

College of Staten Island

From Shopping Cart to Trash Can:

A data-focused study of how American families waste food

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Abstract

Food waste is an important issue that causes families to go hungry and valuable resources to be squandered. Yet, one of the biggest contributors to food waste are often overlooked: American families. We hope to illustrate the causes of food waste by conducting a data-driven study. Our findings suggest that families buy more food than they eat, do not compost, and throw away leftovers. States that lack composting programs, and have communities that live far from supermarkets waste more food than others per capita. Families waste so much food that their spending even outpaces economic inflation. Finally, we also found cultural and systemic issues with the way consumers are encouraged to purchase food. With this in mind, we propose nationwide and state specific solutions to food waste.

Introduction

One of the most basic needs of any society is to have a supply of food to eat. However, the United States wastes an obscene amount of food. A massive 40% of all food in America is wasted, costing \$240 million annually (*Medical News Today*). Furthermore, wasted food creates greenhouse gasses that contribute to global warming making crops harder to grow, potentially decreasing future food supplies. Finally, the US Department of Agriculture estimates this wasted food could have fed the approximate 33.8 million Americans living in food insecure households in 2021 (Shanker). Truly, food waste is an incredibly important problem to solve.

By conducting a data-driven study, our research aims to illuminate how, where and why American families waste so much food. Existing research suggests families waste food due to

date label confusion, over-preparation, impulsive buying, and a lack of composting programs (Foodprint.org). We have corroborated these known factors with food waste data to confirm their validity and suggest solutions specific to the residential sector. We also aim to identify how consumers, their buying habits, and American food culture influence these reasons for food waste. By furthering studies into food waste caused by American families, effective action can be made to reduce it, and ensure other families do not go hungry.

Our data analysis was performed using Jupyter Notebook, Pandas and Matplotlib, and Microsoft Excel. Tableau was also used for visualizations. Raw data about food-waste was retrieved from multiple sources. A Github repo with our Python code is also provided, with markdown text explaining our analysis methods and decisions.

How Food is Wasted

There is a difference between food waste and food loss. Food loss occurs when food is uneaten at any point. This could be due to farm spoilage, infestations or other damage that makes food inedible (Foodprint.org). The phrase is strongly associated with the agricultural sector. Meanwhile, food waste is a specific type of food loss. According to the US Department of Agriculture, food waste is "*food discarded by retailers due to color or appearance and plate waste by consumers*". This means perfectly edible food that reaches the end of the production chain can still be wasted. Most studies about food waste focus solely on food loss in the agricultural sector and food waste by vendors. American families are a massive contributor to food waste that are often overlooked. These consumers are just under the majority of all food waste, or approximately 50% (Foodprint.org). Unlike other sectors, the residential sector often lacks formal systems or studies to minimize waste.

The current body of research on food waste suggests that American families buy and dispose of much more food than they should. This results in food waste occurring in a variety of ways: the spoilage of uneaten food, over buying, over preparing, date label confusion, and poor meal planning (Foodprint.org). Spoilage occurs simply when food is left out for too long and becomes inedible. This is strongly related to poor planning and overbuying. It is implied that when families do not plan what meals to make, they purchase more food than they would reasonably eat. This phenomenon is supported by behavior studied in larger social gatherings such as parties and potlucks. An experiment conducted by Jeffrey R. Parker and other researchers suggested that people buy and waste more food when entertaining guests. This is because they desire to be gracious hosts and ensure everyone is satisfied. While Parker's experiment was conducted in a restaurant setting, the article mentions that: "*...retailers are reluctant to encourage consumers to refrain from overpurchasing, overconsuming, and wasting...*" which increases sales and is often encouraged by retailers (Parker et al). This means that families are motivated to buy more than they can eat.

American households waste upwards of 30% of their food, creating an annual loss of 240 billion dollars (MedicalNewsToday). The way families judge food quality is a significant factor, as consumers discriminate harshly against imperfect food. The study *Wasted Food: U.S. Consumers' Reported Awareness, Attitudes, and Behaviors* suggests that the most common reasons for throwing out food were concerns of illness and wanting to only eat "fresh" food. The study states: "*While humans may have a natural preference for freshness, this concept has also been heavily promoted by health advocates, cooking shows, local food supporters and others...*" (Neff et al). Sadly, many of the foods families discriminate against could be perfectly edible, but are still wasted over date label concerns. Date labels come in three varieties: "Sell-By",

“Best-By” and “Use-By”. Sell-By dates are used by stores to determine when items should be taken off shelves, while Best-By and Use-By dates recommend when food should be eaten for freshness (“Understanding Food Labels”). Approximately 80 percent of Americans will discard food that is past its date labels (Foodprint.org). These labels are not infallible safety guidelines, with the article stating that these dates “*...are not federally regulated and only serve as manufacturer suggestions for peak quality*”. While it is reasonable to minimize the risk of illness, these date labels alone are not an accurate means of judging food safety, and the desire to only eat during peak quality means food that is perfectly edible – yet less appetizing – is wasted.

Data Analysis

To understand how and why American families waste food, we analyzed data from ReFED. ReFED is a non-profit organization that helps create data-driven solutions to combat food waste. We chose to base our studies off of ReFED’s information as they were the most thorough, recent and organized. Most of the other sources we found were either paywalled, or too vague to draw any meaningful conclusions. Each of ReFED’s .csv files contains data from many perspectives of food waste such as: specific food categories, causes of waste across sectors, and state populations. All of ReFED’s data can be downloaded directly from their website.

Surplus Cause Analysis

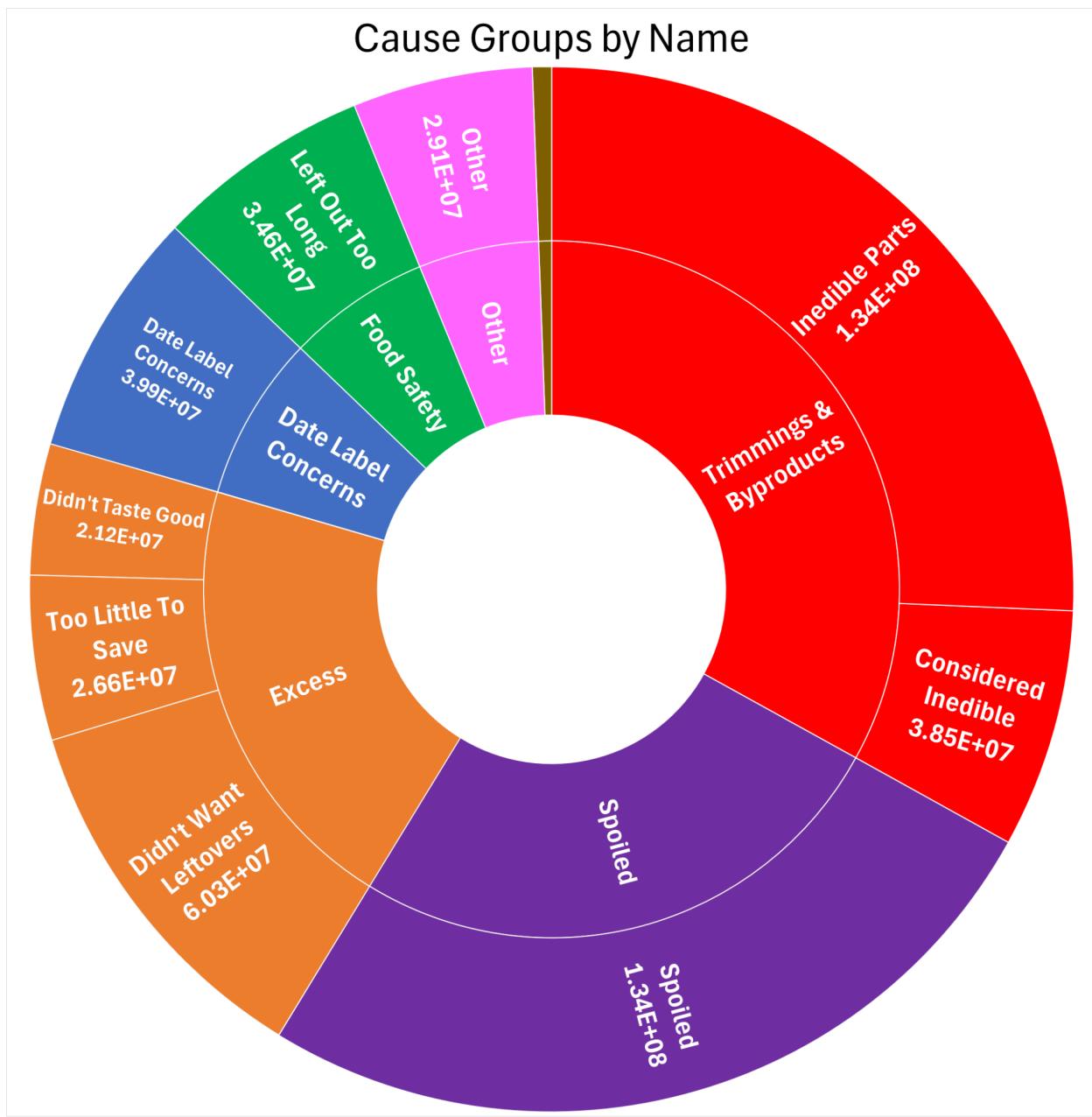
We downloaded data detailing the causes of the food surplus in North America from the years 2010 to 2022. This file was titled *ReFED US Food_Surplus_Cause_Summary*. We also downloaded data detailing where food was wasted in each state, titled: *ReFED*

US_State_Food_Surplus_Summary. Information from both files were analyzed and transformed to relate food amounts with their causes. The following categories are represented as columns in *ReFED US Food_Surplus_Cause_Summary:* **year, sector, sub_sector, food_type, cause_group, and cause_name.** Each row records the total amount of tons of surplus as **tons_surplus_due_to_cause, us_dollars_surplus_due_to_cause, tons_inedible_parts or tons_not_fit_for_human_consumption.** Each row of the dataset includes a unique combination of categories and a matching count for each. There are no duplicate entries for the exact same sources, null values or other data that needed immediate cleaning. To focus on North American families, we filtered specifically for the sector value **residential.** It was here that we found the basis for many of the claims we read about food waste.

The reasons for waste were categorized under **cause_group**, with each group also having subcategories of **cause_name**. The three most significant cause groups were *Food Trimmings & Byproducts, Excess and Spoiled* food (in descending order). *Food Trimmings & Byproducts* are defined as parts of a product that were removed during the cooking process such as bones, skins, and stems. Excess refers to additional food that was edible but for some reason was not eaten, while *Spoiled* food is simply food that became inedible overtime (ReFED.org). This should not be confused with the cause name *Left Out For Too Long* – under the cause group *Food Safety* – which only applies to food that deteriorates when unrefrigerated or otherwise not stored properly: “*Food that is discarded due to safety concerns because it was left out or unrefrigerated for too long*”. The *Spoiled* category description on ReFED’s website implies that it relates to food that was stored properly, but deteriorated long enough to be inedible: “*Product that was pulled because it was determined unfit for human consumption due to decay or deterioration.*”. It is also worth noting that some cause groups and names were more relevant to the agricultural and

retail sectors. The *Food Safety* cause groups was among the least influential causes of waste in the residential sector, with the cause names *Packhouse Losses (Not Marketable)*, *Catering Overproduction*, and *Overproduction* not appearing at all in our analysis.

As mentioned, cause groups encapsulate multiple cause names, giving further specification to how food was wasted. Some cause names are titled identically as their respective cause group. The most significant cause names under each group are as follows: *Spoiled* was self-explanatory (same cause_name *Spoiled*), *Trimmings & Byproducts* was most caused by *Inedible Parts*, and *Excess* was most caused by *Didn't Want Leftovers*. The latter two categories are particularly telling as they relate strongly to families. ReFED mentions *Inedible Parts* comes purely from the residential sector, while *Didn't Want Leftovers* is “*Leftover prepared food that is edible but left uneaten and is not stored for later consumption.*” Out of all the cause names, *Inedible Parts* was the most concerning, creating over 130 million tons of surplus food, with *Didn't want Leftovers* creating over 60 million tons and *Date Label Concerns* just under 40 million tons. Furthermore, each waste cost created massive economic losses. *Excess* cost just under \$700 billion in surplus, *Trimmings & Byproducts* cost ~\$660 billion, and *Spoiled* cost ~\$650 billion.



*Note: The unnamed sliver represents *Mistakes & Malfunctions*, with a single cause name:

Cooking Issues (3.095229e+06 tons)

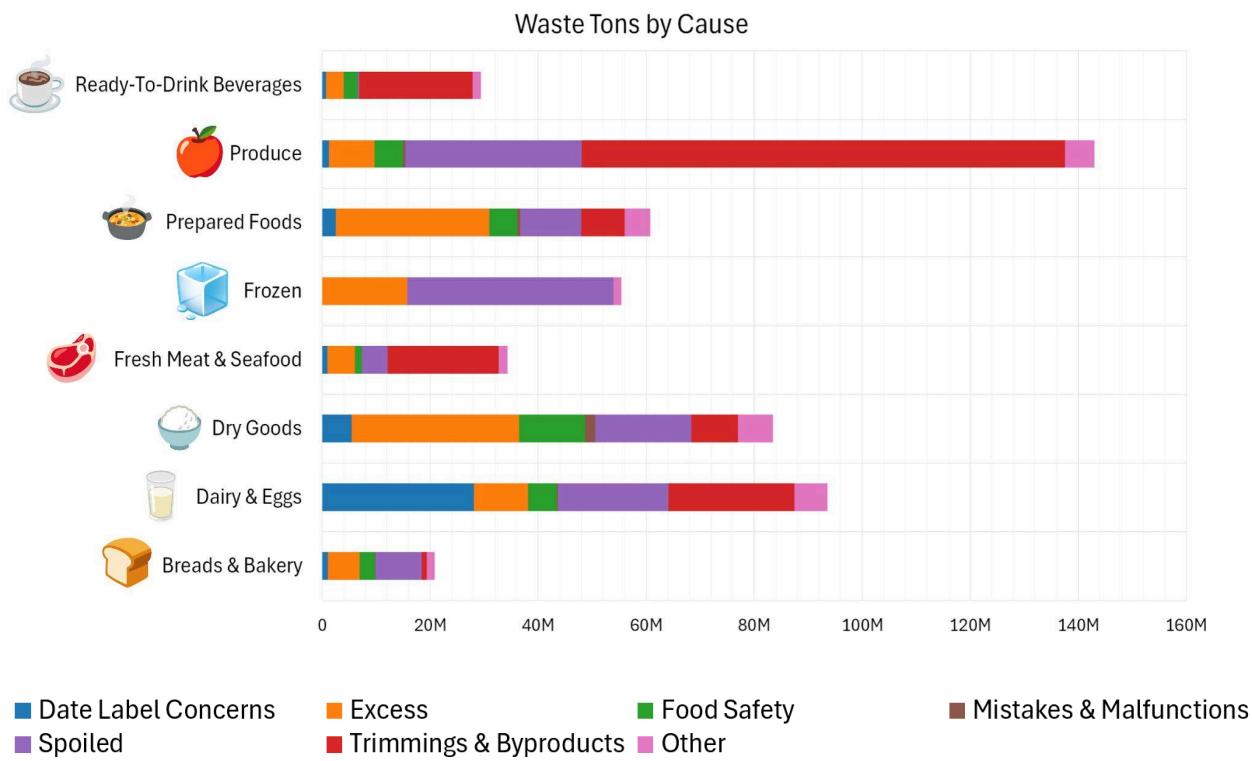
cause_group	cause_name	tons_surplus_due_to_cause
Date Label Concerns	Date Label Concerns	39948950
Excess	Didn't Want Leftovers	60332142
Excess	Too Little To Save	26567535
Excess	Didn't Taste Good	21162810
Food Safety	Left Out Too Long	34648251
Food Safety	Food Safety Recall	0
Mistakes & Malfunctions	Cooking Issues	3095229
Other	Other	29052379
Spoiled	Spoiled	1.34E+08
Trimmings & Byproducts	Inedible Parts	1.34E+08
Trimmings & Byproducts	Considered Inedible	38450219

What Food is Wasted

Due to their nature of consumption and storage, some foods are wasted much more than others. The food being wasted is specified under **food_type**, which has the following values: *Dry Goods, Produce, Breads & Bakery, Dairy & Eggs, Fresh Meat & Seafood, Frozen, Prepared-Foods and Ready-To-Drink Beverages*. The *Frozen* category does not share any items with *Fresh Meat & Seafood* (ReFED.org) and is likely referring to frozen dinners that could include meat or seafood (i.e chicken, steak, shrimp), but do not come in choice cuts for cooking. Such cuts of food are likely under *Prepared Foods*, as they are sold in the delis and seafood sections of grocery stores. Any items sold in these store sections are also considered *Prepared Foods*, even things such as sandwiches, pasta salads and rotisserie chicken. *Prepared Foods* also

encapsulates any prepared food in the food service sector, which could include restaurants (ReFED). Despite this, we considered *Prepared Foods* in our analysis as they could be residential waste if they end up in someone's home. We feel as if leftovers that are brought from a restaurant, spoil in the refrigerator, then thrown away are fundamentally the same as leftover home cooked meals that meet the same fate. The *Ready-To-Drink* category includes any pre-packaged drinks immediately ready for consumption that are not alcohol, water or soft drinks (ReFED.org). Similarly to the *Frozen* category, *Ready-To-Drink* items can include ingredients that would come from another food category (i.e fruit in smoothies, milk in milkshakes), but do not actually share items with other categories.

Our analysis indicates that *Produce* (~140 billion tons), *Dairy & Eggs* (~93 billion tons), and *Dry Goods* (~83 billion tons) are the top three most wasted foods. Produce consists of both fruit and vegetables, even if they were cut up and pre-packaged (ReFED.org). Each waste cause was transformed by its contributions to a specific type of food. *Produce* was wasted most by *Trimmings & Byproducts* (~89 billion tons), *Dairy & Eggs* were wasted most by *Date Label Concerns* (~28 billion tons), and *Dry Goods* were wasted most by *Excess* (~31 billion tons). This means, families are wasting a majority of their food by not using trimmings from produce, throwing out milk and eggs due to their sell-by dates, and buying too many shelf-stable items. To our surprise, *Breads & Bakery* was the food type that created the least amount of waste, with its strongest cause group being *Spoiled*. This was surprising because the abundance of dry goods and lack of spoilage for breads was not emphasized in our initial readings of other food waste research. Bread is similar to many dry goods such as grains or rice, and is a grocery staple. We expected it to trail behind *Dry Goods* as being one of the most wasted foods. However, this actually occurs with *Prepared Foods* (~60 billion tons wasted), being the fourth most wasted.



food_type	cause_group	tons_surplus_due_to_cause
Breads & Bakery	Spoiled	8523368
Breads & Bakery	Excess	5906873.375650619
Breads & Bakery	Food Safety	2832245
Breads & Bakery	Other	1430090.6201879696
Breads & Bakery	Date Label Concerns	1058412.9587898126
Breads & Bakery	Trimmings & Byproducts	947385.9712777433
Breads & Bakery	Mistakes & Malfunctions	109250.6
Dairy & Eggs	Date Label Concerns	28079079.384423144

Dairy & Eggs	Trimmings & Byproducts	23360201.82116024
Dairy & Eggs	Spoiled	20418296.209765922
Dairy & Eggs	Excess	10029531.190279126
Dairy & Eggs	Other	6134536.1229766235
Dairy & Eggs	Food Safety	5356024.836185637
Dairy & Eggs	Mistakes & Malfunctions	211831.81438910816
Dry Goods	Excess	31075551.233049132
Dry Goods	Spoiled	17801561.578277916
Dry Goods	Food Safety	12105969.265198335
Dry Goods	Trimmings & Byproducts	8643475.265479187
Dry Goods	Other	6461977.547364815
Dry Goods	Date Label Concerns	5433136.918587488
Dry Goods	Mistakes & Malfunctions	1898553.8471017038
Fresh Meat & Seafood	Trimmings & Byproducts	20560756.61602146
Fresh Meat & Seafood	Excess	5156237.080812425
Fresh Meat & Seafood	Spoiled	4733977.5431328565
Fresh Meat & Seafood	Other	1634226.9278550858
Fresh Meat & Seafood	Food Safety	1264461.2696912386
Fresh Meat & Seafood	Date Label Concerns	951778.7674659283
Fresh Meat & Seafood	Mistakes & Malfunctions	17547.625783503227
Frozen	Spoiled	38179283.04194332
Frozen	Excess	15702769.638333242
Frozen	Other	1539487.2194400122
Frozen	Date Label Concerns	0
Frozen	Food Safety	0

Frozen	Mistakes & Malfunctions	0
Frozen	Trimmings & Byproducts	0
Prepared Foods	Excess	28385375.213736862
Prepared Foods	Spoiled	11324762.800331088
Prepared Foods	Trimmings & Byproducts	7993225.3184437705
Prepared Foods	Food Safety	5236007.161167211
Prepared Foods	Other	4829176.447912005
Prepared Foods	Date Label Concerns	2530935.5799076967
Prepared Foods	Mistakes & Malfunctions	480981.52020099445
Produce	Trimmings & Byproducts	89503774.37312552
Produce	Spoiled	32656056.34986825
Produce	Excess	8457582.589240037
Produce	Other	5420425.763158982
Produce	Food Safety	5322210.238950775
Produce	Date Label Concerns	1218303
Produce	Mistakes & Malfunctions	365430.0748515826
Ready-To-Drink Beverages	Trimmings & Byproducts	21020858
Ready-To-Drink Beverages	Excess	3348565.9781380123
Ready-To-Drink Beverages	Food Safety	2531333.560870154
Ready-To-Drink Beverages	Other	1602458.4498903472
Ready-To-Drink Beverages	Date Label Concerns	677303.9181560142
Ready-To-Drink Beverages	Spoiled	237831.9101858854
Ready-To-Drink Beverages	Mistakes & Malfunctions	11633.082563780403

Key Insights from Cause Analysis

The data from ReFED reveals important aspects about the process in which Americans waste food. This, coupled with our findings concerning food culture as a whole, illustrate a clear cycle of waste. First, food is purchased in excess with unreasonably large portion sizes. Then, meals with massive portions are cooked, with scraps left for the trash. Leftovers and stand-alone staples are forgotten then left to spoil. The spoiled food is found and disposed of, creating the need to shop again and repeat the cycle. Our analysis showed *Food Trimmings & Byproducts* was the biggest cause group for waste, and the *Inedible Parts* cause name belonged only to the residential sector. This suggests that American families are not only throwing out many food scraps, but also the aforementioned idea that families are buying more food than they can eat. The over-purchasing of food can also be seen in the Excess cause group, the third greatest cause of waste.

As for the types of foods wasted, *Produce* being wasted by *Trimmings & Byproducts* likely persisted due to the preference to not eat certain parts (i.e. skins and peels). This also coincides with the creation of large meals, which would naturally create many food scraps. *Dairy & Eggs* were likely prone to *Date Label Concerns* as they are food staples that spoil quickly. The phenomena behind *Dry Goods* could be due to the larger portion sizes in processed foods, which has been rapidly increasing since the 1980s (Young and Nestle). If there are more of these foods to begin with, and families are quick to discard foods past date labels, then more food will inevitably be thrown away. Keep in mind that the ReFED data measures food waste from 2010 to 2022, well after the 1980s. The portion sizes of processed foods has likely increased dramatically, giving Americans an grandiose idea of how large meals “should” be. With this in mind, families could be cooking enormous meals that they cannot reasonably finish, especially if

they are catering to others. Therefore, *Spoiled* food is also a strong cause of waste, being the second greatest and comparable to the surplus wasted from *Excess*. Surely, if too much food is being purchased and cooked, it would reflect similarly in the amount that goes bad when it is not eaten. This pattern still persisted when each value in the *food_type* category is subdivided into cause groups of descending surplus waste. *Spoiled* was one of the top three cause types in every food type except *Ready-To-Drink Beverages*. This means that unless the food was actually something that families could drink, *Spoilage* and *Excess* were always the driving force towards its waste.

Waste by Expenditure

In addition to our analysis with ReFED data, we also deemed it necessary to look into consumer spending data. This was for a few reasons. We wanted to see how American consumer spending habits had changed over time, and if these changes could have contributed to food waste habits amongst American households. Additionally, one of our initial hypotheses was that food waste might be more prevalent amongst higher income households, as they can afford to spend more on food, and thus have a great capacity to waste. To that end, we sourced data from the Bureau of Labor Statistics, and their yearly Consumer Expenditure Surveys. We specifically analyzed income and expenditure data from 2010 to 2020, broken up into quintiles based on income. We had two primary conclusions we wanted to draw from this data: First, how has consumer food spending changed from 2010 to 2020. Has it increased significantly? Could this spending confirm that US food waste is tied to overspending on food? Second, and arguably more important, is there a discrepancy between food spending in lower income, and higher income consumer units? What role does economic class play in food waste?

Expenditure Analysis

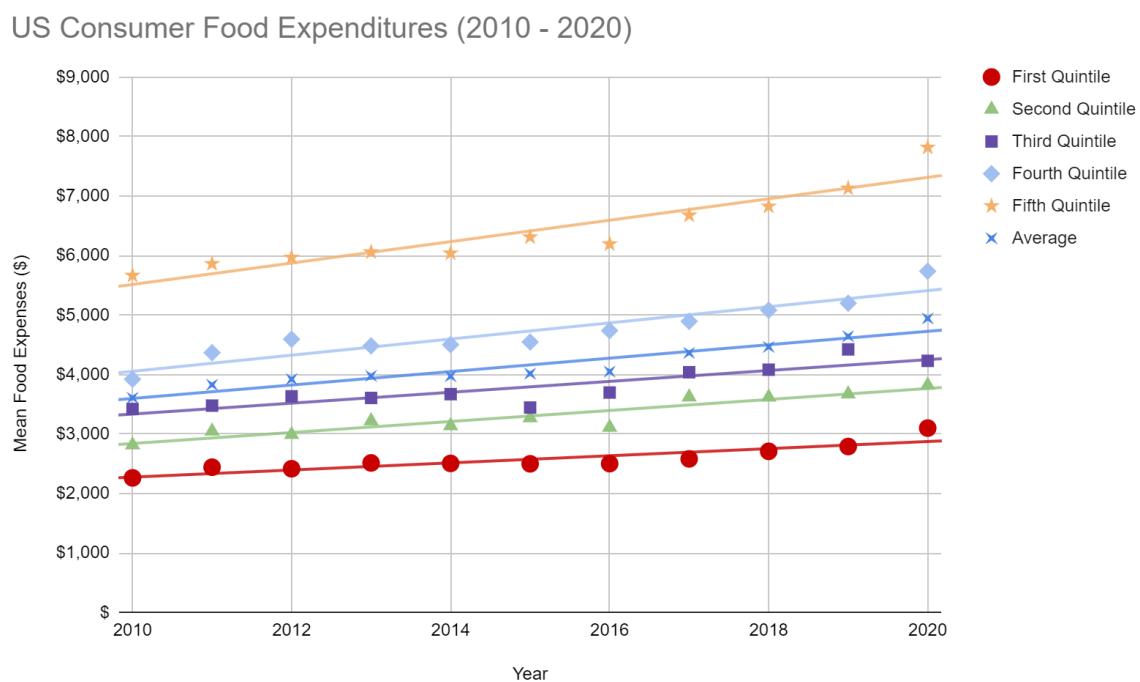
The BLS Consumer Expenditure Survey Data data is broken up into quintiles based on the income levels of each individual consumer unit. A consumer unit is defined by the BLS as any one of the following: “(1) all members of a particular household who are related by blood, marriage, adoption, or other legal arrangements; (2) a person living alone or sharing a household with others or living as a roomer in a private home or lodging house or in permanent living quarters in a hotel or motel, but who is financially independent; or (3) two or more persons living together who use their income to make joint expenditure decisions.”(BLS Consumer Expenditures Survey Glossary). Each survey contained data on anywhere between 120 million, and 135 million consumer units, including all of their expenditures for the year (not just food), income, demographic data, etc. In regards to food expenditure data specifically, the food category is divided into two groups: ***Food at Home***, which covers food expenditures related specifically to food that is intended to be stored, prepared, or consumed at home; and ***Food Away From Home***, which covers things like restaurant visits and take out. This study focuses on residential food waste, thus we specifically focused on ***Food at Home***.

Food at Home is further divided into multiple subcategories, including: *Cereals and bakery products*; *Meats, poultry, fish, and eggs*; *Dairy products*; *Fruits and vegetables*; and *Other foods at home*, and each of these subcategories is again further divided into specific foods, such as *Beef*, *Eggs*, *Fresh Fruits*, *Bakery Products*, etc. It is important to recognize that these categories do not directly overlap with the food categories in ReFED’s data, most notably in that frozen food is its own category in the ReFED data, while it is distributed throughout all other food groups in the BLS data. As such, the BLS data will be useful for drawing broader

conclusions regarding spending and food waste, but not as relevant in determining how spending relates to waste in specific food categories.

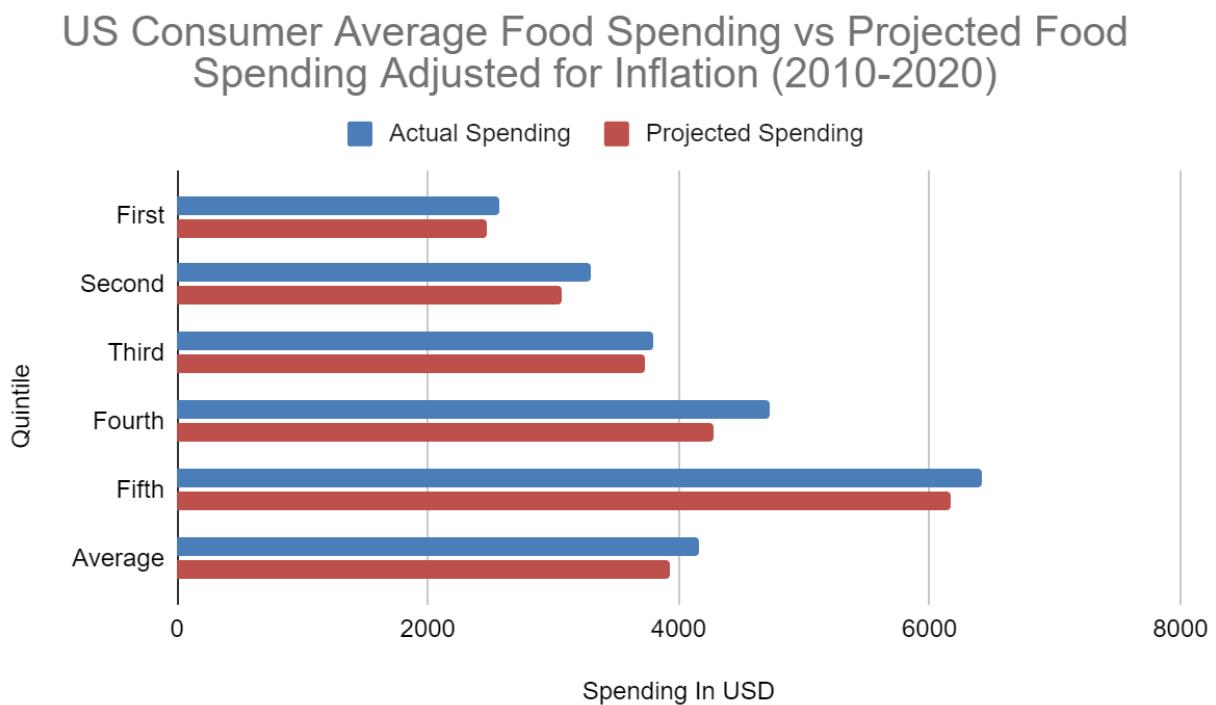
How Food Spending has Changed

From 2010 to 2020, the amount of money US consumers have spent on food has increased, as depicted in the following table:



An increase in spending on food could suggest that US consumers are purchasing more food. We even witness this trend when accounting for outside factors that might have contributed to increased spending. The most immediate factor to consider is inflation. Using the BLS's inflation calculator, we adjusted the value of 2010's food expenditures for each subsequent year based on inflation, and then compared that value to the money actually spent on food for each quintile for every year. We then took the average actual and projected spending over the entire

time period for each quintile. The results are depicted below:

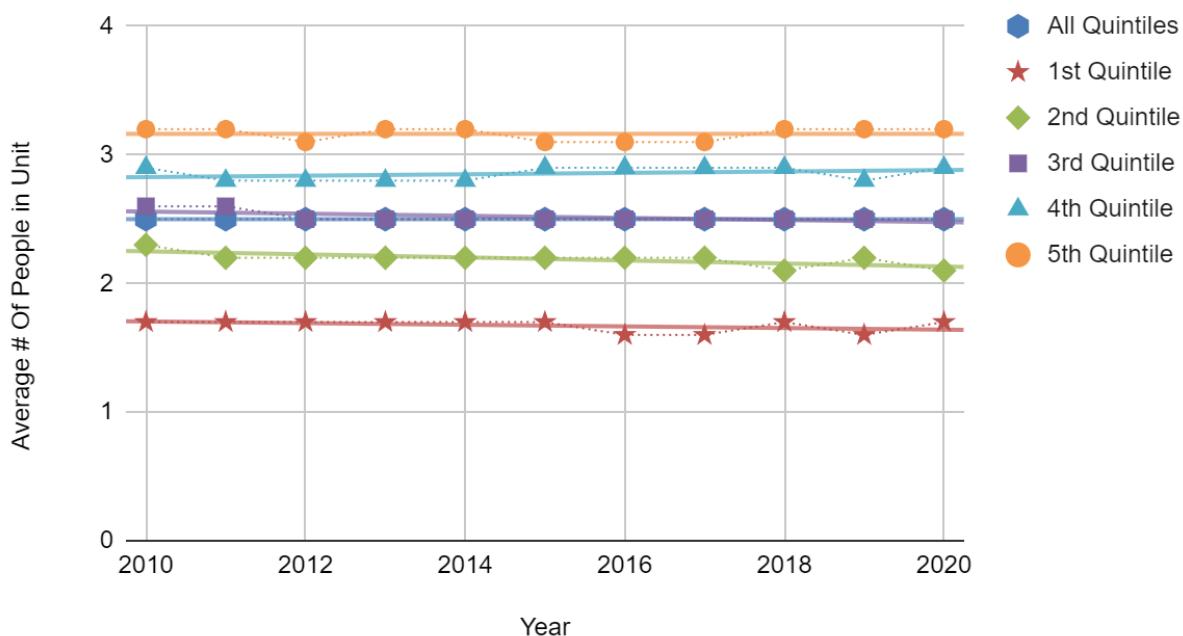


Across every single quintile, consumer food spending has outpaced inflation, meaning overall, US consumers are indeed spending more on food, even accounting for inflation. The most immediate explanation for an increase in food spending, is that people are purchasing more food, and evidently, buying more food could be a key contributor to food waste. However, this line of thinking only tracks if we assume that the population has remained stagnant, and that households have not grown over this same period. Thankfully, the Bureau of Labor Statistics data also provides data regarding changes in consumer unit size, which were used to determine whether or not household size played an inherent factor in this change in consumer spending.

From the year 2010 to 2020, household sizes across the united states have remained remarkably stagnant, According to the BLS Consumer Surveys, household sizes have either

remained stagnant, or declined from 2010 to 2020 across every economic quintile in the United States. Across all quintiles, the average household size has remained stagnant at 2.5 persons per consumer unit. When examining individual quintiles, 1, 4, and 5 remained stagnant at 1.7, 2.9, and 3.2 persons per household respectively, while quintiles 2 and 3 had decreases from 2.3 to 2.1, and 2.6 to 2.5 respectively.

American Household Growth (2010 - 2020)



Ultimately, while the BLS data cannot be used to definitively conclude that US consumers are purchasing larger quantities of food, what can definitively be concluded is that they are spending more money on food, and that this is not the result of increased household size.

Analysis Across Quintiles

While many of the trends in consumer spending are consistent across quintiles, there are some variations between the individual quintiles that could suggest if food waste is more

prevalent among certain economic groups. When analyzing the data, the most noticeable difference between quintiles is the amount of food spending. As expected, as we move up to higher quintiles, food spending increases. This is to be expected, as higher quintiles have more income to spend. Higher quintiles also tend to have more persons in each consumer unit, which would imply a need for more food, thus more spending. However, what is interesting is the difference in spending per quintile. For quintiles one through four, each quintile sees a jump of between five and six hundred dollars on yearly food spending from the previous, with the average spending for all US consumer units sitting somewhere between quintiles three and four. However, the jump from the fourth to the fifth quintile is closer to 1600 dollars. While this could potentially be because the fifth quintile has the highest number of people per consumer unit, the difference in average consumer unit size from quintile 5 to 4 is .3. The difference of .3 is also seen between quintiles 4 and 3, as well as 3 and 2 (2 is the only outlier, being .6 people per unit higher than quintile 1). This might suggest that the difference in price is not necessarily the result of increased spending to account for more people, but a general increase in spending due to buying more expensive food. These spending patterns could also be caused by people buying significantly more food than is needed by the other quintiles, which would imply that food waste could be more prevalent in higher earning groups.

We can also analyze the inflation breakdown between quintiles. Here, the two most interesting quintiles to analyze are three and four, as three has the smallest difference between projected and actual spending, while four has the largest. While spending outpacing inflation is consistent across all quintiles, three and four are notable outliers. We might expect that the highest income group would have the largest disparity, and the lowest would have the smallest, as it is easier for wealthier units to spend more money on food as time goes on, which is

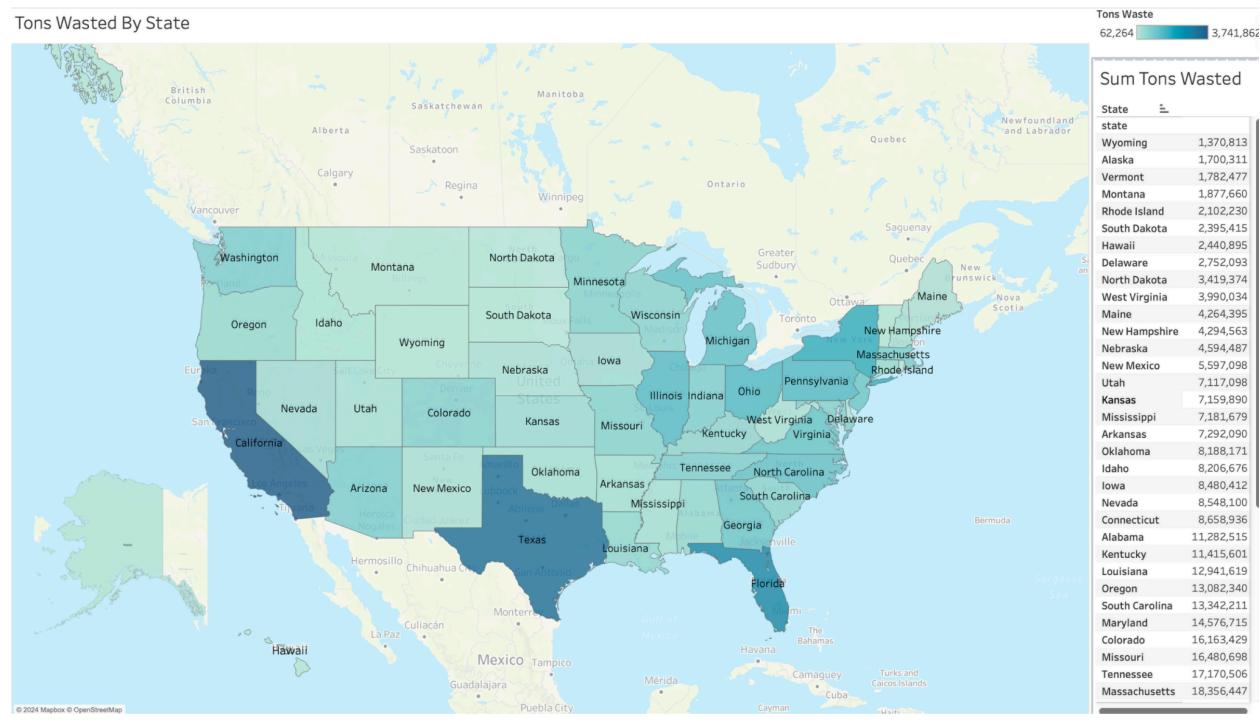
conversely true for less affluent units. Ultimately however, this is not the case, and instead the greatest disparity is concentrated in the middle, suggesting that all quintiles are spending more on food over time, and that higher economic standing does not necessarily translate to increased food spending.

Waste By State Demographics

Within the ReFED website, we found a dataset that broke down food wastage at the state level. Using this data, we were able to analyze and compare food waste trends across different states and identify high-waste regions. The state data was organized in a CSV file that broke down food waste by sector, subsector, subsector category, and food type. Meaning, each sector had a subsector that it fell under, and that subsector had a subsector category that fell under a food type. For instance, a loaf of bread wasted in a household would fall under the residential sector, and the Breads & Bakery food type. Because the ReFED data had information across multiple sectors, (Retail, Foodservice, Farm, etc), we needed to filter out the data just to the Residential sector. After filtering out for the residential sector, we cleaned up some of the unnecessary columns provided with the ReFED data, such as sub sector category, seeing that the subsector category was not applicable to the residential sector. We also removed columns such as downstream_mtco2e_footprint, upstream_mtco2e_footprint because we felt that they were unnecessary for our analysis. Once this data was cleaned up, we uploaded it to Tableau Desktop as a CSV file to further analyze the data.

State Demographics Analysis

Across the United States, food waste varies. This hypothesis was further proven by greater analysis of ReFED data titled: *US_State_Food_Surplus_Summary*. Our analysis was conducted through Tableau, using their data visualization software. By importing the data into Tableau and filtering for the residential sector, we were able to see a clearer picture of residential food waste in the United States. We first noticed that the states of California, Texas, Florida, New York, and Ohio wasted the most food. These states also had the largest sum of tons wasted for each year throughout the 2010s. In the year 2010 alone, California wasted the most with approximately 3.7 million tons of food in the residential sector. Alternatively, states with less food waste include Wyoming, Montana, Vermont and Rhode Island, with Wyoming in particular being the least wasteful (just 64 tons of food in 2010). After collecting and visualizing the ReFED data, we analyzed the populations of each state in order to find a pattern of food wastage. From the year 2010 to 2020, the following are five states with the highest populations in decreasing order: California, Texas, New York, Florida, and Illinois. Alternatively, Wyoming, Vermont, North Dakota, Alaska, and South Dakota had the lowest state populations (in decreasing order). The top states in both categories (least and most wasteful) fluctuate between rankings, but would consistently remain in the top five for their respective categories.



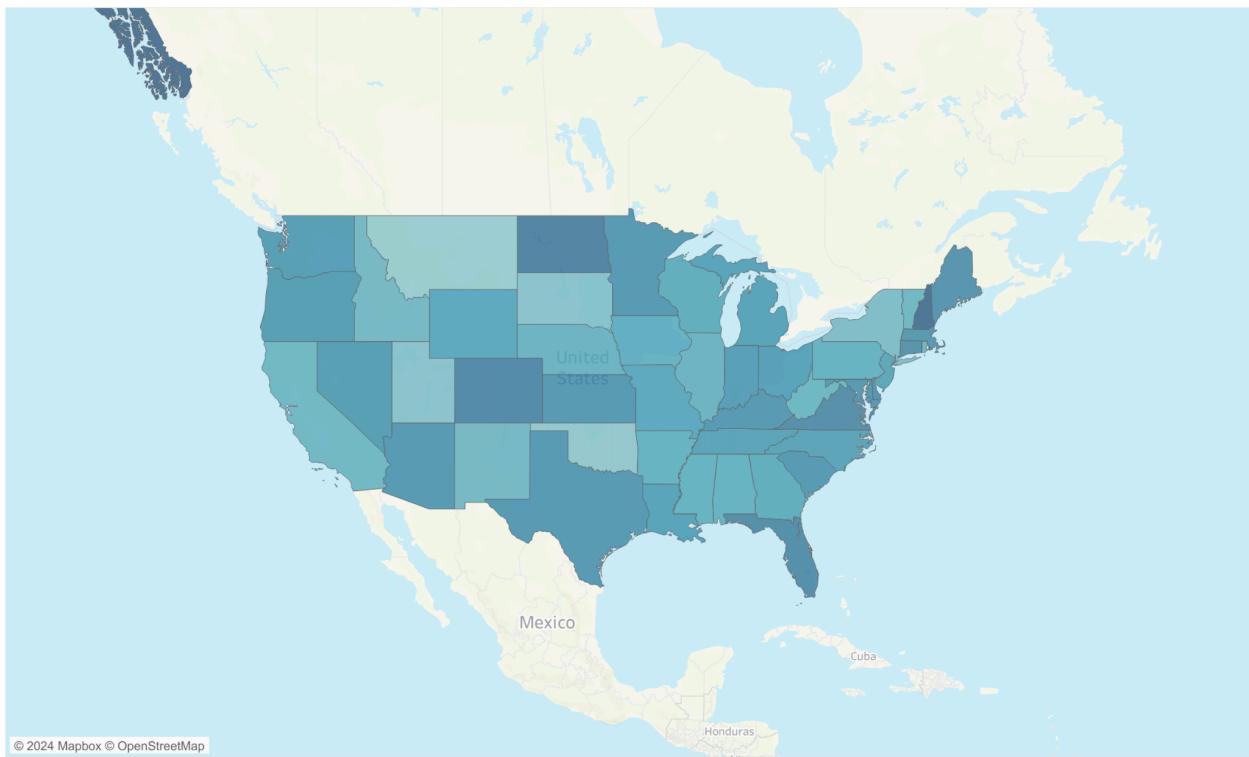
In order to gain more insight into our data, we decided to visualize our state wastage by capita. We wanted to see if the populations of each state had any correlation with the levels of wastage, allowing us to identify trends, disparities, and other patterns that could inform more targeted waste reduction strategies. Before we could visualize our data at the per capita level, we needed to do further data cleaning and preparation. The previous cleaned data set, *US_State_Food_Surplus_Summary_Residential*, still needed to be organized to include census data on the U.S. state population, which would be used in our per capita analysis. First, the precleaned Residential data was placed into a new excel file for a cleaner workspace. Then we placed a filter on this data, which allowed for easy segmentation. Since our population data was segmented by year, we decided to do the same for our ReFED data, which eased the process of implementing per capita data in Tableau. Since we only needed the *Sum Tons Wasted* column in order to implement our per capita calculation, we copied that column into a new sheet as well as

the column with the data for each population (*Population*) by state using an Excel function. Both data sets—the population sizes and the ReFED surplus summary—were both categorized by year, with each year put in its own Excel sheet for organization. Meaning, each sheet would have the *Sum Tons Wasted* by its respective year in one column, and the *Population* in another column. After this cleaning, we uploaded each .CSV file into a new Tableau tab to do further analysis.

With Tableau properly structured, we were able to see per capita fluctuations clearly. In the year 2010, the top 10 states with the most tons wasted per capita were Alaska, New Hampshire, North Dakota, Colorado, Florida, Virginia, Delaware, Connecticut, Maine, and Massachusetts. These states fluctuated in order of appearance throughout the decade, an example being New Hampshire becoming the top food wastage state per capita in 2011, but all of aforementioned states remained top wastage states throughout the decade. On the contrary, Hawaii, Montana, Oklahoma, Utah, South Dakota, New York, Idaho, New Mexico, Rhode Island, and Vermont had the lowest tons of food waste per capita.

Originally, we hypothesized that food waste in the US would correlate by population, meaning that states with higher populations would have higher per capita food wastage. However, we discovered this was not the case. In our map, we found that Alaska, New Hampshire, Colorado, North Dakota, and Florida were consistently in the top 10 states with the most food waste, from 2010 to 2020. However, all of these states except Florida were not in the top 10 let alone top 20 states with the highest populations. Because of this, we decided to do more research on the cultural and socioeconomic aspects.

2010 Residential Food Waste



States	Tons Wasted Per Capita (2010)	States	Tons Wasted Per Capita (2010)
Alaska	0.1691	North Carolina	0.1183
New Hampshire	0.1662	New Jersey	0.1177
North Dakota	0.1514	Missouri	0.1136
Colorado	0.1444	Wyoming	0.1136
Florida	0.1402	Wisconsin	0.1104
Virginia	0.1392	Georgia	0.1102
Delaware	0.1367	Iowa	0.1065
Connecticut	0.1365	Pennsylvania	0.1061

States	Tons Wasted Per Capita (2010)	States	Tons Wasted Per Capita (2010)
Alaska	0.1691	North Carolina	0.1183
New Hampshire	0.1662	New Jersey	0.1177
Maine	0.1335	Alabama	0.1057
Massachusetts	0.1323	Mississippi	0.1055
Kansas	0.1310	Arkansas	0.1044
Maryland	0.1295	Nebraska	0.1036
Minnesota	0.1294	Illinois	0.1035
Arizona	0.1293	West Virginia	0.1008
Texas	0.1280	California	0.1003
Kentucky	0.1279	Vermont	0.0995
South Carolina	0.1277	Rhode Island	0.0993
Oregon	0.1255	New Mexico	0.0969
Indiana	0.1248	Idaho	0.0968
Nevada	0.1246	New York	0.0893
Washington	0.1232	South Dakota	0.0849
Ohio	0.1225	Utah	0.0843
Louisiana	0.1208	Oklahoma	0.0785
Michigan	0.1204	Montana	0.0744
Tennessee	0.1188	Hawaii	0.0457

Possible Solutions

The unfortunate truth surrounding residential food waste in the United States is that there is no easy solution to combating it. Residential food waste isn't the result of one problem that

can be easily combated, but rather, the result of dozens upon dozens of key areas that exacerbate waste, compounding it into the issue we see today. While analyzing the effectiveness of individual strategies for combating food waste exists outside the scope of this research, we believe it is imperative to identify potential solutions that could help reduce food waste in the United States based on what we have seen in our research.

Composting

One of the most immediate solutions to combat food waste is composting. Whether at the level of individual households or local governments. Based on our analysis of waste causes, *Trimmings & Byproducts* are the highest cause of food waste across all foods, being the highest cause of food waste in *Produce*. It is also worth noting that Produce was observed to be the largest food type contributing to waste by a large margin. Therefore, produce is a prime candidate for composting. When food is composted, it is not considered waste as it continues to have use after consumption. Composting promotes soil health and supports the growth of future crops by allowing nutrients in food to return to farms. Unfortunately, food is not being composted nearly as much as it should. According to the EPA, in 2019, only 5% of food waste was successfully composted. With so much wasted food being compostable, more US households composting would be an incredible way to slash waste numbers.

If composting has so much potential to combat waste, why is it so rarely done? The most straightforward solution to composting would be government funded programs, similar to trash collection or recycling initiatives. While this would no doubt be a shot in the arm for composting efforts, It would require policymakers to actually implement and maintain these programs, which could be a challenge. Some such programs do exist, the most substantial of which is in

New York City, which is in the process of rolling out full complementary curbside compost pickup across all five boroughs (The Official Website of the City of New York). However, it has taken decades for this goal to come to fruition just in New York. Implementing such a solution across the United States will also be a challenge. The other option would be to leave it up to individual households to take responsibility for composting by creating their own bins, raising awareness of the issues, and possibly government incentives to compost. However, given the lamentably small rates of composting, and how much the residential sector already wastes, trusting consumers with proper composting may only go so far. Ultimately, composting is one of the most difficult food waste solutions to implement on a large scale.

Conscious Food Habits

Another method to reduce household waste could be the widespread changing of attitudes and habits towards how US households consume food. In essence, this solution would involve individual households being more aware of food waste, and choosing to consume food in a way that could help diminish it. The second most common cause of waste was *Excess*, and the third was *Spoiled* food. Recall that excess is defined as food that was edible, but simply discarded as opposed to being eaten (i.e plate waste), while Spoiled referred to food that rotted even under proper storage conditions (i.e forgotten leftovers). Households need to be more conscious of how much food they can actually eat, and take steps to not prepare more than necessary. Perfection is not necessary here, but even small decreases in portion sizes make a big difference towards combating excess from waste. To help address spoiled foods, households just need to keep better track of their food supply. Being aware of what things are purchased, when they are going to

expire, and prioritizing eating food before it spoils are possible strategies. By adopting smarter habits, households can have help diminish food waste in the United States

Sadly, while better habits would be effective in theory, they are difficult to implement in reality. There is no real way to guarantee conscious food habits on any institutional or governmental level, because institutions cannot truly regulate the minds of individuals. The burden of consuming food in a way that discourages waste would ultimately fall on the shoulders of individual households, where governing bodies have little control. Punishing individuals for wasteful behaviors could also be fruitless. Given how small the scope of research on residential waste already is, it would be even harder to track every individual household to scrutinize their habits. At best, people can be made aware of the prevalence of food waste, and the ways they can help prevent it. Government initiatives could motivate this thinking, but never ensure it occurs with actual laws and enforcement. But it is ultimately up to the individual to take the initiative to make these lifestyle choices, and no rule of law can guarantee it.

Limiting Spending

Similar to the previous solution, encouraging families to limit overspending is an excellent way to combat food waste in the residential sector, because it helps prevent waste from entering the residential sector in the first place. Our economic analysis indicated that food spending is on the rise year over year, even after inflation is taken into account, and assuming this correlates with the amount of food purchased, creates an alarming pattern. Simply put, families are purchasing more food when they already have too much going to waste. Limiting the amount of food they purchase is a key step in cutting back on residential food waste. This

solution can also be considered on a quintile by quintile basis, as the wealthiest populations spend uncharacteristically more on food than lower populations.

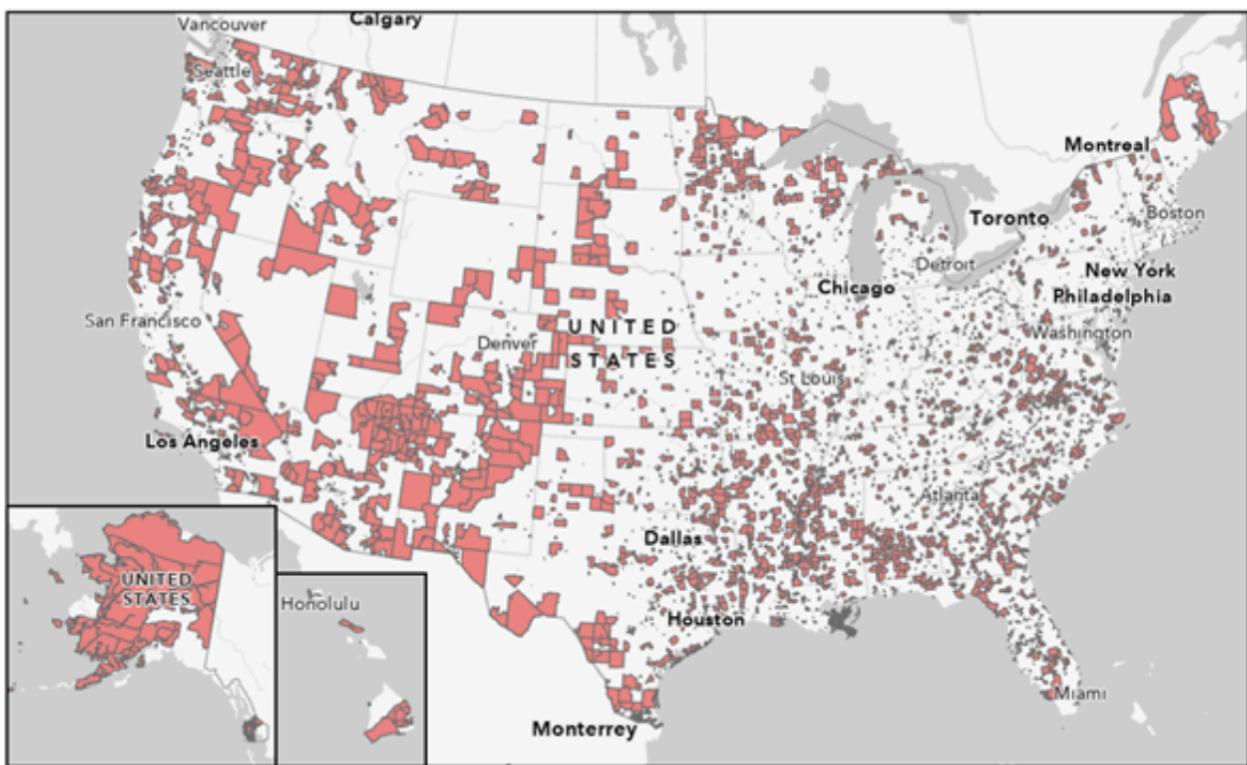
Much like with conscious food habits, there is no real way to regulate decreased food spending on a mass scale. Rather, the implementation of this solution would have to fall to the individual households themselves, and they might perceive spending less as inconvenient or difficult. This is especially important to consider given the aforementioned pressure to buy more food than is needed: supermarkets encourage overspending, and social pressures encourage pleasing others over minimizing waste (Parker et al). It could be inconvenient to not take advantage of supermarket sales, and difficult to give guests smaller meals without fear of judgment. Similarly to food habits, awareness for this solution could be a viable method, but beyond that, conscious spending would have to be the responsibility of each household.

Food Deserts and Low Access Communities

A considerable amount of food is wasted due to consumers being unaware of their consumption and habits. While this can be attributed solely as a fault of consumers, additional research has revealed a systemic issue contributing to waste: food access. Many Americans live in food deserts where food is over purchased out of desperation – not ignorance – often leading to waste. A food desert is defined as an area that is typically low-income and underserved, where access to affordable, healthy food options is limited. Food deserts occur due to the absence of grocery stores, farmers' markets, and other vendors from most homes. All over the country, food deserts are very prevalent. However, some states have a higher frequency or number of food deserts than others. The U.S. The Department of Agriculture Economic Research Service

publishes the Food Access Research Atlas, which is a dataset that measures areas whose populations lack reliable access to food markets. This report mapped out areas in the country that are at lower income levels, and have lower access to food, based on the U.S. Census data. Low income areas are considered to be places that have a poverty rate of at least 20% , or have a median family income of less than 80% than that of the surrounding area, which includes surrounding cities and metropolitan areas. Low food access areas are places that have, “*least 500 people in or 33 percent of a census tract who live more than 1 mile from the nearest supermarket in an urban area or more than 10 miles from the nearest supermarket in a rural area.*”

Food Deserts in the United States

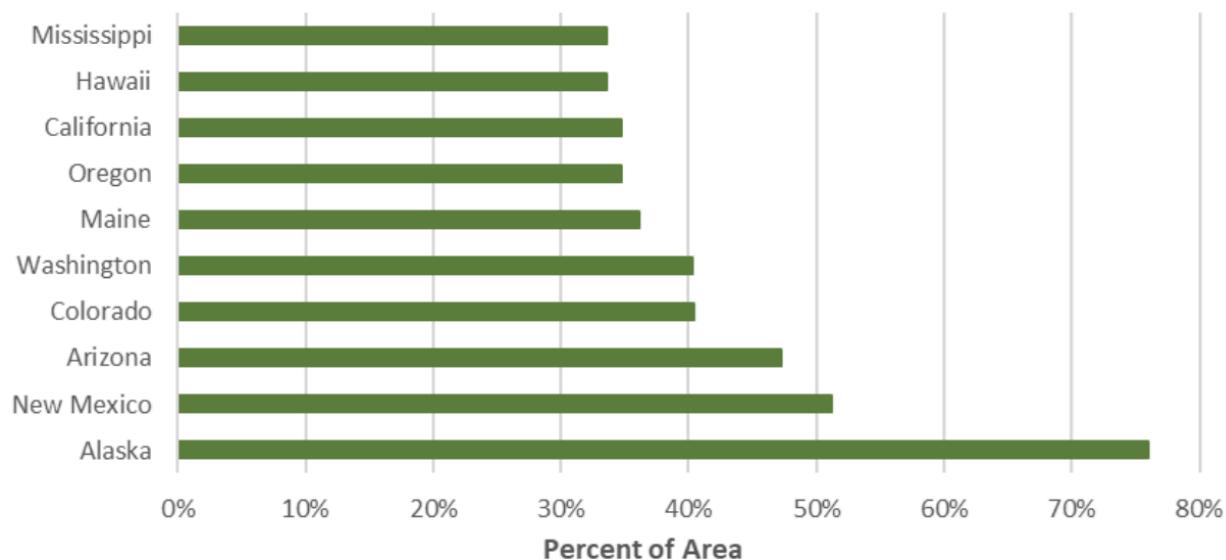


Food deserts by county in the US [U.S. Department of Agriculture Economic Research Service]

In our state analysis, we found that Alaska, Maine, Colorado, Florida, and New Hampshire were consistently top wastage states throughout 2010 to 2020. According to the The U.S. The

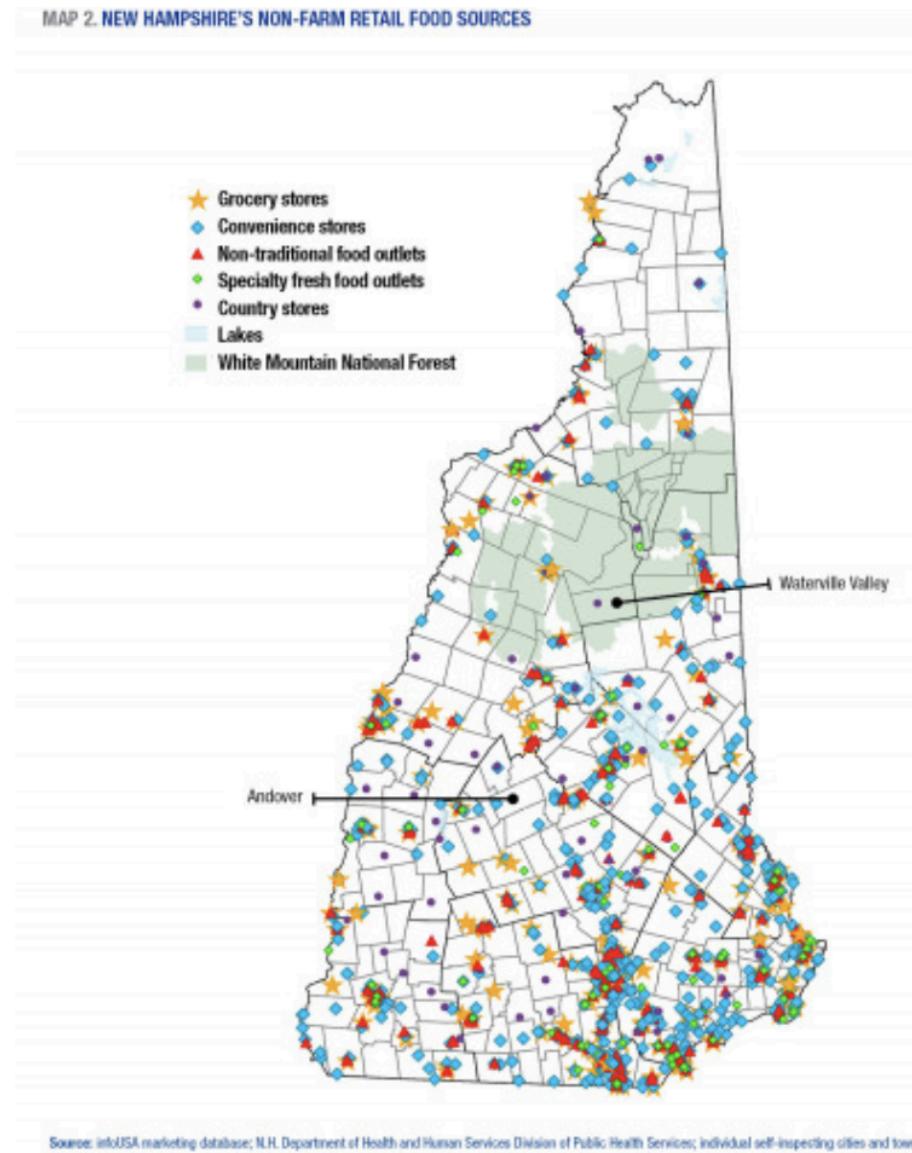
Department of Agriculture Economic Published Research Service, Alaska, Colorado, and Maine have the highest percent area of food deserts in the country, with Alaska being the highest in the country. Families who live in food deserts are more likely to purchase food in bulk due the time and cost of completing shopping trips. However, oftentimes the food stashed will end up being wasted due to early expiration dates or quick spoilage.

Top States by Percent of Area in a Food Desert



New Hampshire, however, is not listed as a food desert for one reason, income. A ‘traditional’ food desert defined by the The U.S. The Department of Agriculture is an area that is, “low income and having low access to food.” In 2010, New Hampshire had one of the highest average household incomes in the United States, ranking seventh among all states. However, many areas in New Hampshire struggle with accessible food options. “With its ten counties, approximately 47% of the population and 84% of the landmass in NH is considered rural.” Due to the state’s

rural landscape, many of its residents face challenges in accessing supermarkets and fresh food markets. This scarcity is primarily due to the significant distances and transportation issues prevalent in less populated areas, making food accessibility a critical issue despite the high average income.



The map above maps the food landscape in New Hampshire in 2019, with each dot representing a non farm retail food source. In the map, some countries have more retail food sources than

others, specifically with the more populated southern portion of the state having easier food access. However, there are some counties as shown in the map that have one or no retail food stores, with that being a decent chunk of the state.

Improving Food Accessibility

As determined in our analysis at the state level, one of the key commonalities between all of the top wasting states was that a majority of them had an extremely high amount of food deserts. As previously discussed, curtailing overbuying is a great way to reduce food waste. Thus, if food deserts are causing such significant contributions to waste, food accessibility would need to be improved to curtail waste. Reducing food deserts is more realistic to implement compared to other solutions: although the building of new grocery stores and supermarkets in vulnerable areas cannot be enforced, it can be highly incentivized by local governments. This would in turn help reduce one key factor to the overbuying of food in the United States.

Conclusion

The battle to end food waste in households across the United States of America will be a long and costly one. Through our analysis, we have managed to decipher some extremely key components of the food waste problem in the US. We've determined what food is being wasted (no food is spared from food waste), and to what degree each individual category of food is wasted. We determined how specific foods are wasted, what causes them to be wasted, and which of these causes are most prevalent. Our economic analysis suggests that food waste may only get worse as consumers spend more on food year over year, and that while the most affluent

members of society spend significantly more on food, it does not inherently mean that they are entirely responsible for the food waste crisis, as it exists everywhere. Furthermore, our analysis at the state level has revealed that food waste can be greatly exacerbated by a lack of infrastructure allowing people to have easy access to the food they need, encouraging them to overbuy and in turn, creating more waste.

It's important to remember why food waste is such an important issue in the first place. According to the Food Research and Action Center, 1 in 8 US households suffered from food insecurity in 2022. This number is absolutely unacceptable. There is more than enough food in this country to ensure everyone is well fed, yet extreme amounts of food are wasted every day. By accurately identifying how and why food waste occurs in the residential sector, we provide clarity into how we prevent it, ensuring all households can one day live well and not waste.

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Appendix

All ReFED data can be found at the following webpage. Click the button that says “Download Data” to obtain .csv files. <https://insights-engine.refed.org/food-waste-monitor>

Food Waste Cause Analysis (Savion Watson):

<https://github.com/SavionW-Works/Food-Waste-Cause-Analysis>