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## **Moving beyond the ‘what’ and ‘how much’ to the ‘why’: Researching food waste at the consumer level**

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### **Abstract**

With an increasing focus on preventing the amount of food discarded by consumers, there is a need to understand not only *what* and *how much* food is wasted, but *why* it is wasted. Qualitative

research is critical to understanding the food waste phenomenon and makes an important contribution towards designing evidence-based interventions. This chapter provides a brief overview of research on the causes of consumer-level food waste. After a brief explanation of dominant theories on consumer behavior, theories of practice is further explored. As an alternative to traditionally individual approaches to behaviour, theories of practice provides a robust analytical framework for understanding how social, cultural, material, and other contexts influence how food becomes waste. The remainder of the chapter focuses on two methods, ethnography and diaries, which are well aligned with a practice-based approach. A detailed overview of each of these methods is given including benefits and limitations. Overall, this chapter provides an analytical toolkit for academics and practitioners to use when researching food waste at the consumer level.

### **Introduction**

Globally, it is estimated that approximately one-third of food intended for human consumption is lost or wasted. The consumer level of the food supply chain has been identified as one of the largest contributors to food waste generation, especially for more developed and affluent countries (Gustavsson et al, 2011). As a result, there is an increasing focus on wasted food at the consumer level, particularly in households (see chapter 8 in this Handbook). Previously, efforts to mitigate the impacts of food waste largely focused on diverting food materials from landfill and incinerators to compost or other diversion options (Papargyropoulou et al, 2014; Thyberg and Tonjes, 2016). However, there is an increasing acknowledgement that waste prevention or source reduction, rather than diversion, is the optimal solution to reduce the negative environmental and social

impacts of food waste (Salemdeeb et al, 2017; Papargyropoulou et al, 2014; Thyberg and Tonjes, 2016).

Beyond methane emissions from landfills, the impacts of wasted food are many. The resources and pollutants associated with food production, including energy, water, and greenhouse gas emissions, are essentially ‘wasted’ when food goes uneaten (FAO, 2013). Prevention addresses the impacts of wasted food by maximizing the amount of food eaten by people and minimizing the generation of food waste. As such, prevention interventions tend to focus on the ‘avoidable’ or ‘edible’ portions of food waste. Common suggestions for food waste prevention in households include improving storage practices, better planning, and using all parts of food items (e.g. the broccoli stalk). Other suggestions, including reformatting date labels or offering smaller portion sizes, aim to change practices in other stages of the food supply chain to influence consumer level food waste (Papargyropoulou et al, 2014; Thyberg and Tonjes, 2016).

Food waste prevention at the individual (person, household, or business) level requires changes in behaviours that contribute to wasted food, such as food provisioning, storage, and cooking (Watson and Meah, 2013; Quested et al, 2013; Papargyropoulou et al, 2014; Thyberg and Tonjes, 2016). These behaviours are often difficult to change because they are rooted in habit or engrained in a person’s culture or identity (Devaney and Davies, 2017; Stefan et al, 2013). To understand how to design policies, consumer outreach programs, or other interventions that target food waste prevention, a deeper understanding of *why* food is wasted is necessary. Despite the growing body of literature on the causes of wasted food, there is relatively limited knowledge about the underlying determinants of consumer-level food waste (Schanes et al, 2018; Graham-Rowe et al, 2014). Given the complexity and diversity of behaviours, experiences, meanings, values, and

contexts related to wasting food, a research approach that is flexible and iterative is needed. Many qualitative research methods fit these needs because they allow for behaviours to be studied within social, cultural and local contexts. It is within these contexts that values, attitudes and beliefs acquire particular cultural meaning that allow for a better understanding of how and why food is discarded.

Qualitative methods are commonly used in research eliciting information on human behaviour. In the context of food waste, qualitative methods reveal how people perceive discarding food within their homes and why they do it, beyond the often-quoted answer, “because we buy too much!” (Roodhuyzen et al, 2017; Koivupuro et al, 2012). Qualitative methods provide tools for researchers to talk to participants and observe them in a way participants do not feel pressured to change their behaviour. This is important as people may act in ways that are contrary to the attitudes and knowledge they hold towards an issue. For example, most people report that wasting food makes them feel guilty. In a national survey of U.S. consumers, 52% of respondents indicated that throwing food away “bothers them a lot” (Neff et al., 2015). However, presence of guilt has not been correlated with amount of food waste generated in a household (NRDCa, 2017). Qualitative research is suited to not only provide explanations of how people may not act in accordance with their stated beliefs, but also how someone’s perception of their behaviours (stated behaviour) compares to their actual, or revealed, behaviour (Barr, 2006).

While modeling, auditing and quantification can provide important information about the food waste problem, namely *what*, *how much*, and *where*, it does not tell us *why* food is wasted. Food waste comes about as an often overlooked result of the mundane, routinized nature of people’s lives (Evans, 2011a; Evans, 2014). Understanding why food is wasted involves exploring not just

the food material itself, but also people and the flow of actions that make up their everyday lives (Spaargaren, 2011). There are many behavioural theories in sociology, psychology, and economics that can be used to explain consumer-level food waste. However, theories of practice has proven theoretically and analytically beneficial for studying unsustainable behaviours, such as wasted food (Evans, 2014).

In this chapter, a theories of practice approach is presented as a means of framing methods to study why food is wasted. The discussion highlights the capacity of theories of practice to overcome the drawbacks of other approaches that have a narrow focus on the responsibility of individuals that subsequently preclude wider contextual aspects of society and culture (Wahlen and Dubuisson-Quellier, 2018). Critically, a ‘practice lens’ re-characterises the problem of wasted food away from one that is understood and solved via the pursuit of individual control, to one that considers the routines and habits of consumers within a larger set of social, cultural, and structural contexts. Instead of piecemeal change by individual behavior in isolation, insight derived from theories of practice can provide structure and guidance to help create transformative, socio-technical change (Shove and Walker, 2010; Spurling et al., 2013; Shove, 2014; Welch and Yates, 2018).

The following section gives a brief overview of behavioural theories used in consumer food waste research followed by a more detailed introduction to theories of practice. The remainder of the chapter outlines two sets of methodologies that can be used to explore ‘why’ food is wasted: ethnography and kitchen diaries. Broadly, ethnography is a toolkit of qualitative methods for understanding lived experiences in a ‘natural’ setting within cultural context. Diaries can be used to capture both qualitative and quantitative information about routines and habits that might otherwise be overlooked. As a whole, this chapter puts forward and discusses theoretical

underpinnings and methodologies that can be applied to research to help answer the question of why food is wasted at the consumer level.

### **Understanding the *Why*: An Introduction to Theories of Consumer behaviour**

Increasing interest in food discarded by consumers has led to an uptick in research related to behaviour, with a specific focus on how food is wasted in households (Stangherlin and de Barcellos, 2018). It is widely accepted that the single act of throwing food away is not the only behaviour of interest that allows researchers to understand why and how food is discarded in households. Rather, food-related household practices and routines within the food activity stages, including planning, shopping, storing, cooking, and eating are also studied in order to understand how these stages contribute to excess or discarded food (Setti et al., 2018; Queded et al, 2013). From the point of view of participants, the purpose of participating in these activities is to produce and consume food, not to discard it. However, food can be discarded at many points within and between these activity stages. For example, leftovers from dinner can be discarded immediately after eating or stored in the refrigerator to be either eaten or discarded at a later date. Understanding how people engage with food is critical to understanding how food is transformed into waste within households as well as allowing for intervention opportunities to be identified. Thus, to fully define the act of wasting food, behavioural models must capture factors related to both waste *and* food.

Many studies use a psychology or sociology based lens for framing how people act and why they waste food. Psychology-based approaches, such as Theory of Planned Behaviour or the Transtheoretical Model of Behaviour Change, tend to identify and measure specific factors and processes that either serve as barriers or motivators for pro-environmental behaviours (Schanes et

al., 2018). Additionally, the dominant ways of characterising behaviour places the individual/consumer/eater at the center of the analysis (Southerton and Yates 2015; Hargreaves 2011) either as a rational actor making independent choices or as a simple follower of social norms and expectations (Warde, 2005). Studies utilising these psychology-based theories tend to mainly focus on the predicting determinants, such as:

- Planning and shopping being important predictors (Stefan et al., 2013)
- Intentions being potentially linked with waste reduction (Graham-Rowe et al., 2015)
- Perceived behavioural control, or a person's perception of what they can and cannot change, being somewhat insignificant in predicting behavior (Stancu et al., 2016).

The Theory of Planned Behaviour (TPB) is one of the dominant psychological theories applied to consumer-level food waste. TPB assumes that: 1) The majority of human behaviour is goal-directed; 2) Someone's intention is the closest precursor to behaviour and can be used to determine what they do; and 3) Intention is mostly influenced by attitudes and social norms about that behaviour (Ajzen, 1985). One of the strengths of TPB is that it provides a somewhat linear model of behavior that is easily applied to quantitative modelling. However, TPB has many shortcomings that make it less than ideal for food waste research. Firstly, TPB focuses on one specific behaviour; the behaviour of wasting food is often intertwined with many food-related behaviours which are omitted from the analysis. Secondly, to effectively use TPB, the variables (e.g. social norms, attitudes) must be compatible in terms of time and context. Behaviours associated with wasting food often vary significantly both spatially and temporally, thus limiting the TPB model to very specific times and contexts (Hargreaves, 2011). Additionally, TPB does not consider the attitude-behaviour gap whereby the attitudes of individuals, such as their values and motivations (often used as measures in TPB), do not always represent their actual, performed behaviour (Boulstridge



and Carrigan, 2000; Moraes et al., 2012). With the focus on the individual as the main agent of change in TPB, there has been a tendency to categorise wasting food as a behaviour that is a result of an individual's laziness, apathy, or lack of knowledge (Evans, 2011b; Meah, 2014). Researchers have questioned the accuracy and usefulness of understandings of wasteful behaviours derived from individually-based attitudes, motivations and beliefs (Lazell, 2016). Furthermore it is questionable whether the long term behaviour changes required to significantly lower the amount of food can be achieved through relying on individual behaviour changes (Evans, 2011a).

In contrast, sociology-based approaches, such as theories of practice, look beyond the individual to include social, cultural, and contextual factors. This approach involves seeking an understanding of the underlying social norms, the materials and objects involved in behaviour, and how these are organised over the course of daily life. Here, "behaviours" are called "practices", and are considered to be representative of factors that exist and are constructed beyond the individual. Shove et al. (2012:14) states that practices are made up of 3 elements: meanings, which refers to "symbolic meanings, ideas and aspirations"; materials, which refers to the objects and the components of these objects that are involved in practices; and finally competencies, which are the skills and knowledge of knowing how to do something. In some ways, the process of behavioral influence can be considered cyclical and continuous; behaviours are situated and distributed in social norms which in turn hold influence over the conduct and behaviour of others (Evans, 2018). In other words, practices here are positioned as the vehicles through which behaviour can be understood including how they are employed in the flow of everyday life.

Theories of practice represent an increasingly used theoretical frame for both sustainable consumption and food waste research (Evans et al., 2012; Southerton and Yates, 2015). There is

no single theory of practice, rather this approach draws upon a heterogeneous group of theoretical contributions that situate practices and their dynamics at the centre in systems and structures of society. Using this as a theoretical underpinning, wasting food is not seen as an individual phenomenon, but rather a social phenomenon arising from shared meanings, things and their uses, bodily and mental activities, knowledge, and understanding (Evans, 2014; Lazell, 2016). Individuals are considered “carriers of practice” meaning that the behaviours they participate in are not qualities of the individual, but are qualities of the practice (Reckwitz, 2002; Hargreaves, 2011). A key difference between this practice approach and a psychology-based theory is that rather than characterising all individuals’ behaviours as a result of deliberation and weighing possible options, a practice approach is able to consider the automated or unconscious nature of behaviours that are difficult to explain through people’s rational accounts of their actions (Warde, 2016). While theories of practice has the advantage of capturing the complexity of behaviour, it is less easily translatable to quantitative modeling because it has no pre-established structure.

Theories of practice takes into account many of the complexities in behaviour that TPB does not effectively address. They allow for multiple practices to be linked and to incorporate the spatio-temporal component of food-related behaviours (Shove et al., 2012). To give an example, TPB can capture the pro-environmental beliefs and intentions to not waste food by a parent and their children. However, it cannot capture how the parent’s routine, such as their work schedule, may influence if meal plans were followed or how changes in that routine may subsequently effect how meals are prepared, potentially leading to waste through uneaten food. During a particularly stressful week at work, a parent may choose to order pizza instead of following through with their week’s plan of cooking a healthier meal from scratch. The fluctuating dynamics of daily life

intertwined with many other factors and contexts all influence how much food is eventually discarded in that household.

The following outlines a version of theories of practice for research on food waste, encapsulating the need to look at wider consumption behaviours within everyday life.

### **A Practice-Based Approach to Research Food Waste**

#### ***What is a practice?***

‘Practices’ are the core analytical unit for theories of practice that encompass expressions of behaviour. There are many different definitions of a practice. However, a practice is generally accepted as a set of repeated actions or activities that occur in different contexts across time and space, with specific components of what happened (‘doings’) and how it was perceived (‘sayings’) (Schatzki 1996). A practice represents the generally accepted norms of how people go about activities, such as how the practice of driving a car features a number of doings (e.g. moving the steering wheel or stopping at a red light) and sayings (e.g. feeling impatient in traffic). Reckwitz (2002) expands this definition further to explain:

*“A practice is thus a routinized way in which bodies are moved, objects are handled, subjects are treated, things are described, and the world is understood...A practice is social, as it is a ‘type’ of behaving and understanding that appears at different locales and at different points in time and is carried out by different body/minds” (Reckwitz, 2002:250)*

By de-centering the individual and making the practice the focal point, there is a broader focus on how a “combination of material objects, practical know how, and socially sanctioned objectives [are] deployed” (Southerton and Yates, 2015:138). Various authors have presented a framework of elements that constitute a practice which typically include:

- *Objects, tools and their materiality* which can include physical objects and their use (Reckwitz, 2002), including tools and technologies. For instance, in food waste research, the food item itself is a key factor in terms of its putrescibility and freshness which prompts a visceral response. Other key objects and tools include packaging, refrigerators, and grocery stores. These ‘things’ are not just important as physical objects or technologies, but also in how they create and carry social meanings and script actions
- *Competencies and practical know-how* signifies the skills and techniques, knowledge and understanding required to perform a practice (Reckwitz, 2002; Shove et al., 2012). For example, this might include cooking abilities or knowledge of how to store food
- *Socially negotiated meanings* which includes “symbolic meanings, ideas and aspirations,” mental activities, motivations and emotions (Shove et al., 2012:14). For instance, the act of showing love and care by providing food or cooking for someone (Evans, 2011a)

Theories of practice outline the workings of practices in the social world. A first wave of theoretical work by Giddens and Bourdieu, amongst other theorists, established how habits and routines are a basis for knowledge. Giddens’s (1984) and Bourdieu’s (1977,1990) works were critical in explaining how society can be interpreted as a series of recurring practices that represent

the automated, mundane, and dispositional actions in everyday life. A second wave of work by Schatzki (1996, 2001, 2010) and Reckwitz (2002) brought together, clarified and further developed a range of practice-based theories, known as a ‘practice-based approach’ (for a more comprehensive overview of theories of practice see David Nicolini’s book *Practice Theory, Work, & Organization*).

Schatzki (1996, 2010) explains that a practice can be viewed not only as a coordinated entity, as described above, but also as a performance. This gives an important clarification of how practices can be studied as the main unit of analysis in research. In simpler terms, the ‘performance’ of a practice are the actions performed by individuals. For example, observing household members interact with and eventually discard food is documenting the ‘performance’ of wasting food. These observed actions are theorised as practices by interrogating the routine habitual nature of the actions as well as their meaning, competence, and or material elements. People participate in a practice in different ways, depending on varying contexts and characteristics (for instance, household organisation or eating preferences) (Reckwitz, 2002). These differences can be explored to better understand how people engage in a practice as well as the structure of the practice (Warde, 2005). These differences exist because the individual is a skilled performer (neither autonomous nor a thoughtless conformer) who actively negotiates and enacts a wide range of practices within daily life (Hargreaves, 2011). At the same time, the performer reproduces, negotiates and shapes practices through their repeated performances (Warde, 2016).

A practice lens can help achieve societal transformation towards more sustainable forms of consumption. It offers an alternative form of environmental governance from strategies that rely on change via consumer’s moral conscious or responsibility of doing the ‘right’ thing (Spaargaren,

2011). Rather, policy interventions should seek to address sets or bundles of practices that are representative of different domains of everyday life (Shove, 2014). Food waste is inherently linked to wider food practices such as food provisioning and preparation. Instead of focusing narrowly on changing the behavior of wasting food, change should be pursued for the 'bundle' of interlinked practices, also called 'regimes'. A 'regime' describes the shared understandings or ways of living actioned through bundles of practices (Crivits and Paredis, 2013; Evans, 2014). For example, a 'bundle' of practices for wasting food may include components of planning for meals, transportation to purchase food, shopping, preparing and storing food, interactions with family or friends, and eventually discarding any leftovers. Regimes of food practices are based on socio-cultural understandings and interconnected with the practices of everyday life. Halkier et al (2011) explains that a focus on multiple intersecting practices is required, rather than single practices, in order to achieve an understanding of consumption practices. A practice approach incorporates such factors into research and therefore into designing policy interventions. Using a practice lens, interventions might include modernising a practice, modifying the materials involved through technological change, or laying out new ways of doing a practice. The next section discusses application of theories of practice in the area of sustainable consumption and food waste in more detail.

### **Application of Theories of Practice in Consumer Food Waste Research**

A small but ever-evolving field has started to emerge in the food waste literature that utilises a practice-based approach. The prominent work of David Evans has made a distinct case for moving away from blaming food wastage on the individual (Evans, 2011a) and shifting consumer-focused studies towards practice approaches. His work is an established marker for knowledge of domestic

consumption and material culture (Evans, 2014), in particular the socially and materially organised practices present in the the passage of food into waste (Evans, 2012). This knowledge is set against a backdrop of behavioural dimensions of sustainable consumption, such as the social and cultural conventions of everyday life (Evans, 2011a; Evans 2011b).

A number of authors have also utilised a similar approach. Practice based studies of domestic food and waste have examined the provision of food (Watson and Meah, 2013), eating of food (Southerton and Yates, 2014), devices such as fridges and freezers (Waite and Phillips, 2016; Hand and Shove, 2007), food preparation and cooking (Foden et al., 2017), household organisation (Evans, 2011a; Hebrok and Heidenstrøm, 2019), work and school routines (Revilla and Salet, 2018) and food waste bins (Metcalf et al., 2012) amongst other factors yet to be explored (Hebroks and Boks, 2017; Schanes et al., 2018).

### **Methodological Considerations for Practice-Based Food Waste Behaviour Research**

In the field of consumption, literature provides mixed guidance on methodological and analytical questions of practice (compare Halkier and Jensen, 2011 and Crivits and Paredis, 2013, for example), and this has yet to trickle down to sub-themes, such as food waste. Nevertheless this can be viewed as an advantage in enabling the researcher or practitioner to tailor aspects of the field of theories of practice to suit their study or program, with this chapter illustrating the ways in which theories of practice can be employed to study why food goes to waste at consumer or household level.

The choice of methods and their implementation must “get at the heart” of practices. Observational methods to understand both the doings and sayings of a practice are ideal as they overcome limitations of methods that rely on stated behaviors, which can be different than actual lived behaviours (Vermier and Verbeke, 2006). Studies of food waste using a practice-based lens have utilised ethnographic and mixed method approaches, including interviews, material collation (e.g. collecting receipts and recipes), participant observation (e.g. shop-alongs), and participant generated resources, like kitchen diaries. These methods allow researchers to better understand wasting food within the lived, mundane, everyday experience by triangulating the participants reflections on their practices with both researcher and participant generated accounts of actions (Pink, 2012). Researchers are seeking data on what people consider normal day-to-day habits; the “shared understandings of normality” as represented in the practices participants both engage in and coordinate (Evans et al. 2012:116).

Studies of practices should also take into account the aspects that order, shape, condition and contextualise these practices. These may extend across practices of acquisition, appropriation, appreciation, disposal, divestment and devaluation in the case of consumption (Evans, 2018). For example, understanding the practice of wasting food requires researchers and practitioners to also explore aspects such as how food is purchased, how people communicate or express love by cooking and eating food, if people are concerned about health, and daily routines. Questions can be raised over where the study of practice begins and ends. Which adjacent practices are relevant and which are not is not always clear, including which details of which elements should be considered (Warde 2005; Southerton and Yates, 2015). Nicolini’s (2012) ‘Bringing it All Together: A Toolkit to Study and Represent Practice at Work’ chapter is an excellent account of approaching this problem. Nicolini explains a process of “zooming in” to look at the performative



intricacies and outcomes of a practice then “zooming out” to explore how practices relate to each other in space and time. Understanding of the practice is accomplished by translating the doings and sayings of participants using descriptive and contextualised accounts of their performances (Nicolini, 2012).

When studying food waste behaviours and related practices, there are three key things to consider in order to ensure practices are placed centrally in the data collection and analysis procedure. Firstly, methods should be able to record performances and their embodied nature (such as the visceral nature of interactions with food and waste). Secondly, participants are not always able to explain their actions, particularly in the case of habits and routines. For some participants, practice relevant details may seem obvious and overlooked, such as the banalities of preparing food or organising food in the home. Thirdly, there are potential challenges in the invasiveness of methods, especially since many of the performances of interest happen behind closed doors, in a household. Ideally a practice based account is produced from a fully immersive position, being present during participant’s performances of practices to break down boundaries between the participant’s account of the practices they engage in and their actual lived behaviour. However, a fully immersive experience in a household can be difficult to achieve. Options such as material collation and voluntarily recorded photography/video with a follow up interview can mitigate such concerns.

In the following two sections, ethnography and diaries are explored as two common methodologies to explore consumer-level food waste using a practice-based lens. Each section will briefly describe the methodology, including how it can be specifically tailored to a study food waste.

## **Ethnography: A Toolkit of Observation Methodologies**

### ***What is Ethnography?***

Ethnography, from the Greek words *ethnos* meaning folk or people and *grapho* meaning to write, is the systematic study of people and cultures. It can help us understand human behaviour by discovering its meanings in a socio-cultural context (Hammersley and Atkinson, 2007). Ethnography is a set of qualitative methods used in social sciences that focuses on the observation of social practices and interactions. The goal is to observe without imposing any structure or framework upon the situation, or as Spradley (1979) states, the researcher must “get inside their heads.” This reference is made with regards to the researcher understanding the culture and values of the participants, or in this case, of how they construct their world and what they are saying and doing about food waste. Several different types of ethnography exist based on different approaches and contexts (see Hammersley and Atkinson, 2007 in further reading for an extensive account of ethnography approaches).

Studies of food waste using ethnography allow researchers to provide a socially and culturally contextualised account of the passage of food into waste as part of the lived experience of the individual. Ethnography allows for thick descriptions of behaviour and its framing in naturally occurring settings (Elliott and Jankel-Elliott, 2003; Brewer, 2000). How and why food becomes wasted by consumers is wrapped up in a myriad of practices, objects, tools and meanings related to consumption (Schanes et al., 2018). An ethnographic approach allows researchers to capture such aspects of the food waste phenomenon to more fully understand it.

Evans' (2014) ethnographic work exploring food consumption and waste in the home featured methods such as shop-alongs and observing meal preparation. His research outlined the benefits of "hanging out" with participants to understand their consumption habits. Another example is Cappelini and Parsons' (2013) work on interpersonal family relationships and food waste showing how food can be a point of contention between family members. Farr-Wharton et al. (2014) used ethnography to understand the reasons leading to food being wasted due to not being eaten before its expiry. Ganglbauer et al. (2013) showed how food waste arose from multiple moments and how those moments were integrated with other practices by using interviews and in-home tours alongside a fridge camera. Work exploring kitchen practices also utilised visual ethnographies to enable participants to present stories of their use of kitchens through tours, photography, diaries, scrapbooks, interviews, and video footage (Wills et al., 2015).

### ***Methodological Considerations for Ethnography***

Ethnographic methods are field-based, personalised, use more than one data collection technique, require a long-term commitment (from several weeks to a year or more), and are inductive. In other words, research is performed without prior assumptions or hypotheses. Instead, it is more exploratory in nature, accumulating descriptive detail to build towards general patterns or explanatory theories. Ethnography relies heavily on storytelling and presenting the critical incidents being studied (selectively), which is viewed as a weakness by those using quantitative methods. However, ethnography can uncover experiences and knowledge that other research methods do not and it can highlight those things that are taken for granted.

Employing ethnography with a practice lens must place performances at the centre of its data collection procedure. This means seeking to collate accounts of performances through different

means, for example through observation, interviewing, visually through photography or video, through participant generated materials such as diaries and images, and also drawing upon researcher reflections of the research progress. Each of these have their merits as methods. Hitchings (2012) and Martens (2012) discuss the extent to which aspects of practice can be uncovered through ‘talk’ highlighting some limitations of how actions are translated into words. Martens and Scott (2017) explain a three spurred ethnographic practice based strategy of looking ‘at’ and ‘into’ performances to supplement understanding of everyday kitchen practices. Kendall et al. (2016) presents a similar multifaceted approach as a ‘tool kit’ that aligns well with a practice theoretical lens. These methods are able to move the research premise along from individualistic accounts that solely consider attitudes and motivations to properly account for how food comes to be wasted. Depending upon the nature and context of study, certain tools will be more applicable than others in unearthing participant’s actions.

Three methodological considerations are now outlined in the context of studying why food is wasted through ethnographic means. Firstly, ethnography seeks an insiders’ view of a study group and the dynamics of their activities. Naturally, the researcher is an integral part of the research, often bringing their own views and subjectivities. It is therefore important to take into consideration the researcher’s background in order to properly account for any subjectivities (Creswell, 2017; Eberle & Maeder, 2011). Max Weber stated that all research is influenced to some extent by the values of the researcher and through those values certain problems are identified and studied in particular ways (Weber, 1946). The conclusions and implications drawn from a study are largely grounded in the moral and political beliefs of the researcher. As a way of acknowledging this potential limitation, Layder (2006) explains that stating the researcher’s own

assumptions at the start facilitates the production of more powerful and adequate interpretations of data.

Secondly, it is critical to define the field of study and social environment within which behaviours are being observed and researched. When making observations, the actual event of interest, in this case discarding food, should not be the only information recorded. Contextual information about the physical and social environment as well as other relevant practices should also be recorded. Given there are several different methods that represent an ethnographic approach, important information to adequately record might include: the location, time, or other other relevant information about where the observation is taking place, including spatial and material characteristics (e.g. size of kitchen or type of supermarket); usage of objects and typical behaviours that represent the place or event (e.g. size of refrigerator and how full it is) (Pink, 2012); level of participation and involvement of study subjects; the level of formality of the interview; whether the discussion took place as a separate action or whilst the participant was engaged in activities; and a description of other relevant practices and activities that were observed (e.g. cooking).

Thirdly, ethnographic research is time consuming, as it is carried out over significant periods of time in order to accumulate in-depth knowledge of the group or culture being observed. In order to obtain rich data, the ethnographer must build up trust with participants and as an outsider, must be able to exercise discretion to avoid offending, alienating or harming those being observed. It can also be costly to have a researcher in situ for extended periods of time. Factors such as the combination of the methods to be used and the length of deployment in the study site should be jointly considered in context with the study goals, resources, and intended location of observation.

## **Diaries as a Research Method**

Diaries are a commonly used research method to gather information about behaviours and experiences, especially for situations that are difficult to observe or routine events, such eating or discarding food (Shelbe et al, 2017). Generally, participants are asked to record specific information in a “diary” based on the specific goals of the research. Used in many disciplines including public health, urban planning, and sociology, diaries can be designed to capture both quantitative and qualitative information. The information collected can range from counts or weights of objects to feelings about events or happenings. Diaries can be considered a part of an ethnographic study or a substitute for ethnography or other more detailed observations (Reid et al, 2011).

Diaries allow researchers and practitioners to look at the set of behaviors related to wasting food, including what, how, and why food is wasted. Diaries can capture performances of other practices related to wasting food that are important to understanding the practice of disposal, including shopping, storage, preparation of food, and eating. They can also take spatiality and temporality into account. By studying and comparing performances by different people or households, diaries allow for the individualized differentiation of performances.

There are four main types of diaries that can be used individually or together to study wasted food:

- 1) *Kitchen Diaries* - Kitchen diaries are a quantitative or quasi-quantitative self-reporting tool involving individuals or a group of individuals (e.g. all members of a household) recording a daily log of food waste and other information (Hanson et al, n.d-a.). The objective of using kitchen diaries as a data collection tool is to record both the quantity (or estimate of

the quantity) of food waste and the associated behaviour that led to each occurrence. While kitchen diaries are used to estimate the amount of food discarded, they are also used to capture information on the larger performance of wasting food. They can be used to record more detailed information about the performance such as the reason that food was discarded, the meal the food was associated with, or the discard destination. This tool is primarily used to gather data on household food waste, although similar methods are used in commercial settings.

- 2) Purchasing/Storage Diaries - Similar to kitchen diaries, purchasing/storage diaries seek to quantitatively or quasi-quantitatively capture food purchasing and storage behaviours. Storage diaries require respondents to catalogue the food in their refrigerators, cupboards, and other storage locations and sometimes indicate when and why food is used or discarded from the storage locations. In purchasing diaries, respondents quantify and describe their purchasing decisions, often including reasons for purchasing an item. These two types of diaries can also be used in conjunction with a food intake and kitchen diary to capture the flow of food in and out of a household. Richter and Bokelmann (2017) tested a multi-diary method with 25 households in Germany. Each household completed a storage, purchasing, and waste diary along with information on their attitudes towards food and waste.
- 3) Time Diaries - Time diaries can be used to capture information on a variety of activities including food disposal, eating, and food preparation. This type of diary tracks the activities of the person(s) of interest, including when and where the activities happen, sequencing with other activities, and social interactions. The purpose of the time diary method is to allow for activities to be identified into clusters that form practices and to record them chronologically (Southerton and Yates 2015). Southerton and Yates performed a study that

asked 2,784 consumers to record their eating activities in a time diary. Respondents were asked to describe their eating events including information on what they ate, where they ate, who they ate with, what was eaten, how long the meal lasted, how the food was prepared, how much food was leftover, and whether the excess food was saved or discarded. Time diaries can also be used to collect other information on experiences such as their understanding of or feelings towards the experience.

The remainder of this section will focus mostly on kitchen diaries, though many of the benefits and limitations of kitchen diaries apply to the other types of diaries as well.

### ***What are kitchen diaries?***

A kitchen diary is a method that typically involves participants (or in some cases practitioners) recording the contents and weight of food consumed and/or discarded. A paper based or online template provides a “form” for participants to complete with the requested information. For quantitative research this has been considered a core methodology and used in many large scale studies such as those done by the UK Waste & Resources Action Programme (WRAP, 2013), the Natural Resources Defense Council (NRDC, 2017a), Metro Vancouver (2018), and Oregon Department of Environmental Quality (McDermott et al, 2019) (see table 17.1 for further details on previous kitchen diary studies).

Table 17.1: Select kitchen diary studies focused on household food waste

Research	Location	Number of	Method of	Food	Qualitative Information
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Organization/ Source		Households Sampled	Recording Data	Waste Metric	Captured
Waste & Resources Action Programme (WRAP, 2013)	Various Cities in England and Wales, United Kingdom	948	Paper	Weight, volume, number or amount	<ul style="list-style-type: none"> <li>• Description of food</li> <li>• How food was purchased</li> <li>• Pack size</li> <li>• State of food</li> <li>• Where food waste was disposed</li> <li>• Reason for wasting</li> </ul>
Natural Resources Defense Council (NRDC, 2017a)	Nashville, TN, USA Denver, CO, USA New York, NY, USA	613	Paper	Weight	<ul style="list-style-type: none"> <li>• Time</li> <li>• Description of Food</li> <li>• Meal</li> <li>• Type of packaging</li> <li>• Where food waste was disposed</li> <li>• State of food</li> <li>• Reason for wasting</li> </ul>
Metro Vancouver (via email communication, 2018)	Metro Vancouver, BC, Canada	501	Paper	Weight	<ul style="list-style-type: none"> <li>• Description of food</li> <li>• State of food</li> <li>• Where food waste was disposed</li> <li>• Reason for wasting</li> </ul>
Oregon Department of Environmental Quality, 2017 (McDermott et al, 2019)	OR, USA	299	Digital (via website)	Weight	<ul style="list-style-type: none"> <li>• Description of Food</li> <li>• Meal</li> <li>• Where food waste was disposed</li> <li>• Origin of food</li> <li>• State of food</li> <li>• Reasons for wasting</li> </ul>

The type of information recorded in a kitchen diary varies depending on the specific goals of the study, but generally includes at least a short description of the food item being discarded accompanied by a quantitative measure such as the weight, volume, or item counts. Additional information captured in a kitchen diary can include the time of discard, discard destination, which meal the food is associated with, state of the food (e.g. cooked, prepared, or inedible parts), and reason for disposal. A comment section can also be provided to capture any additional information or reactions from the participants. Kitchen diaries are normally recorded for a one to two week duration, either consecutively or a minimum number of days within a time period (e.g. seven days

within two weeks). The methods of recording data for kitchen diaries are further discussed in the section on types of kitchen diaries.

Kitchen diaries are normally recorded by recruited participants in a voluntary study. The total number of participants in a study mostly depends on available budget and resources, as well as the goal of the study. Some studies may use the diary method to explore potential themes, but don't need statistical representativeness for extrapolating to a larger population. For studies that seek representative data, it is estimated that statistical representativeness is typically achieved with between 300 to 500 participants for a population of 10,000 people or greater when looking at edible food waste generated in households. After data collection and analysis, the NRDC study back-calculated the ideal sample size (using 10% margin of error and 95% confidence interval) for the study when focusing on edible food waste generated in households. They found that the ideal sample sizes for New York City and Denver, respectively, were 573 and 405 households (NRDC, 2017b). Recruitment, especially for studies seeking statistical representation, can be resource-intensive and difficult to correct for self-selection bias (see section on limitations for more information on bias in diary studies). For these studies, participants can be recruited using random or stratified-random sampling techniques or through pre-selected samples identified by research firms (e.g. omnibus surveys). Participants can be recruited via door-to-door engagement, by phone, web service, or survey panels. In some cases, open recruitment is used, but may generate results that are not representative. Participants are normally compensated with a small honourarium for completing the study and supplied with any materials needed to complete the study, such as scales for weighing food. It is important to consider an honourarium that would be adequate to mitigate attrition, which may be as high as half of the participants if the compensation is too low.

Kitchen diaries are often used alongside other research tools such as surveys or waste audits. Combining the results of kitchen diaries with information collected from surveys is used to connect food waste generation with information such as demographics, attitudes, and behaviours to better understand the waste patterns of different types of people. Guides and methodology documents with details on implementing kitchen diaries have been published by WRAP (2013), NRDC (2017b), Oregon Department of Environmental Quality (McDermott et al, 2019) and the National Zero Waste Council (2018).

### ***Types of Kitchen Diaries***

There are three main types of kitchen diaries that are currently being used: 1) Paper; 2) Digital; and 3) Automatic. Each of these types has the same overall outputs, however, the data is collected differently, with different levels of participation required from the respondent.

#### **Paper**

Participants are given a paper diary with a data entry form to complete each day of the diary recording period. Instructions on how to complete the diary are also included. See figure 17.1 below for an example of a kitchen diary page. Participants record descriptions of food items that they discard along with the quantity (as weight, estimated volumes, or counts depending on the recording method used) and other relevant information. Weight-based recording is considered the best method as it reduces the level of subjectivity for the participant while reducing analysis time

by researchers to convert volumes to weights. Participants are instructed to record separate weights for each type of food item (e.g., weigh potato peels separate from onion skins).

Figure 17.1: A sample page of a kitchen diary

**<FIGURE 17.1 HERE>**

To compile and analyze results, coding of food descriptions into categories is conducted by research staff for consistency and to make analysis easier. Kitchen diary data is entered using a standardized food list to allow for analysis of food by type. For example, participants may write ‘Granny Smith apple’, ‘apple’, ‘red apple’, or ‘apples’ in their diary. These entries would all be coded as ‘apple’. Additionally, mistakes in self-categorization by participants are corrected (e.g. participant indicated that they discarded ‘moldy pizza’ because it is ‘inedible parts’, however, it should be corrected to ‘spoiled/moldy’ for the loss reason based on the description). If participants recorded quantities as volumes or item counts, at this stage the researchers also convert the volumes or item counts to weights. Some research seeks to identify which portion of the food discarded is ‘edible.’ Using the project definition of edibility, research staff will also classify what items or portions of items are edible.

One of the benefits of a paper-based method is that the kitchen diary can be left in the kitchen near the place of disposal to best capture food wasted by all members of the household at the time of disposal. Web-based and app-based methods have the potential to introduce a barrier for all household members to equally participate and may increase risk of an item not being recorded if the computer or phone isn’t close at hand at the time of discard. However, the paper-based method is generally the most time-consuming, with the need to hand write most of the information.

Additionally, the handwritten method is the most time-consuming for the research staff to digitize the information from the paper form.

### Digital Kitchen Diaries

“Digital” kitchen diaries are essentially the paper kitchen diary in a digital form. A survey tool or other online form can be used to collect the information from the respondent using a computer-based or a phone-based online interface. For digital kitchen diaries, the respondent is still generally asked to measure the food at the time of disposal either using a scale, container, or by providing counts. Digital kitchen diaries can include tools, such as photos or drop-down menus, to streamline data entry and reduce errors and omissions. Additionally, digital kitchen diaries reduce costs by eliminating the need to convert paper kitchen diaries to digital form for data analysis.

### Automatic Kitchen Diaries

“Automatic” kitchen diaries are currently in development to eliminate the need for measurement by the respondent. Instead, an automatic kitchen diary can estimate quantities of discarded food using a photo, generally taken using a phone app. Reducing the step of measurement has the potential to both increase accuracy and decrease omissions by reducing effort needed by the respondent. The respondent would still be required to fill in any additional information such as the reason for discard.

The Remote Food Photography Method<sup>®</sup> (RFPM) or SmartIntake<sup>®</sup> app is an example of a type of automatic kitchen diary. RFPM estimates plate waste over a period of many days, including multiple meals. Participants use a smartphone app to take photos of their plate of food before and after each meal or serving. Benefits of this technology include that information is recorded in “real-

time” and reminders can be sent to the participants phone if a period of time elapses without pictures being taken. Using validation of doubly labeled water, it was found that the error in reporting was less than 4% (Roe et al, 2018). While this method is currently being used to measure plate waste, there is potential for it to be expanded to other types of wasted food. Additionally, this method currently tracks food at the individual level, whereas household-level data is often desired to best understand why food is wasted in households.

Table 2 below provides a summary of the benefits and drawbacks of paper, digital and automatic kitchen diary methods.

Table 17.3: Summary of benefits and drawbacks by type of kitchen diary

	<b>Paper</b>	<b>Digital</b>	<b>Automatic</b>
<b>Ease of Use</b>	<ul style="list-style-type: none"> <li>• Literacy is a basic requirement</li> <li>• Participant must learn to operate a scale or follow a measurement scheme</li> <li>• Does not require use of computer or cell phone</li> </ul>	<ul style="list-style-type: none"> <li>• Literacy is a basic requirement</li> <li>• Participant must learn to operate a scale or follow a measurement scheme</li> <li>• Requires use of computer or cell phone</li> </ul>	<ul style="list-style-type: none"> <li>• Literacy is a basic requirement</li> <li>• Participant is not required to operate a scale</li> <li>• Requires use of computer or cell phone</li> </ul>
<b>Time</b>	<ul style="list-style-type: none"> <li>• Most time required by participants to complete this type of diary because of need to handwrite all information</li> <li>• Most time required for researchers to convert information on paper to digital form</li> </ul>	<ul style="list-style-type: none"> <li>• Reduces time needed by participant to record items, especially if tools are used to streamline data input</li> <li>• Reduce time needed by researchers because information does not need to be converted from paper to digital</li> </ul>	<ul style="list-style-type: none"> <li>• Reduces time needed by participant to record items, especially if tools are used to streamline data input</li> <li>• Reduce time needed by researchers because information does not need to be converted from paper to digital</li> </ul>

<b>Accuracy</b>	<ul style="list-style-type: none"> <li>• Potential omissions due to effort needed to record items</li> <li>• Diary can be kept in the kitchen area to facilitate reporting and participation of all family members</li> </ul>	<ul style="list-style-type: none"> <li>• Fewer potential omissions in terms of ability to take picture and submit items at later time</li> <li>• Fewer omissions due to reduced effort needed to record items</li> <li>• More omissions due to lack of accessibility of phone or computer in kitchen or by all members of household</li> <li>• Potentially fewer errors for recording weight and other information via picture</li> </ul>	<ul style="list-style-type: none"> <li>• Fewer potential omissions in terms of ability to take picture and submit items at later time</li> <li>• Fewer omissions due to reduced effort needed to record items</li> <li>• More omissions due to lack of accessibility of phone or computer in kitchen or by all members of household</li> <li>• Potentially fewer errors for recording weight and other information via picture</li> </ul>
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### ***Benefits of Kitchen Diaries***

Other than kitchen diaries, the two other main food waste quantification techniques for the household level are waste composition studies and waste recalls/estimations. Waste composition studies collect municipal solid waste, generally either collected at the curbside or at a waste transfer station, and divides the material into set categories by material type (see chapter entitled “Quantifying food waste: Food waste audits, surveys, and new technologies” for more information). Waste recalls or estimations retrospectively ask respondents to estimate or remember how much they wasted over a given period of time.

One of the major benefits of kitchen diaries compared to waste composition studies and waste recalls/estimations is that they provide a more accurate estimate of *total* generation of household food waste. Many of the methods used in food waste studies are based on dietary assessment methodologies that have been used for decades in public health. Research has shown that dietary recalls (analogous to waste recalls/estimations) are generally more inaccurate than dietary records (analogous to kitchen diaries) because dietary records are completed at the time of food intake rather than relying on memory (Thompson and Subar, 2013). Additionally, people have been

shown to generally underestimate how much food they waste (Neff et al, 2015). Kitchen diaries also provide information of food discarded to discard destinations that are generally missed by waste composition studies, such as drain disposal, feeding pets, and backyard composting. Thus, waste composition studies also do not capture *total* generation.

Another significant benefit of kitchen diaries is that they provide more detailed information on the type of food items discarded since they generally require the respondent to identify exactly what types of food are discarded, the state of the food, and the discard destination. Specifically, in waste composition studies, identifying the type of food discarded can be difficult especially if it has been in the waste bin for a long period of time or the waste has been tossed, compacted, or altered in another way. Furthermore, waste composition studies aren't usually directly linked with individual households, rather the material sorted is an aggregate of many households, thus specific characteristics and contexts of how and why food is discarded are lost. Kitchen diaries, however, are generally linked to a specific household and coupled with a survey to collect information about the household. Given that the context and who is discarding the food is important to understanding the larger set of behaviours and factors, this coupling of methods allows researchers to understand the larger practice of wasting food.

Lastly, a major benefit of kitchen diaries is the ability use the information to develop relevant messages for interventions. Solid waste managers may continue to use waste composition studies to estimate generation of food waste, but kitchen diaries have additional benefits for government and other organizations focusing on consumer education and other interventions. Kitchen diaries can give more detailed information on how and why food is wasted. Are certain food items frequently discarded for the same reason? Are people discarding items because they think they are



inedible, but they can be safely eaten (e.g. broccoli stalks)? For example, a common finding across the studies conducted by WRAP, NRDC, and Metro Vancouver was that leftovers and prepared food were thrown out frequently because they were spoiled. Therefore, in all three campaigns, some of the main messages were on how to keep food fresher for longer, how to incorporate leftovers into new meals, and how to get people to prioritize eating leftovers before they spoil.

### *Limitations of Kitchen Diaries*

While kitchen diaries have many benefits comparatively to waste composition studies and waste recalls/estimations, they also have drawbacks. Some of the drawbacks are unique to kitchen diaries while others are limitations of all three methods. When designing a research study, actions should be taken to minimize these limitations, however, eliminating all bias may not be possible. The major limitations of kitchen diaries are:

- Recruitment Bias: If the goal of the study is to provide a representative sample of households, then recruitment bias should be considered. Due to the time-intensive nature of the kitchen diary, as well as the requirement for literacy, certain populations may be systematically excluded from the study. For instance, participants that are already interested in issues of food waste may oversubscribe while participants without previous interest may drop out. Additionally, people that consider themselves time-constrained may not agree to participate.
- Self-Reporting/Response Bias: The self-reporting nature of the diary may lead to under-reporting through intentional or unintentional omissions of occurrences of food waste or changes in behaviour that result from the act of completing a diary (e.g., participants want to show they don't waste food and alter their food consumption patterns for that week). In

dietary assessment studies, respondent fatigue has been shown to result in less accurate reporting as the study progresses. Recording periods of greater than 4 days in dietary assessment studies are shown to yield unsatisfactory results (Thompson and Subar, 2013).

- Resource Constraints: Cost to implement studies with kitchen diaries with statistical representation is high. Significant resources are needed for recruitment, support, and incentives during measurement, especially if waste audits are being used in the study to corroborate what is recorded in the kitchen diary and to estimate underreporting. Resources needed to standardize and interpret data can be high, even for digital kitchen diaries because of how food is described.
- Accounting For Edibility: Many studies are often interested in only the “edible” portion of food discarded or want to distinguish between the edible portion and associated inedible parts. This is particularly relevant for studies focusing on food waste prevention because they tend to focus on the ‘avoidable’ or ‘edible’ portions of food. However, edibility is a socioculturally constructed concept and not an innate characteristic of a material (Gillick and Quested, 2018; Hanson et al., n.d.-b; Papargyropoulou et al, 2014; Nicholes et al, 2019), thus there is no universally agreed upon definition of edibility, even within a country or culture. USDA National Nutrient Database for Standard Reference (USDA, 2019), UK WRAP (Gillick and Quested, 2018; Nicholes et al, 2019), and NRDC (NRDC, 2017b) have different classifications of edibility that can be used. Unfortunately, digestibility or ingestibility cannot be used as a measure of edibility because most parts of food are digestible with enough treatment (Gillick and Quested, 2018). Additionally, respondents may have very different definitions of edibility (that may or may not align with the definition in the study). Consistently accounting for edibility can be difficult given the

respondents' varying definitions (e.g. pizza crusts defined as 'inedible parts' by respondent). However, it is important to transparently report edibility for easier comparison to other studies.

- Logistics: To make measurement easier, respondents often include packaging in the measurement. Information can be collected to remove the weight of packaging as part of the data analysis. Even with simple and straightforward instructions, respondents may not follow directions even with respondent support. Incomplete or incorrect data will either need to be omitted or corrected using suitable assumptions.
- Hard to Capture Items: Some food items are harder to capture in a kitchen diary format than others. For instance, food wasted outside of the household is difficult to measure if a quantitative estimate is desired because a respondent is unlikely to carry a measuring implement around with them and measure in public places. Additionally, purges, such as refrigerator cleanouts, are unlikely to be captured due to lack of frequency as well as respondent decisions to postpone purges due to work required to record in the kitchen diary. To still capture this information, a qualitative measure can be used or an automatic kitchen diary may also overcome the limitation of needing to carry around a measuring instrument.
- Representativeness of Measured Time Frame: A kitchen diary records a snapshot in time and may not be representative of a "typical" week for a household. Additionally, seasonal differences as well as lack of consistency in household habits and behaviours can make it questionable to extrapolate kitchen diary data to a whole year.

Despite the limitations of the kitchen diary, it is still one of the most used methods for quantitatively and qualitatively capturing detailed information on food discarded in households. For studies only needing quantity of food discarded and collected as municipal solid waste without

additional information, a waste audit may be a better option. However, for studies wanting more detailed information, there are currently no other mainstream methods with fewer limitations. Additionally, techniques can be used and new technologies are being developed to help reduce the impacts of the limitations described above.

### *Ways to Overcome Limitations*

Using computer or app-based technologies as well as careful planning in study design can help reduce the impacts of the biases and limitations described previously. Dietary assessment to measure food intake has many analogies to measuring discarded food, thus strategies from public health can potentially be used to overcome some of the outcomes above. One method to improve the representativeness of dietary records (or kitchen diaries) is to measure non-consecutive days. Another is to have a trained interviewer review the record to clarify entries and probe for food items that might have been omitted (Thompson and Subar, 2013). The development of digital and automatic kitchen diaries also provides the opportunity to reduce resources needed for research staff to transcribe paper kitchen diaries into digital form. Automatic kitchen diaries take it a step further by reducing the need for the respondent to measure the quantity of food wasted themselves. This reduces significant burdens of time, effort, and user error which could both increase participation across more populations as well as reduce omissions and errors. Additionally, eliminating the need for user measurement would allow for food discarded outside of the household to be more easily captured.

If trying to estimate the amount of underreporting in a kitchen diary study, a waste composition study can be used to determine the level of underreporting in the municipal solid waste stream. UK WRAP, NRDC, and Oregon Department of Environmental Quality used this method to

estimate that the underreporting rate for kitchen diaries. Interestingly, all three studies resulted in an underreporting rate of around 40% (WRAP, 2013; NRDC, 2017a; McDermott et al, 2019). While this is the most used method to determine underreporting in kitchen diaries, it is untested whether the underreporting factors for materials reaching curbside collection are the same as those for other disposal destinations (e.g. drain disposal, feeding animals, and backyard composting). Additionally, the type of error from under-reporting would be systematic between repeated studies as long as they have the same approximate sample characteristics. Therefore, any difference between the two studies represents a valid difference.

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