

TOWARD CLEANER PLATES:

A STUDY OF PLATE WASTE IN FOOD SERVICE

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EXECUTIVE SUMMARY

Until now, little research has been done to understand why people dining out leave food on their plates. With this first-of-its-kind study, Bon Appétit Management Company and Natural Resources Defense Council set out to better understand the causes of plate waste in a food service environment, and to examine café characteristics and operational practices that might influence guests (both college students and corporate employees) to have more food waste at the end of their meal.

In this study we analyzed the effects of various café characteristics (e.g. service model - either all-you-care-to-eat, or “AYCTE” or for purchase, known as “retail”) and operational practices (e.g. availability of tasting spoons) on the amount of edible plate waste per guest and found that:

- Across all variables tested, the establishment type (either Education or Business and Industry, known as “B&I”) had the strongest association with edible waste. Edible waste per guest in Education cafés was more than double the waste in B&I cafés.
- Edible food waste in all-you-care-to-eat locations was nearly 40% higher than in retail settings.
- Edible waste per guest at lunch and dinner was more than double the per-guest waste at breakfast, with dinner having the highest waste per guest of the three meal types.
- Both providing clear and consistent portioning instructions to serving staff and offering a wide availability of tasting spoons had a statistically significant association with lower amounts of edible waste.
- Entrée plate size, the availability of trays, access to self-serve beverages, and the percentage of food stations that were self-serve did not have a statistically significant association with the amount of edible food waste.

We found the average amount of edible plate waste per guest served was 1.61 ounces. This was about 0.61 to 2.76 ounces lower than the average amount of edible plate waste per guest found in previous studies in other environments. Despite being lower than average, when extrapolated companywide that’s a projected 12,578 tons of edible plate waste that could potentially be prevented each year.

Through this preliminary study, we’ve concluded that a wide range of nuanced variables influence guests to leave food on their plates. Some of these variables, such as the choice of AYCTE or retail service models, are beyond the control of food service providers while others are variables that can be addressed through operational updates. While no silver-bullet solutions emerged, we have identified some clear learnings about what programs and operational changes are worth pursuing to prevent plate waste. Future research is needed to deepen our collective understanding of what causes edible waste and what we can do to prevent it. We hope this study serves as a starting point for future examinations.

INTRODUCTION

Many of us remember a time as a child when we were scolded for leaving food uneaten on our dinner plate. We either lived through or were raised by the generations of Americans who emerged from the Great Depression ingrained with a strong aversion to waste of any kind, especially of a resource as valuable as food. Times have changed. Despite food waste being considered taboo, today an estimated 40% of food in the United States is wasted.¹ Natural Resources Defense Council (NRDC) estimates that roughly 20% of all food wasted in the U.S. is, in fact, consumer plate waste occurring in commercial settings.² Past studies have found plate waste ranging anywhere from 3.3% to 39.1% of the food being served depending on the service setting and the population being studied.³ This suggests a significant disconnect between what we practice and what we preach.

Wasted food is a huge problem. In addition to the food itself, we waste all of the water, fertilizer, and pesticides required to grow it, along with the energy and packaging associated with processing it and getting it to our tables. When landfilled, discarded food produces methane, a greenhouse gas that is more than 80 times more powerful than carbon dioxide.⁴ As if that weren't enough, this tremendous amount of food is going to waste at the same time that an estimated 1 in 8 Americans is considered food insecure.⁵

For these reasons, a significant amount of research has been undertaken to better understand why nearly half of the food in the country is being wasted at various points along the supply chain and what to do about it. In the institutional food service industry, that has included extensive tracking of food waste on a "pre-consumer" basis in commercial kitchens. On a "post-consumer" basis, previous studies have quantified the amounts of food wasted on plates and categorized the types of food thrown away, but those studies focused exclusively on K-12 school meal programs^{6,7,8,9,10} or examined adult consumers but did not examine the reasons for why the food was wasted³. Other existing research on plate waste has been limited to testing the efficacy of unique interventions such as removing trays¹¹, changing plate type¹² and plate size¹³, the impacts of different meal pricing¹⁴, and the effects of awareness raising and education^{15,16} and were often limited to a specific meal time. Given the scale of post-consumer waste, commercial plate waste clearly warrants further research and innovation.

To begin addressing that gap, Bon Appétit Management Company and NRDC developed a first-of-its-kind study to better understand the drivers of edible plate waste in a food service environment. This study is the first to look broadly across breakfast, lunch and dinner meal service and to evaluate a range of structural, operational, and behavioral variables that may lead people to waste more food when dining out in a food service setting. This white paper is a culmination of that research. Recognizing the scale of this issue and the dearth of publicly available data on post-consumer food waste, we are sharing our findings in hopes of informing future waste fighting initiatives and contributing to the growing body of knowledge around food waste causes and solutions.

METHODOLOGY

The purpose of the study was to understand how much plate waste is generated in selected Bon Appétit-managed food service cafés; determine how much of that waste was edible (i.e. excluding peels, rinds, and other inedible parts); and identify operational variables that influence the amount of food waste left on guests' plates. The study included three parts:

1. An assessment of key operational practices in each study location to understand the structural and service variables that might impact plate waste;
2. A waste scraping station set up in each café at which guests separated their waste into edible waste, inedible waste, liquid waste, and disposables/packaging waste; and
3. An optional written survey for guests to provide insight into what food was left on their plates and why they were discarding it.

THE CAFÉ ASSESSMENT

At each location, the researcher completed a checklist that made note of the following attributes:

- the location's geographic region
- establishment type (Education or Business and Industry, known as "B&I")
- service model (all-you-care-to-eat, or "AYCTE," vs. for purchase, known as "retail")
- meal period (breakfast, lunch, or dinner)
- whether a café offered trays
- the number of dining stations
- the number of self-serve dining stations
- serving line length
- plate size
- the availability of self-serve beverage refills
- the availability of tasting spoons
- the availability of to-go containers

(For further detail about the terms used in our assessment, please see 'Understanding Important Terms' in the Appendix.)

WASTE MEASUREMENT

During meal service, a plate scraping station was set up and waste bins normally located in the cafés were removed or closed. This required the majority of guests to bring their plates (and whatever was left on them) to the scraping station to be tracked.

Researchers used a clicker counter to record the number of guests who came through the scraping station, regardless of whether they had any food waste remaining on their plates. Researchers helped guests separate their waste into one of four categories: edible food waste, inedible food waste, liquid waste, and packaging and napkin waste.



Image 1: A waste scraping station at one of the surveyed cafés

GUEST SURVEY

After dining in the café and dropping off their plates at the scrape station, guests were encouraged to fill out a brief survey to provide more information about what was left on their plate and why. Guests who completed a survey had the option to enter a raffle to win a \$50 Amazon.com gift card. The full guest survey and results can be found in the Appendix.

THE SAMPLE

The study was run at a sample of 20 Bon Appétit locations for 2 meal periods each, totaling 40 meal periods surveyed between May 2018 and March 2019. During the study period, plate waste scrapings were obtained from a total of more than 12,269 individuals, and 1,572 of those individuals completed a survey. The locations represented in this sample were geographically spread across the United States (see map in the Appendix). They were selected by the research team to ensure the study included an even spread of establishment types in even geographic distribution. Locations were evenly divided between cafés located at business and industry (B&I) locations and institutions of higher education ('Education') locations. The sample was split equally between retail cafés and all-you-care-to-eat cafés; and the breakdown by meal period surveyed was 13 breakfasts, 18 lunches, and 9 dinners.

ANALYSIS

The effects of café characteristics (e.g. service model) and operational practices (e.g. availability of tasting spoons) on the average amount of plate waste per guest at each café were analyzed using t-tests and multiple linear regression. Most of the analysis was focused on the impact (or lack of impact) certain variables had on the average ounces of edible waste per guest. Average ounces of liquid waste, inedible waste, and packaging/napkin waste per guest were also analyzed. The statistical significance level was set at $p < 0.1$, indicating the probability that the result occurred by random chance was less than 10%. It is important to note that some variables were evaluated within a more limited sample in cases where a variable was only relevant in some situations (e.g. plate size was analyzed for AYCTE cafés).

only). When a particular finding pertains to a limited sample, it is explicitly stated in the findings below.

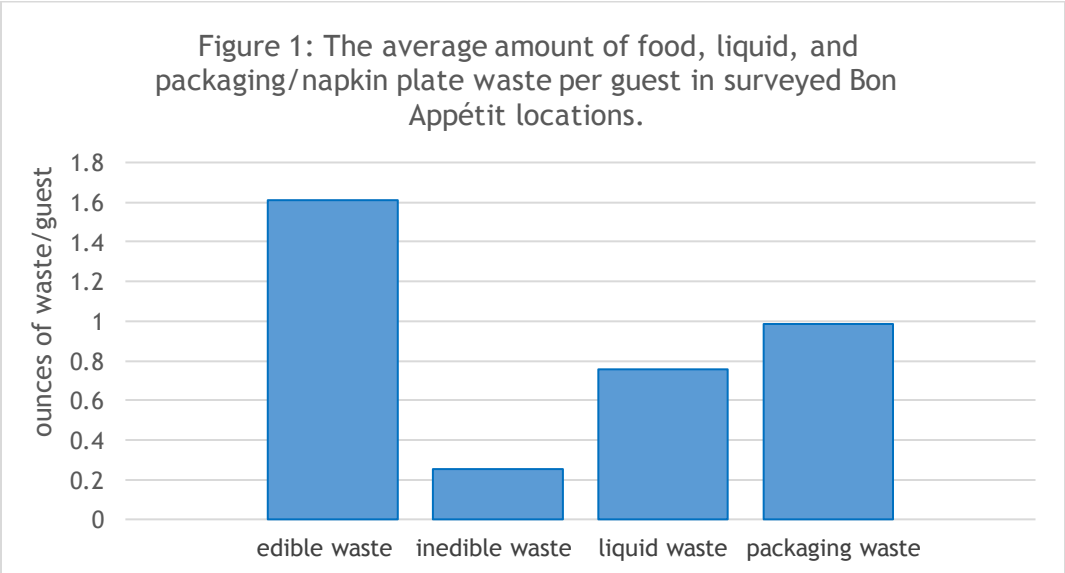
LIMITATIONS OF THE STUDY DESIGN

This study allowed the researchers to capture a significant amount of data that hasn't been tracked on this scale before. That being said, there were some limitations to the design including:

- Researchers did not measure the amount of food wasted by each guest individually. Instead, waste from individuals' plates was collected, weighed in aggregate, and the total weight was divided by the number of guests that came through the waste station. Therefore, the measurement for each surveyed period is a calculated average food waste per guest, and there is only one measurement for each meal period surveyed (n=40 meal periods rather than n=12,269 guests who scraped their plates).
- At some locations, guests were aware of the plate scraping station; this may have influenced some of them to waste less or take their food to-go and dine outside the café in order to avoid interacting with the study.
- The different cafés surveyed used a variety of operational practices (e.g. some offered tasting spoons, while others did not). These "variables" were not evenly distributed across the café types or mealtimes.

FINDINGS

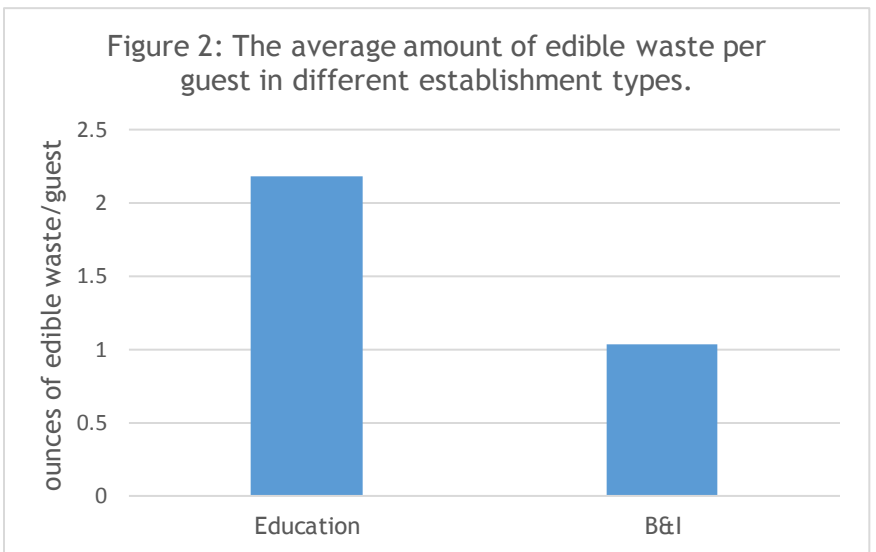
The plate waste collected included edible food waste, liquid waste, packaging/napkin waste and inedible food waste. Edible food waste was by far the largest category of guest plate waste by weight, averaging 1.61 ounces of edible waste per guest when evaluated across all account types and meal periods (Figure 1). That is about 0.61 to 2.76 ounces lower than the average amount of edible plate waste per guest found in similar studies in other settings.³ However, Bon Appétit serves 250 million meals a year so that is still a projected 12,578 tons of food waste that could be prevented annually across Bon Appétit's operations.



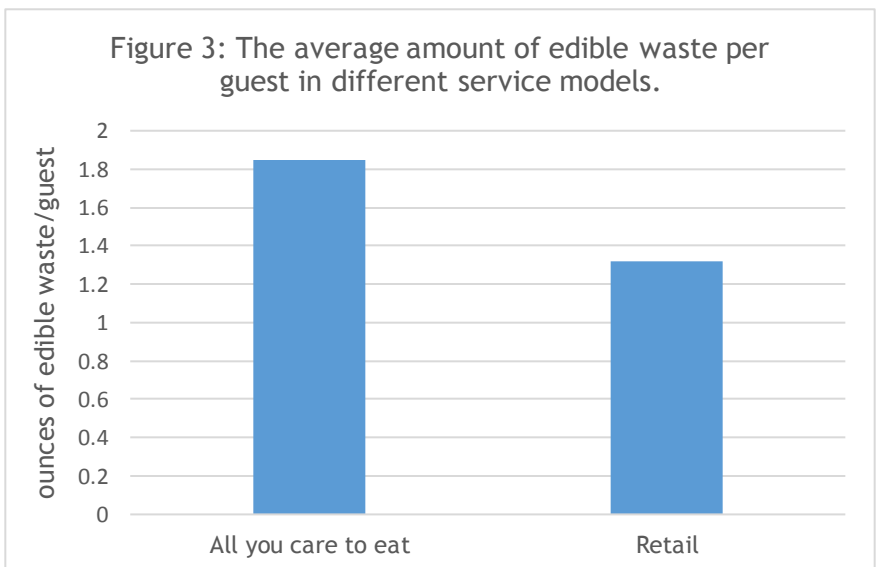
Several café characteristics and operational practices affected the amount of food wasted by guests, while others measured as part of this study did not. Both categories are helpful in understanding actions that could be taken to reduce edible waste. In some cases, we found the variables that *didn't* lead to lower amounts of edible waste were as telling as the ones that did.

WHAT HAD AN IMPACT

ESTABLISHMENT TYPE: Across all variables tested, the establishment type (Education vs. B&I) had the strongest association with the volume of edible waste produced. Edible waste per guest in Education cafés was more than double the waste in B&I cafés. At Education cafés, guests had an average of 2.18 ounces of edible waste compared to an average of 1.03 ounces of edible waste at B&I cafés ($p < 0.001$) (Figure 2).

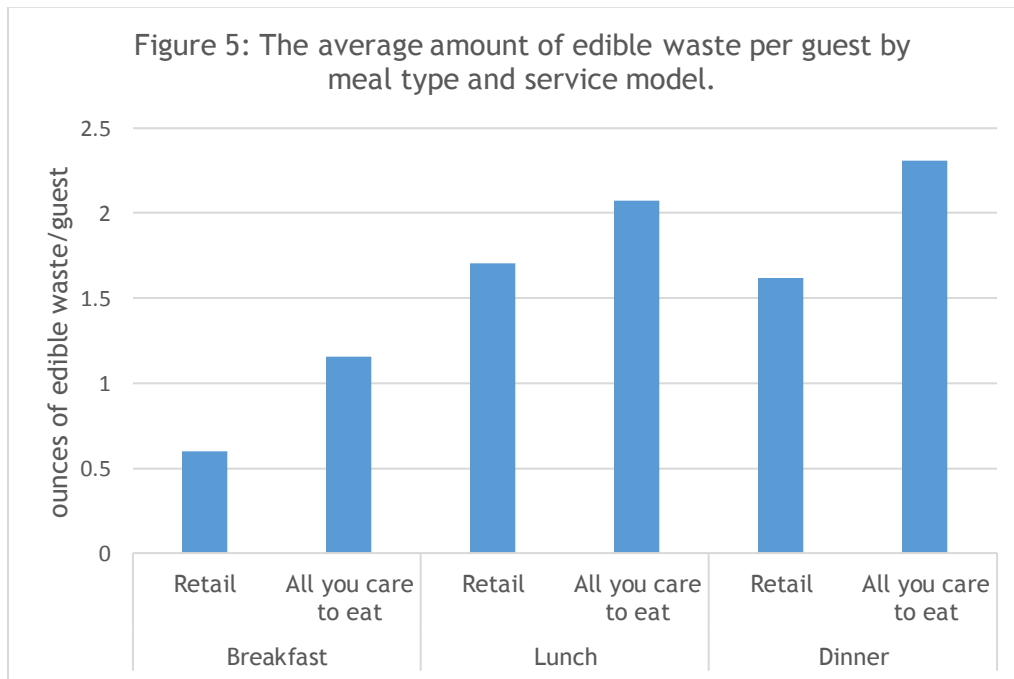
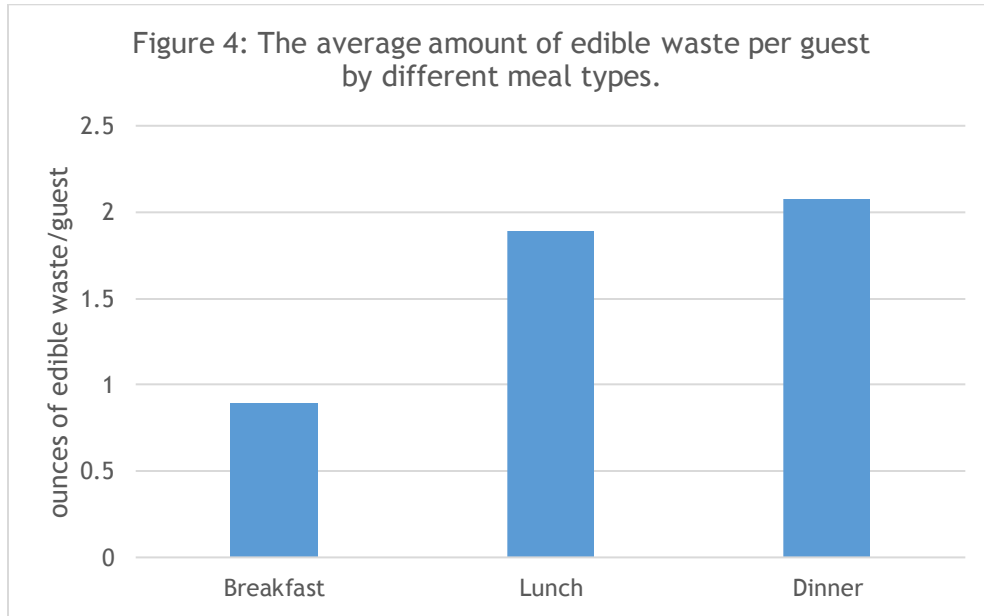


SERVICE MODEL: The locations tested were either AYCTE (all-you-care-to-eat) or retail (ordering from a menu and paying à la carte). It is often assumed that the AYCTE service model leads to more edible waste because there is no economic disincentive for taking more than one needs. People want to derive the most value they can from their eating experience (i.e. get the most “bang for their buck”) and often overestimate how much they will eat, leading individuals to take more food than they can actually consume.



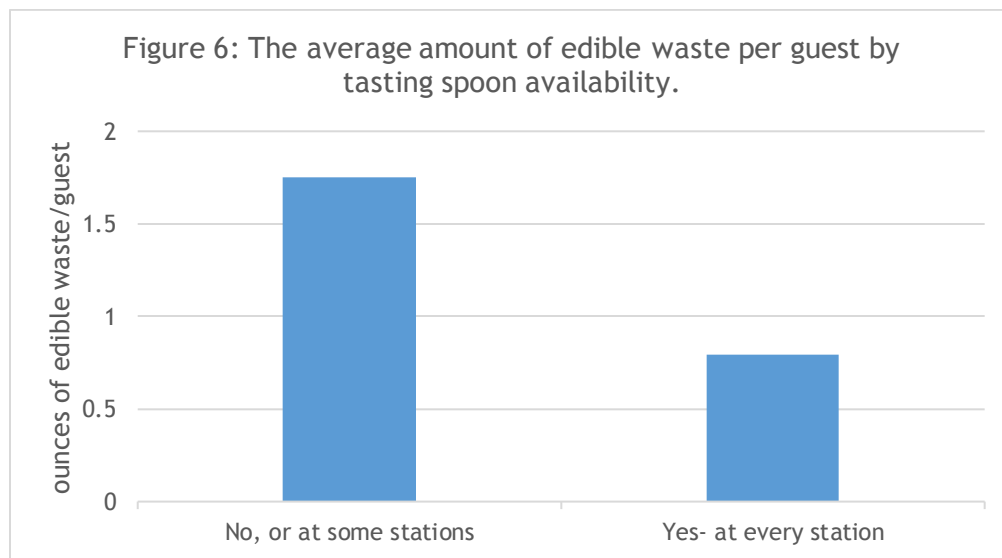
Our findings confirmed this assumption, showing that edible food waste in AYCTE locations was nearly 40% higher than in retail settings. On average AYCTE cafés generated significantly more edible waste (1.84 oz/guest) than retail operations (1.32 oz/guest; $p=0.09$) (Figure 3).

MEAL TYPE: Meal type has a clear association with amounts wasted. Guests wasted significantly less food at breakfast than at lunch or dinner ($p=0.02$). The analysis showed that edible waste was lowest at breakfast (0.90 oz/guest), intermediate at lunch (1.89 oz/guest), and highest at dinner (2.08 oz/guest). This trend was generally true for both AYCTE and retail cafés (Figure 4 and Figure 5).

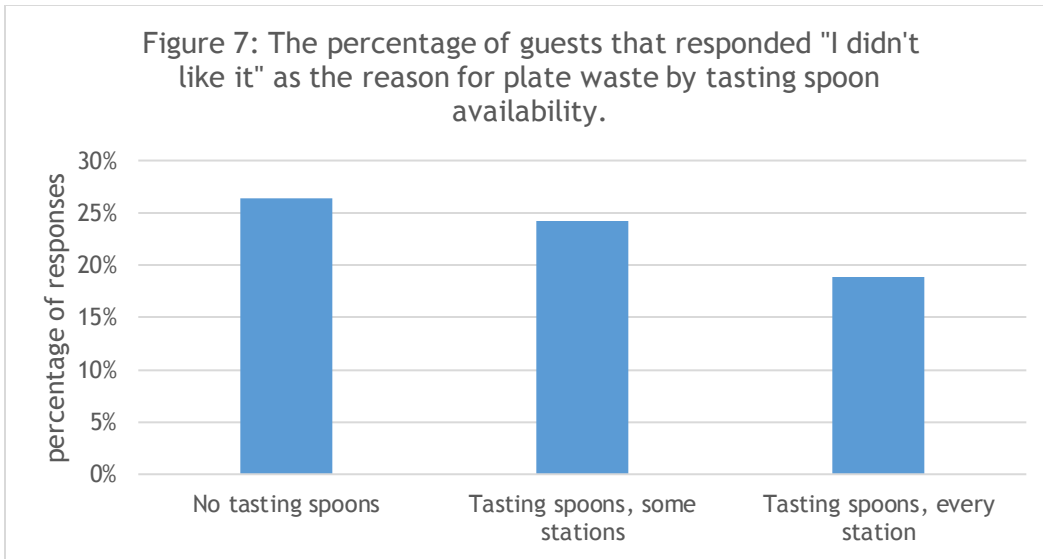


Overall, multiple regression analysis demonstrated that establishment type and meal type accounted for nearly half (45%) of the variation in edible waste between meal periods surveyed.

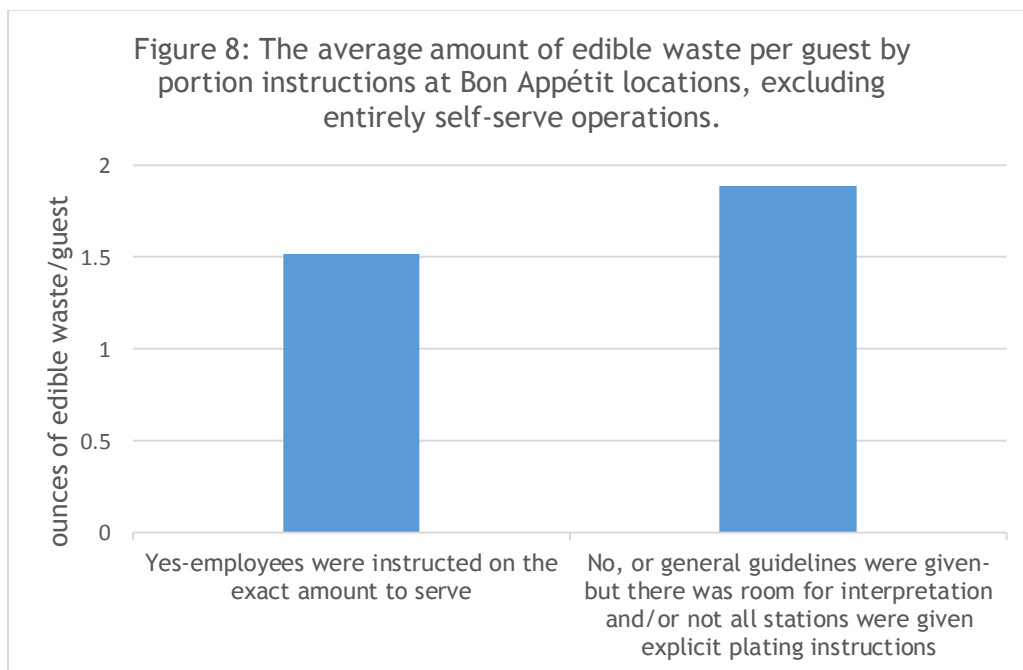
TASTING SPOONS: Of the 1,572 survey responses received, 948 respondents (60%) said they had food left on their plates. When asked why they had food to throw away, the most frequently cited reason was that they “didn’t like it” (24%). One way to combat this issue is to offer guests the opportunity to taste food options *before* they choose their meal through the use of tasting spoons at café stations. Our results showed that cafés offering tasting spoons at every station had significantly less plate waste, on average 0.79 oz/guest, than those that didn’t offer tasting spoons at all, or only offered them at some stations (1.75 oz/per guest) ($p < 0.01$) (Figure 6).



Furthermore, at cafés where tasting spoons were offered at every station, fewer survey respondents said they wasted food because they “didn’t like it” (19% compared to 26%), suggesting that consistent access to tasting spoons can help guests choose food they will like and reduce edible waste (Figure 7). Offering tasting spoons at only *some stations* did not have as clear an impact on the amount of edible waste as offering tasting spoons *at every station*. This suggests that consistent availability of tasting spoons is necessary to have a noteworthy impact on waste.



PORTION INSTRUCTIONS: When asked “How can we help you waste less food?” on the guest survey, more than half of comments provided related to portion sizes. Those comments included requests for smaller portions, more portion options, and better communication between guests and servers about portion size desired. We examined how portion instructions given to staff influenced edible waste per guest. Cafés that were entirely self-serve were excluded from this particular analysis, given that the focus of this question was on employees who received serving instructions, which is not relevant for cafés where employees are not serving food. At cafés where employees received explicit instruction around portion sizes from their managers, there was less edible waste per guest than at cafés where ambiguous or no portion instructions were given to staff ($p < 0.1$) (Figure 8).



WHAT DIDN'T HAVE AN IMPACT

As interesting as it was to see the variables that are associated with less edible waste, it was just as informative to see which variables *did not* appear to be associated with the amount of food waste generated. The findings in this section challenge some commonly held beliefs about what should be done to reduce edible waste and highlight nuances to existing assumptions about what helps people waste less.

TRAYS: We found no statistically significant difference in the amount of edible waste per guest in AYCTE cafés that offered trays and cafés that didn't offer trays or made them less accessible. We examined tray availability in AYCTE cafés specifically, because in that food service model, guests have the option to take unlimited food and may take more as a result of the convenience provided by a tray. In retail cafés, guests purchase and are served set portions whether trays are available or not.

This study did not control for or focus specifically on trays, and this learning is not intended to encourage the use of trays in food service environments. It does, however, cause us to question the commonly held belief that removing trays always leads to less waste.

SELF-SERVE STATIONS: Our findings show that the percentage of stations in a café that were self-serve were not significantly associated with the volume of edible waste generated. This finding was consistent with many of the guest survey responses, in which nearly equal numbers of respondents blamed edible waste on having “served themselves too much” as those that said “they were served too much” by food service staff. This suggests that regardless of service model, getting the “right” amount of food is challenging, and self-serve is not inherently more or less wasteful than any other service model.

PLATE SIZE: A common way for cafés to try to reduce edible waste is by offering smaller plates, with the hypothesis that guests will fill the space they have, regardless of appetite. However, we found the size of the entrée plates used in the café did not have a noteworthy impact on the amount of edible waste. Even when looking at the AYCTE service model specifically, there was no statistically significant difference in the amount of edible waste between cafés that offered small entrée plates (8 inches) and those with medium or large plates (10 inches and 12 inches or more, respectively).

SELF-SERVE BEVERAGES: We also looked at liquid waste to better understand what might lead guests to waste beverages. It is often assumed that when guests can serve themselves as much as they want and they have access to refill beverages themselves, they are likely to take more of a drink than they need. However, our analysis found that the availability of self-serve beverage stations was not significantly associated with the volume of liquid waste generated.

NEXT STEPS

With a clearer understanding of how much edible food is being left on guests' plates and why, researchers identified strategies that could help Bon Appétit and other food service providers reduce edible plate waste at their locations in both the immediate and long-term.

IMMEDIATE ACTION

- Comprehensively and consistently provide tasting spoons at all food stations (ideally reusable spoons so that an effort to decrease edible plate waste doesn't lead to an increase in single-use disposable waste). Inconsistent distribution of tasting spoons throughout the café is less likely to impact edible waste; to reduce edible waste, it is imperative to ensure that tasting spoons are offered at every station. In theory, this helps create a culture that welcomes food exploration and allows people to try before committing to something they may not like (and thus prevents food from being unnecessarily wasted).
- Provide all serving staff with explicit instructions on proper portion sizes. Our findings demonstrate that when serving staff receive clear and consistent guidance on how to portion food for guests, the average amount of edible waste per guest is lower. In addition, given the sheer volume of write-in comments about portion sizes, it is clear this topic merits further research and experimentation around how to help guests receive their ideal portion sizes.

LONG-TERM ACTIONS AND FUTURE RESEARCH

- When opening new cafés or planning remodels, consider moving away from AYCTE. This is a difficult recommendation to put into action, because it is not a decision the food service provider makes alone but is usually dictated by the needs and desires of the particular education or B&I campus they are serving. There are many considerations for why a location may opt for AYCTE, and we recognize its impact on waste is not the only factor. Our recommendation is that it be taken into consideration during opportune moments, such as remodels of existing cafés or when new cafés are being designed.
- At retail operations, identify opportunities for flexible portion sizes. This would require further research and testing; it's also important to consider the possible financial implications for a café offering half-size or smaller food options.
- We noticed a wide variability in the average amount of edible plate waste per guest between participating locations (see 'By Participating Location' graph in Appendix). In this study, the establishment type and meal type had the strongest influence on edible plate waste, but the combination of all of the statistically significant variables (establishment type, service model, meal type, availability of tasting spoons, consistency of portioning instructions) explained 62% of the variability of edible food waste per guest across the locations participating in this study. We suggest that future researchers aim to:
 - Focus their research on the situations with the highest waste, namely edible waste at Education locations, in order to better understand why cafés on college and university campuses have more waste than those at B&I locations. Our study revealed the substantial difference in edible waste amounts between these different establishment types but did not provide insight into why that is the case, thus would benefit from further research.
 - Conduct a study that examines the relationship between plate waste and the amount of food initially served to see if the increase in plate waste throughout the day (i.e. breakfast versus lunch and dinner) is actually

related to the time of day or more associated with the amount of food and the types of food served during those meal periods.

- Explore the remaining variability not accounted for in this analysis, including those variables that are difficult to measure, such as culture and consumer education.

CONCLUSION

It is time to call attention to the less widely recognized issue of edible plate waste and move toward action to reduce it. In this first-of its kind study, guests generated an average of 1.61 ounces of edible waste per meal. When extrapolated over an entire year of eating, this totaled more than 110 pounds of edible food going to waste per person. While some of the most impactful variables turned out to be ones food service providers have the least control over, this study revealed several key actionable learnings and called out opportunities to deepen understanding of edible plate waste through future research and innovation.

About Bon Appétit Management Company

Bon Appétit Management Company is an on-site restaurant company operating 1,000-plus locations in 34 states for corporations, universities, and museums. Bon Appétit chefs cook from scratch, including sauces, stocks, and soups. The Palo Alto-based food service company is a recognized industry leader in environmentally and socially responsible practices, with awards from organizations including the [Sustainable Purchasing Leadership Council](#), [Acterra](#), [James Beard Foundation](#), and many others. Visit them at www.bamco.com and follow them on social media at [@bonappetitmgmt](#). Please contact Waste Programs Manager Claire Cummings Claire.Cummings@bamco.com for more information.

About Natural Resources Defense Council

The Natural Resources Defense Council (NRDC) is an international nonprofit environmental organization with more than 3 million members and online activists. Since 1970, their lawyers, scientists, and other environmental specialists have worked to protect the world's natural resources, public health, and the environment. NRDC has offices in New York City, Washington, D.C., Los Angeles, San Francisco, Chicago, Bozeman, MT, and Beijing. Visit them at www.nrdc.org and follow them on Twitter [@NRDC](#). For more information on this study, please contact JoAnne Berkenkamp at jberkenkamp@nrdc.org.

Acknowledgements

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APPENDIX

Understanding Important Terms

These are phrases and words that are mentioned throughout the whitepaper that we have defined here for reference.

- **Plate waste:** Plate waste refers to any waste that is disposed of by a guest after dining in the café. In this study, we separated plate waste into four unique subcategories: edible food waste, inedible food waste, liquid waste, and single-use disposables waste.
- **Edible food waste:** Any food item that was left on a plate that was edible (i.e. could have been eaten) at the time of disposal. This includes items such as pizza crust, excess ketchup or other condiments, a partially eaten apple, etc. Throughout this paper, edible plate waste, edible food waste, and edible waste are used synonymously.
- **Inedible food waste:** Any food item that was left on a plate that was deemed inedible (i.e. could not have been eaten) at the time of disposal. This includes items such as chicken bones, banana peel, unripe avocado, strawberry stems, etc.
- **Liquid waste:** Any beverage that was left in a cup (including water and ice) at the time of disposal. This includes drinks such as tea, coffee, soda, water, juice, etc.
- **Packaging and napkin waste:** Any single-use serviceware or packaging that was used and disposed of within the café. This includes items such as disposable clamshells, coffee cups, cutlery, paper napkins, candy wrappers, etc.
- **All-you-care-to-eat (AYCTE):** A food service model that allows guests to take an unlimited amount of food, typically restricted to in-café dining. It is worth noting that the B&I AYCTE cafés included in the sample were all “free food programs,” meaning that meals and snacks are provided to employees as a benefit at no cost to the employee. This is different from Education AYCTE cafés, in which a guest must pay to enter (often in the form of a swipe from a prepaid meal-plan card) and once in the café, they can eat as much as they want.
- **Retail (à la carte):** A food service model in which guests purchase and pay for their desired food items from a set menu.
- **Location:** A place where Bon Appétit has been hired to provide onsite food service. For this study, it refers to a B&I café or college/university campus.
- **Business and Industry (B&I):** A corporate client’s offices where Bon Appétit provides on-site food service to employees.
- **Institution of Higher Education (Education):** A college or university campus where Bon Appétit provides on-site food service to students, faculty, and staff.

GUEST SURVEY

Did you have any food remaining on your plate today?

- Yes No

If yes, why? (Note: Please select only one response that best represents the majority of waste on your plate.)

- I ran out of time to eat everything
 I didn't like it
 It was inedible (banana peels, apple cores, bones, etc.)
 I was served too much food
 I served myself too much (if selected, tell us more)
 I took too large of a portion
 I took portions of many dishes and it was too much food overall
 Other reason

What food was left on your plate? If you have time, give us a sense of the breakdown (i.e. part of a sandwich, a few fries, and a banana peel).

Any other comments? Any thoughts on how we could help you waste less food in the future?

Please share your email address, if you'd like to be entered into the drawing.

GUEST SURVEY RESULTS (MULTIPLE CHOICE QUESTIONS)

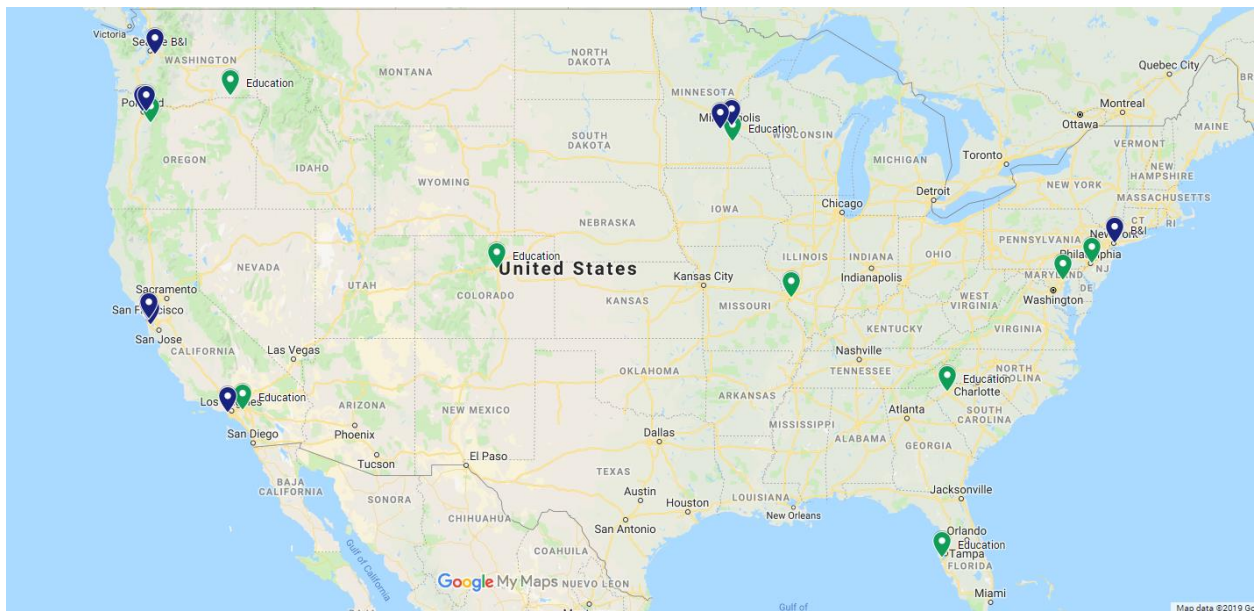
Do you have any food remaining on your plate today?

- Yes [948 responses]
- No [624 responses]

If yes, why?

- I didn't like it [231 responses]
- I ran out of time to eat everything [76 responses]
- I served myself too much food [191 responses]
- I was served too much food [165 responses]
- It was inedible (bones peels etc) [124 responses]
- Other reason [121 responses]
- (blank) [40 responses]

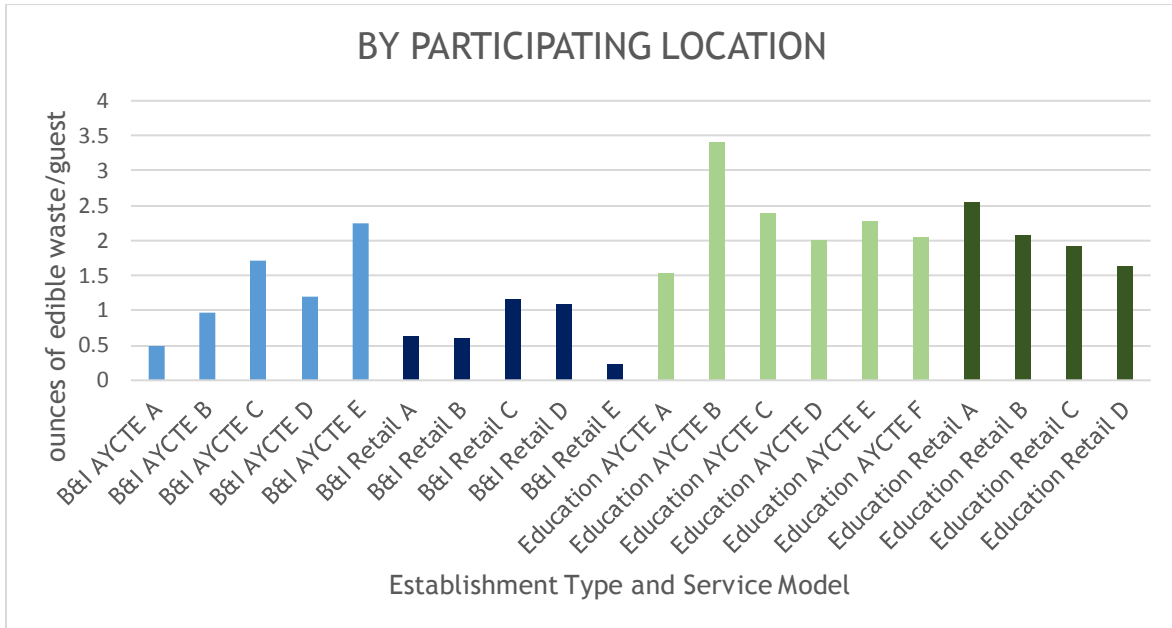
MAP OF LOCATIONS THAT PARTICIPATED IN THE STUDY



Green: Institution of Higher Education

BLUE: Business & Industry

AVERAGE AMOUNT OF EDIBLE WASTE FOR EACH LOCATION



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- ¹ Dana Gunders, Natural Resources Defense Council, “Wasted: How America Is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill” August 2012, <https://www.nrdc.org/sites/default/files/wasted-food-IP.pdf> (accessed 6/11/19)
- ² JoAnne Berkenkamp, Caleb Phillips, Natural Resources Defense Council, “Modeling the Potential to Increase Food Rescue: Denver, New York City, and Nashville” <https://www.nrdc.org/sites/default/files/modeling-potential-increase-food-rescue-report.pdf> October 2017 (accessed 6/18/19), and personal correspondence with JoAnne Berkenkamp of Natural Resources Defense Council on 6/18/19
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- ⁴ U.S. Environmental Protection Agency, Understanding Global Warming Potentials. <https://www.epa.gov/ghgemissions/understanding-global-warming-potentials#Learn%20why> (accessed 6/24/19)
- ⁵ Alisha Coleman-Jensen, Matthew P. Rabbitt, Christian A. Gregory, and Anita Singh. 2018. Household Food Security in the United States in 2017, ERR-256, U.S. Department of Agriculture, Economic Research Service
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