance, there is evidence to suggest that encouraging people to maximize consumption of already-provisioned food items through increased participation

in the six clustered behaviors would reduce the amount of wasted food generated by households. One challenge is that the number of respondents that indicated agreement that they regularly engaged in maximization behaviors was relatively high (see figure 10) meaning that interventions to increase frequency of participation in those behaviors may have a limited effect. It is a rule-of-thumb in psychology that behaviors targeted for change are more likely to be effective if they have a strong correlation with the intended outcome variable, in this case the amount of wasted food, *and* have low levels of participation (Schmidt & Matthies, 2018).

The other two factors have slightly positive coefficients and are non-significant at the 95% level. Behaviors associated with planning and minimizing overages are not correlated with wasted food, however, we contend that these behaviors may still be important determinants. Specifically, we suggest that there may be intervening factors in terms of their contribution to reduce wasted food. This is supported by the mixed results in the quantitative literature, some showing correlations with these behaviors and others not. Additionally, the qualitative literature highlights the variable impact that long-term planning has on the amount of wasted food based on varying contexts, cognitive fallacies, and competing priorities of everyday life (Evans, 2012; Farr-Wharton et al., 2014; Hebrok & Heidenstrøm, 2019) as well as the variable impacts of purchasing more of items due to value or sale (Quested & Luzecka, 2014).

Factor 1 is different from the others not only in terms of statistical significance, but because the latter two are related to planning and shopping behaviors that are farther removed in time and space from the act of discard. On the other hand, behaviors relating to maximization all occur within the household after the food is provisioned. Setti et al (2018) explore this distance in what they term the "behavior-outcome gap," which represents a real and critical distance between choices and their outcomes, in this case food choices and how much food is discarded. The farther the distance, the greater the uncertainty in how that food choice impacts the amount of wasted food given intervening factors (Setti et al., 2018). There is a much shorter distance between behaviors clustered in the maximizing factor (e.g. cutting off bruised parts of items instead of throwing the whole item away) compared to the other two factors representing behaviors associated with planning and shopping. This may partially explain the differences in correlation due to the lack of clear feedback households get on how planning and minimizing behaviors impact the amount of food they discard.

Factor 3, related to minimizing overages, includes some behaviors that are mediated by elements related to financial resources (e.g. buying more than desired due to sale or value), indicating that participation in these behaviors may be tightly linked to money saving measures. The lack of correlation could be explained by some households participating in "worse" behaviors of buying more because of a sale, but still having very little wasted food since monetary efficiency is a main driving factor. Additionally, research by the Waste and Resources Action Programme (WRAP), found that some households reduce other food purchases when they "over-purchase" foods due to packaging, value, or other factors (Quested & Luzecka, 2014).

A key difference between Factor 2 (planning) and the other factors is that, shopping and meal planning behaviors are aspirational in the sense that people partake in these behaviors with specific goals of wasting less, eating healthier, saving money, and saving time (Moreno, McDermott, & Billings, Doc, 2017). In some ways, they represent the aspirations and "intent" of people rather than an actual behavior. This is supported by other literature that illustrates how people beneficially perceive planning behaviors, but may be unable to regularly execute the plan or may over-plan which leads to more discarded food (Evans, 2012; Farr-Wharton et al., 2014; Hebrok & Heidenstrøm, 2019; Moreno et al., 2017).

Another notable result from the regression analysis is that the level of fullness people generally keep their refrigerator is significantly correlated with edible food waste generation. This correlation may be partially a result of how much people prepare meals from scratch and/or eat at home as well as their purchasing habits. This could be linked to food waste generation simply because people with a more full refrigerator have more perishable food items to potentially discard compared to people with less full refrigerators. However, this could also be a result of crowding in the refrigerator, which makes it more difficult to remember and identify what is in the refrigerator. Other literature has identified food being "lost in the back of the refrigerator" as a reason that people discard food (Romani et al., 2018).

As cited by other literature (Milne, 2012; Neff et al., 2019), the relationship with how people use and interpret date labels also warrants further investigation. While not statistically significant at the 5% level, people that use date labels as the main source of information when deciding whether to discard food were correlated with higher levels of edible wasted food.

2.4.1. Does planning work to reduce wasted food? A deeper dive into how people plan

In this section, we further explore the role of shopping and meal planning, a target of many consumer education campaigns because these behaviors are regularly hypothesized to be important determinants of wasted food. While our results did not show a correlation between participation in these behaviors and wasted food, we contend that this does not mean that planning behaviors are not important for understanding both how food becomes waste and how to intervene to reduce wasted food. Specifically, the results of our regression analysis show that planning behaviors have a coefficient close to zero and the factor is not statistically significant. We suggest that there may be intervening factors that prevent planning behaviors from being executed in a way that would reduce the amount of wasted food for *all* households. Factors may include potential cognitive fallacies (e.g. Chandon & Wansink, 2006) or a mismatch between the anticipated and actual week (e.g. Evans, 2012). These factors are also linked with the materiality of food (e.g. perishability), concepts of freshness, and the routines and habits of everyday life.

In **table 9**, we present four "scenarios" that provide potential explanations for why no statistical correlation between planning and wasted food was found. Given that some previous literature found a correlation, we also included a scenario 0 in the table, which

assumes a correlation between frequency of participation in planning behaviors and edible food waste generation. The final column of the table lists potential interventions that would be appropriate given the relationship between planning and wasted food described in each scenario. The purpose of this column is to illustrate that potential interventions to address "better" planning can be very different based on the relationship found between planning and reducing wasted food. More research is needed to better understand the nuances of planning, including which scenario(s) best describes how planning behaviors influence the generation of wasted food. Generally, we contend that standardized interventions across all households may not be as effective as more specialized approaches that focus on differences, including household characteristics and food types. The scenarios provide an entry point into designing interventions that address the variable nature of how planning works in households.

Scenario 1 recognizes that there might be varying "levels of success" for executing planning behaviors, both between households and also week-to-week within a single household. Previous literature explains the differential impacts of planning from the perspective of unpredictable lifestyles and how food planning interacts with other practices, priorities, and contextual factors embedded within everyday life (Evans, 2012; Farr-Wharton et al., 2014; Hebrok & Heidenstrøm, 2019). Hebrok and Heidenstrøm (2019) suggest that long-term planning can result in more wasted food by restricting food choices amidst unexpected changes, thus flexible planning techniques should be used. Further research should be done to identify which factors impact the successful implementation of shopping and meal planning.

In much of the quantitative literature on food planning, there is an implicit assumption that planning is being used to match purchasing with consumption needs. However, as presented in scenario 2, there is evidence that people may regularly over-plan, meaning they plan for purchasing more food than they can consume, either consciously or unconsciously. Evans (2012) highlights planned over-purchasing, where people purposefully purchase more than they can eat in a given amount of time for reasons such as self-improvement, comfort, and convenience. For example, people may aspirationally purchase healthy foods, mainly fruits and vegetables, to have them available to eat even if they regularly go uneaten. Another reason for regular over-planning and over-purchasing may be biased estimates of inventory or purchasing needs based on cognitive fallacies. Chandon and Wansink (2006) highlight the heuristics used and resulting biases when people estimate how much food they have in their cupboards and refrigerator. They found that stockout-averse people are more likely to regularly over-purchase. Improved food literacy is a potential intervention to help people more accurately estimate available inventory, thus reducing instances of over-purchasing (Chandon & Wansink, 2006). Further research is needed to understand the various reasons why people regularly or purposefully over-plan, including provisioning food for children, desires to eat healthier, and vastly different food preferences or dietary restrictions within households.

Scenario	Description	Examples of supporting literature	Research findings	Potential interventions
A. Correlation between planning behaviors & wasted food				
Scenario 0: Correlation found	There is a correlation between more frequent participation in planning and less wasted food.	Mostly quantitative papers using approximations (e.g. Stefan et al , 2013). Moderate evidence of correlation for some planning behaviors (Quested & Luzecka).	Scenario not supported by findings of this research.	• Increase the frequency that people partake in planning behaviors.
B. No correlation between planning behaviors & wasted food				
Scenario 1: Levels of success for executing plan	Some households are able to execute plan successfully, while others are not. May also shift within household over time.	Qualitative literature (Evans, 2012, Ganglbauer et al, 2013) supports that unexpected events, household priorities, and other factors prevent some households from executing plans, resulting in increased levels of waste.	Scenario not explored in detail in this research.	• Flexible planning techniques • Focus on successful execution of plans rather than increasing participation.
Scenario 2: Over-planning	Some people may regularly over-plan, despite high levels of participation in planning behaviors. Could be due to cognitive fallacies or planned over-purchasing.	Qualitative literature (Evans, 2012, Ganglbauer et al, 2013) supports concept of regular and planned over-purchasing. Chandon and Wansink (2006) identified cognitive fallacies that lead to systematic under- estimating of household food inventory thus over-purchasing.	Scenario not explored in detail in this research.	• Planning literacy to help address cognitive fallacies. • Address issues related to why people may purposefully over-plan
Scenario 3: High levels of waste that aren't addressed through planning	Planning is "successful" for households. However, some households have high levels of wasted food for reasons not addressed by planning.	Quested and Luzecka (2014) found a significant relationship between avoidable food waste not "used in time" and higher levels of planning, despite lack of correlation between planning and total edible food generation.	Findings from additional analyses did not support this scenario.	• Target planning interventions at the portion of the population that does not already plan frequently.
Scenario 4: Biases in perceptions of participation	Self-reporting biases where people report they more frequently participate in behaviors than they do.	Neff, et al (2015) suggests that people may overestimate their participation in behaviors associated with food waste prevention.	Scenario not explored in detail in this research.	• Create better measures to capture how planning does or does not result in discarded food.

Table 9. Potential scenarios explaining relationship between planning behaviors and edible food waste generation.

In scenario 3, participation in planning activities are successfully helping households to reduce wasted food, however, some households are still high wasters. Essentially, planning is "successful" for these households, but another unrelated factor is the cause of the wasted food. We explored two possible reasons for the mismatch as part of this paper, but did not find evidence to support either explanation. The first reason was that households may have restrictive views of edibility meaning they perceive many food

parts as inedible that we considered edible as part of the study (e.g. broccoli stalks). To test this, we used respondent-chosen indications of edibility to generate a new outcome variable for edible wasted food. To test the second explanation, we assumed that only some wasted food could be avoided through planning behaviors, if it was discarded because it wasn't used in time. We re-ran the regression to only include this subset of wasted food. Given that neither analysis resulted in a statistically significant correlation between planning behaviors and wasted food, our findings did not support this scenario as an explanation.

The final scenario presents a situation where people have biased perceptions of their participation in planning activities because it is largely considered a "good" behavior. As mentioned previously, many people associate planning with positive things such as eating healthier, saving money, and wasting less. Neff et al (2015) suggested that people may overestimate their participation in behaviors related to food waste prevention. This may be exacerbated for planning behaviors compared to the behaviors associated with the other two factors because planning is aspirational, seen as beneficial on multiple fronts compared to other behaviors like eating leftovers. While this scenario does not illuminate a specific behavioral intervention, it does suggest that better measures are needed to capture actual behavior beyond frequency of participation.

Overall, the lack of statistically significant correlation with edible food waste generation does not mean that planning is not an important behavior. Rather, we argue that planning should be further explored as a potential area of intervention. Enactment of behaviors relating to wasting food or preventing its waste, including planning, are enabled and mediated by social constructs and context. We must consider the varying factors to understand how to intervene in these behaviors to enact change. As illustrated in **table 9**, understanding the potential explanations, or scenarios, for the lack of correlation can be used to select interventions that might be successful in reducing wasted food. Our findings also suggest that using frequency of participation in planning behaviors is not an appropriate measure when considering planning as a determinant of wasted food. Better measures may want to capture how a plan is executed, whether food discarded could be prevented from planning, and other factors that capture the nuances of planning behaviors and how plans are actually enacted. At the minimum, our findings suggest that quantitative research should better incorporate measures to better account for concepts of over-planning and not implicitly assume that more planning is "better."

2.5. LIMITATIONS

The data used in these analyses is the largest known household-level dataset in the United States using weight-based estimates for edible wasted food from all discard destinations coupled with a survey identifying attitudes, knowledge, contexts, and behaviors relating to food and waste. However, it has several limitations. Firstly, the kitchen diary captured a *snapshot* of how a household discards food given that it only captured a week's worth of data. This week may not be representative of an entire year due to the seasonality of waste generation (e.g. watermelons discarded more in summer) and the variable nature of waste generation by households (Bulkeley & Gregson, 2009). Secondly, while there was likely bias in both sampling and respondent reporting, efforts were taken to minimize these biases whenever possible. Some populations may be systematically excluded,

would not agree to participate, or are unlikely to complete the study after committing. Reasons for this could include that they are not likely to be contacted or would be unlikely to partake in a time-intensive study like this, including non-literate populations and populations that would consider themselves time constrained. Other populations may be overrepresented -- populations that are not time-constrained and people with a previous interest in food or other environmental issues.

Thirdly, as a research tool, it is relatively well documented that kitchen diaries result in underreporting due to unintentional omissions, intentional omissions due to the time and energy needed to record items, changes in behavior as a result of tracking food waste, and self-reporting bias since wasting food is generally considered an undesirable behavior (Moreno et al., in press). There has been no research that the authors are aware of to understand how underreporting impacts different types of households, so no correction factor was made for this analysis. However, kitchen diaries also have the ability to track food that is discarded to all end-of-life destinations, including those not generally captured by waste audits. Finally, many of the behaviors included in this analysis may vary depending on the food type. For example, people may be much more likely to freeze certain food items or more risk averse for other food items, like meats. More research is needed to understand if participation in and outcomes associated with these behaviors vary greatly by food type.

2.6. CONCLUSION

Overall, we found that behaviors associated with the reduction of wasted food cluster to form "suites" of behavior that can be targeted for intervention. More research is needed to identify a more comprehensive list of behavioral clusters, including how these behaviors may be variable by food type. Surprisingly, the set of behaviors related to maximizing food that had already been acquired was the only factor that was correlated with lower levels of edible food waste generation. For the other two clusters, we contend that the lack of correlation does not mean that they are not important determinants of wasted food. Instead, we suggest that a more nuanced and holistic understanding of how these behaviors are enacted within the contexts and priorities of everyday life is needed to better inform intervention strategies. Specifically related to planning behaviors, we presented multiple potential explanations for the lack of correlation supported by existing literature. In light of these potential explanations, we suggest that more nuanced measures of planning, beyond simple frequency of participation in the behavior, are needed to capture the complexities of behaviors related to discarding food.

CHAPTER 3

Human subjects approval was obtained for this project from UC Berkeley's Institutional Review Board, Protocol # 2014-06-6449, entitled "Transformation of Food to Waste at the Household Level" and Portland State University's Institutional Review Board, Protocol # 174131, entitled "Oregon Wasted Food Interview Study."

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3. WHY WE WASTE: WEIGHING THE COSTS AND BENEFITS THAT LEAD TO NON-CONSUMPTION OF FOOD IN HOUSEHOLDS

3.1. INTRODUCTION

In energy efficiency, the phrase "leaving a twenty dollar bill on the sidewalk" is used to illustrate the money that people lose when choosing not to adopt behaviors or technologies to reduce energy use in their homes (Gillingham, Newell, & Palmer, 2009). Why are people making economically irrational decisions even when provided with the information showing them that they would save money? Using theories of practice to explore everyday consumption, Shove and others contend that people do not directly consume energy, rather, they consume the services or benefits provided by it. Better understanding these cultural services, like comfort and convenience, helps illuminate why people may "waste" money instead of reducing their energy use (Shove, 2003).
This moves us to ask the question of whether the benefits that energy provides to people are accounted for in the analysis of how people make these economic choices.

A similar narrative related to economic rationality is developing around wasted food, with messaging focused on the concept that wasting food is wasting money. Used to inspire changes in behavior, it is commonly cited that the average American family of four could save between $1,500 and $2,275 each year by not wasting edible food (Ad Council, n.d.; Horwitz, 2018). This relatively simplistic framing of the economic consequences of discarding food does not account for how households negotiate economic priorities within the context of everyday life. Creating effective messaging and other interventions relies on an improved understanding of the multi-faceted and complex nature of decisions made to either consume or discard food (Hebrok & Boks, 2017; Hebrok & Heidenstrøm, 2019; Schanes et al., 2018).

While saving money was found to be the most important motivator for households to discard less food (Neff et al., 2015; Quested et al., 2013), there has not been solid evidence that interventions focusing on money saving measures are effective. Porpino et al (2015) found that some strategies used to save money, such as bulk purchasing, resulted in more wasted food (Porpino, Parente, & Wansink, 2015). Quested et al (2013) noted that the concept of saving money in a household was multi-faceted, suggesting further research to better understand its potential to change consumer behavior.

Unlike energy, we do directly consume food; however we also get benefits from food beyond our physiological needs. Food is culture. Food is language. We express ourselves, show love and care, and communicate through cooking, eating, and other practices related to food including discarding it (Evans, 2012; McCracken, 1986; Southerton & Yates, 2015; Tiu Wright, Nancarrow, & Kwok, 2001). Southerton and Yates (2015) contend that many studies view the practice of wasting food in isolation from the sociocultural contexts within which people plan, shop, prepare and eat food. They identify cultural dynamics related to food that are inextricably linked to how food is discarded in homes, including expressing care, access to a variety of foods, and indulgence (Southerton & Yates, 2015). I contend that the benefits provided by our relationships and interactions with food are critical to an improved understanding of how food becomes waste in households.

Generally, discarding food is considered an undesriable behavior. As has been found in multiple studies, people do not like to waste food or feel guilty when they discard it (Evans, 2012; Neff et al., 2015; Qi & Roe, 2016). By classifying the act of wasting food as a negative behavior, an implicit assumption is made that people consider it to be "costly." This chapter provides a novel perspective by also considering the "benefits" that people might experience as a result of discarding food, directly or indirectly. By omitting the benefits associated with the non-consumption of food, I contend that we do not fully capture the practice of wasting food which limits our ability to identify effective interventions.

3.1.1. CONSUMER-LEVEL FOOD WASTE PREVENTION

With an estimated one-third of food discarded globally (Gustavsson et al., 2011), attention is being paid to the environmental, social, and economic impacts of edible food going uneaten. Food that is discarded often ends up in landfills, where methane, a potent greenhouse gas, is emitted from its decomposition. The lifecycle impacts of food production include greenhouse gas emissions, water and energy use, and pollution from inputs such as fertilizers and pesticides. When food goes uneaten, all of the resources that went into producing that food and getting it to the consumer's plate are essentially wasted (Food and Agriculture Organization (FAO), 2013). Globally, over three million Gt of CO2e per year are associated with wasting food, not accounting for land use change (Food and Agriculture Organization (FAO), 2013). While previous efforts have focused on diverting food waste from disposal in landfills, there is a growing focus on food waste prevention, or reducing the amount of edible food that is discarded to any end-of-life destination (Papargyropoulou et al., 2014). Food waste prevention is considered to have far greater benefits than diversion, including the potential to make more food "available" without increasing agricultural production (Papargyropoulou et al., 2014; Quested et al., 2013). Campaigns and interventions to promote food waste prevention are increasingly targeting consumers due to their large contribution to the problem.

In the United States, consumer-level FLW, including restaurants, is the largest portion of total FLW (Buzby et al., 2014). Within that category, households are a primary focus because it is estimated that they contribute over 40% of all food discarded along the supply chain in the U.S. (ReFED, 2016). A similar trend was found in Europe with an

estimated 53% of all FLW in the European Union attributed to households (Stenmarck et al., 2016). Education campaigns and other interventions target consumer behavior with a focus on reducing edible, or avoidable, food discarded in households. Despite the significant focus on changing consumer behavior, there is little evidence of the effectiveness of interventions (Reynolds et al., 2019) and there is relatively sparse information about the underlying causal mechanisms that result in food being discarded (Schanes et al., 2018). In addition, messaging and interventions tend to be standardized across a diverse set of households and eaters, without much consideration for the oft-changing contexts in which people discard food. In order to design effective interventions, there is a need to better understand why and how household members decide whether to discard or consume foods in light of shifting household priorities.

3.1.2. To consume or not to consume?: Food choice models

Based on nutrition science, Furst et al (1996) presents a conceptual food choice model where the choice to consume or discard food is based on value negotiations. These negotiations result in several factors being weighed against each other, including financial resources, time, sensory perceptions and social relationships. This does not mean that household members consciously weigh the costs and benefits of every decision because some behaviors become routinized and automatic over time (Furst et al., 1996). In other terms, value negotiations can be considered a tool to maximize the utility, or satisfaction people get from food in relation to the costs they endure from consuming or discarding it (Jabs & Devine, 2006).

Money is not the only cost considered by households, but is intertwined with time as a resource or currency. People participate in behaviors to save money and/or time based on their available resources at any given time. Referred to as "time-deepening" behaviors, strategies such as multitasking, substituting shorter tasks for longer ones, and speeding up or shortening activities are regularly employed in relation to food choices and is evidenced by how people interact with food (Jabs & Devine, 2006). Within sociology, time is often considered a social construct to help order and regulate daily activities (Ellegård, 1999; Furst et al., 1996; Jabs & Devine, 2006). Time geography elaborates on this by showing that the characteristics of time create competition for how time should be used. This is based on the idea that a person or object can only be in one place at any given time and it takes time for people to move in space (Ellegård, 1999), thus time is a finite resource just as money is. Availability of both time and money influences choices made in relation to food. However, I argue that these must be considered alongside the benefits or values provided by food to understand how households maximize their utility from food and how that influences whether food is consumed or discarded.

In a national survey of United States consumers, Qi and Roe (2016) analyzed patterns in attitudes related to discarding food. They identified "perceived practical benefits", representing benefits that households risk losing if they attempt to reduce the amount of food they discard (Qi & Roe, 2016). Barone et al (2019) also found that consumer goals related to food were sometimes in conflict with their desire to reduce wasted food (Barone et al., 2019). Goals and benefits identified included providing for their loved ones, eating a healthy diet, saving time and money, improved food quality and safety (Barone et al., 2019; Qi & Roe, 2016). This chapter adds to the growing body of literature

seeking to understand how goals and benefits related to food may be in tension with other household priorities, namely time and money, and how these value negotiations influence choices made by households to either consume or discard food.

To identify benefits and place them within a framework specifically related to wasted food, I used the conceptual framework described in the Introduction to shape my analysis. Following this framework, the key focus of this chapter is the component of "meaning," specifically the symbolic and practical benefits of food considered in the value negotiations that determine whether food is discarded or consumed. After the methods, the first section provides a brief overview of the structural, economic and policy factors influencing households interviewed as part of this study, including respondents' profiles. The subsequent sections then explore the five major benefits of food related to both its consumption and non-consumption, or waste, as identified through this research: pleasure/enjoyment; comfort; self-identity; "good" food; and convenience. We find that the benefits of food: 1) are sometimes realized through consumption of a food, which directly or indirectly results in the non-consumption of other food items or parts; and 2) can sometimes be realized even if the food is not consumed. The final section illustrates the multi-faceted nature of how households partake in value negotiations to maximize utility. While economic factors are important determinants of behaviors related to wasting food, they must be considered jointly with time and benefits derived from food.

3.2. METHODS

A total of 52 households in the states of California, Oregon, and Washington in the United States participated in open-ended interviews that were approximately one hour in length. The primary purpose of these exploratory interviews was to understand why food was discarded in households. The interviews also heavily focused on routines and behaviors related to food planning, shopping, storage, preparation, cooking, and eating as well as the basic characteristics and priorities of the households. Previous research has shown that understanding how people interact with food in the context of their everyday lives is critical to understanding how food becomes waste (Evans, 2012; Graham-Rowe et al., 2014). Interviews of households in Seattle, Washington (n = 9) and Oakland, California (n = 11) were completed in 2014 and 2015, while interviews in Oregon (n = 32) were conducted in 2017 as part of the Oregon Wasted Food Study (Oregon Department of Environmental Quality, 2019). The households were not recruited to be representative of the population they were in; however, information was collected to recruit a set of households with varying ethnicities, household compositions, income levels, and geographic areas. Criteria for inclusion required that all interviewees be at least 18 years of age. While these interviews were conducted as part of separate studies, they were combined because they were all conducted by the same interviewer, using the same set of questions and prompts. All households were compensated for their participation in the interview.

Interviews in Seattle and Oakland were all conducted in-person, sometimes in the household of the participant, other times in public spaces based on the comfort-level of the participant. In Seattle, snowball sampling through young professional groups and solicitation at grocery stores were the two modes of recruiting participants. In Oakland,

an advertisement on Craigslist, emails using research team's contacts in the region, and snowball sampling through "mommy groups" was used. One interview from Oakland was excluded because the recording was largely inaudible. Interviews with Oregon households were located across the state and were all done by phone. A non-proportional quota sample was used in order to get representation from a variety of sub-populations, based on area of residence (urban, suburban, rural), household composition, and income level. Recruitment was done through Craigslist as well as emails sent to known contacts of the research team.

To analyze the content of the interviews, the interviews were recorded and transcribed. The transcriptions were then coded using Atlas.ti to identify themes that cut across multiple interviews. Inspired by grounded theory, interviews were systematically coded by identifying repeated subjects and issues that emerged from the transcriptions without relying on pre-existing hypotheses to determine codes (Mills, Bonner, & Francis, 2006). The initial codes were combined to create the key themes presented in this paper. In the coding, behaviors/performances related to discarding food were noted if they were routine or regular, not just unusual, one-time events. This is because theories of practice highlight routinized behavior rooted in sociocultural, material, contextual, and personal factors (Hargreaves, 2011).

3.2.1. LIMITATIONS

Given the small sample size and non-random sampling, the sample is not representative of the larger population of interest. Due to the recruitment strategies used, the sample is likely to be more aware of issues related to food than the larger population. Notably, the sample had a high proportion of female respondents, lower-income households, and participants aged 25-44. As a result, the magnitude of impact of the themes identified on the generation of edible wasted food cannot be determined from this analysis.

Most respondents lived in an area that either had access to curbside collection of household food waste for composting, used a backyard composting system, or knew about composting, indicating that interviewees may be more aware than the average U.S. household about food waste in general. This is potentially a result of California, Oregon, and Washington having state and local level goals and regulations to specifically reduce the quantity of food sent to landfills.

3.3. RESULTS/DISCUSSION

Five major themes or categories of benefits linked to the regular or routinized non-consumption of food in households were identified: pleasure/enjoyment, comfort, self-identity, "good" food, and convenience. Specifically, I found that some of the benefits provided by the planning, shopping, cooking, and eating of food are realized through the consumption of a food item, which directly or indirectly results in the discard of other foods (e.g. seeking pleasure from eating out with friends instead of eating food already prepared or available at home). Additionally, some of the benefits provided by interactions with food can be realized even when the food or part of a food item is not consumed. For example, expressing love and care, by providing food to loved ones, or assuming a "good provider identity," is common. The benefits are strongly linked to providing healthy food, especially to children; however, the benefits can be realized by

providing the *opportunity* for children to eat healthily rather than whether the children actually eat the vegetables or not.

Following the conceptual framework, the next section provides a broad description of the structural, economic, and policy factors influencing the households whose members were interviewed. The remaining sections provide details on the five identified benefits, explore the time-money relationship in households, and provide an example of a complex value negotiation that resulted in regularly discarded food.

3.3.1. STRUCTURAL, ECONOMIC, AND POLICY FACTORS

The transformation of food to waste is negotiated within the larger structural, economic, and policy factors influencing households, including the structure of the food supply chain and waste management (Lee, 2018; Quested et al., 2013; Soma, 2019). As the outermost ring of the conceptual framework (figure 3), these factors have broad influences across the entire food waste chain. Within the United States, there is somewhat reliable access to relatively cheap food produced through industrial agriculture methods (Institute of Medicine and National Research Council, 2015). Most households have access to the retail food sector, with supermarkets predominating as the main source of food (Cannuscio et al., 2013). All of the participating households purchased some portion of their food at a grocery store. Additionally, city governments typically provide waste and recycling services that take waste material directly from households (Sustainable Packaging Coalition, 2016). As a result of the dominant food and waste management regimes, there is sometimes a cognitive disconnect between personal choices and the impacts of food production and waste management, especially for households in urban centers. People are not always cognizant of the environmental and social impacts of their choices because they are separated in time and space from the production and consumption chain (de Coverly, McDonagh, O'Malley, & Patterson, 2008; Peterson, 1979; Pothukuchi & Kaufman, 1999).

California, Oregon, and Washington are located on the West Coast of the United States and are largely viewed as progressive with regard to issues of food and waste. In terms of waste, all three states have well-established recycling infrastructure, including access to curbside collection of food materials for compost or anaerobic digestion in multiple cities (Streeter & Platt, 2017). Each of the states also has specific legislation and goals to reduce food and other organic materials from reaching landfills (ReFED, 2016). As a result of policy and technological infrastructure around waste, many residents may be more knowledgeable about the issue of waste generally and food waste specifically. These national and regional factors provide the context within which people negotiate the priorities of everyday life and impacts how and why food is discarded.

3.3.1.1. RESPONDENTS' PROFILES

While respondents were not chosen to be representative of the larger population, they were chosen to represent a variety of household compositions, sizes, incomes, and ages as shown in **table 10**. While many of these characteristics influence the second ring of the conceptual framework, "priorities and factors of everyday life," others have broader influences. Specifically, lower income households, including those participating in the

study, are more likely to have limited access to grocery stores, spend a larger portion of their income on food-related expenses, and experience food-related health issues (Pothukuchi & Kaufman, 1999). One respondent summed up her experience living in a low-income neighborhood for most of her life. Her concerns about access to healthy, reasonably-priced food largely shaped her relationship with food.

> *"There's definitely class discrimination with food...I grew up in the projects and in my community, there was not one grocery store and I think that's very racist…it's set up for people who live in low income communities to have diet-related health problems…. We [only] had one grocery store…. it was overpriced."*

		Seattle, WA	Oakland, CA	Oregon
# of people in household				
	1	2	1	8
	2	3	4	9
	3	3	3	5
	4	1	1	6
	5 or more	0	0	4
Household composition				
	With children (under 18)	4	6	11
	Without children	5	5	21
Household income				
	Lower (<$50k)	3	5	13
	Middle ($50k-$100k)	4	4	16
	Higher (>$100k)	2	2	3
Geographic location				
	Urban	n/a	n/a	22
	Rural	n/a	n/a	10
Gender of interviewee				
	Female	5	9	26
	Male	4	2	5
	Transgender/Other	0	0	1
Race/Ethnicity of interviewee				
(multiple answers allowed)	White	6	6	28
	Latino	1	2	2
	Black	2	3	1
	Asian	0	2	3
	American Indian	0	0	2
Age of interviewee				
	Under 35	5	5	15
	Between 35 and 55	4	4	15
	Over 55	0	2	2

Table 10. Summary of Participant Characteristics. Total of 52 interviews in Seattle (n = 9), Oakland (n = 11), and Oregon (n = 32).

Other trends related to structural and economic factors based on respondent characteristics include: difficulty acquiring the desired quantity of food for single-person

households from supermarkets (Moreno et al., 2017), women being responsible for a large portion of household tasks and chores, and older household members experiencing food insecurity during wars or the Great Depression, shaping their perceptions of food access. These factors provide the context in which households relate to food and waste, which can either limit or enable specific behaviors. For example, households with limited access to grocery stores may shop less frequently than households with more access. This connects to wasted food in that more frequent shopping trips has been suggested as a way to reduce the amount of food discarded by households by curtailing over-purchasing (Holthaus, 2015; Martinko, 2015).

3.3.2. BENEFITS OF THE CONSUMPTION AND NON-CONSUMPTION OF FOOD

Discarding food is largely considered to be a costly practice, resulting in the loss of food, money, and other resources. This framing of discarding food fails to recognize that people may also realize benefits from discarding food. This does not mean that people *want* to waste food; rather, that the process of discarding food involves costs and benefits that are jointly considered. The benefits linked to the discard of food are explored below in further depth, including key sub-themes identified from interviews. A schematic diagram was created to elucidate how individual codes were merged to identify significant themes repeated across multiple interviews (see appendix 3). As noted in the methods, benefits were coded in relation to habitual or routinized discard of food, not one-time or unusual events, in line with theories of practice.

3.3.2.1. PLEASURE & ENJOYMENT

One of the oft-cited benefits of food is the pleasure and enjoyment that people derive from planning, shopping, cooking, and eating. Within this overarching type of benefit, I found that participants specifically derived pleasure from: social engagements, including dining out with friends and outings to farmers markets; tasty food, or getting pleasure from the consumption of food; creativity, including experimentation with cooking and eating; and relaxation, or enjoyment through cooking (see **table 11** for a set of representative quotes for pleasure and enjoyment).

As a benefit, social enjoyment was realized by eating out with friends or family and through outings such as visits to farmers' market. Sometimes, unplanned social engagements resulted in already-obtained food in the refrigerator or cupboards going unconsumed. It was also noted that shopping during an outing to the farmers' market sometimes resulted in unplanned purchases. Engaging in these pleasurable activities can shift the consumption away from previously planned or purchased food items, sometimes resulting in their discard. Relaxation was seen to have a similar impact to social enjoyment, shifting consumption away from already-obtained food to other food that was more pleasurable to cook. It was noted that some food types were less enjoyable to cook than others (e.g. bell peppers with their seeds were not enjoyable). One household noted that the relaxation associated with cooking was directly linked to cooking large quantities, even if all of the food was not eaten.

> *"I think if I were able to cook smaller batches of things, then I would not have to throw away so much...I think that's just my default... There is enjoyment in my cooking because I get to say I am going to [prepare] the pumpkin and it covers the whole cookie sheet."*

Ensuring that food consumed was tasty, delicious, and in line with current cravings sometimes resulted in wasted food by shifting consumption away from less tasty food options. The types of foods considered tasty varied by person, with vegetables being noted as less enjoyable by many. Leftovers were mentioned as a commonly discarded food type that resulted from a desire to eat other, tastier food. Specifically, interviewees mentioned that they didn't like the repetition of leftovers, with some preferring leftovers from restaurants over those from home.

> *"And I always make soup, even though we never eat all of it. (laughter) I get sick of soup so I end up throwing out probably a third of it every time."*

However, several respondents stated that they found leftovers to be even more delicious and enjoyable than food cooked fresh that day. This is an example of the same benefit of enjoying tasty food having variable influences on households based on different preferences and views of tasty food. For households that considered leftovers to be tastier, eating leftovers was seen as a benefit in this sense. For households that considered leftovers to be less tasty than freshly cooked food, eating leftovers did not result in realizing the benefits of eating delicious food. Notably, some households mentioned strategies of re-purposing the leftovers, sometimes without telling other household members who dislike leftovers, to overcome the idea that leftovers are repetitive or not as tasty.

Some respondents acknowledged that their food cravings rapidly change, resulting in wasted food because they sought to satisfy their cravings at that time. Some households specifically mentioned going through phases or fads where they consumed a lot of one item for a short amount of time, then suddenly did not want to consume it anymore, often leading to waste at the end of the phase. It was also noted by some that long-term meal planning was restrictive because they planned for a specific meal that sounded delicious at the time of planning, but it no longer sounded good when they planned to eat it. Realizing the benefits of tasty food for all members of the household was complicated by dietary restrictions and picky eaters, which sometimes resulted in the need for multiple meals consumed at a particular mealtime, or purchasing food items that were only eaten by a subset of the household. For example, a couple living together, one with lactose intolerance, frequently purchased dairy and non-dairy versions of items due to dietary restrictions and preferences of household members. This resulted in the regular wastage of sour cream and other items that were considered too much for one person to eat.

Creativity and experimentation through cooking and eating is the final sub-theme of the benefit of pleasure and enjoyment. Sometimes household members experimented with new techniques or food, resulting in items that did not taste good or were improperly

cooked. For some, experimentation was linked to the source of the food, whether from a grocery store or a farmers' market or garden. Specifically, one household noted that they used more parts of food items when cooking foods that were harvested from their garden compared to food they purchased at the grocery store:

> *"I cherish [food from the garden] a lot more, even though it's cheaper. We've created this zone of high expectations in the grocery store. And, at home, in the garden, I'm very appreciative and curious, so I'll go out of my way to try things and when they're not ripe, when they're overripe, and you know... I'll try the shoots and leaves and try things that maybe I hadn't tried before."*

Code Name	Description	Representative Quotes
1. Pleasure/Enjoyment *(Seeking pleasure from food through planning, shopping, preparation, cooking, and eating. Unlike "comfort," seeking pleasure or enjoyment is not a result of a stressor or insecurity.)*		
1.A. Social Enjoyment	Pleasure derived from shopping or dining with friends, family, or other people.	*"We go to the farmers market more as an experience, not necessarily a shopping experience, but we go and they have live music and food vendors....I randomly say 'oh, that looks good!' and then buy different things...If it's not necessarily part of my meal plan, then it often gets forgotten about... you buy something that looks really tasty and wonderful, and you have a recipe in mind, but you don't have the other ingredients that need to go with it, so that requires another trip to the grocery store, and then that takes another week, by then maybe your produce that looked really good at the farmers market no longer looks good."*
1.B. Tasty Food	Preferences to eat certain types of food to maximize pleasure from taste (including texture).	*"Sometimes I make too much stir fry and I just can't do it. I don't want it anymore and it will sit in a Tupperware in my fridge for a couple of days and then I throw it away."* *"I'll know that my phase is ending when I make a bunch and my husband won't eat any of it. (laughter) It'll be like 'oh you don't like risotto anymore, should i stop making that?' And all of a sudden it's rotten."* *"Whenever we do try to plan ahead. Say, next Thursday we will make this dish, but then next Thursday we won't feel like that. So, we don't end up using it."*
1.C. Creativity/ Experimentation	Planning, cooking and eating as a form of expression, creativity, or experimentation.	*"I burn stuff and ruin stuff all the time, and I'm like, "that didn't work." But that's how you learn too. I like the experimentation of cooking. There's so many different things you can come up with. I think the part is fun you never know what's going to happen when you add these two things together, until you actually do it."*
1.D. Relaxation	Planning, shopping, cooking, and eating as a form of relaxation.	*"My ideal would be [that] we don't waste any food that we get. If it's edible, we eat it and that just does not happen ...I'll get a vegetable and I'm like, "Oh, God, like cooking this would be such a b***h [slang for hassle]. Like I don't want to do it."* *"And then sometimes, I just don't eat [leftovers] because I'm usually not in the mood for like leftovers... Like I just want to have that experience cooking..."*

Table 11. Summary and representative quotes for "pleasure/enjoyment" related to food

For many of the people interviewed, seeking pleasure and enjoyment through food was a key consideration in deciding what food to consume, which resulted in the routinized non-consumption of certain food items. Key factors influencing whether these benefits resulted in wasted food include: the physical properties of food including food type and physical changes over time; sources of food; personal tastes, including tolerance for repetition; dietary restrictions; cooking skills; and desires for creativity, experimentation, relaxation, and social experiences.

3.3.2.2. COMFORT

Comfort is similar to pleasure and enjoyment; however I make the distinction that benefits related to comfort are derived in response to stressors or insecurities. I found that the benefit of comfort was specifically derived from: security, referring to feeling more stable or secure from gaining access to food, generally larger amounts than needed; and self-gifting or providing a gift to oneself due to life stresses (see **table 12** for a set of representative quotes for comfort).

Some respondents noted that they used food as a safety net or that a full refrigerator was essential to feeling the "comforts of home." Access to more food than was needed at any given time was linked to feelings of security with one respondent noting that she liked *"...having a little bit more in the kitchen than [she] needs so [she] can feel fulfilled."* For this benefit, the food is providing security or comfort even if the food is not consumed. One respondent, on a fixed income, purchased extra canned goods just in case she didn't have money to purchase food at the end of the month, resulting in many of the canned goods expiring and being thrown away. Another respondent spoke about her desire for a full refrigerator because of fears about lack of access to food as a result of her mother's experience with hunger:

> *"[My mother's] fear drives her relationship with food and I think I have taken on a little bit of that. She always has to have food around her because it's her sense of security because she never wants to be hungry again. And I have the same, not as visceral, reaction. But I hate being hungry so I get really nervous when I don't have access to food, knowing food is around me. That's just more of like, I guess an additional piece of my relationship with how I view food… it's kind of like a safety net."*

Self-gifting is another sub-theme of comfort related to the non-consumption of food. Self-gifting refers to gifting oneself in response to stresses of life. This was found to result in shifting consumption from one food item to another that is more comforting, sometimes resulting in discarded food. For example, some respondents noted that they went out to eat, with people or alone, instead of eating food at home during stressful times in life. Others preferred "comfort foods" when they were stressed which led to the discard of the often healthier and cheaper alternatives available to them.

"My roommate...we are the worst influences on each other because neither of us likes to cook unless we have time. So if I'm stressed, it's not enjoyable....So my roommate and I will be like, 'Oh, should I cook tonight... I don't know, I was thinking of going out. Let's just go out.' So it's that kind of thing, where we negatively influence each other….It's not like I'm buying more food than I can eat in the time that it goes bad. It's just that I'm ignoring the food."

Using food for security or comfort was a common theme. Many interviewees commented on the waves of stress that led to "spur of the moment" food choices used to relieve stress or "treat themselves." Others noted that stressors led to stockpiling more food than was consumed. Key components influencing whether the benefits associated with comfort resulted in wasted food include: the physical properties of food, including shelf life and whether a food is considered a "comfort food"; types of stressors and insecurities related to food including fears of hunger and financial insecurity; and desires for creativity, experimentation, relaxation, and social experiences.

Code Name	Description	Representative Quotes
2. Comfort *(Security and pleasure derived in response to stressors and insecurities.)*		
2.A. Self-Gifting	Providing a gift to oneself through seeking pleasure in response to a stressor (e.g. deserve treat due to stressful week).	*"Tonight, I got salmon, which is good. We're being good. And I was gonna make some nice vegetables and then he [partner] calls me and he's like 'hey, some of the guys and me are going out for a beer after work, you want me to pick you up?' And I said 'yes, get me out of the house!' (laughter) So I don't think I'm gonna make anything, I'm not gonna feel like cooking, after that. no way. So you know, paving the road to hell. (laughter)" [context: woman was unemployed and taking on all of the cooking responsibilities to save money. Additionally, eating healthier was a priority because her partner needed to improve his health for a new job. She acknowledged that she is stressed and frustrated with her situation. Going out to dinner despite it being worse for their budget, health and the amount of food wasted.]* *"I'll be like 'we cannot go out for dinner tonight because I planned a meal.' And he's like 'I had a rough day, I am exhausted like please I just need pizza'…"*
2.B. Security	Feeling secure with supply of food in response to fear of food insecurity, lack of access to food, or as part of maintaining a "legitimate" home.	*"A nicely stocked refrigerator is comforting to me. I have a friend who never has food in his refrigerator. It's just condiments and I just feel it's not really home. He's just kind of a vagrant living in his place. I associate food, like good food, like a lot of food with the comforts of a home. And if you don't have that, there's something missing from that equation."* *"If I'm running low at the end of the month on funds, I'll have something here to make something with because it's not always possible to have a lot of money to buy things with at the end of the month...trying to keep a little extra food in, just in case. And, I did recently come across some cans of beans and things like that [that were expired and going to be discarded]."*

Table 12. Summary and representative quotes for "comfort" related to food

3.3.2.3. SELF-IDENTITY

Many people expressed their identity, including showing love and care for their family and friends, through providing food to or feeding people. The following aspects of self-identity were found to be related to the non-consumption of food: good provider identity, or showing love and care for family and friends through provisioning food; feeling provided for, or the inverse of the good provider identity where you "receive" love and care by someone else providing food for you; and self-improvement, or bettering oneself (see **table 13** for a set of representative quotes for self-identity).

In the interviews and in other literature, good provider identity has been linked to the generation of wasted food (Barone et al., 2019; Graham-Rowe et al., 2014; Visschers, Wickli, & Siegrist, 2016). I found that the expression of love and care through food led to regularly having more food available than was eaten, often in response to unpredictable eating habits of children or planning for unexpected visitors. In some cases, good provider identity continued to influence household purchasing habits even after the children were out of the home, with empty nesters sometimes continuing to cook the same amount of food as when their children lived at home. Regardless of whether the food ended up being consumed, people were able to realize the benefit of feeling like a good provider or expressing love and care through food.

> *"There's some kind of value that I derive from being able to provide food for people whether it be at a party or a dinner. If someone came over and suddenly they are hungry, I could say 'Oh look at me. I got all these different things and I got more than we need. Let me take care of you. And, this is kind of where I throw stuff away, because they don't get eaten."*

> *"There's not a regular routine because my son, instead of coming home…I'm making dinner and then all of a sudden, he texts me that he's staying at his friend's house or, you know, the opposite. He can come home with two other boys and then they eat everything in sight. So I over shop just because it's erratic. So sometimes I get things and then it turns out, you know, none of them are coming home for dinner and it turns out the next three days, they've somehow eaten out or…so that's where the waste happens."*

Feeling provided for is the inverse of the good provider identity, or receiving love and care from family members and friends. One respondent noted that he preferred that his partner cook for him, not because he did not like to cook, but because he enjoyed being cared for. He mentioned that one of his regular issues was that his partner frequently cooked too much food and it would be discarded. For him, the benefit of being cared for came with the tradeoff of feeling guilty and frustrated with food going uneaten.

In terms of food, many people expressed changing their food choices to eat "better" food. Generally, this was related to eating healthier, specifically more vegetables, but was also linked to eating food with lesser environmental and social impacts. Aspirations of self-improvement were linked to the healthier food items regularly going uneaten. This aligns

with the findings of Trocchia et al (2002) showing that one of the major motivations for purchasing items that end up going unused was self-improvement, often related to the ideal physical self (Trocchia & Janda, 2002). In relation to providing healthier food to children, it was sometimes noted that the opportunity for children to eat healthier food was "worth" the regular wastage, thus acknowledging that the actual consumption of the healthier food may not be connected with realizing the benefits of self-improvement. One respondent noted that they were trying to force themselves to eat breakfast as a change to their regular routine to be healthier, but regularly were unable to follow-through:

> *"I don't eat everything I put in my bowl. I just can't do it. I tell myself in the morning that I need to eat a bunch of food and then I just can't do it. I don't have the stomach for breakfast."*

Many studies have shown that people express themselves through the food they prepare, feed to others, and consume (Evans, 2012; McCracken, 1986; Southerton & Yates, 2015; Tiu Wright et al., 2001). As was shown in other literature, good provider identity and eating better food were linked to instances of provisioning more food than was eaten. Additionally, aspirations to eat healthier foods were not always successfully realized, with vegetables and other food items going uneaten in favor of less healthy options. Key components influencing whether the benefits of self-identity resulted in wasted food include: the physical properties of food including vegetables as a commonly wasted food item; past and present household composition, including the presence of children; unpredictable eating habits, especially those of children; perceptions of "better food" including what is considered healthy; and relationships with nearby family members and friends.

Code Name	Description	Representative Quotes
3. Self-Identity *(Expression of identity through providing food to people, receiving "gifted" food, and improving oneself through eating healthier or consuming "better" food.)*		
3.A. Good Provider Identity	Expressing love and care for family and friends through provisioning food	*"Some of it gets thrown away because I cook for a lot more [people] than there are. I can't get out of doing that. I don't know why... I had the kids when they were growing up but then I still cook like they're here."* *"Because, you know [the kids] might want something, and if the fridge is mostly empty and I have dry stuff it's usually not nutritious, so i'll probably feel kind of guilty for their sake. If I was single, I wouldn't care too much."* *"I've never had any problems with access to food. I think it is more the opposite... that there was always food and that's kind of where my expectations are. If my son is hungry and he needs a snack, he can get whatever he wants. We don't have one jar, it's multiple containers. He doesn't even snack. One cracker and he is done. Yet. we have all of these…[referring to cabinet and table almost exclusively filled with a large selection of snacks]."*
3.B. Feeling Provided For	Feeling love and care by receiving food from someone else	*"Well, when my girlfriend is not around, I cook for myself. When she comes in, she takes over. I like it that way...she has an issue where she cooks too much because she wants me to eat. She likes me to eat a lot of food, and I can't eat that much... I always tell her to make like less…"*
3.C. Self-Improvement	Aspirational desires to consume "better" food, including healthier food.	*"When I'm shopping, I get these bright ideas. I'm going to eat healthy this week and you buy all this produce and then you realize 'I can't eat all this'"* *"The thing that consistently goes bad in my refrigerator and I continue to buy it. I am so stubborn. When I plan the meal that doesn't have as many vegetables as I like, I feel like I should throw a mixed green salad on the side. Well, I never ever make the mixed green salad. I just don't make it. So, every week, I have a half rotted bag of mixed greens in my vegetable drawer. Every week. Every week I stubbornly buy a new one."* *"I'm a household of one. I waste so much food because I'm by myself and I don't have the opportunity to buy single serve portions unless it's been pre-cooked and packaged and flash frozen for one person, but I don't wanna do that. It's just not a healthy way to eat."*

Table 13. Summary and representative quotes for "self-identity" related to food

3.3.2.4. "GOOD" FOOD

People regularly discussed negotiating whether food was "good enough to eat" or serve to other people. This benefit of food is different from healthy eating or tasty food in that food is considered "good" or "bad" based on physical characteristics or physical changes to the food. Specifically, we found that people addressed the following physical characteristics when considering "good" food: freshness, generally considered in terms of physical changes that happen to food over time including staleness; edible parts, or perceptions of what parts of food items are "edible"; and food safety, which relates to

avoiding sickness from consuming food items (see **table 14** for a set of representative quotes for "good" food).

The sub-theme of freshness is distinguished from food safety by whether the food is considered "safe to eat" or not. Food items can be considered safe to eat, but not fresh. Freshness is generally associated with physical changes to items. For example, cookies and crackers become stale, soda becomes flat, rice becomes hard, and coffee gets cold or bitter. Items that were no longer considered fresh were sometimes discarded in favor of eating fresher food. When making decisions on whether to "revive" food or discard it, for instance putting crackers in the oven to eliminate staleness, the amount of food left and the type seemed to be significant, with small amounts or certain types of food "not worth saving." Alternatively, food safety is linked to items considered risky or unsafe to eat, potentially causing sickness. People tended to be more concerned about safety in relation to certain food types including dairy, meats, and canned goods.

> *"It depends on what it is. If it's dairy, I never eat it past the expiration date because I don't trust it even if it smells ok, I don't trust it….I think it is definitely a psychological thing. Dairy, I get so weird about that."*

Concern for the safety of others, children and family, also spurred the discard of food. Parents were specifically more hesitant to take risks related to food safety with their children. Additionally, multiple people mentioned visiting the households of family members and somewhat forcibly discarding food that was considered unsafe:

> *"My grandparents grew up during the depression and they definitely live that way still... they will keep canned goods three years past the expiration date. They will keep salad dressings in the refrigerator for like a year past and so every time we go visit them, it's like a safety purge…. going through and figuring out what will actually hurt them. And what is probably okay because they are getting angry...they feel like you are throwing away perfectly good food."*

Another sub-theme of "good food" is the perception of what parts of food are considered edible, which can vary widely between people and by situation (Gillick & Quested, 2018; Nicholes et al., 2019; Papargyropoulou et al., 2014) This influences whether parts of food are considered "good" enough to eat, including food parts such as pizza crusts, bread crusts, and fats. Additionally, the source of the food can determine whether a "potentially edible" part of the food is consumed. One respondent noted that they tend to experiment with parts like carrot tops if the carrots are sourced from the garden or farmers' market but not if purchased from the grocery store.

Code Name	Description	Representative Quotes
4. "Good" Food (*Related to deciding whether food is "good to eat" in terms of material nature or physical transformations of a specific food or food part.)*		
4.A. Freshness	Refers to physical changes that happen over time where food is considered safe to eat, but not good to eat. Examples include staleness or texture changes.	*"Sometimes she makes a week's worth of soup, and I don't want to eat it if it's going to be more than two days of soup...I've tried going longer on the soups, they start to taste weird. I guess we could freeze it, but I just prefer, why not make it fresh? I don't like to eat more than two days that's been stored."*
4.B. Edibility	Perception of whether food is "edible" and thus good to eat. This can differ by food type and where the good came from.	*"When I buy [vegetables] from the grocery store, I don't tend to consume [all of the parts]. I don't know why. Occasionally I'll use [carrot tops] as a little art piece or table setting or something like that. I will throw them in if I'm pickling carrots, just put them... At home though, I use those things... I cherish them a lot more, even though they're cheaper.. "*
4.C. Food Safety	Refer to assessments made about whether food is safe to eat. May vary depending on risk aversion and food type.	*"I throw the expired foods away. Whenever I purchase any item, I check the expiration date. I have the expiration dates memorized in my head because I have a very sensitive stomach. I'm not trying to get sick and I throw it away. "* *" I get paranoia that things are gone bad and then I won't eat them because I don't want to get food poisoning"* *"Obviously, with meat and poultry, you have to be careful, you know, refreezing certain things. You just got to chalk it up it's a loss."*

Table 14. Summary and representative quotes for "good food" related to food

Freshness, edibility, and food safety come together to help people gauge whether food is "good" enough to be eaten by themselves or others based on the material characteristics and physical changes that happen to food over time. Watson and Meah (2012) discuss how conflicting issues of food safety and food waste are negotiated in households and how fears of getting sick can result in food being discarded. Key components influencing whether the benefits of "good" food resulted in wasted food include: the physical properties of food, including changes over time; household composition, including the presence of children; quantity of the food item; perceptions and assessments of freshness, edibility, and risk; relationships with nearby family members; storage locations of food items; and sources of food, including gardens and grocery stores.

3.3.2.5. CONVENIENCE

Convenience is often conceptualized as the ability to save or shift time (Jabs & Devine, 2006; Shove, 2003), such as saving time by purchasing pre-prepared food or shifting time by doing meal preparation for the whole week ahead of time. Within this overarching type of benefit, I found that participants specifically discussed convenience in terms of: household management or managing the needs of the household; and access/urgency, including meeting urgent hunger needs and negotiating the unpredictable eating habits of children (see **table 15** for a set of representative quotes for convenience).

Ensuring that the entire household has access to enough food is one major component of the benefit of convenience, especially in light of priorities and restrictions of household management, including time scarcity. An example of saving and shifting strategies that sometimes led to wasted food is going on fewer shopping trips, which was especially relevant for rural households and households that were constrained by time. Feeling constrained by time sometimes caused people to switch course from their planned meal to one that took less time, sometimes resulting in the discard of the planned meal. Additionally, foods that took more time to prepare and vegetables were regularly cited as the food types that were discarded in favor of more convenient options.

> *"My fridge is gross right now. I buy fresh vegetables and meats and stuff, but because I don't have time to cook them...it goes bad. Right now I have a lot of vegetables in [the refrigerator] that probably need to be thrown away."*

Access and urgency refers to meeting the unpredictable and urgent needs for food, especially those of children. One respondent described children as snakes, *"sometimes they won't eat for four or five days and then they'll just eat a ton."* Ensuring that enough food was available for children and negotiating how to save food when children had a small appetite were linked to routinized discard of food in households. Additionally, some adults noted that they would "forget to eat" or not get around to eating because they were busy and only realized they were hungry when they were famished and needed to eat immediately. In these moments, people opted out of cooking their planned meal or a meal from scratch for a quicker option, sometimes leading to the discard of other food.

> *"You're busy so you don't notice that you're hungry so then when you hear your stomach growling, you're like 'Oh, I need to eat something and it needs to be right then and there'... [I will not] wash this zucchini and squash, chop it up and throw it in the oven...It's a really bad habit...[but I] make a microwaved quesadilla 'cause you're just that stressed out and your body needs it."*

Access to "convenient" food and the participation in time-saving and time-shifting behaviors can lead to both the over-provisioning of food and the discard of food in favor of food options that require less time. Key components influencing whether the benefits of convenience resulted in wasted food include: the physical properties of food, including whether they are pre-prepared; access to sources of food, including distance from a grocery store; perceived and actual time scarcity, including strategies to save time; and unpredictable eating habits.

Code Name	Description	Representative Quotes
5. Convenience *(Ability to save or shift time)*		
5.A. Household Management	Managing the needs of the household in terms of time scarcity.	*"The idea of being rural and wanting to stock up, no one wants to go to the grocery store that often out here. It adds to the waste."* *"I do try to eat a lot of vegetables. I'm usually pretty good about it but if I'm really busy or stressed and I just don't have the time then that is what goes out the window first."*
5.B. Urgent Access to Food	Fulfilling needs of convenience access to food, including meeting urgent hunger needs (e.g. forgetting to eat and suddenly being famished) and negotiating the unpredictable eating habits of children.	*" I think the majority of the time I'm on the bus and I'm so hungry that I don't want to cook anything. [I] just stop by this burrito place that's right next to my house. Most of the time it's spur of the moment. If I was gonna plan it out, I wouldn't be eating out as much as I do... yes, definitely yes [it ends up in other food not being eaten]. That happens a lot. I'll say that sometimes I have this sauce that's gonna go bad but I'm not in the mood to cook the noodles. Like I'll say that outloud. Like that's literally the process that happens."*

Table 15. Summary and representative quotes for "convenience" related to food

3.3.3. VALUE NEGOTIATIONS: MAXIMIZING UTILITY FROM FOOD

When considering food that is regularly discarded in households, people noted both costs and benefits of their decisions. Considering the costs alone did not explain when food was consumed and when it was discarded. Notably, it was found that behaviors varied over time even within the same household as certain costs and benefits were prioritized in light of shifting household priorities and contextual factors, such as time availability. In line with the food choice model presented by Furst et al (1996), I argue that the choice to consume or discard a food is based on value negotiations or utility maximization, where utility is satisfaction. I consider the negotiations or tradeoffs that people make between the costs of time and money and the five major benefits identified. I contend that understanding the benefits provided by food, through both its consumption and non-consumption, and how they interact with household restrictions and priorities around time and money is necessary to design effective interventions and messaging to reduce wasted food.

3.3.3.1. WASTING FOOD DOES NOT ALWAYS EQUAL WASTING MONEY

Presenting the cost or value of wasted food to consumers is one message used to encourage changes in behavior to prevent the discard of food (Ad Council, n.d.; Horwitz, 2018). The logic behind this messaging is that food costs money and most households would like to save money, especially on items that go unused. However, how people perceived wasting food, and thus money, was often nuanced and linked to current household circumstances. For instance, multiple respondents noted that they would like to be "able" to waste food which was linked to higher income.

"I'd rather be able to afford throwing things out here or there…I should be able to afford to throw things out."

"And, interestingly the more income I have, the more food I waste….Cause I'm gonna go out tonight. (laughter) I don't wanna cook, you know?...and you know you treat yourself with something to wear, you treat yourself with something to eat."

Most people interviewed *did* associate discarding food with wasting money. However, it was not always a simple relationship of wasting food being considered equivalent to wasting money. The absolute cost of the discarded food is less relevant for some than the *relative* cost. Relative cost takes into account the cost of the alternative option. For example, a larger box of an item may be less per unit than a smaller one or the price of three may be the same as one somewhere else. In some cases, people mentioned that a portion of those purchases were regularly discarded and that discarding food was not really "wasting money" because the alternative was more expensive, thus they already saved money, offsetting the waste.

"I had to buy three zucchini when I only actually need one. The grocery stores that sells one zucchin I hate… So I will just get three zucchini [from the place I like]. Plus, they are dirt cheap. They cost as much as one anywhere else. So, that is an issue for me. Because I had to buy three and I only needed one. And, I am probably not going to use the other ones. I am gonna wait till they go flaccid. Then, I compost it. Because I can compost it, I don't feel bad about it."

3.3.3.2. TIME AND MONEY AS INTERTWINED COSTS

As found in Jabs and Devine (2006), time and money are closely linked as costs associated with shopping, planning, preparing, storing, cooking, eating, and discarding food. The intertwined nature of time and money was expressed by many households, including the shifting nature of which one was considered a bigger priority.

"Price is less of a factor than convenience is. I don't like having to pay more for something that I know is less expensive somewhere else but it is not going to stop me from buying it."

"Since I work and my husband works, time is sometimes more important than money."

Jointly considering time and money as the "currency" of the household is important to understanding how households weigh the costs and benefits associated with the consumption and non-consumption of edible food. The substitutability and rates of exchange between time and money are not necessarily constant within a household, but may shift over time based on the available time and financial resources. This can lead to shifting behaviors based on constrained resources such as saving money but using time by eating at home instead of eating out or vice versa. Understanding how time and money interact with the "benefits" of food through value negotiations is critical to understanding

whether food is consumed or discarded. The following section provides an example of a value negotiation shared during the interviews to illustrate how a person weighs the costs and benefits of behaviors that routinely result in wasted food.

3.3.3.3. *VALUE NEGOTIATIONS WITHIN HOUSEHOLDS RESULTING IN WASTED FOOD*

A young couple living together in a single-family home both work full-time for non-profits thus saving money and time are both priorities for their household. Both are trying to eat healthier, but one of them does not "naturally like vegetables" so eating more vegetables has been a struggle. As is common, they clearly expressed that they do not like to waste food and feel guilty when they do. However, they routinely waste produce they get every other week as part of their community supported agriculture (CSA) box. Below is a compilation of quotes about their experience with the CSA box that illustrates how the benefits provided by participating in this mode of provisioning food interact with the perceived costs of time and money associated with it and how this tension results in the regular wastage of edible food. While the CSA model reflects a particular way of sourcing food, value negotiations were not unique to this mode of food provisioning.

Bolded text highlights key themes within the quote and bolded text in parentheses are used to denote "costs" and "benefits" associated with each key theme.

> *"We get a bag of vegetables and fruit every two weeks. We actually **don't go through everything** in the [community supported agriculture (CSA) box]… we usually go to the grocery store every couple of weeks to supplement whatever we get from the CSA [box]…[we joined because] I just wanted to **support community gardening and make sure that my fruit and vegetables came locally (self-identity)**…and the food is really amazing. Just the fruits and vegetables that we get in the CSA are **so fresh and delicious (pleasure/enjoyment)**…and **it's easy too (convenience)**. Like that way, **I don't spend an hour in a grocery store (time) and trying to decide between what brand of corn is the best**…I was getting I think a little complacent, cooking the same things that I knew how to cook well. And so it was **kind of a challenge (pleasure/enjoyment)**. I'd be like, 'OK, I'm going to get a CSA and like whatever comes in that bag is what I'm going to have to deal with and work with for that week.' …**it's only $15.00 (money)** every time you get it…. They send like cilantro and parsley in huge quantities and **I don't like cilantro (pleasure/enjoyment)** that much…**most of that goes in the trash."***

Participating in the CSA, where a set of fruits and vegetables are regularly delivered for a household, provides many benefits to this couple, including self-improvement (self-identity) to eat healthier and choosing foods that support local farmers and have a lesser environmental impact. Additionally, the respondent notes that the produce is fresh and delicious, which is important given that one of them did not historically like vegetables (pleasure/enjoyment). It was noted that the CSA provides food that is not familiar to the couple, which is exciting and helps them experiment with their food

(pleasure/enjoyment). In terms of time and convenience, the CSA box saves them time by reducing the need to go to the grocery store and spend time choosing amongst a large variety of options. While the couple say that they regularly do not get through all of the produce provided by the CSA and throw certain items away if they are disliked, they also note that the cost is "only $15," which is cheaper than the alternative of purchasing produce from the grocery store. This illustrates that while they are "wasting money" by discarding food, they are not perceiving this as a significant waste because it was cheaper than the alternative.

For this household, I contend that using the concept of "saving money" as an intervention point to reduce wasted food is unlikely to be effective because the householders do not conceptualize their regular discard of food as a waste of money. There are many benefits associated with their current standardized setup that outweigh the alternative of buying produce as needed at the grocery store.

When considering the benefits of the CSA in terms of the food itself and the impact on money and time, we illustrate that some benefits can be realized even if some of the food is not consumed (e.g. being a "better environmental steward" through supporting local farmers and convenience) and that others are realized by not consuming food that is disliked (e.g. pleasure and enjoyment from not eating cilantro). Additionally, participation in the CSA saves time, which is valuable for their household because they both work full-time jobs. It also saves them money comparaed to the alternative. In terms of costs and benefits, their current situation is not considered problematic to them or a waste of money. In some ways, not eating all of the produce provided is simply the "cost of doing business."

3.4. CONCLUSION

This chapter identified key benefits included in value negotiations that occur within households to determine whether foods go unconsumed. I consider the tradeoffs made between the costs of time and money and the five major benefits identified. I contend that understanding the benefits provided by food, through both its consumption and non-consumption, is necessary to design effective interventions to reduce wasted food. Messaging and interventions defining economic rationality purely in terms of money do not account for the complex negotiations that happen within households to maximize the utility they get from their interactions with food. Interventions that allow households to continue to maximize their utility while wasting less may be more likely to be successful because they do not ask people to "sacrifice" the benefits they associate with food.

CONCLUSION

My love for studying waste began with my first "formal'" exploration into a trash can during a waste audit at the age of 17, the first of hundreds. Digging through trash was my entry point into this topic, and I viewed food waste as a landfill problem, a problem of how waste *management* rather than an issue of why it is being generated in the first place. After college, I started working to reduce the environmental impact of organic waste materials, and my obsession with the topic of food waste *prevention* began. I learned about the climate change implications of food waste – that discarding food was not just a landfill issue. The lifecycle impacts of producing food that was going uneaten were large, all while millions of people were food insecure and hungry. As I began graduate school, I hoped to address food waste as an issue of climate change and equity, focusing on changing individual behavior.

The interdisciplinary structure of the Energy and Resources Group allowed me to explore disciplines that I was previously unfamiliar with and further shaped my perspective on wasting food. I immediately gravitated towards sociology and the framing of wasting food as a social, not an individual, phenomenon. I began to see the topic of wasted food as a food systems issue, not just a waste issue. To understand why we discard food, we must also understand how we consume food. Sociology allowed me to adopt a "systems perspective" that included factors such as symbolism and meaning from food and the structure of the larger food system. Urban planning also influenced my understanding of wasted food by spurring me to integrate issues of justice and equity, as well as exploring how our environment influences our food choices. I also explored nutrition with the goal of improving food waste measurement and quickly realized that the connections between wasted food and nutrition were more than methodological. Practitioners focusing on improving food-related health outcomes and those focusing on decreasing food waste shared a common goal – to get people to eat more vegetables! This realization further illuminated the need for addressing this issue alongside other food-related topics.

My shift to viewing the discard of food in households as a complex social issue rooted in meeting the priorities of everyday life serves as the foundation on which this dissertation was written. The three chapters are a representation of this journey and include principles, theories, and methods from sociology, urban planning, nutrition, and environmental science.

Chapter one started by asking the question "what is food?" When researching the topic of wasted food, one must first understand what we consider food. A material is not inherently food; rather a material becomes food through its treatment by humans and its relationship with their cultural and social conditions. *Do you eat the apple core? The broccoli stalk? Chicken skin? Do you consider those to be "food"? Does it depend on the situation?* The widely varying perceptions of edibility illustrate a key theme of this dissertation, namely that the relationships we have with food are diverse and complex. This theme plays a central role in understanding behaviors relating to wasted food, and also in how researchers categorize food, and thus study food waste.

Chapter two moved beyond the question of defining wasted food to explore how participation in specific behaviors relates to how much food is discarded in households. This chapter highlighted another key theme of this dissertation – that participation in behaviors may have nuanced and variable impacts within and between households. This is especially important when considering interventions, such as increased promotion of meal and shopping planning. Our findings suggest that planning may work for some households, but for others it may cause increased levels of wasted food. Realizing that there is not a standard approach to reducing food waste in households, more research is needed to better understand the details of how these behaviors are enacted within households and how they result in wasted food. This chapter also calls for the creation of new and improved measures to capture the nuances of behaviors instead of solely focusing on frequency of participation.

Chapter three explored how the myriad of benefits that people derive from food is related to its non-consumption, or discard. This chapter highlights two final themes of this dissertation: 1) that the changing goals and priorities of everyday life are fundamental to understanding how food is discarded in households; and 2) that understanding the relationships people have with food is critical to understanding how they discard it. Issues of healthy eating, access to food provisioning options, and the larger structure of the food supply chain came up regularly during interviews with households about waste. As has been previously called for by others, this suggests that we need to better coordinate disciplines and topics related to food and waste, including nutrition, urban planning, and environmental science.

In summary, food waste is not just a waste issue. It is a food issue, an equity issue, an environmental issue, and an economic issue. Understanding the topic of wasted food as all of these is critical to developing more effective ways to address it.

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APPENDIX 1: FOR CHAPTER 1

Lists of Standardized Food Names and Food Categorizations

The following are lists of food items included in kitchen diaries:
1) List of all food items by standardized food name;
2) List of all food items of mixed or potential edibility; and
3) List with all food items categorized by food type and subtype.

List 1: List of Items by Standardized Food Names
List of all of the standardized food names including whether each was considered: always edible, always inedible, or potentially edible/inedible.

The description of discarded food from each kitchen diary entry was coded into a standardized food name for easier comparability. Items were standardized into 367 food names ranging from names of single food types (e.g. banana, burrito, or chicken wing) to names of aggregated food types (e.g. pepper or beef). The same standardized food names was used (e.g. apple), no matter what part of the food (e.g. apple core, whole apple, or apple peel) was recorded in the kitchen diary. Using the information provided by the respondent, the most detailed standardized food name was chosen (e.g. if "chicken breast" was provided as the food description, the standardized food name of chicken breast, not chicken, would be assigned). For entries where the food type could not be determined "unknown" was used. For entries where multiple food items were recorded together in spite of study instructions, "combined" was assigned.

The following symbols are used to indicate which items were considered *"always edible"* and *"always inedible."* All unmarked items are considered to have potentially inedible parts. Please note that these assumptions are made based on what is generally available to consumers at stores.

e Indicates *always edible*
i Indicates *always inedible*

- Acorn squash
- Almond (e)
- Almond butter (e)
- Almond milk (e)
- Anchovy (e)
- Anise (i)
- Apple
- Apple sauce (e)
- Artichoke
- Arugula (e)
- Asparagus
- Avocado
- Babaganoush (e)
- Baby food (e)
- Baby formula (e)
- Baby kale (e)
- Bacon
- Bagel (e)
- Baked good (e)
- Bamboo shoot
- Banana
- Basil
- Bay leaf (i)
- Bean (e)
- Beef
- Beef roast
- Beer (e)
- Beet
- Bell pepper
- Berry
- Biscuit (e)
- Bitter melon
- Black eye peas (e)
- Blackberry (e)
- Blueberry (e)
- Bok choy

- Bologna (e)
- Bone (i)
- Bone-in steak
- Bonito
- Bread (e)
- Bread pudding (e)
- Broccoli
- Broccoli rabe
- Brownie (e)
- Brussels sprouts
- Buckwheat (e)
- Burger (e)
- Burrito (e)
- Butter (e)
- Buttermilk (e)
- Butternut squash
- Cabbage
- Cake (e)
- Candy (e)
- Cantaloupe
- Caramel (e)
- Cardamom (i)
- Carrot
- Casserole (e)
- Cauliflower
- Celery
- Celery Root
- Cereal (e)
- Chard
- Cheese
- Cherry
- Cherry tomato (e)
- Chestnut
- Chicken
- Chicken Breast
- Chicken Thigh
- Chicken Wing
- Chili (e)
- Chip (e)
- Chive
- Chocolate (e)
- Cilantro
- Cinnamon (i)
- Cinnamon roll (e)
- Citrus
- Clam
- Coconut milk (e)
- Cod
- Coffee (liquid) (e)
- Coffee (grounds) (i)
- Coleslaw (e)
- Collard greens
- Condiment (e)
- Cookie (e)
- Cookie butter (e)
- Corn
- Cornmeal (e)
- Cottage cheese (e)
- Couscous (e)
- Crab
- Crab cake (e)
- Cracker (e)
- Cranberry (e)
- Cream cheese (e)
- Creamer (e)
- Crème fraiche (e)
- Crepe (e)
- Croissant (e)
- Crouton (e)
- Cucumber
- Cupcake (e)
- Currant (e)
- Curry (e)
- Curry powder (e)
- Daikon
- Date
- Dill
- Dip (e)
- Donut (e)
- Dosa (e)
- Dough (e)
- Dragon fruit
- Dried chili
- Duck
- Dumpling (e)
- Edamame
- Egg
- Egg roll (e)
- Eggnog (e)
- Eggplant
- Elk
- Empanada (e)
- Enchilada (e)
- Endive
- Falafel (e)
- Fat
- Fennel
- Fenugreek
- Fig
- Fish
- Flour (e)
- French toast (e)
- Fries (e)
- Frosting (e)
- Fruit
- Garbanzo bean (e)
- Garlic
- Goulash (e)
- Ginger
- Gingerbread (e)
- Granola (e)
- Granola bar (e)
- Grape
- Grapefruit
- Gravy (e)
- Grease
- Greens
- Grits (e)
- Guacamole (e)
- Ham
- Hamburger (e)
- Health bar (e)
- Herb
- Herring
- Honey (e)
- Honeydew
- Hot chocolate (e)
- Hot dog (e)
- Hummus (e)
- Ice cream (e)
- Ice cream cone (e)
- Jackfruit
- Jalapeno
- Jalapeno popper (e)
- Jam (e)
- Jambalaya (e)
- Jerky (e)
- Juice (e)

- Kabocha squash
- Kale
- Kiwi
- Kohlrabi
- Lamb
- Leek
- Lemon
- Lentil (e)
- Lettuce
- Licorice Root (i)
- Lime
- Lobster
- Lotus root
- Lychee
- Mandarin
- Mango
- Mayonnaise (e)
- Meat
- Meatball (e)
- Meatloaf (e)
- Melon
- Milk (e)
- Milkshake (e)
- Mint
- Mixed fruits & veg.
- Mousse (e)
- Muffin (e)
- Mushroom
- Mussels
- Nachos (e)
- Napa cabbage
- Nectarine
- Noodle (e)
- Nut
- Oatmeal (e)
- Oil
- Okra
- Olive
- Omelet (e)
- Onion
- Orange
- Other beverage (e)
- Other breakfast food (e)
- Other coffee beverage (e)
- Other combined
- Other dessert (e)
- Other entrees (e)
- Other liquid
- Other sides (e)
- Oxtail
- Oyster
- Pancake (e)
- Papaya
- Parsley
- Parsnip
- Passion fruit
- Pasta (e)
- Pastry (e)
- Pea (e)
- Peach
- Peanut
- Peanut butter (e)
- Pear
- Pepper
- Pepperoni (e)
- Persimmon
- Pesto (e)
- Pickle
- Pie (e)
- Pineapple
- Pistachio
- Pita (e)
- Pizza (e)
- Plantain
- Plum
- Poblano
- Polenta (e)
- Pomegranate
- Pop tart (e)
- Popcorn (e)
- Pork
- Pork chop
- Pork ribs
- Pork roast
- Potato
- Pretzel (e
- Prosciutto (e)
- Protein shake (e)
- Prune (e)
- Pudding (e)
- Pumpkin
- Pupusa (e)
- Quesadilla (e)
- Quiche (e)
- Quinoa (e)
- Radicchio
- Radish
- Raisin (e)
- Raspberry (e)
- Red cabbage
- Rice (e)
- Rice paper (e)
- Risotto (e)
- Romaine Lettuce
- Rosemary
- Roti (e)
- Sage
- Salad (e)
- Salami (e)
- Salmon
- Salsa (e)
- Salt (e)
- Samosa (e)
- Sandwich (e)
- Sauce (e)
- Sauerkraut (e)
- Sausage (e)
- Scallion
- Scone (e)
- Sea conch
- Seaweed (e)
- Seitan (e)
- Shallot
- Shellfish
- Shiitake
- Shishito
- Shrimp
- Shwarma (e)
- Smoothie (e)
- Soda (e)

- Soup (e)
- Sour cream (e)
- Sourdough starter (e)
- Soursop
- Soy milk (e)
- Spaghetti Squash
- Spice (e)
- Spinach (e)
- Split peas (e)
- Spring roll (e)
- Sprout (e)
- Squash
- Squid
- Starch (e)
- Steak
- Stew (e)
- Stir fry (e)
- Strawberry
- String bean
- Sugar (e)
- Summer squash
- Sunflower seed
- Sushi (e)
- Sweet pea
- Sweet potato
- Swiss chard
- Syrup (e)
- Tabouleh (e)
- Taco (e)
- Tamale
- Tamarind
- Taquitos (e)
- Taro
- Tarragon
- Tater tot (e)
- Tea (liquid) (e)
- Tea (leaves) (i)
- Thai food (e)
- Thyme
- Tofu (e)
- Tomatillos
- Tomato
- Tortilla (e)
- Trail mix (e)
- Trout
- Tuna
- Turkey
- Turkey Breast
- Turnip
- Turnover (e)
- Uncrustable (e)
- Unknown
- Vegetables
- Venison
- Vinegar (e)
- Waffle (e)
- Walnut
- Wasabi (e)
- Water (e)
- Watercress
- Watermelon
- Whitefish
- Wine (e)
- Winter squash
- Wonton (e)
- Wrap (e)
- Yam
- Yogurt (e)
- Zucchini

List 2: List of Potentially Edible Food Items and Items of Mixed Edibility Recorded in Kitchen Diary by Standardized Food Name

In order to quantify edibility for each definition, only items that were "potentially edible" (edible in one definition, but inedible in another) or of "mixed edibility" (both edible and inedible parts are included in one entry so conversion factor must be used to determine proportion that is edible) were analyzed. Items that were considered always edible or inedible were removed from the list.

Items of mixed edibility (in bold italics) were included in study measurement unless they met exclusion criteria. All kitchen diary entries were coded to indicate whether they were a mixture of edible and inedible parts under any of the definitions of edibility, called "mixed edibility." All entries of mixed edibility of the same standardized food name were summed to determine a combined mixed weight. If the combined mixed weight of a food type was less than 20 ounces, or 0.2% of all items of mixed edibility, it was excluded from measurement. Food types with a combined mixed weight of less than 20 ounces were considered to be negligible in terms of contribution to overall weight.

Some descriptions of items were not included with enough detail, so were categorized as an "aggregate" category such as "beef" or "peppers." To determine conversion factors for aggregate categories, three food items were used (and results averaged) to represent the aggregate.

Bolded and italicized items were included in the study measurement as one of the 69 most wasted items recorded in the kitchen diary (m)

An asterisk (*) Indicates that the item is an aggregate item.

- Acorn squash
- ***Apple***
- Artichoke
- Asparagus
- ***Avocado***
- Bacon
- Bamboo shoot
- ***Banana***
- Basil
- ***Beef****
- ***Beef roast***
- ***Beet***
- ***Bell pepper***
- Berry*
- ***Bitter melon***
- ***Bok choy***
- ***Bone-in steak***
- Bonito
- ***Broccoli***
- Broccoli rabe
- ***Brussels sprouts***
- ***Butternut squash***
- ***Cabbage****
- ***Cantaloupe***
- ***Carrot***
- ***Cauliflower***
- ***Celery***
- Celery Root
- Chard
- Cheese*
- Cherry
- ***Chestnut***
- ***Chicken****
- ***Chicken Breast***
- ***Chicken Thigh***
- ***Chicken Wing***
- Chive
- Cilantro
- ***Citrus****
- Clam
- ***Cod***
- Collard greens
- Corn
- Crab
- ***Cucumber***
- Daikon
- Date
- Dill
- Dragon fruit
- Dried chili
- Duck*
- Edamame
- ***Egg***
- ***Eggplant***
- Elk*
- Endive
- Fat
- Fennel
- Fenugreek
- Fig
- Fish*
- Fruit*
- Garlic
- Ginger
- ***Grape***
- ***Grapefruit***
- Grease
- Greens*
- Ham
- Herb*
- Herring
- ***Honeydew***
- Jackfruit
- ***Jalapeno***
- Kabocha squash
- ***Kale***
- Kiwi
- Kohlrabi
- Lamb*
- Leek
- ***Lemon***
- ***Lettuce****
- ***Lime***
- Lobster
- Lotus root
- Lychee
- ***Mandarin***
- Mango
- Meat*
- ***Melon****
- Mint
- Mixed fruits & veg.*
- ***Mushroom****
- Mussels
- ***Napa cabbage***
- Nectarine
- Nut*
- Oil
- Okra
- Olive
- ***Onion***
- ***Orange***
- Other combined*
- Oxtail
- Oyster
- ***Papaya***
- ***Parsley***

- Parsnip
- Passion fruit
- Peach
- Peanut
- ***Pear***
- ***Pepper****
- Persimmon
- Pickle
- ***Pineapple***
- Pistachio
- Plantain
- Plum
- ***Poblano***
- Pomegranate
- ***Pork****
- ***Pork chop***
- ***Pork ribs***
- ***Pork roast***
- ***Potato***
- ***Pumpkin***
- Radicchio
- ***Radish***
- ***Red cabbage***
- ***Romaine Lettuce***
- Rosemary
- Sage
- ***Salmon***
- ***Scallion***
- Sea conch
- Shallot
- Shellfish*
- ***Shiitake***
- Shishito
- ***Shrimp***
- Soursop
- ***Spaghetti Squash***
- Squash*
- Squid
- ***Steak* (average of boneless and bone-in steak)***
- ***Strawberry***
- ***String bean***
- Summer squash*
- Sunflower seed
- Sweet pea
- Sweet potato
- Swiss chard
- Tamale
- Tamarind
- Taro
- Tarragon
- Thyme
- Tomatillos
- ***Tomato***
- Trout
- ***Tuna***
- ***Turkey****
- ***Turkey Breast***
- ***Turnip***
- Unknown*
- Vegetables*
- Venison*
- Walnut
- Watercress
- ***Watermelon***
- Whitefish
- ***Winter squash****
- Yam
- ***Zucchini***

List 3: List of Food Types & Subtypes (with standardized food names listed and Types and Subtypes as headings/overarching groups)

- ***Baked Goods***
  - Baked good ('other' category of baked food)
    - Baked good
    - Biscuit
    - Brownie
    - Cinnamon roll
    - Crepe
    - Croissant
    - Donut
    - Dough
    - Muffin
    - Pastry
    - Pie
    - Pop tart
    - Scone
    - Turnover
    - Uncrustable

- Bread (bread and bread-like items including flatbreads)
  - Bagel
  - Bread
  - Crouton
  - Dosa
  - Pita
  - Pretzel
  - Roti
  - Tortilla
- Cake
  - Cake
  - Cupcake
- Cookie
  - Cookie
  - Gingerbread
- Crackers
  - Crackers

- ***Beverages***
  - Alcohol
    - Beer
    - Wine
  - Coffee
    - Coffee
    - Other coffee beverages (including coffee with milk)
  - Dairy milk (animal produced milks and milk-like items)
    - Buttermilk
    - Creamer
    - Milk
  - Dairy-based beverage (beverages largely made of milk-based items, excluding dairy milk)
    - Eggnog
    - Hot chocolate
    - Milkshake
  - Fruit-based beverage (beverages largely made of fruit and vegetable items)
    - Juice
    - Smoothie
  - Non-Dairy Milk (milk-like foods with non-animal origins)
    - Almond milk
    - Baby formula
    - Coconut milk
    - Soy milk
  - Other beverages
    - Other beverage
    - Protein shake
  - Soda (soda and soda-like beverages)

        - Soda
    - Tea
        - Tea
    - Water
        - Water
- ***Condiments***
    - Condiment (items generally stored for long amounts of time, unlike sauces)
        - Almond butter
        - Condiment
        - Cookie butter
        - Frosting
        - Honey
        - Jam
        - Mayonnaise
        - Peanut butter
        - Pickle
        - Sauerkraut
        - Syrup
        - Wasabi
- ***Dairy (except liquid milk)***
    - Cheese (excluding cream cheese)
        - Cheese
    - Ice cream
        - Ice cream
    - Semi-soft dairy
        - Butter
        - Cottage cheese
        - Cream cheese
        - Crème fraiche
        - Sour cream
        - Yogurt
- ***Dry Goods (including grains, snacks, & sugars)***
    - Grains
        - Buckwheat
        - Cornmeal
        - Couscous
        - Flour
        - Grains
        - Lentil
        - Quinoa
        - Rice
        - Rice paper
        - Split peas
        - Starch

    - Snacks (including candies)
        - Candy
        - Caramel
        - Chip
        - Chocolate
        - Granola
        - Granola bar
        - Health bar
        - Ice cream cone
        - Jerky
        - Trail mix
    - Sugar
        - Sugar
- ***Eggs***
    - Egg
- ***Fish (and shellfish)***
    - Fleshy Fish
        - Anchovy
        - Bonito
        - Cod
        - Fish
        - Herring
        - Salmon
        - Trout
        - Tuna
        - Whitefish
    - Seafood
        - Seafood
    - Shellfish
        - Clam
        - Crab
        - Lobster
        - Mussel
        - Oyster
        - Sea Conch
        - Shellfish
        - Shrimp
        - Squid
- ***Fruit***
    - Berry
        - Berry
        - Blackberry
        - Blueberry
        - Cranberry
        - Currant
        - Raspberry

        - Strawberry
    - Citrus
        - Citrus
        - Grapefruit
        - Lemon
        - Lime
        - Mandarin
        - Orange
    - Dried Fruit
        - Prune
        - Raisin
    - Fleshy Fruit (‘other’ category of fruit with soft fleshes and thin skins)
        - Cherry Tomato
        - Fig
        - Grape
        - Persimmon
        - Tomatillos
        - Tomato
    - Melon
        - Cantaloupe
        - Honeydew
        - Melon
        - Watermelon
    - Other Fruit
        - Fruit
    - Stone Fruit
        - Avocado
        - Cherry
        - Date
        - Lychee
        - Mango
        - Nectarine
        - Olive
        - Peach
        - Plum
    - Thick-Peeled Fruit (‘other’ category of fruit with thick peels)
        - Banana
        - Plantain
        - Pomegranate
    - Tome Fruit
        - Apple
        - Pear
    - Tropical Fruit (‘other’ category of fruit of tropical origins)
        - Dragon fruit
        - Jackfruit
        - Kiwi

        - Papaya
        - Passion fruit
        - Pineapple
        - Soursop
        - Tamarind
- ***Fungi & Other***
    - Fermentation
        - Sourdough starter
    - Mushroom
        - Mushroom
        - Shiitake
    - Seaweed
        - Seaweed
- ***Herbs***
    - Herbs (fresh)
        - Basil
        - Chive
        - Cilantro
        - Dill
        - Fenugreek
        - Herb
        - Mint
        - Parsley
        - Rosemary
        - Sage
        - Tarragon
        - Thyme
- ***Leftovers (Meals)***
    - Casserole (excluding pasta-based casseroles)
        - Casserole
    - Dessert (excluding baked goods)
        - Bread pudding
        - Other dessert
        - Mousse
        - Pudding
    - Meat Entree
        - Meatballs
        - Meatloaf
    - Noodles
        - Noodles
        - Pasta
    - Other Entrees
        - Curry
        - Falafel
        - French toast
        - Nachos

        - Omelet
        - Other breakfast foods
        - Other entrees
        - Quiche
        - Stir fry
        - Sushi
        - Tamale
        - Tofu
    - Other Sides
        - Crab cake
        - Dumpling
        - Egg roll
        - Empanada
        - Jalapeno popper
        - Other sides
        - Popcorn
        - Samosa
        - Spring roll
        - Tabouleh
        - Wonton
    - Pizza
        - Pizza
    - Salad
        - Coleslaw
        - Salad
    - Sandwich (including sandwiches and sandwich-like items)
        - Burger
        - Hamburger
        - Pupusa
        - Quesadilla
        - Sandwich
        - Taco
    - Sauces/Dips (items not generally stored for long periods of time)
        - Apple sauce
        - Babaganoush
        - Baby food
        - Dip
        - Gravy
        - Guacamole
        - Hummus
        - Pesto
        - Salsa
        - Sauce
    - Soup (including stews and chili)
        - Chili
        - Goulash

        - Jambalaya
        - Soup
        - Stew
    - Starchy Sides
        - Fries
        - Grits
        - Oatmeal
        - Pancake
        - Polenta
        - Risotto
        - Seitan
        - Tater Tot
        - Waffle
    - Wraps
        - Burrito
        - Enchilada
        - Shwarma
        - Taquitos
        - Wrap
- ***Meat***
    - Bone (entries where just bone was indicated)
        - Bone
    - Fat (entries where just fat was indicated)
        - Fat
    - Other Meat
        - Meat
    - Poultry
        - Chicken
        - Chicken breast
        - Chicken thigh
        - Chicken wing
        - Duck
        - Turkey
        - Turkey breast
    - Red Meat
        - Bacon
        - Beef
        - Beef roast
        - Bologna
        - Bone-in steak
        - Elk
        - Ham
        - Hot dog
        - Lamb
        - Oxtail
        - Pepperoni

        - Pork
        - Pork chop
        - Pork ribs
        - Pork roast
        - Prosciutto
        - Salami
        - Sausage
        - Steak
        - Venison
- ***Mixtures & Unknown***
    - Mixtures (for combined category which indicates a combination of multiple food items)
        - Other combined
    - Unknown (not enough information to determine what food type is most appropriate)
        - Unknown
- ***Nuts (including dried legumes)***
    - Nut
        - Almond
        - Chestnut
        - Nuts
        - Peanut
        - Pistachio
        - Sunflower seed
        - Walnut
- ***Oils & Other Liquids (non-beverage)***
    - Oils
        - Grease
        - Oil
    - Other liquids
        - Vinegar
        - Other liquids
- ***Spices***
    - Spice (dried)
        - Anise
        - Bay leaf
        - Cardamom
        - Cinnamon
        - Curry powder
        - Licorice root
        - Salt
        - Spice
- ***Vegetables (including tubers and fresh legumes)***
    - Allium (onion and onion-like things)
        - Garlic
        - Leek

        - Onion
        - Scallion
        - Shallot
    - Beans and Peas (fresh)
        - Black eye peas
        - Edamame
        - Garbanzo bean
        - Pea
        - String bean
        - Sweet pea
    - Cabbage (all cabbage and cabbage-like items)
        - Bok choy
        - Brussels sprout
        - Cabbage
        - Napa Cabbage
        - Radicchio
        - Red Cabbage
    - Leafy Greens (non-lettuce and non-cabbage leafy greens)
        - Arugula
        - Baby kale
        - Chard
        - Collard greens
        - Greens
        - Kale
        - Spinach
        - Swiss Chard
        - Watercress
    - Lettuce
        - Endive
        - Lettuce
        - Romaine Lettuce
    - Other Vegetables
        - Artichoke
        - Bamboo Shoot
        - Corn
        - Mixed fruits & vegetables
        - Sprouts
    - Peppers (including sweet and spicy peppers)
        - Bell pepper
        - Dried chili
        - Jalapeno
        - Pepper
        - Poblano
        - Shishito
    - Root Vegetables (excluding tubers)
        - Beet

        - Carrot
        - Celery Root
        - Daikon
        - Ginger
        - Parsnip
        - Radish
        - Turnip
    - Stalky Vegetables (items not in the other categories that have stalks and something similar to a floret)
        - Asparagus
        - Broccoli
        - Broccoli rabe
        - Cauliflower
        - Celery
        - Fennel
        - Kohlrabi
    - Summer Gourd
        - Bitter melon
        - Cucumber
        - Eggplant
        - Okra
        - Summer squash
        - Zucchini
    - Tuber
        - Lotus root
        - Potato
        - Sweet potato
        - Taro
        - Yam
    - Winter squash
        - Acorn squash
        - Butternut squash
        - Kabocha squash
        - Pumpkin
        - Spaghetti Squash
        - Squash
        - Winter squash

Table a1-1: Summary of definitions used: inclusive, restrictive, USDA, and WRAP

The following table summarizes definitions of edibility used for this chapter. The inclusive and restrictive definitions were developed as part of the research. The USDA and WRAP definitions were based largely off of the National Nutrient Database for Standard Reference and Gillick and Quested (2018), respectively. If USDA and/or WRAP did not provide definitions for a specific food item, the definition was assumed based on how they treated similar foods.

In the second column, "food parts" the following is a legend for the color:

- Red: considered inedible in all definitions
- Yellow: sometimes considered edible/sometimes inedible
- Green: considered edible in all definitions

		Definitions Created By Authors		USDA Definition	WRAP Definition
Food Item	**Food Parts**	**Inclusive Definition (x if inedible)**	**Restrictive Definition (x if inedible)**	**Definition as Determined from National Nutrient Database for Standard Reference (NNDSR) (x if inedible)**	**Definition as Determined from WRAP (x if inedible)**
Acorn Squash					
	Peel		x	x	x
	Seeds		x		x
	Insides	x	x		x
	Ends	x	x	x	x
	Flesh				
Anise					
	Whole	x	x	x	x
Apple					
	Stem	x	x	x	x
	Seeds	x	x	x	x
	Core		x	x	x
	Peel		x		
	Flesh				
Artichoke					
	Leaves	x	x	x	x
	Choke	x	x	x	x
	Peel	x	x	x	x
	Heart				
Arugula					
	Root	x	x	x	x
	Stem	x	x	x	x
	Leaves				

Asparagus					
	Stalks		x	x	
	Shoots/spear				
Avocado					
	Pit	x	x	x	x
	Skin	x	x	x	x
	Flesh				
Bacon					
	Grease		x	x	
	Meat				
Bamboo Shoot					
	Shell	x	x	x	x
	Interior part/layers				
Banana					
	Peel	x	x	x	x
	Flesh				
Basil					
	Stem		x	x	x
	Leaves				
Bay Leaf					
	Whole	x	x	x	x
Beef					
	Bones	x	x	x	x
	Gristle	x	x	x	x
	Fat		x	x	
	Meat				
Beef Roast					
	Gristle	x	x	x	x
	Fat		x	x	
	Meat				
Beet					
	Greens		x	x	x
	Stems		x	x	x
	Stem End	x	x	x	x
	Peel		x	x	x
	Rootlet		x	x	x
	Flesh				
Bell Pepper					
	Stem	x	x	x	x
	Seeds & Pith	x	x	x	x
	Skin and flesh				
Bitter Melon					
	Skin		x		

	Ends	x	x	x	x
	Seeds		x		x
	Core/Pith		x		x
	Flesh				
Bok Choy					
	Bottom	x	x	x	x
	Outer Leaves		x	x	
	Core		x		x
	Inner Leaves				
Broccoli					
	Stalk		x	x	
	Peel		x	x	
	Leaves		x	x	
	Florets				
Broccoli Rabe					
	Stem		x		
	Florets				
Brussels Sprouts					
	Outer Leaves		x	x	x
	Bottom	x	x		x
	Bud				
Butternut Squash					
	Peel		x	x	x
	Seeds		x	x	x
	Insides	x	x	x	x
	Ends	x	x	x	x
	Flesh				
Cabbage					
	Bottom	x	x	x	x
	Outer Leaves		x	x	
	Core		x	x	x
	Inner Leaves				
Cantaloupe					
	Rind	x	x	x	x
	Seeds		x	x	x
	Insides	x	x	x	x
	Flesh				
Cardamom					
	Whole	x	x	x	x
Carrot					
	Peel		x	x	
	Greens		x	x	x
	Stem End	x	x	x	x

	Flesh				
Cauliflower					
	Leaves		x	x	
	Stalk		x	x	
	Bottom		x	x	
	Florets				
Celery					
	Leaves		x		
	Top		x		x
	Bottom	x	x	x	x
	Branches				
Celery Root					
	Tops		x	x	x
	Stem Ends	x	x	x	x
	Rootlets	x	x	x	x
	Peel	x	x	x	x
	Flesh				
Chard					
	Stalk		x	x	x
	Leaves				
Cherry					
	Stem	x	x	x	x
	Pit	x	x	x	x
	Skin and flesh				
Chestnut					
	Shell	x	x	x	x
	Nut				
Chicken					
	Bones	x	x	x	x
	Gristle	x	x	x	x
	Fat		x		
	Skin		x		
	Meat				
Chicken Breast					
	Bones	x	x	x	x
	Gristle	x	x	x	x
	Fat		x		
	Skin		x		
	Meat				
Chicken Thigh					
	Bones	x	x	x	x
	Gristle	x	x	x	x
	Fat		x		

	Skin		x		
	Meat				
Chicken Wing					
	Bones	x	x	x	x
	Gristle	x	x	x	x
	Fat		x		
	Skin		x		
	Meat				
Chive					
	Ends		x		
	Top		x		
	Leaves				
Cilantro					
	Stem		x	x	x
	Leaves				
Cinnamon					
	Bark	x	x	x	x
Citrus (Orange, Grapefruit, Lemon)					
	Peel		x	x	x
	Pith		x	x	x
	Inner Membranes/Pulp		x		
	Seeds	x	x	x	x
	Ends	x	x	x	x
	Juice				
Clam					
	Shell	x	x	x	x
	Meat				
Cod					
	Skin		x		
	Bones	x	x	x	x
	Fat		x		
	Meat				
Coffee					
	Grounds	x	x	x	x
Collard Greens					
	Stems		x	x	x
	Leaves				
Corn					
	Cob	x	x	x	x

	Husk	x	x	x	x
	Silk	x	x	x	x
	Kernels				
Crab					
	Shell	x	x	x	x
	Meat				
Cucumber					
	Ends	x	x	x	x
	Peel		x	x	
	Flesh and seeds				
Daikon					
	Peel		x	x	x
	Tops		x	x	x
	Rootlets		x	x	x
	Stem End	x	x	x	x
	Flesh				
Date					
	Pit	x	x	x	x
	Skin and flesh				
Dill					
	Stem		x	x	x
	Leaves				
Dragon Fruit					
	Skin	x	x	x	x
	Seeds and Flesh				
Duck					
	Gristle	x	x	x	x
	Bones	x	x	x	x
	Skin		x		
	Fat		x		
	Meat				
Edamame					
	Pod	x	x	x	x
	Beans				
Egg					
	Shell	x	x	x	x
	Egg White				
	Egg Yolk				
Eggplant					
	Peel		x	x	
	Ends	x	x	x	x
	Flesh				

	Seeds		x		
Elk					
	Gristle	x	x	x	x
	Fat		x	x	
	Meat				
Endive					
	Core		x	x	
	End	x	x	x	x
	Outer Leaves		x	x	
	Inner leaves				
Fennel					
	Fronds		x	x	
	Bottom	x	x	x	x
	Stalks		x	x	
	Bulb				
Fenugreek					
	Stem		x	x	x
	Leaves				
Fig					
	Stem	x	x	x	x
	Peel		x		x
	Flesh				
Fish					
	Skin		x		
	Bones	x	x	x	x
	Fat		x		
	Meat				
Garlic					
	Peel	x	x	x	x
	End	x	x	x	x
	Core		x		
	Bulb				
Ginger					
	Peel	x	x	x	x
	Ends	x	x	x	x
	Flesh				
Grape					
	Stem	x	x	x	x
	Seed	x	x	x	
	Peel		x		
	Flesh				
Grapefruit/ Pomelo					
	Peel		x	x	x
	Pith		x	x	x

	Inner Membranes/Pulp		x	x	
	Seeds	x	x	x	x
	Ends	x	x	x	x
	Juice				
Green Pepper					
	Stem	x	x	x	x
	Seeds & Pith		x	x	x
	Flesh				
Ham					
	Bone	x	x	x	x
	Rind	x	x	x	
	Meat				
Honeydew					
	Rind		x	x	x
	Seeds		x	x	x
	Insides	x	x	x	x
	Flesh				
Iceberg Lettuce					
	Bottom	x	x	x	x
	Core		x	x	
	Outer Leaves		x		
	Inner Leaves				
Jalapeno					
	Stem	x	x	x	x
	Seeds & Pith		x	x	x
	Skin and Flesh				
Kabocha Squash					
	Skin		x	x	x
	Seeds		x	x	x
	Insides	x	x	x	x
	Stem	x	x	x	x
	Flesh				
Kale					
	Stems		x	x	x
	Leaves				
Kiwi					
	Skin		x	x	x
	Seeds and Flesh				
Kohlrabi					
	Peel		x	x	x
	Tops		x	x	x
	Ends	x	x	x	x
	Flesh				

Lamb					
	Fat		x	x	
	Bones	x	x	x	x
	Gristle	x	x	x	x
	Meat				
Leek					
	Root	x	x	x	x
	Top		x	x	
	Outer leaves		x	x	
	Inner Leaves				
Lemon					
	Peel		x	x	x
	Pith		x	x	x
	Inner Membranes/Pulp		x		
	Ends	x	x	x	x
	Seeds	x	x	x	x
	Juice				
Lettuce					
	Bottom	x	x	x	x
	Core		x	x	
	Outer Leaves		x	x	
	Inner Leaves				
Licorice Root					
	Bark	x	x	x	x
Lime					
	Rind		x	x	x
	Inner Membrane		x		
	Ends	x	x	x	x
	Seeds	x	x	x	x
	Juice				
Lobster					
	Shell	x	x	x	x
	Offal		x	x	x
	Meat				
Lychee					
	Pit	x	x	x	x
	Peel	x	x	x	x
	Flesh				
Mandarin					
	Rind		x	x	x
	Seeds	x	x	x	x
	Ends	x	x	x	x
	Inner Membranes/Pulp		x		

	Juice				
Mango					
	Peel	x	x	x	x
	Core	x	x	x	x
	Flesh				
Melon					
	Rind		x	x	x
	Seeds		x	x	x
	Insides	x	x	x	x
	Flesh				
Mint					
	Stems		x	x	x
	Leaves				
Mushroom					
	Stem		x		
	Cap				
	Peel		x		
	Gills		x		
	End	x	x	x	
Napa Cabbage					
	Bottom	x	x	x	x
	Outer Leaves		x	x	
	Core		x	x	x
	Inner Leaves				
Nectarine					
	Stem	x	x	x	x
	Pit	x	x	x	x
	Peel		x		
	Flesh				
Nut					
	Shell	x	x	x	x
	Nut				
Okra					
	Ends	x	x	x	x
	Peel		x		
	Insides				
Olive					
	Pit	x	x	x	x
	Skin and Flesh				
Onion					
	Skin/Peel	x	x	x	x
	Ends	x	x	x	x
	Core		x	x	
	Bulb				

Orange					
	Peel		x	x	x
	Pith		x	x	x
	Inner Membranes/Pulp		x		
	Ends	x	x	x	x
	Seeds	x	x	x	x
	Juice				
Oyster					
	Shell	x	x	x	x
	Meat				
Papaya					
	Skin	x	x	x	x
	Stem	x	x	x	x
	Seeds		x	x	
	Flesh				
Parsley					
	Stems		x	x	x
	Leaves				
Parsnip					
	Peel		x	x	x
	Greens		x	x	x
	Stem End	x	x	x	x
	Flesh				
Passion Fruit					
	Skin	x	x	x	x
	Seeds		x		
	Flesh				
Peach					
	Pit	x	x	x	x
	Stem	x	x	x	x
	Peel		x		
	Flesh				
Peanut					
	Shell	x	x	x	x
	Seed/Nut				
Pear					
	Core		x	x	x
	Seeds	x	x	x	x
	Stem	x	x	x	x
	Peel		x		
	Flesh				
Pepper					
	Stem	x	x	x	x
	Seeds & Pith		x	x	x

	Skin and Flesh				
Persimmon					
	Peel		x	x	x
	Top (aka calyx)	x	x	x	x
	Seeds	x	x	x	x
	Flesh				
Pheasant					
	Bones	x	x	x	x
	Gristle	x	x	x	x
	Fat		x		
	Skin		x		
	Meat				
Pickle					
	Juice		x		
	Ends		x		
	Skin				
	Insides				
Pineapple					
	Top	x	x	x	x
	Bottom	x	x	x	x
	Skin	x	x	x	x
	Core		x	x	
	Flesh				
Pistachio					
	Shell	x	x	x	x
	Nut				
Plantain					
	Peel	x	x	x	x
	Insides				
Poblano					
	Stem	x	x	x	x
	Seeds & Pith		x	x	x
	Skin and Flesh				
Pomegranate					
	Peel	x	x	x	x
	Pith	x	x	x	x
	Seeds		x		
	Flesh				
Pork					
	Bones	x	x	x	x
	Gristle	x	x	x	x
	Fat		x	x	
	Meat				

Pork Butt/Shoulder					
	Bones	x	x	x	x
	Gristle	x	x	x	x
	Fat		x	x	
	Meat				
Pork Chop					
	Bones	x	x	x	x
	Gristle	x	x	x	x
	Fat		x	x	
	Meat				
Pork Ribs					
	Bones	x	x	x	x
	Gristle	x	x	x	x
	Fat		x	x	
	Meat				
Portabella Mushroom					
	Stem		x		
	Cap				
	Peel		x		
	Gills		x		
	End		x	x	
Potato					
	Peel		x	x	
	Eyes		x	x	
	Flesh				
Pumpkin					
	Peel		x	x	x
	Seeds		x	x	x
	Insides	x	x	x	x
	Ends	x	x	x	x
	Flesh				
Radicchio					
	Bottom	x	x	x	x
	Core		x	x	
	Leaves				
Radish					
	Stem End	x	x	x	x
	Tops		x	x	x
	Rootlet		x	x	x
	Peel		x	x	x
	Flesh				
Red Cabbage					

	Bottom	x	x	x	x
	Outer Leaves		x	x	
	Core		x	x	x
	Inner Leaves				
Red Leaf Lettuce					
	Bottom	x	x	x	x
	Core		x	x	
	Outer Leaves		x	x	
	Inner Leaves				
Romaine Lettuce					
	Bottom	x	x	x	x
	Core		x	x	
	Outer Leaves		x		
	Inner Leaves				
Rosemary					
	Stem	x	x	x	x
	Leaves				
	Flowers		x		
Sage					
	Stem		x	x	x
	Leaves				
Salmon					
	Skin		x		
	Bones	x	x	x	x
	Fat		x		
	Meat				
Scallion					
(green onion)	Root	x	x	x	x
	Green Parts		x		
	White Parts				
Sea Conch					
	Shell	x	x	x	x
	Meat				
Shallot					
	Skin	x	x	x	x
	End	x	x	x	x
	Bulb/Leaves				
Shiitake					
	Stem		x		
	Cap				
	Peel		x		
	Gills		x		
	End		x	x	

Shrimp					
	Shell/Legs	x	x	x	x
	Head	x	x	x	x
	Tail	x	x	x	x
	Meat				
Snap Pea					
	Ends	x	x	x	x
	Shell				
	Beans				
Soursop					
	Leaves/Stem	x	x	x	x
	Seeds	x	x	x	x
	Skin	x	x	x	x
	Flesh				
Spaghetti Squash					
	Peel		x	x	x
	Seeds		x	x	x
	Insides	x	x	x	x
	Ends	x	x	x	x
	Flesh				
Squid					
	Intestine	x	x	x	x
	Hard Part	x	x	x	x
	Meat/Soft Part				
Steak (Bone-in)					
	Bone	x	x	x	x
	Gristle	x	x	x	x
	Fat		x	x	
	Meat				
Steak (Boneless)					
	Gristle	x	x	x	x
	Fat		x	x	
	Meat				
Strawberry					
	Top	x	x	x	x
	Hull		x		
	Flesh				
String Bean					
	Ends	x	x	x	x
	Middle/Flesh				
Sunflower Seed					
	Shell	x	x	x	x

	Seed				
Sweet Potato					
	Peel		x	x	x
	Ends	x	x	x	x
	Flesh				
Swiss Chard					
	Stems		x	x	x
	Leaves				
Tamale					
	Corn Husk	x	x	x	x
	Insides				
Tamarind					
	Seeds	x	x	x	x
	Pods	x	x	x	x
	Flesh				
Taro					
	Peel	x	x	x	x
	Ends	x	x	x	x
	Flesh				
Tarragon					
	Stem		x	x	x
	Leaves				
Tea					
	Leaves	x	x	x	x
Thyme					
	Stems	x	x	x	x
	Leaves				
Tomatillo					
	Husk	x	x	x	x
	Stem	x	x	x	x
	Flesh				
Tomato					
	Seeds		x		
	Peel		x		
	Core		x	x	
	Stem	x	x	x	x
	Flesh				
Tuna					
	Skin		x		
	Bones	x	x	x	x
	Fat		x		
	Meat				
Turkey					
	Bone	x	x	x	x

	Skin		x		
	Fat		x		
	Gristle	x	x	x	x
	Offal		x		
	Meat				
Turkey Breast					
	Bone	x	x	x	x
	Skin		x		
	Fat		x		
	Gristle	x	x	x	x
	Meat				
Turkey Leg					
	Bone	x	x	x	x
	Skin		x		
	Fat		x		
	Gristle	x	x	x	x
	Meat				
Turkey Wing					
	Bone	x	x	x	x
	Skin		x		
	Fat		x		
	Gristle	x	x	x	x
	Meat				
Turnip					
	Peel		x	x	x
	Rootlet		x	x	x
	Top		x	x	x
	Stem End	x	x	x	x
	Flesh				
Venison					
	Bones	x	x	x	x
	Gristle	x	x	x	x
	Fat		x		
	Meat				
Walnut					
	Shell	x	x	x	x
	Nut				
Watercress					
	Stem		x	x	x
	Leaves				
Watermelon					
	Rind		x	x	x
	Seeds		x	x	x
	Flesh				

White Button Mushroom					
	Stem		x		
	Cap				
	Peel		x		
	Gills		x		
	End		x	x	
Winter Squash					
	Peel		x	x	x
	Seeds		x	x	x
	Insides	x	x	x	x
	Ends	x	x	x	x
	Flesh				
Yam					
	Peel		x	x	x
	Ends	x	x	x	x
	Flesh				
Zucchini					
	Peel		x		
	Ends	x	x	x	x
	Flesh				

Table a1-2: Summary of inedibility percentages for 69 measured food items under each definition: inclusive, restrictive, USDA, and WRAP

The following table summarizes the results from the study measurement of 69 food items of mixed edibility. The second column provides average proportions of food items by part and the other columns are estimates of the proportion considered inedible under each definition, in addition to the estimate provided in the USDA National Nutrient Database for Standard Reference (NNDSR).

Edibility Definitions by Part & Percentage Considered Inedible by Definition
(x if part is considered inedible for that definition)
(may not add to 1 or 100% due to rounding)

		Percentage of whole food item considered inedible by definition				
	Proportions of food by part (as estimated by study measurement)	(estimated from study measurement)				(estimates from USDA NNDSR)
Food Item & Part		Inclusive	Restrictive	WRAP	USDA	USDA NNDSR
Apple		**1%**	**20%**	**9%**	**9%**	**10%**
Stem	<0.01	x	x	x	x	x
Peel	0.01		x			
Core	0.08		x	x	x	x
Seeds	0.10	x	x	x	x	x
Flesh	0.80					
Avocado		**31%**	**31%**	**31%**	**31%**	**26%**
Skin	0.15	x	x	x	x	x
Pit	0.16	x	x	x	x	x
Flesh	0.69					
Banana		**36%**	**36%**	**36%**	**36%**	**36%**
Peel	0.36	x	x	x	x	x
Flesh	0.64					
Bone-In Steak		**27%**	**46%**	**27%**	**46%**	**25-32%**
Bone	0.18	x	x	x	x	x
Gristle	0.09	x	x	x	x	x
Fat	0.19		x		x	x
Meat	0.54					
Boneless Steak		**3%**	**25%**	**3%**	**25%**	**1-17%**
Gristle	0.03	x	x	x	x	x
Fat	0.22		x		x	x
Meat	0.75					
Beef Roast		**6%**	**27%**	**6%**	**27%**	**1-32%**
Gristle	0.06	x	x	x	x	x
Fat	0.21		x		x	x
Meat	0.73					
Beet		**4%**	**33%**	**33%**	**33%**	**33%**
Greens	0.07		x	x	x	x
Stems	0.12		x	x	x	x
Stem End	0.04	x	x	x	x	x
Peel	0.08		x	x	x	x
Rootlet	0.01		x	x	x	x
Flesh	0.67					
Bell Pepper		**13%**	**13%**	**13%**	**13%**	**18%**

Stem	0.03	x	x	x	x	x
Seeds & Pith	0.10	x	x	x	x	x
Flesh	0.67					
Bitter Melon		**2%**	**29%**	**17%**	**2%**	**17%**
Ends	0.02	x	x	x	x	x
Skin	0.12		x			
Seeds	0.08		x	x		
Core/Pith	0.07		x	x		
Flesh	0.71					
Bok Choy		**10%**	**35%**	**13%**	**32%**	**12%**
Bottom	0.10	x	x	x	x	x
Core	0.03		x	x		
Outer Leaves	0.22		x		x	x
Inner Leaves	0.65					
Broccoli		**0%**	**32%**	**0%**	**32%**	**39%**
Stalk	0.28		x		x	x
Peel	0.03		x		x	x
Leaves	0.01		x		x	x
Florets	0.68					
Brussels Sprouts		**15%**	**23%**	**23%**	**8%**	**10%**
Outer Leaves	0.08		x	x	x	x
Stem End	0.15	x	x	x		
Inner Leaves	0.77					
Butternut squash		**8%**	**18%**	**18%**	**18%**	**16%**
Ends	0.04	x	x	x	x	x
Peel	0.07		x	x	x	x
Seeds	0.02		x	x	x	x
Insides	0.04	x	x	x	x	x
Flesh	0.82					
Cantaloupe		**38%**	**42%**	**42%**	**42%**	**49%**
Rind	0.36	x	x	x	x	x
Seeds	0.03		x	x	x	x
Insides	0.03	x	x	x	x	x
Flesh	0.58					
Carrot		**4%**	**26%**	**11%**	**26%**	**11%**
Greens	0.07		x	x	x	x
Stem End	0.04	x	x	x	x	x
Peel	0.15		x		x	x
Flesh	0.74					
Cauliflower		**0%**	**24%**	**0%**	**24%**	**61%**
Bottom	0.05		x		x	x
Stalk	0.09		x		x	x
Leaves	0.10		x		x	x
Florets	0.76					
Celery		**8%**	**26%**	**23%**	**8%**	**11%**
Bottom	0.08	x	x	x	x	x
Leaves	0.04		x			
Top	0.15		x	x		
Stalks	0.74					
Chestnut		**21%**	**21%**	**21%**	**21%**	**25-37%**

Shell	0.21	x	x	x	x	x
Flesh	0.79					
Chicken Breast		**12%**	**28%**	**12%**	**12%**	**19%**
Bone	0.10	x	x	x	x	x
Gristle	0.02	x	x	x	x	x
Fat	0.10		x			
Skin	0.06		x			
Meat	0.72					
Chicken Thigh		**14%**	**37%**	**14%**	**14%**	**33%**
Bone	0.11	x	x	x	x	x
Gristle	0.03	x	x	x	x	x
Fat	0.15		x			
Skin	0.08		x			
Meat	0.63					
Chicken Wing		**39%**	**54%**	**39%**	**39%**	**40%**
Bone	0.33	x	x	x	x	x
Gristle	0.06	x	x	x	x	x
Fat	0.03		x			
Skin	0.13		x			
Meat	0.46					
Cod		**0%**	**6%**	**0%**	**0%**	**53%**
Bones	<.01	x	x	x	x	x
Skin	<.01		x			
Fat	0.05		x			
Meat	0.94					
Cucumber		**2%**	**18%**	**2%**	**18%**	**27%**
Ends	0.02	x	x	x	x	x
Peel	0.15		x		x	x
Flesh	0.82					
Egg		**13%**	**13%**	**13%**	**13%**	**12%**
Shell	0.13	x	x	x	x	x
Yolk	0.58					
White	0.29					
Eggplant		**10%**	**32%**	**10%**	**21%**	**19%**
Stem End	0.10	x	x	x	x	x
Peel	0.11		x		x	x
Seeds	0.11		x			
Flesh	0.68					
Grape		**3%**	**18%**	**2%**	**3%**	**4-42%**
Stem	0.02	x	x	x	x	x
Seeds	<.01	x	x		x	x
Peel	0.15		x			
Flesh	0.82					
Grapefruit		**3%**	**68%**	**32%**	**68%**	**50%**
Ends	0.03	x	x	x	x	x
Peel	0.12		x	x	x	x
Pith	0.18		x	x	x	x
Seeds	<0.01	x	x	x	x	x
Inner Membrane/Pulp	0.36		x		x	x
Juice	0.32					
Honeydew		**2%**	**37%**	**37%**	**37%**	**54%**

Rind	0.32		x	x	x	x
Seeds	0.03		x	x	x	x
Insides	0.02	x	x	x	x	x
Flesh	0.63					
Iceberg Lettuce		**5%**	**18%**	**5%**	**7%**	**5%**
Bottom	0.05	x	x	x	x	x
Core	0.02		x		x	x
Outer Leaves	0.11		x			
Inner Leaves	0.82					
Jalapeno		**7%**	**25%**	**25%**	**25%**	**8%**
Stem	0.07	x	x	x	x	x
Seeds & Pith	0.17		x	x	x	x
Flesh	0.75					
Kale		**0%**	**36%**	**36%**	**36%**	**28%**
Stem	0.36		x	x	x	x
Leaves	0.64					
Lemon		**5%**	**70%**	**39%**	**39%**	**47%**
Ends	0.04	x	x	x	x	x
Peel	0.14		x	x	x	x
Pith	0.19		x	x	x	x
Seeds	0.01	x	x	x	x	x
Inner Membrane/Pulp	0.31		x			
Juice	0.30					
Lime		**3%**	**57%**	**17%**	**17%**	**16%**
Ends	0.03	x	x	x	x	x
Rind	0.13		x	x	x	x
Seeds	<0.01	x	x	x	x	x
Inner Membrane/Pulp	0.40		x			
Juice	0.43					
Mandarin		**5%**	**61%**	**23%**	**23%**	**26%**
Ends	0.04	x	x	x	x	x
Rind	0.18		x	x	x	x
Seeds	0.01	x	x	x	x	x
Inner Membrane/Pulp	0.38		x			
Juice	0.39					
Napa Cabbage		**8%**	**21%**	**11%**	**21%**	**20%**
Bottom	0.08	x	x	x	x	x
Core	0.02		x	x	x	x
Outer Leaves	0.10		x		x	x
Inner Leaves	0.79					
Onion		**8%**	**8%**	**8%**	**8%**	**10%**
Ends	0.06	x	x	x	x	x
Skin	0.02	x	x	x	x	x
Core	<.01		x		x	x
Flesh	0.92					
Orange		**4%**	**67%**	**28%**	**28%**	**27%**
Ends	0.04	x	x	x	x	x
Peel	0.12		x	x	x	x
Pith	0.12		x	x	x	x

Seeds	<0.01	x	x	x	x	x
Inner Membrane/Pulp	0.40		x			
Juice	0.33					
Papaya		**11%**	**21%**	**11%**	**21%**	**38%**
Stem End	0.02	x	x	x	x	x
Skin	0.09	x	x	x	x	x
Seeds	0.10		x		x	x
Flesh	0.79					
Parsley		**0%**	**38%**	**38%**	**38%**	**5%**
Stems	0.38		x	x	x	x
Leaves	0.62					
Pear		**3%**	**21%**	**10%**	**10%**	**10%**
Stem	0.02	x	x	x	x	x
Peel	0.11		x			
Core	0.07		x	x	x	x
Seeds	<0.01	x	x	x	x	x
Flesh	0.79					
Pineapple		**45%**	**52%**	**45%**	**52%**	**49%**
Top	0.19	x	x	x	x	x
Bottom	0.05	x	x	x	x	x
Skin	0.22	x	x	x	x	x
Core	0.07		x		x	x
Flesh	0.48					
Poblano		**5%**	**13%**	**13%**	**13%**	**18%**
Stem	0.05	x	x	x	x	x
Seeds & Pith	0.08		x	x	x	x
Flesh	0.87					
Pork Chop		**17%**	**29%**	**17%**	**29%**	**4-40%**
Bone	0.13	x	x	x	x	x
Gristle	0.04	x	x	x	x	x
Fat	0.12		x		x	x
Meat	0.71					
Pork Ribs		**34%**	**44%**	**34%**	**44%**	**30-32%**
Bone	0.28	x	x	x	x	x
Gristle	0.05	x	x	x	x	x
Fat	0.10		x		x	x
Meat	0.56					
Pork Roast		**4%**	**23%**	**4%**	**23%**	**6-43%**
Bone	0.02	x	x	x	x	x
Gristle	0.02	x	x	x	x	x
Fat	0.19		x		x	x
Meat	0.77					
Portabella Mushroom		**0%**	**38%**	**0%**	**2%**	**3%**
End	0.02		x		x	x
Stem	0.08		x			
Peel	0.08		x			
Gills	0.21		x			
Cap	0.62					
Potato		**0%**	**12%**	**0%**	**12%**	**25%**
Peel	0.12		x		x	x

Eyes	0.01		x		x	x
Flesh	0.88					
Pumpkin		**12%**	**26%**	**26%**	**26%**	**30%**
Ends	0.02	x	x	x	x	x
Peel	0.07		x	x	x	x
Seeds	0.07		x	x	x	x
Insides	0.10	x	x	x	x	x
Flesh	0.74					
Radish		**2%**	**38%**	**38%**	**38%**	**10%**
Top	0.21		x	x	x	x
Stem End	0.02	x	x	x	x	x
Peel	0.13		x	x	x	x
Rootlet	0.02		x	x	x	x
Flesh	0.62					
Red Cabbage		**4%**	**17%**	**10%**	**17%**	**20%**
Bottom	0.04	x	x	x	x	x
Core	0.07		x	x	x	x
Outer Leaves	0.07		x		x	x
Inner Leaves	0.83					
Red leaf Lettuce		**8%**	**28%**	**8%**	**28%**	**20%**
Bottom	0.08	x	x	x	x	x
Core	0.04		x		x	x
Outer Leaves	0.16		x		x	x
Inner Leaves	0.72					
Romaine Lettuce		**9%**	**31%**	**9%**	**14%**	**6%**
Bottom	0.09	x	x	x	x	x
Core	0.05		x		x	x
Outer Leaves	0.17		x			
Inner Leaves	0.69					
Salmon		**1%**	**14%**	**1%**	**1%**	**53%**
Bones	0.01	x	x	x	x	x
Skin	0.12		x			
Fat	0.02		x			
Meat	0.86					
Scallion		**4%**	**60%**	**4%**	**4%**	**4%**
Root	0.04	x	x	x	x	x
Green Top	0.55		x			
White Bottom	0.40					
Shiitake Mushroom		**0%**	**37%**	**0%**	**3%**	**3%**
End	0.03		x		x	x
Stem	0.14		x			
Peel	0.11		x			
Gills	0.08		x			
Cap	0.63					
Shrimp		**14%**	**14%**	**14%**	**14%**	**17%**
Head	<0.01	x	x	x	x	x
Tail	0.07	x	x	x	x	x
Shell/Legs	0.07	x	x	x	x	x
Flesh	0.86					

Spaghetti Squash		**10%**	**22%**	**22%**	**22%**	**29%**
Ends	0.04	x	x	x	x	x
Peel	0.09		x	x	x	x
Seeds	0.03		x	x	x	x
Insides	0.07	x	x	x	x	x
Flesh	0.78					
Strawberry		**12%**	**17%**	**12%**	**12%**	**6%**
Top	0.12	x	x	x	x	x
Hull	0.06		x			
Flesh	0.83					
String bean		**6%**	**6%**	**6%**	**6%**	**12%**
Ends	0.06	x	x	x	x	x
Flesh	0.94					
Sweet Potato		**4%**	**19%**	**19%**	**19%**	**28%**
Ends	0.04	x	x	x	x	x
Peel	0.16		x	x	x	x
Flesh	0.81					
Tomato		**0%**	**42%**	**0%**	**13%**	**9%**
Stem	<.01	x	x	x	x	x
Peel	0.11		x			
Core	0.13		x		x	x
Seeds	0.18		x			
Flesh	0.58		x			
Tuna		**0%**	**5%**	**0%**	**0%**	**53%**
Bone	<.01	x	x	x	x	x
Skin	0.01		x			
Fat	0.03		x			
Meat	0.95					
Turkey breast		**17%**	**37%**	**17%**	**17%**	**8-12%**
Bone	0.15	x	x	x	x	x
Gristle	0.02	x	x	x	x	x
Fat	0.13		x			
Skin	0.06		x			
Meat	0.63					
Turkey leg		**34%**	**45%**	**34%**	**34%**	**19%**
Bone	0.25	x	x	x	x	x
Gristle	0.09	x	x	x	x	x
Fat	0.05		x			
Skin	0.07		x			
Meat	0.55					
Turkey wing		**42%**	**57%**	**42%**	**42%**	**34-38%**
Bone	0.38	x	x	x	x	x
Gristle	0.04	x	x	x	x	x
Fat	0.03		x			
Skin	0.12		x			
Meat	0.43					
Turnip		**3%**	**13%**	**13%**	**13%**	**19%**
Top	<0.01		x	x	x	x
Stem End	0.03	x	x	x	x	x
Peel	0.09		x	x	x	x
Rootlet	<0.01		x	x	x	x

Flesh	0.87					
Watermelon		**0%**	**41%**	**41%**	**41%**	**48%**
Rind	0.41		x	x	x	x
Seeds	0.01		x	x	x	x
Flesh	0.59					
White Button Mushroom		**0%**	**38%**	**0%**	**3%**	**3%**
End	0.03		x		x	x
Stem	0.16		x			
Peel	0.09		x			
Gills	0.10		x			
Cap	0.62					
Zucchini		**7%**	**22%**	**7%**	**7%**	**5%**
Ends	0.07	x	x	x	x	x
Peel	0.15		x			
Flesh	0.78					

APPENDIX 2: FOR CHAPTER 2

Criteria for Edibility as Defined for Project

For Chapter Two, we used the following rules to determine whether an item was considered edible or an associated inedible part:

- The food part was considered "edible" if it fit at least one of the following:
  - Intended for human consumption and generally considered "edible" in the United States
  - Part can be safely eaten, but may be considered inedible by a portion of the population AND generally does not require special processing/cooking to make them desirable to eat (in other words, food part can be cooked alongside the generally edible components without additional effort) (e.g. potato peels, broccoli stalks).
    - Some items may need to be chopped slightly smaller to cook alongside generally edible portions, but that is not considered special processing. Special processing requires a largely different cooking or preparation technique for all major preparations.
    - Note that the stem ends or hard ends of some vegetables and fruits are considered inedible due to their "tough" nature, which makes them difficult to prepare alongside the edible parts (e.g. carrots, sweet potatoes, zucchini and cabbage).
- For any items that include both edible and inedible parts (e.g. a whole apple), a conversion factor for the percentage of the food item considered refuse was used. The conversion factors were determined through direct measurement as part of the project.

Table a2-1: Definition of edibility by food type and part for chapter two

The following table summarizes definitions of edibility used for this chapter using the criteria above.

Food Item	Food Parts	Project Edibility Definition (x if inedible)
Acorn Squash		
	Peel	x
	Seeds	x
	Insides	x
	Ends	x
	Flesh	
Apple		
	Stem	x
	Seeds	x
	Core	x
	Peel	
	Flesh	

Artichoke		
	Stem	x
	Choke	x
	Leaves	x
	Heart	
Asparagus		
	Stalks	
	Shoots/spear	
Avocado		
	Pit	x
	Skin	x
	Flesh	
Bacon		
	Grease	
	Meat	
Banana		
	Peel	x
	Flesh	
Basil		
	Stem	
	Leaves	
Beef		
	Bones	x
	Gristle	x
	Fat	
	Meat	
Beef Roast		
	Gristle	x
	Fat	
	Meat	
Beet		
	Greens	x
	Stems	x
	Stem End	x
	Peel	
	Rootlet	
	Flesh	
Bell Pepper		
	Stem	x
	Seeds & Pith	x
	Skin and flesh	

Bitter Melon		
	Skin	
	Ends	x
	Seeds	x
	Core/Pith	
	Flesh	
Bok Choy		
	Bottom	x
	Outer Leaves	
	Core	
	Inner Leaves	
Broccoli		
	Stalk	
	Peel	
	Leaves	
	Florets	
Broccoli Rabe		
	Stem	
	Floret	
Brussels Sprouts		
	Outer Leaves	
	Bottom	
	Bud	
Butternut Squash		
	Peel	x
	Seeds	x
	Insides	x
	Ends	x
	Flesh	
Cabbage		
	Bottom	x
	Outer Leaves	
	Core	
	Inner Leaves	
Cantaloupe		
	Rind	x
	Seeds	x
	Insides	x
	Flesh	
Carrot		
	Peel	

	Greens	x
	Stem End	x
	Flesh	
Cauliflower		
	Leaves	
	Stalk	
	Bottom	
	Florets	
Celery		
	Leaves	
	Top	
	Bottom	x
	Branches	
Celery Root		
	Peel	x
	Tops	x
	Rootlets	x
	Stem End	x
	Flesh	
Chard		
	Leaves	
	Stem	
Cherry		
	Stem	x
	Pit	x
	Skin and flesh	
Chestnut		
	Shell	x
	Nut	
Chicken		
	Bones	x
	Gristle	x
	Fat	
	Skin	
	Meat	
Chicken Breast		
	Bones	x
	Gristle	x
	Fat	

	Skin	
	Meat	
Chicken Thigh		
	Bones	x
	Gristle	x
	Fat	
	Skin	
	Meat	
Chicken Wing		
	Bones	x
	Gristle	x
	Fat	
	Skin	
	Meat	
Cilantro		
	Stem	
	Leaves	
Citrus		
	Peel	x
	Pith	x
	Inner Membranes/Pulp	
	Seeds	x
	Ends	x
	Juice	
Clam		
	Shell	x
	Meat	
Cod		
	Skin	
	Bones	x
	Fat	
	Meat	
Coffee		
	Grounds	**X**
Collard Green		
	Stem	x
	Leaves	
Corn		
	Husk	x
	Silk	x

	Cob	x
	Kernels	
Cucumber		
	Ends	x
	Peel	
	Flesh and seeds	
Daikon		
	Peel	
	Tops	x
	Rootlets	
	Stem End	x
	Flesh	
Date		
	Pit	x
	Skin and flesh	
Dill		
	Stem	
	Leaves	
Dried chili		
	Stem	X
	Seeds & Pith	
	Skin and flesh	
Duck		
	Gristle	x
	Bones	x
	Skin	
	Fat	
	Meat	
Edamame		
	Pod	x
	Beans	
Egg		
	Shell	x
	Egg White	
	Egg Yolk	
Eggplant		
	Peel	
	Ends	x
	Flesh	
	Seeds	
Fennel		

	Fronds	x
	Bottom	x
	Stalks	x
	Bulb	
Fish		
	Skin	
	Bones	x
	Fat	
	Meat	
Garlic		
	Peel	x
	End	x
	Core	
	Bulb	
Ginger		
	Peel	x
	Ends	x
	Flesh	
Grape		
	Stem	x
	Seed	x
	Peel	
	Flesh	
Grapefruit		
	Peel	x
	Pith	x
	Inner Membranes/Pulp	
	Seeds	x
	Ends	x
	Juice	
Ham		
	Bone	x
	Rind	x
	Meat	
Honeydew		
	Rind	x
	Seeds	x
	Insides	x
	Flesh	
Jalapeno		

	Stem	x
	Seeds & Pith	
	Skin and Flesh	
Kabocha Squash		
	Skin	x
	Seeds	x
	Insides	x
	Stem	x
	Flesh	
Kale		
	Stems	x
	Leaves	
Kiwi		
	Skin	x
	Seeds and Flesh	
Kohlrabi		
	Peel	
	Tops	x
	Ends	x
	Flesh	
Lamb		
	Fat	
	Bones	x
	Gristle	x
	Meat	
Leek		
	Root	x
	Top	
	Outer leaves	
	Inner Leaves	
Lemon		
	Peel	x
	Pith	x
	Inner Membranes/Pulp	
	Ends	x
	Seeds	x
	Juice	
Lettuce		
	Bottom	x
	Core	

	Outer Leaves	
	Inner Leaves	
Lime		
	Rind	x
	Inner Membrane	
	Ends	x
	Seeds	x
	Juice	
Lychee		
	Pit	x
	Peel	x
	Flesh	
Mandarin		
	Rind	x
	Seeds	x
	Ends	x
	Inner Membranes/Pulp	
	Juice	
Mango		
	Peel	x
	Core	x
	Flesh	
Melon		
	Rind	x
	Seeds	x
	Insides	x
	Flesh	
Mint		
	Stems	x
	Leaves	
Mushroom		
	Stem	
	Cap	
	Peel	
	Gills	
	End	
Napa Cabbage		
	Bottom	x
	Outer Leaves	
	Core	

	Inner Leaves	
Olive		
	Pit	x
	Skin and Flesh	
Onion		
	Skin/Peel	x
	Ends	x
	Core	
	Bulb	
Orange		
	Peel	x
	Pith	x
	Inner Membranes/Pulp	
	Ends	x
	Seeds	x
	Juice	
Papaya		
	Skin	x
	Stem	x
	Seeds	x
	Flesh	
Parsley		
	Stems	
	Leaves	
Parsnip		
	Peel	
	Greens	X
	Stem End	x
	Flesh	
Peach		
	Pit	x
	Stem	x
	Peel	
	Flesh	
Peanut		
	Shell	x
	Seed/Nut	
Pear		
	Core	x
	Seeds	x

	Stem	x
	Peel	
	Flesh	
Pepper		
	Stem	x
	Seeds & Pith	x
	Skin and Flesh	
Persimmon		
	Peel	
	Top (aka calyx)	x
	Seeds	x
	Flesh	
Pineapple		
	Top	x
	Bottom	x
	Skin	x
	Core	x
	Flesh	
Plantain		
	Peel	x
	Insides	
Poblano		
	Stem	x
	Seeds & Pith	x
	Skin and Flesh	
Pomegranate		
	Peel	x
	Pith	x
	Seeds	
	Flesh	
Pork		
	Bones	x
	Gristle	x
	Fat	
	Meat	
Pork Roast		
	Bones	x
	Gristle	x
	Fat	
	Meat	
Pork Chop		

	Bones	x
	Gristle	x
	Fat	
	Meat	
Pork Ribs		
	Bones	x
	Gristle	x
	Fat	
	Meat	
Potato		
	Peel	
	Eyes	
	Flesh	
Pumpkin		
	Peel	x
	Seeds	x
	Insides	x
	Ends	x
	Flesh	
Radish		
	Stem End	x
	Tops	x
	Rootlet	
	Peel	
	Flesh	
Red Cabbage		
	Bottom	x
	Outer Leaves	
	Core	
	Inner Leaves	
Red Leaf Lettuce		
	Bottom	x
	Core	
	Outer Leaves	
	Inner Leaves	
Romaine Lettuce		
	Bottom	x
	Core	
	Outer Leaves	
	Inner Leaves	
Rosemary		

	Stem	x
	Leaves	
	Flowers	
Sage		
	Stem	x
	Leaves	
Salmon		
	Skin	
	Bones	x
	Fat	
	Meat	
Scallion		
(same as green onion)	Root	x
	Green Parts	
	White Parts	
Shiitake		
	Stem	
	Cap	
	Peel	
	Gills	
	End	
Shrimp		
	Shell/Legs	x
	Head	x
	Tail	x
	Meat	
Spaghetti Squash		
	Peel	x
	Seeds	x
	Insides	x
	Ends	x
	Flesh	
Steak (Bone-in)		
	Bone	x
	Gristle	x
	Fat	
	Meat	
Steak		
	Bone	x
	Gristle	x

	Fat	
	Meat	
Strawberry		
	Top	x
	Hull	
	Flesh	
String Bean		
	Ends	x
	Middle/Flesh	
Sweet Potato		
	Peel	
	Ends	x
	Flesh	
Taro		
	Peel	x
	Ends	x
	Flesh	
Tomatillo		
	Stem	x
	Flesh	
Tomato		
	Seeds	
	Peel	
	Core	
	Stem	x
	Flesh	
Turkey		
	Bone	x
	Skin	
	Fat	
	Gristle	x
	Meat	
Turkey Breast		
	Bone	x
	Skin	
	Fat	
	Gristle	x
	Meat	
Turnip		
	Peel	
	Rootlet	

	Top	x
	Stem End	x
	Flesh	
Watercress		
	Stem	
	Leaves	
Watermelon		
	Rind	x
	Seeds	x
	Flesh	
Zucchini		
	Peel	
	Ends	x
	Flesh	
Winter Squash		
	Peel	x
	Seeds	x
	Insides	x
	Ends	x
	Flesh	
Combined		

Table a2-2: Results of polychoric factor analysis of twenty behaviors relating to food waste prevention.

The following table summarizes the results of the polychoric factor analysis for the three identified factors, including eigenvalues and loading scores by factor. The following behaviors did not load onto any factor:

- Regularly cleaning out refrigerator (at least once every two weeks)
- Putting items that need to be eaten in certain part of the refrigerator
- Making unplanned purchases because something looks good at the time
- Frequently preparing meals a day or more in advance
- Refrigerator is generally….mostly full, half full, empty
- Using date labels as main source of info when deciding whether to throw away food

Specific Behavior	Factor Score
Factor 1 (eigenvalue: 2.5): Maximizing consumption of already acquired food items	
Removing bruised/rotten parts instead of discarding whole item	0.60
Trying to use all parts of a food item	0.70
Prioritizing eating leftovers	0.63
Freezing food that might not be eaten in time	0.57
Using sight, taste, and smell to determine if items are good	0.42
Improvise meals based on what food is available	0.50
Factor 2 (eigenvalue: 2.3): Shopping and meal planning	
Making shopping list before shopping	0.60
Looking at what is in cupboards and refrigerator before shopping	0.68
Planning meals before shopping	0.74
Estimating how much you need of something before shopping	0.76
Factor 3 (eigenvalue: 2.1): Minimizing overages associated with purchasing and cooking	
NOT buying food in larger quantities than desired due to packaging	0.59
NOT buying more of a product than needed because it is on sale	0.77
NOT buying more of a product than needed because it is cheaper to buy in larger quantities	0.83
Main cook does NOT frequently cooks too much food	0.47

Table a2-2. Results of polychoric factor analysis of twenty behaviors relating to food waste prevention. Total variance explained was 91%.

Variable	Coeff (Robust Std. Err.)	95% Confidence Interval		t-value	p-value
Factor 1 (Maximizing)*	-0.75 (.27)	-1.28	-0.22	-2.8	<0.01
Factor 2 (Planning)	0.03 (0.19)	-0.40	0.35	-0.14	0.89
Factor 3 (Minimizing)	0.38 (0.21)	-0.03	0.79	1.80	0.07
Clean Out Fridge Regularly					
- Agree/Somewhat Agree	-0.91(0.44)	-1.77	-0.05	-2.08	0.04
- Disagree/Somewhat Disagree	-0.51 (0.38)	-1.26	0.25	-1.32	0.19
Use Date Labels as Main Source of Info					
- Agree/Somewhat Agree	1.08 (0.67)	-0.23	2.39	1.63	0.10
- Disagree/Somewhat Disagree	-0.10 (0.41)	-0.91	0.70	-0.25	0.80
Put Items That Need to be Eaten in Certain Part of Refrigerator					
- Agree/Somewhat Agree	-0.34 (0.50)	-1.33	0.64	-0.69	0.49
- Disagree/Somewhat Disagree	-0.34 (0.37)	-1.06	0.38	-0.92	0.36
Make Unplanned Purchases Because Something Looks Good					
- Always/Often	0.84 (0.71)	-0.56	2.23	1.18	0.24
- Rarely/Never	-0.13 (0.36)	-0.84	0.59	-0.35	0.72
Prepare Meals In Advance					
- Agree/Somewhat Agree	-0.11 (0.49)	-1.05	0.87	-0.19	0.85
- Disagree/Somewhat Disagree	-0.87 (0.48)	-1.82	0.08	-1.79	0.07
Refrigerator is generally…*					
- Mostly full*	0.88 (0.40)	0.10	1.66	2.22	0.03
- Fairly Empty	-0.69 (0.47)	-1.63	0.24	-1.46	0.15
Children Living in Household*	1.18 (0.58)	0.04	2.32	2.03	0.04
Household Size (persons)*	0.54 (0.17)	0.20	0.88	3.16	<0.01
New York City*	-1.07 (0.35)	-1.76	-0.38	-3.04	<0.01
Full-Time Employment	-0.04 (0.36)	-0.75	0.67	-0.12	0.91
Income					
- Low (less than $45k)	0.28 (0.53)	-0.77	1.33	0.52	0.60
- High (more than $95k)	0.07 (0.36)	-0.64	0.78	0.19	0.85
Intercept*	4.55 (1.60)	1.40	7.7	2.84	<0.01

*Statistically significant at the 95% confidence level
* *R-squared = .22

Table a2-3. Secondary regression model results using respondent-indicated edibility. For model run with robust standard errors. Model was run to test whether the perception of edibility by the respondent, which could differ from the definition used by the research team, was responsible for the lack of correlation between the planning factor and edible food waste generation.

Variable	Coeff (Robust Std. Err.)	95% Confidence Interval		t-value	p-value
Factor 1 (Maximizing)	-0.22 (.15)	-0.52	0.08	-1.46	0.15
Factor 2 (Planning)	-0.09 (0.11)	-0.31	0.12	-0.85	0.40
Factor 3 (Minimizing)*	0.32 (0.15)	0.03	0.61	2.18	0.03
Clean Out Fridge Regularly					
- Agree/Somewhat Agree	-0.47 (0.31)	-1.08	0.15	-1.49	0.14
- Disagree/Somewhat Disagree	-0.22 (0.26)	-0.73	0.30	-0.83	0.41
Use Date Labels as Main Source of Info					
- Agree/Somewhat Agree	0.39 (0.42)	-0.43	1.21	0.94	0.35
- Disagree/Somewhat Disagree	-0.36 (0.24)	-0.83	0.11	-1.49	0.14
Put Items That Need to be Eaten in Certain Part of Refrigerator					
- Agree/Somewhat Agree	-0.223 (0.34)	-0.90	0.43	-0.68	0.49
- Disagree/Somewhat Disagree	-0.33 (0.25)	-0.82	0.16	-1.34	0.18
Make Unplanned Purchases Because Something Looks Good					
- Always/Often	-0.06 (0.40)	-0.85	0.74	-0.14	0.89
- Rarely/Never	-0.13 (0.23)	-0.58	0.32	-0.55	0.58
Prepare Meals In Advance					
- Agree/Somewhat Agree	.023 (0.35)	-0.45	0.91	0.66	0.51
- Disagree/Somewhat Disagree*	-0.63 (0.29)	-1.20	-0.06	-2.17	0.03
Refrigerator is generally…*					
- Mostly full*	0.62 (0.23)	0.17	1.07	2.72	<0.01
- Fairly Empty	-0.20 (0.34)	-0.87	0.46	-0.60	0.55
Children Living in Household	-0.08 (0.35)	-0.76	0.60	-0.24	0.81
Household Size (persons)*	0.35 (0.13)	0.09	0.60	2.67	<0.01
New York City*	-0.68 (0.25)	-1.18	-0.17	-2.65	<0.01
Full-Time Employment	-0.10 (0.24)	-0.37	0.57	0.42	0.68
Income					
- Low (less than $45k)	0.22 (0.37)	-0.51	0.95	0.59	0.56
- High (more than $95k)	0.05 (0.23)	-0.41	0.51	0.21	0.84
Intercept	1.28 (1.00)	-0.70	3.25	1.27	0.21

*Statistically significant at the 95% confidence level
* *R-squared = .13

Table a2-4. Tertiary regression model results using respondent-indicated edibility. For model run with robust standard errors. Model was run to test whether a subset of edible food waste, items that could have been prevented from better planning, were correlated with planning behaviors.

APPENDIX 3: FOR CHAPTER 3

Figure a3-1: Overall Coding Diagram for "Benefits" Related to the Non-Consumption of Food

Split into two parts, this coding diagram summarizes the codes used to identify the five major categories of symbolic and practical benefits related to the non-consumption of food (middle tier).