BREN SCHOOL OF
ENVIRONMENTAL SCIENCE & MANAGEMENT
UNIVERSITY OF CALIFORNIA SANTA BARBARA

Investigating the drivers of household food waste and methods to increase public awareness

A Group Project submitted in partial satisfaction of the requirements for the degree of Master's in Environmental Science & Management for the Bren School of Environmental Science & Management

Prepared by:
Holly Capell
Adam Knox
Travis Lee
Brooke Malik

Faculty Advisor: Gary Libecap, PhD

Client: The Innovation Center for U.S. Dairy

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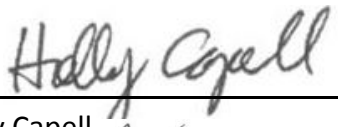
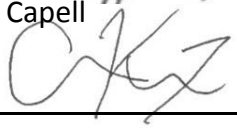
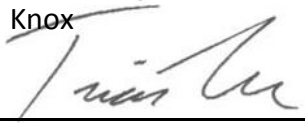


Holly Capell



Adam Knox



Travis Lee

Brooke Malik

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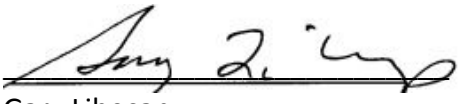
The Group Project is required of all students in the Master's of Environmental Science & Management (MESM) Program. It is a three-quarter activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Final Group Project Report is authored by MESM students and has been reviewed and approved by:



Gary Libecap

Acknowledgements

We would like to thank the following people who assisted us by generously sharing their knowledge, time, and energy: Juan Tricarico (Director, Cow of the Future) and Erin Fitzgerald (Senior Vice President, Sustainability) from the Innovation Center for U.S. Dairy.

We would like to extend a special thanks to Professor Gary Libecap, our faculty advisor at the Bren School of Environmental Science & Management at the University of California, Santa Barbara, for his invaluable guidance. Matthew Potoski, Professor of Corporate Environmental Management and Sarah Anderson, Assistant Professor of Environmental Politics also provided incredibly valuable insight to this project. Our short film, *I Am The 40%*, could not have been completed without Chris Jenkins, Lecturer in the University of California, Santa Barbara Film and Media Studies department and our undergraduate team member, Michelle Musser.

We would also like to thank the following individuals from the Bren School of Environmental Science & Management at the University of California, Santa Barbara for their continued support and assistance: Amy Burgard, Group Project Coordinator; Satie Airame, Assistant Dean of Academic Programs; Corlei Prieto, Student Affairs Manager; PhD Candidates Darcy Bradley and Trevor O'Grady; BJ Danetra, Senior Events Manager; and the Bren School Finance Group.

Finally, we are grateful to our friends and family who were extremely supportive throughout this process.

Abstract

Waste throughout the food system, or from farm to fork, in America causes a multitude of environmental problems. Food which is thrown away or wasted at any stage of the supply chain for any reason eventually rots in our nation's landfills, where it releases methane into the atmosphere as it decomposes. Beyond leading to methane emissions, food waste also implies the waste of all resources such as fertilizer, energy, and water embodied in that food. Significant social and economic problems also persist as a result of food waste in the United States, where experts assert that overall 40% of food produced is lost or wasted.

Among all of the stages in the food supply chain, losses at the consumer level, both in and out of the home, are the largest both in terms of weight and value. While the United Kingdom has conducted several studies on the drivers of consumer food waste, such studies are lacking in the United States. Similarly, countries such as Australia, Ireland, and others have strived to raise consumer awareness about the problems surrounding food waste and encourage simple behavioral changes that can help to mitigate the problem. Our project, consisting of a survey of Californians regarding their knowledge, attitudes, and behaviors related to food waste as well as our integrated communications campaign, aims to help fill both of these voids within the United States.

We believe that the results of our survey, which was completed by over 1,000 adult Californians, reveal significant opportunities and potential for the United States to achieve reductions in food waste witnessed in countries which have made food waste a priority.

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Executive Summary

About

Food is perhaps one of our most valuable resources but, astoundingly, as much as 40% of it is discarded from farm to fork. Until recently, little attention or effort has been dedicated to reducing this widespread inefficiency in the food system of the United States. Other countries such as the United Kingdom and Australia have made reducing consumer food waste a national priority with in-depth studies and educational campaigns to stem the tide of this growing problem. This report builds on some of the successful research and campaign efforts of these other countries, as well as the limited research done here in the United States.

Our aim is to better understand the underlying behaviors and attitudes related to domestic food waste, in this case specifically within the state of California. We provide relevant background information about food waste and its impacts as well as comprehensive information about the survey and associated campaign we created in order to give the reader exposure to the problem with an understanding of how our project fits in with efforts to mitigate it.

Impacts

Economy

Food waste is responsible for one quarter of all freshwater used in agriculture as well as overutilization of arable land. It has also been estimated that 2% of all energy consumption in the United States can be attributed to food waste. With so much food wasted, it has been estimated that we spend over $1.3 billion transporting it to landfills where it decomposes to form methane, a highly volatile greenhouse gas (GHG).

Society

One in six Americans suffers from food insecurity, meaning they are not able to secure consistent access to safe and nutritious food. It contradicts common sense that a country with so many hungry people would also throw so much food away. Fixing this inefficiency to provide better living conditions for those in need of food could prove vital to the well-being of these U.S. citizens.

Environment

Food waste exacts a significant toll on natural ecosystems as well as the environment in general. From farm to fork, impacts can be observed that affect the quality and quantity of our freshwater supply, the productivity and health of our arable land, and the atmosphere of our

planet which controls the behavior of world climate. We will describe these impacts in further detail throughout the report.

Behavioral Drivers

We believe that U.S. consumers do not realize or understand the magnitude of the food waste problem we currently face. Research done by others in various countries has hypothesized the same and often found these theories to be true under widely accepted assumptions. This report outlines what is currently known about the causes of consumer food waste as well as our findings which both inform and support the consensus.

Our Approach

Methods

We decided that a survey would be the best method to investigate the drivers of food waste at the consumer level. Our survey was designed to elicit the behavioral drivers of food waste as well as knowledge of and attitudes toward the problem.

Survey

Our survey was completed by 1,185 adult residents of California. The survey was distributed statewide by SurveyMonkey, an internet-based survey distribution and collection service.

Campaign

Using the data from our survey we were able to craft a campaign against food waste using a website, Twitter account, and short film to deliver our message to consumers in California. The report will go into further detail on how we designed this campaign.

Results

We found that Californians do not generally know the extent of food waste impacts. For example, respondents overwhelmingly chose packaging as the greatest waste stream coming from households, when in reality food represents the largest source of household waste. They also significantly undervalued the monetary value per household of the food they throw out annually, which is likely to be upwards of $2,200. Unlike many other studies, we did observe that our sample understood different date labeling schemes used by retailers such as “best before” and “use by.” However, this may be due to our sample being older and more educated than the California average.

Conclusion

After completing this study and acknowledging the work of others, we believe that addressing this problem will undoubtedly be in the best interest of the state of California as well as the entire country. Food waste has both indirect and direct influences on climate change, unsustainable use of water and other natural resources, food insecurity of individuals, and the amount of disposable income we retain. In light of growing environmental awareness and a tough economic climate, coupled with the low-tech and low-cost characteristics of food waste mitigation campaigns, refining our food system to reduce food waste should be a feasible option to increase efficiency and reduce impacts. Additional attention and awareness through education campaigns will be critical in advancing the understanding of food waste impacts and could serve as a driver for widespread changes needed to decrease the nationwide food waste estimate of 40%.

Acronym Guide

BEA- Bureau of Economic Analysis
BTU- British Thermal Unit
EIA- Energy Information Administration
EPA- Environmental Protection Agency
ERS- Economic Research Service
EU- European Union
FAO- Food and Agriculture Organization of the United Nations
MJ- Mega Joules
MMT- Million Metric Tons
NSW– New South Wales, Australia
USGS - United States Geological Service
USDA- United States Department of Agriculture
WRAP - Waste & Resources Action Programme

Objectives

The main objective of this project was to understand the behaviors that lead to consumer food waste and assess awareness and concern for the issue in order to create an effective public awareness campaign. In order to achieve this objective, we created a survey to provide insight into consumer behaviors and attitudes. In particular, we wanted our survey to answer the following questions:

1) What are the drivers of consumer food waste?
2) Are consumers aware that food waste is a problem?
3) What would be more likely to motivate behavior change--the financial implications of wasting food, or the environmental impacts of food waste?
4) Are consumers willing to adopt behaviors that will help them to reduce their food waste?
5) Is there confusion about the true meaning of date labels?

Project Significance

Food waste has a large footprint on the planet and our economy, but to date has not received as much attention as environmental issues such as climate change, energy and natural resource consumption, and air pollution. Interestingly, food waste actually contributes to all of these larger environmental problems. For example, it is estimated that food waste is responsible for emissions of at least 113 million metric tons (MMT) of carbon dioxide equivalent each year, thus contributing to climate change [1]. Additionally, the GREET Life Cycle Assessment model developed by the U.S. Department of Energy, the emissions embodied in food waste are roughly equivalent to total emissions of all cars in the state of California, a total of 120 MMT of carbon dioxide equivalent each year (Argonne GREET Model 2013) [2]. In addition to greenhouse gas emissions, there are several additional environmental impacts associated with food waste, as well as significant economic and social implications.

Though food losses occur at all stages of the supply chain and some is unavoidable, the largest proportion of loss occurs at the consumer level [3]. Focusing on understanding the attitudes and behaviors that drive this problem is a difficult task; however, it is an important step in crafting messages or campaigns to reduce food waste now and into the future. We believe it is likely that the general public does not understand the full implications of wasteful behavior when it comes to food. This could be attributable to the fact that while food waste has garnered much attention and action from governments and organizations abroad, efforts in the United States are just beginning [4]. The results of our survey, which sought to gain a more thorough understanding of consumer knowledge, attitudes, and behaviors within the state of California, will add to the existing, though seminal, research on this subject of growing interest and also inform a public awareness campaign.

Background

Innovation Center for U.S. Dairy

In 1995, the National Dairy Research and Promotion Board and the United Dairy Industry Association board members created Dairy Management Inc., an organization responsible for increasing demand for U.S.-produced dairy products on behalf of America's dairy producers through the "checkoff program". U.S. dairy producers and dairy importers across the country invest in the dairy checkoff program which helps increase demand for and sales of dairy products and ingredients [5]. More than 300 national, state, and regional dairy producer board members direct funding for promotional and research programs. In 2008, the U.S. dairy industry came together to create a new research program with the intent of fostering new ways to work collectively in a pre-competitive manner and to create opportunities for the industry at large. The main part of this effort was the creation of the checkoff program, which is funded by the Innovation Center for U.S. Dairy. The Innovation Center (IC) is a non-profit organization which serves as a platform for creating innovative and progressive concepts to improve the dairy industry [6]. Within the IC are six departments that contribute the continuing goals of providing opportunities for the industry: Consumer Confidence, Health & Wellness, Research & Insights, Globalization, Dairy Research Institute, and Sustainability.

In fulfilling its commitment to sustainability, the IC has produced an array of information which helps guide industry stakeholder efforts to operate sustainably. Most notably, a comprehensive Life Cycle Assessment (LCA) study of fluid milk was completed in 2010, which established a quantified baseline of the industry's environmental impacts and led to the prioritization of improvement strategies. The main sustainability goal for the industry is to reduce greenhouse gas emissions throughout the supply chain by 25% by 2020 [6]. This goal is supported by IC produced programs such as Cow of the Future, Farm Smart, Farm Energy Efficiency, Dairy Power/Biogas Capture and Transport, Dairy Plant Smart, UV Pasteurization, and Dairy Fleet Smart, which all aim to reduce dairy's environmental footprint and increase efficiency throughout the supply chain.

Though the IC has taken progressive steps to improve the environmental performance of the dairy industry, there are still further opportunities for improvement to explore. With this realization, the IC Sustainability department proposed a project to our team at the Bren School of Environmental Science & Management, requesting that we identify and address an issue that would contribute to the center's overall sustainability goals. This project also needed to focus

on a topic that had not been previously addressed by the organization. We ultimately decided to focus our efforts on food waste, as its effects had not yet been explored at the IC.

Quantifying Food Waste

Accurately quantifying food waste, both from the consumer stage and from the food system as a whole, is extremely important in order to ensure that less food will be wasted in the future. As the old adage goes, "what gets measured gets managed." In other countries, such as the United Kingdom, concentrated efforts to accurately measure food waste throughout the entire system have informed policies and programs which have been credited with decreasing avoidable food waste from households by 18% [7].

Several studies which aim to quantify food waste have been conducted in the United States; unfortunately, none of them provides information that is sufficiently up to date or comprehensive and many rely primarily on anecdotal evidence. Further exacerbating the issue, studies are often not comparable as they have been conducted using disparate metrics and methods, or they do not attempt to measure waste from the same stages of the food supply chain.

Until now the most comprehensive study conducted in the United States was executed by the USDA in 1997. Unfortunately, that study focused only on waste streams generated by retailers and consumers. Though this study concluded by advocating for further research, significant progress has been made since [8].

Although our project does not seek to better understand the quantity of food wasted in America, selecting a benchmark to refer to throughout this report is necessary. Currently, the most current and complete study which seeks to model the quantity of food wasted throughout the entire food supply chain estimates that 40% of food, on a kilocalorie basis, produced in the United States is wasted [9]. This study was conducted using a validated mathematical model and the best available data from the USDA and the FAO. It is important to note, however, that data provided by the FAO is given for all of North America, which includes the United States, Canada, Australia, and New Zealand.

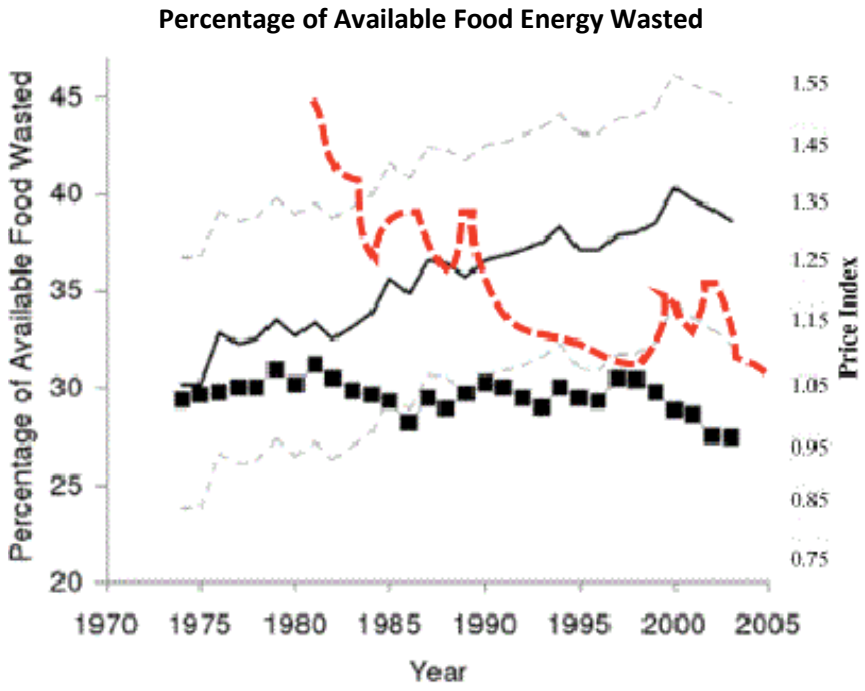


Figure 1: This figure shows that, according to research done by Hall, Guo, and Dore that the percentage of available food energy wasted in the United States has outpaced predictions made by the USDA (square trendline). Their estimations are represented by the solid black line. Overlaid in red is the consumer price index between 1980 and 2005 for food consumed at home. It is possible that decreases in food costs have led to increased waste. [9], [10]

Though FAO data is not specific to the United States, they provide the clearest picture of losses that occur throughout each step of the supply chain. Using this data, we have concluded that approximately 18.8% of all food produced in the United States is ultimately thrown away by consumers. This is an approximation; details on this calculation can be found in Appendix A. Though varying estimates of the total amount of food wasted in the United States exist, we will refer to the findings of Hall's model, which estimates that 40% of food produced in the United States is wasted [9]. Our estimation of the total percentage of available food energy that is discarded by consumers, 18.8%, was used in the development of an infographic (Appendix B) as part of our public awareness campaign.

Environmental Impacts of Food Waste

The environmental effects of food waste, and of the food system in general, are vast. By the time food reaches the average American consumer, whether at home or in a restaurant, food has traveled through a complex supply chain. Consider the several million glasses of orange juice that were consumed by Californians at breakfast this morning. First, the oranges had to be grown across the country in Florida, requiring the use of land, water, fertilizer, pesticides, and capital equipment such as tractors and other necessities of modern farming. Most of these oranges were then likely harvested by mechanical shakers. The oranges were then transported in 400 horsepower trucks to a processing plant. Next, the oranges were washed with high powered hoses to remove any excess dirt or insects. After being mechanically de-stemmed, the oranges were eventually juiced. Next the juice was pasteurized to remove any potentially dangerous bacteria, a process which also lengthens the product's life. Once it had been packaged, the juice was shipped in refrigerated trucks to wholesalers and then to retailers across the country, and was ultimately purchased by consumers. At each stage of this chain, our nation's natural resources are consumed, creating environmental impacts [11].

This section of our report will provide a brief overview of some of the primary environmental effects of the United States food system. The analysis provided will in no way be exhaustive. Further research is necessary in order to fully understand and quantify the entire impact of our demand for food. Where possible, quantitative data, based either on published figures or estimates synthesized through simple calculations, will be provided. However, assigning quantitative values for environmental impacts which are very difficult to quantify, such as monetizing the damages to native ecosystems due to land use change, is outside the scope of this project. In those cases qualitative information will be provided, though we believe that future efforts to quantify or monetize all environmental effects of delivering food to tables in the United States would be of value.

It is important to keep in mind that even if it were possible to identify, either quantitatively or qualitatively, all environmental impacts created by our country's system for producing and distributing food, the resulting picture would still be incomplete and inaccurate. This is due to significant importing and exporting of food. According to the USDA, the United States is the world's largest agricultural exporter. Exporting produce is often an attractive option for farmers in the United States as they have some of the world's lowest production costs, especially for crops such as wheat, soybeans, almonds, and sunflower oil. In fact, respectively, 45%, 34%, 71%, and 60% of these crops are exported and overall about 1 out of every 3 acres of crops planted is exported [12]. Simultaneously, as of 2007, the United States imported approximately $80 billion worth of food from abroad, a figure which is increasing steadily year

after year [13]. The implication of trading food across national borders is that, from a life cycle assessment standpoint, some of the environmental effects of producing food domestically are attributable to the people abroad consuming the end products. Similarly, we as Americans are also the consumers of food items produced abroad, where associated environmental impacts will be experienced. For example, American flagged fishing vessels use approximately 800 million gallons of fuel on an annual basis (marine diesel weighs about 7 pounds per gallon), with every ton of fuel burned yielding approximately 2.25 tons of carbon dioxide equivalent [14]. Simple calculations indicate that these ships release greenhouse gas emissions of approximately 6.3 million tons each year. However, much of the seafood caught by these ships will be exported. Furthermore, approximately 84% of the seafood consumed by Americans is imported, making allocation of environmental impacts a very complex task [15]. Therefore, simply measuring domestic environmental impacts would not present an accurate or meaningful picture.

There are two main phases in which food waste exerts impacts on the environment: upstream and downstream. Upstream impacts include all processes which occur before food reaches the end consumer. Inherently, these impacts will be felt regardless of whether the food is consumed or discarded. So while it is in the best interest of our environment to lessen these impacts in any case, these impacts are regarded as especially egregious when the food, and hence all of the resources consumed in producing and distributing the food, is not eaten. The downstream impacts of food waste occur after consumers have thrown food away and the food is ultimately disposed of in a landfill. Evaluations of both the upstream and downstream impacts in this report will primarily address the variable direct inputs into processes, rather than the impacts of generating capital goods. For example when evaluating the environmental impact of grocery stores, energy requirements will be considered while the impact of constructing the grocery store itself will not.

Food Supply Chain

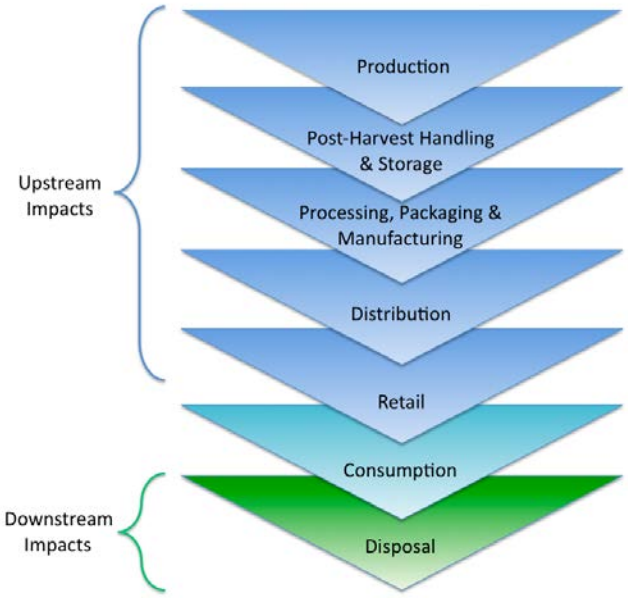


Figure 2: Original graphic outlining the typical flow of food throughout the supply chain

Upstream Impacts

Production

The production of food is a very resource intensive process and represents a significant portion of the environmental impacts caused by the entire food system. While continuous innovation in the agricultural sector has led to ever increasing productivity, it still requires a significant amount of land to feed America's growing population of 330 million. In fact, over 50% of the contiguous United States is used for agricultural purposes [16]. In addition to the negative effects of applying chemical pesticides and fertilizers to this land, diverting the land from natural ecosystems and the erosion that results from food production also impact the environment. For example, over half of our nation's wetlands have been repurposed, and 80% of this has been for agricultural use [17]. Beyond providing critical habitats for many plant, bird, and animal species, wetlands also provide society with important ecosystem services such as temporary stormwater storage, groundwater recharging, and pollution control. As demand for food increases in the future, it is possible that more land will be needed to meet it if efficiency gains should slow. If this occurs, less habitat area will be available to wildlife and important ecosystem services will be eliminated. Therefore reducing waste at the consumer level, and at all other stages of the supply chain, could help to protect remaining natural lands.

Erosion of topsoil is another important impact of producing food. While erosion is a natural process and new topsoil is slowly generated over time by the weathering of the earth's surface, agriculture causes accelerated erosion, which occurs at a rate that far outpaces geology's ability to replenish the earth's topsoil. In fact, David Pimentel writes "In all instances, we must consider soil to be a non-renewable resource. The rate of soil formation is very slow: it takes from 300 to 1000 years for nature to replace the soil that a field can lose to erosion in 25 years at a loss rate of 1 mm per year" [18]. It is estimated that agricultural processes in the United States lead to the erosion of 6.9 billion tons of topsoil annually. Beyond making soil less fertile, erosion runoff from soil also damages nearby aquatic ecosystems. Erosion can reduce growth of aquatic plants as stream waters become murky and excess sediment can also clog the gills of fish, making them more susceptible to disease. Impacts such as these have ripple effects that extend far beyond the original deposition site [18].

As previously mentioned, agricultural innovation has resulted in the ability to produce increasingly greater quantities of food per unit of land. Much of this increased productivity is due to the application of chemicals to the land in the form of fertilizers, pesticides and herbicides. Both the production and use phases of these products negatively impact the environment. For example, production of these substances releases greenhouse gases into the atmosphere. The following table summarizes current research into the carbon dioxide equivalent emissions from producing a kilogram of various fertilizers and pesticides in the United States.

Fertilizer	Equivalent carbon emission (kg CE/kg)	
	Range	Mean ± S.D.
Fertilizers		
Nitrogen	0.9 - 1.8	1.3 ± 0.3
Phosphorous	0.1 - 0.3	0.2 ± 0.06
Potassium	0.1 - 0.2	0.15 ± 0.06
Lime	0.03 - 0.23	0.16 ± 0.11
Pesticides		
Herbicides	1.7 - 12.6	6.3 ± 2.7
Insecticides	1.2 - 8.1	5.1 ± 3.0
Fungicides	1.2 - 8.0	3.9 ± 2.2

Table 1: Carbon Dioxide Equivalent Emissions from Fertilizer and Pesticide Production [19]

Given that the United States produces approximately 10 million tons of both nitrogen and phosphorus-based fertilizers annually, resulting greenhouse gas emissions can be estimated at 15 million tons of carbon dioxide equivalent [19].

Herbicides	Equivalent C emissions (kg CE/kg a.i.)
2, 4-D	1.7
2, 4, 5-T	2.7
Alachor	5.6
Atrazine	3.8
Bentazon	8.7
Butylate	2.8
Chloramben	3.4
Chlorsulfuron	7.3
Cyanazine	4.0
Dicamba	5.9
Dinoseb	1.6
Diquat	8.0
Diuron	5.4
EPTC	3.2
Fluazifop-butyl	10.4
Fluometuron	7.1
Glyphosate	9.1
Linuron	5.8
MCPA	2.6
Metolachlor	5.5
Paraquat	9.2
Propachlor	5.8
Trifluralin	3.0

Table 2: Equivalent carbon emissions for common herbicides [19]

Similarly, the United States produces, packages, and distributes millions of tons of pesticides, herbicides, and insecticides with significant associated greenhouse gas emissions [20]. Greenhouse gases, primarily nitrous oxide, are also released during the use of nitrogen fertilizers.

The use phase has additional implications on our nation's water quality and downstream freshwater and marine ecosystems. Modern agriculture typically involves applying an excess of fertilizer to farmlands, meaning that it is not fully absorbed by crops. Those excess nutrients

remain in the soil until they are drained, either naturally or artificially, into surface groundwater, then streams and rivers, and ultimately into oceans. Pesticides, herbicides, and fungicides follow the same route but have disparate environmental effects. The sheer volume of these two categories of pollutants, combined with that of fecal matter from animal agriculture, make agriculture nonpoint source pollution the leading source of water quality impacts on surveyed rivers and lakes according to the 2000 National Water Quality Inventory [21].

Both phosphorus and nitrogen fertilizers that enter surface water lead to eutrophication; a process in which water bodies receive excess nutrients that stimulate excessive plant growth. While eutrophication does occur naturally, excess concentrations of nutrients have resulted in an unnaturally high rate of occurrence. Eutrophication resulting from excess nutrients occurs not only in the streams and rivers within the immediate vicinity of agricultural land, but also far downstream and in oceans. Initially, the increase in available nutrients leads to an increase in production and biomass of phytoplankton, algae, and other macrophytes. This increased biomass can alter the natural balance of the local ecosystem. For example, when eutrophication occurs in streams in which salmon, a carnivorous species, are endemic, salmon populations often decline while non-native, and thereby less desirable, herbivorous species thrive. Eventually this excess plant life dies, and as it decays, oxygen levels are severely depleted. This results in fish kills and leaves a “dead zone” where animal life cannot exist. When highly water-soluble nitrates drain into groundwater rather than surface water, groundwater is often polluted to a point where it is no longer potable [22].

Like nitrogen and phosphorus, pesticides can also be detected in streams draining from agricultural land and in shallow groundwater. A study conducted by the USGS between 1992 and 2001 revealed that at least one pesticide compound was present 97% of the time in streams and 61% in shallow groundwater. Many of these compounds are persistent, meaning that they do not easily break down and could ultimately reach oceans as well. Herbicides such as Atrazine, the most commonly detected pesticide in streams and groundwater, are endocrine disrupters that cause reproductive problems in mammals, amphibians, and fish [23].

A final variable input into agriculture is energy. While significant proportions of our available fresh water and land are dedicated to livestock and crop production, agriculture is directly responsible for only slightly more than 1%, or 1.1 quadrillion BTUs, of energy use in the United States as of 2002. Energy is, however, an important input into production, as farming has become increasingly mechanized [24].

Post-Production Stages

After leaving a farm and before food reaches consumers, it typically flows through the following stages: post-harvest handling and storage; processing, packaging, and manufacturing; distribution; and retail. Environmental impacts from these intermediate steps are not as significant as those incurred during the production phase. Thus, a decrease in consumer waste would not necessarily, at least in the immediate future, lead to a decrease in environmental damage resulting from these intermediate stages. For example, if consumer waste was drastically reduced, perhaps less of our country's fresh water would be demanded by the agricultural sector, all other factors held equal. However, a decrease in consumer food waste may not lead to a decrease in the number of grocery stores or the energy and resources used by those stores.

A simple framework to analyze the environmental impacts associated with all of these steps is to break them down into two main categories: energy inputs and capital inputs. Accounting for all environmental impacts of food production would necessarily include a life cycle assessment of all capital equipment used to produce and distribute our nation's food supply. However, this is outside of the scope of this project. Instead, we focus on impacts from energy use, which is more closely correlated with an increase or decrease in food production.

According to an input-output material flow analysis performed by the USDA Economic Research Service in 2007 using data from the Bureau of Economic Analysis' Benchmark Input-Output Tables and the Energy Information Administration's State Energy Data System, these intermediate stages accounted for approximately 6.3% of all energy consumed in the United States in 2002 [25].

Consumers and Restaurants

Consumers may be surprised to learn that the energy used in homes and restaurants to prepare food almost equals the amount of energy used by the formerly mentioned intermediate steps, coming to approximately 6% of the country's energy use. The USDA has recognized a troubling trend: between the years of 1997 and 2002, per capita energy use in the United States declined 1.8%, per capita food related energy use increased by 16.4% with most of the increase occurring during final preparation in homes and restaurants [25]. Decreasing food waste streams from these two outlets would significantly reduce energy demand and thus prevent millions of tons of greenhouse gasses and other pollutants from entering the atmosphere.

Downstream Impacts

The environmental impacts of food waste do not end when food scraps are discarded. After being discarded, virtually all food waste is then transported to landfill facilities where it is disposed of. Due to increased recycling rates of paper products, food waste now represents the nation's largest component of municipal solid waste [4]. This process requires capital and energy inputs, but the most significant environmental impact from the end of life stage is the resulting methane emissions.

Over time and a four phase long process, food waste is decomposed anaerobically in landfills. If food decomposed aerobically it would re-emit the carbon it had sequestered as carbon dioxide, but because of the anaerobic conditions, methane emissions are created instead. Methane is a powerful greenhouse gas, which over a 100-year time horizon has 25 times the global warming potential than that of carbon dioxide [26]. It has been determined that nearly 25% of our nation's methane emissions result from food rotting in landfills [27].

Economic Impacts of Food Waste

With the population of the United States projected to reach 438 million by 2050 [28], meeting the increased demand for food will require more resource inputs from our finite reserves of water, arable land, and energy feedstock materials. Furthermore, the extraction and consumption of these inputs have significant economic implications. Given the current economic climate and resource scarcity, it will be increasingly important to understand the impacts of food waste and associated resource consumption on the economy.

Natural Resources

Water

Agriculture uses 80% of consumable fresh water in the United States [29] and one quarter of agricultural water consumption can be attributed to food waste [9]. Additionally, demand for water will likely increase dramatically due to population growth and increasing use of water for industrial and extractive processes [30].

One in three counties in the U.S. is projected to become water stressed by 2050 [31]. As water becomes scarcer, there will be less available for industrial processes and manufacturing, which could hamper economic development. Furthermore, while the price of water has historically been low, encouraging inefficient use of the resource, future water scarcity could lead to increased prices. Higher water prices would negatively impact households and industries that consume water and food prices would also be expected to increase [32]. In order to account for current and future needs, we will need to utilize more efficient methods of water consumption.

Land

Approximately 50% of land in the United States is used for agriculture [33]. Regardless of whether the food produced on this land is consumed or discarded, the significant amount of land used for food production necessarily reduces the supply of land that could be available for other purposes, such as urbanization [34]. In addition to the fact that so much land is used to produce food, modern agricultural practices contribute to decreases in land value and quality. As the population grows it is possible that even greater amounts of land will be necessary to meet the demand for food and/or more intensive farming practices will further degrade the valuation of the land.

Energy

In analyzing the energy requirements of the U.S. food system, we must take into account all of the upstream energy use embodied in food. In 2011, food production accounted for 8 percent, or 8.52×10^{15} mega joules, of the total energy consumption in the U.S. [35]. This figure includes the energy used in agriculture, transportation, processing, and handling of food. Another study estimated energy consumption of the food system at 15.7 percent of total 2007 U.S. energy consumption [25]. This study extended the boundaries of the system to include the energy consumption resulting from imported food items, as well as consumption related to purchase, use, and maintenance of automobiles used to procure food. Of the energy consumed for food production, 2.14×10^{15} mega joules is embodied in wasted food at the retail and consumer levels, comprising 2 percent of total U.S. energy consumption [36]. This energy is equivalent to 594 billion kWh, or the amount of energy used to power 51 million U.S. homes each year [35]. The energy embodied in wasted food represents a substantial target for decreasing energy consumption in the U.S. A decrease in food waste must be accompanied by an overall decrease in food production to ensure that the total energy used in food production decreases as well [36].

Disposal

At present, food constitutes the single largest component of municipal solid waste. Together, edible and inedible food scraps from all stages of the supply chain currently represent 20 percent of the waste stream entering landfills by weight in the United States [29]. There are significant costs associated with disposing of this magnitude of food. In 2008, it cost an estimated $1.3 billion to landfill food waste in the U.S. [34]. As this food decomposes in landfills, it contributes significantly to emissions of methane, a powerful greenhouse gas. Future costs of climate change adaptation and mitigation are likely to be significant. Reducing the amount of food that enters our landfills represents an opportunity to reduce our country's greenhouse gas emissions and associated costs.

Food Waste in the Home

Food waste at the consumer level constitutes the majority of wasted food. A 2011 life cycle assessment found that avoidable food waste in the U.S. for the year 2009 had a total retail value of $197.7 billion [1]. Consumer waste alone accounted for $124.1 billion, or nearly 63% of the total retail value of wasted food. Using the 2009 U.S. population estimate of 307 million, the per capita retail value of total avoidable waste was estimated at $643.95 per year [37]. In his book, *American Wasteland,* Jonathan Bloom asserts that the value of avoidable food waste for a family of four could be as high as $2275 per year [38]. Clearly, reducing consumer food

waste represents an opportunity for households to save money. Several techniques, discussed in a subsequent section of this report, exist to help consumers waste less food. While we can say with confidence that implementing these behaviors can help consumers save money, we cannot precisely quantify potential cost savings. Furthermore, we recognize that some food waste is unavoidable.

The financial benefits to consumers of reducing food waste need to be considered alongside the costs associated with changing behaviors. These costs include the opportunity cost of time spent planning meals ahead or making shopping lists, searching for recipes to use leftovers, and taking inventory of food at home before grocery shopping. Practices such as buying only the quantity of food what one needs might necessitate more frequent trips to the grocery store which also has an opportunity cost as well as increased fuel expenditures. Similarly to the financial benefits of adopting such practices, we cannot adequately quantify the costs that consumers may incur from adopting practices that would reduce food waste.

Social Impacts of Food Waste

It is estimated that 39 million people and almost 15% of all U.S. households are food insecure, meaning they have limited or uncertain availability of nutritionally adequate and safe food [39]. While the link between consumer food waste and hunger in America is indirect, it is possible that reducing consumer level food waste could help to alleviate domestic hunger. For example, perhaps if consumers bought only what they needed and retailers were left with excess stocks, more of them would utilize the Good Samaritan Act and donate food to charitable organizations which feed the hungry. The United States produces more than enough food to feed every American, and the fact that one in six Americans is food insecure ultimately reveals inefficiencies in the way food is distributed. Consumer level food waste plays a part in this mis-distribution, but typically once food is purchased by a final consumer it is no longer available to be donated. This is in contrast to food waste which occurs at different points in the supply chain where food could more easily and effectively be directed towards those in need.

Efforts Abroad

Europe

In January 2012, the European Parliament adopted a resolution to reduce food waste by 50 percent by 2020 and designated 2014 as the "European year against food waste". At that time, the Parliament proclaimed, "The most important problem in the future will be to tackle increased demand for food, as it will outstrip supply. We can no longer afford to stand idly by while perfectly edible food is being wasted. This is an ethical but also an economic and social problem, with huge implications for the environment" [40].

In 2010, the European Union (EU) contracted a large consulting firm to create a report highlighting the causes of food waste and potential actions for mitigation. The firm analyzed the efficacy of five potential policy options aimed at reducing food waste. Two, including creation of public awareness campaigns, were suggested for adoption. The report acknowledged that while raising public awareness and effecting behavior change is difficult, an attempt needed to be made. Secondly, the firm suggested that the EU's role might involve a "web-based resource hub on food waste prevention, including sample communications materials, good practice examples, and informational tools for specific sectors" [41]. This network would also serve as a forum for government officials to share policy-level best practices. The report concluded that these policies have the potential to initially reduce avoidable food waste by 3 percent, based on results of the UK's "Love Food Hate Waste" campaign. It is expected that, in time, these campaigns could spur even further reductions [41].

United Nations

In early 2013, the "Think Eat Save" campaign of the "Save Food Initiative", a partnership between UNEP, FAO and Messe Düsseldorf in support of the UN Secretary-General's Zero Hunger Challenge, was created. This effort aims to instill broad behavioral changes by offering tips and information on the "Think Eat Save" website. The site will also include published information from the leading authorities on food waste. While still in its seminal changes, "Think Eat Save" aims to increase awareness regarding food waste issues on an international scale [42].

United Kingdom

The United Kingdom has emerged as a world leader in the realm of combating and raising awareness about food waste. Created in 2000, the UK's Waste & Resources Action Programme (WRAP) was originally charged with the task of increasing national recycling rates and creating markets for recycled materials. Five years ago WRAP turned its attention to food waste. Its efforts to reduce food waste included extensive surveys of stakeholders across all stages of the

food supply chain to enhance their understanding of food waste attitudes, behaviors, and drivers. Their research indicated that household food waste had reached unprecedented levels in UK homes [7] [43], with 8.3 MMT of food and drink wasted each year at a retail value of $19.3 billion USD. These findings prompted the campaign's efforts to educate consumers about the financial effects of food waste, as well as its effects on the environment, locally and globally. Materials for their highly effective consumer-facing marketing campaign, "Love Food Hate Waste," featured popular celebrities and were designed to be visually evocative.

Since the launch of the "Love Food Hate Waste" campaign in 2007, WRAP asserts that 1.8 million UK households are taking steps to cut back on the amount of food they throw away, resulting in an overall saving of 468 million USD each year, and preventing 137,000 tons of food from being thrown away [43].

Australia

Australia has also conducted thorough research aiming to quantify domestic food waste. It is estimated that they throw out about $5 billion USD worth of food each year [44]. In 2009, Barker et al. performed a survey of 1,603 grocery store shoppers to investigate the behaviors and demographics responsible for food waste [44]. The data revealed that the quantity of food wasted is related to both household income and size. The amount of food wasted was found to increase with household income and decrease with larger household sizes. The results indicated that households with four or more occupants waste the least food per person, while people living by themselves waste the most [44]. The same "Love Food Hate Waste" campaign that gained traction in the UK was also adopted in Australia [45]. The campaign's website lists household tips that consumers can utilize to reduce their food waste and also seeks to educate consumers about the nature of food waste impacts.

Preliminary Domestic Efforts

While countries such as England and Australia have launched national campaigns aimed at raising awareness of the issues caused by consumer level food waste, the United States has lagged behind. Only very recently has the Environmental Protection Agency begun to prioritize food waste as a pressing environmental matter. Thus far, most of the efforts undertaken by the EPA have focused on encouraging institutions and corporations along the food supply chain to adopt waste reduction strategies. These include making more informed purchasing decisions and finding ways to utilize surplus food rather than sending it to a landfill [4].

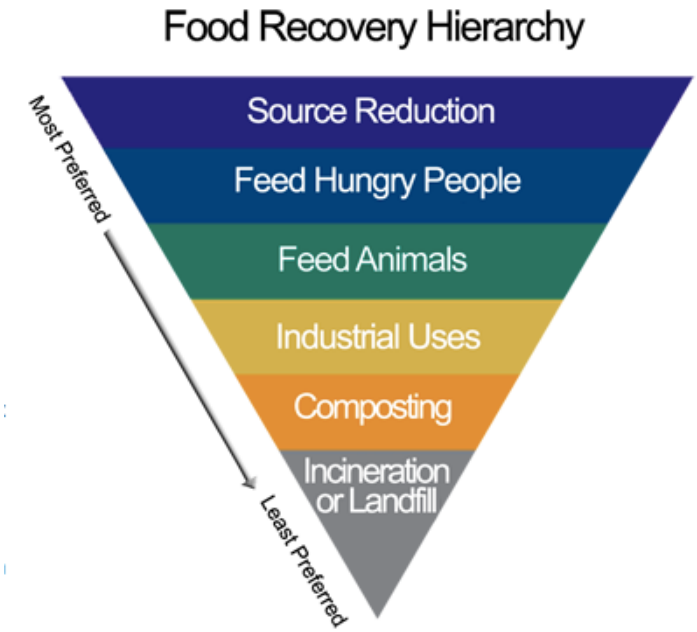


Figure 3: Graphic developed by the Environmental Protection Agency to explain how food waste should be utilized [46]

Though the EPA is aware that most food waste occurs at the consumer level, we believe that their efforts thus far have focused on institutions for four main reasons. First, as corporations are ultimately driven by their bottom line, they are more likely to respond quickly to an opportunity to save money. For example, many businesses that have participated in the EPA's Food Recovery Challenge report saving substantial money on waste management after implementing new practices. Secondly, despite the large size of the food supply chain, the total number of food producers, manufacturers, transporters, distributors, and retailers is clearly dwarfed by the number of consumers. Trying to change the behaviors of a smaller group of

constituents is always more feasible than trying to change the behavior of millions of Americans. Next, while most food is discarded by consumers rather than institutions and companies, corporations on a per capita basis in the food supply chain waste more food. Finally, food that is salvaged along the supply chain before it is sold to consumers can, in many cases, be used to feed hungry Americans. While this is not always possible as some food is lost to spoilage, changes to the way that food is distributed before it reaches consumers could help to ensure that more food is diverted away from landfills and to people who need it.

As the EPA continues to reach out to businesses and institutions, they also realize that while raising consumer awareness and changing behavior is a difficult task, it is nonetheless an important one. In response, they have started to develop a program called Food: Too Good to Waste. Rather than launching a national awareness campaign similar to Love Food Hate Waste, the EPA has chosen to take a different approach: a pilot program which utilizes local governments to raise awareness of food waste within their communities. Selected communities have received Food: Too Good to Waste Pilot Toolkits designed to help them implement effective community-based social marketing campaigns to encourage residents to reduce the amount of food they waste. The Toolkit is comprised of five components: a Research Report, which summarizes findings regarding waste prevention behaviors; a Message Map, which focuses on the adoption of five key waste reduction practices; an Implementation Guide which instructs local governments in launching the program; Behavior Change Tools; and Measurement Tools. Launched in the fourth quarter of 2012, the pilot has been implemented by approximately 20 communities in California, Washington, Oregon, and Minnesota. A report evaluating the efficacy of this pilot is expected to be published in 2013. Initial feedback from participating local governments has been positive, but it remains to be seen if this project could ever be scaled to reach a national audience to affect necessary change [47].

Survey

Significance and Justification

Previous studies on food waste typically fall into one of two main categories, though some fall into both. The first category of studies are those that aim to more accurately measure the volume of food waste streams, while the second tries to better understand consumer knowledge and attitudes surrounding food waste. While up-to-date, comprehensive food waste studies have been conducted abroad, studies of this quality are lacking in the United States. This lack of data could potentially impede efforts to reduce domestic food waste. One researcher acknowledged this dearth of information, reporting that despite the importance of fully understanding the drivers of household food waste, only one such study has been conducted in the United States to date [48]. This study was completed over 25 years ago and was very limited in scope; the sample consisted of only 273 families in Oregon [49]. Given the age and scope of this study, it is unlikely that the results are representative of the behaviors and attitudes of the current population. We identified the general void of information on this topic as an opportunity to advance the research in the field to reflect current behaviors. Some of these studies, mostly those conducted abroad, have involved surveys which served as the basis for communications campaigns aimed at reducing consumer food waste.

For example, campaigns to increase awareness about the environmental and socioeconomic impacts of food waste have already been launched in the UK and Australia after extensive consumer surveys. WRAP's "Love Food Hate Waste" campaign, which was adopted in both the UK and Australia, set out to survey households to better understand the knowledge, attitudes, and behaviors which lead to consumer food waste. The campaigns launched based on the results of the surveys have helped to lower consumer level food waste in both of these countries.

Rather than attempting to improve the data on food waste quantification, our survey aims to increase current knowledge about the drivers and attitudes related to consumer-level food waste. For example, it is well documented that meal planning helps to reduce food waste. Our survey seeks to understand what percentage of the population actually employs this practice and the willingness of those who currently do not to learn how. The results of the survey will be leveraged to tailor our communications campaign to ensure that it is impactful.

Findings Across Different Areas to Inform Survey

Because the literature on consumer food waste in the U.S. is limited, we called upon information from studies on other consumptive activities that we felt exhibit significant parallels. We also drew upon similar studies conducted in other countries in an attempt to provide explanatory evidence that could support our hypotheses. We gathered information from studies on behaviors relating to water consumption and recycling, which are driven by attitudes and behaviors that we believe are similar to those driving consumer food waste decisions. We also turned to studies that were completed abroad, such as the UK's WRAP study to inform our focus and methodology.

"Food Behavior Consumer Research: Quantitative Phase" by Cox and Downing (2007)
This study, commissioned by WRAP, aimed to fully understand drivers of consumer food waste in the UK, and discover what might motivate consumers to discard less food. A national quantitative survey and focus groups were utilized to inform the development of the "Love Food Hate Waste" consumer-focused campaign. The research also included the development of metric that could be used to track the impact of the campaign [50].

"Food Waste Avoidance Benchmark Study" by the New South Wales (NSW) Office of Environment & Heritage (2011)
This study, which included an online survey of 1,200 NSW residents, provided motivation for our hypotheses. The survey targeted adults, aged 16 and over, who were routinely responsible for food purchasing decisions within their households. Similar to studies conducted previously in the UK, the "Food Waste Avoidance Benchmark Study" was designed to "provide a benchmark of community knowledge, attitudes, and behavior around food waste and food management at the household level; [and] develop a segmentation of the NSW community based on food waste knowledge, attitudes" [45]. The results of the study were used to develop NSW's "Love Food Hate Waste" program, and the Office of Environment & Heritage plans to conduct ongoing research to ensure the efficacy of the program.

"Household Water Consumption in an Arid City: Affluence, Affordance, and Attitudes" by Harlan et al. (2009)
This study examined how water consumption in individual households is affected by income. It also sought to determine whether household amenities, attitudes towards one's community, or attitudes pertaining to the natural environment could potentially mediate the effect of income on residential water use. Ultimately the study concluded that income has a positive, significant effect on consumption that was mediated by household size [51].

“Measuring the Impact of Water Conservation Campaigns in California” by Berk et al. (1993)
This study surveyed residents of Los Angeles and San Francisco in an attempt to understand changes in water consumption habits that result from exposure to information regarding the environmental and financial issues tied to water consumption. The researchers drew upon literature about conservation actions stating that 1) The nature of the problem must be well understood (one of our focuses), 2) Conservation options must also be well understood, and 3) household members must believe that they can implement the conservation options. The study found that higher levels of education and income had a positive correlation to increased levels of conservation practices. The research team used a phone survey to gather their data and also used statistical analysis to examine relationships between conservation practices and demographic variables [52].

“Wasteful Food Consumption: Trends in Food and Packaging Waste” by Thogersen (1993)
Thogersen’s research examined the determinants of food and packaging waste among household consumers in the U.S. and Mexico, among other locations. The study found that there are multiple variables that influence food waste besides income. These include cultural differences, consumption of processed vs. unprocessed foods, and family size. The research does suggest that food waste grows faster than income in developing countries which gives it a weakly positive correlation to income. Therefore, it is likely that income would not be a strong indicator of changes in food waste behavior [53].

“Wasting Food – An Insistent Behaviour” by Schneider (2008)
Research performed by Schneider determined that both income and education are positively correlated to food waste at the household level in the U.S. and other developed countries. Possible reasons for this observation include less time spent at home with more meals eaten out, afforded "luxury" of wasting food & other consumables, and failure to plan meals because of lack of time otherwise devoted to work and other activities [54].

Survey Design and Methodology

When designing our survey, we took inspiration from surveys conducted by "Love Food Hate Waste" [55] and WRAP [7]. In crafting the survey, we sought to design questions that would elicit consumer knowledge, attitudes, and behaviors surrounding food waste and its impact on the environment. All questions were multiple choice and whenever practicable, an "Other" choice was provided. To eliminate potential bias associated with the order of response options, we randomized answer choices whenever possible. Goodwin advises positioning demographic questions at the end of the survey due to their sensitive nature [56]. In order to ensure that our survey was respectful and encouraged respondent participation, we placed our demographic questions at the end of the survey.

We received feedback on our survey from a number of sources. Drafts of our survey were reviewed by Bren faculty member and survey design expert Sarah Anderson, as well as our faculty advisory, economist Gary Libecap. In order to be granted approval for our study from the UCSB Human Subjects Committee we also provided respondents with a brief explanation of our project, the potential benefits of our research, the voluntary nature of the survey, and a statement guaranteeing confidentiality. In order to maintain confidentiality, we did not collect any personal information from respondents.

Sample

Due to both time and financial limitations, our survey had to be relatively short and limited to California residents. However, we believe this survey is a starting point that will begin to provide important insight into food waste related attitudes.

We chose to administer our survey via the internet in order to reach the largest audience with our limited budget. As a result, our survey could only reach those with internet access; however, we felt confident in our chosen distribution method as 87 percent of Californians have access to the internet [57]. We contracted the internet survey company SurveyMonkey to deploy our survey to a panel of respondents. We initially paid for 500 guaranteed responses in order to obtain a margin of error of +/- 4 percent for a 95 percent confidence level [58]. Though SurveyMonkey had informed us that we would be provided with information on respondents' income, their system experienced an error when our survey was first deployed and we did not receive this information. As a result, the survey was launched a second time. In total we received 1,185 responses to the survey, though income data was only collected for 624 respondents.

The survey was distributed throughout the state of California with the intention of collecting a sample representative of the state population. Though overall there seem to be similarities between our results and Census data, we found our sample to have a few significant differences in some demographic tests. Our results, shown below (Table 3), indicate a population that is older and more educated when compared with mean figures reported in Census data for California and the U.S. The effect, if any, this may have had on individual responses to the survey questions is unclear. Studies have shown that there is a positive correlation between education and pro-environmental attitudes, but a negative correlation between age and pro-environmental attitudes [59] which may have a balancing effect if applied to our results. Nonetheless, it is important to acknowledge the differences in our responses and the data reported by the Census Bureau, as our data may be influenced by causal factors characteristic of the demographic profile.

	Results of Study	Census Data for CA 2010	Census Data for U.S.
Average Household Size (people)	2.8	2.9	2.6
Household Income (dollars)	$50,000-$99,000 (median)	$61,632 (average)	$52,762 (average)
Age of Adult Pop. (years)			
18-29	18.50%	23.86%	21.90%
30-44	23.30%	27.76%	25.80%
45-60	33.00%	26.69%	29.10%
> 60	25.30%	21.69%	23.20%
Highest Education Attainment (18+ yrs. of age)			
< High School Degree	1.80%	20.00%	13.17%
High School Degree	6.80%	23.00%	30.01%
Some College	30.20%	20.50%	19.46%
Associate or Bachelor Degree	32.80%	27.00%	27.59%
Graduate Degree	28.40%	9.50%	9.76%
Population Characteristic by County Classification*			
Urban	61.8%	58.3%	-
Suburban	15.4%	16.2%	-
Rural	15.7%	13.1%	-
Agricultural	7.1%	8.4%	-
Female	47.90%	50.30%	50.80%
Male	52.10%	49.70%	49.20%

Table 3. Determination of Representative Sample [60], [61]

*See Appendix C for classification analysis

Methods

The first step in our analysis was to calculate the proportions of responses for each question and calculate their standard errors and confidence intervals to determine how confident we were that they represented the true opinions and behaviors of the population. To find the proportion, we used the formula:

$$\text{prop} = \frac{\text{number of responses for answer choice x}}{\text{total number of responses to question}}$$

To calculate the standard error, we used the formula:

$$SE = [\text{prop} * (1-\text{prop})/n]^{0.5}$$, where n is the total number of responses to the question.

To find the confidence intervals, we used the prop.test function of the statistical program R, with a confidence level of 95%.

Findings

QUESTION 1

In general, how concerned are you with environmental problems?

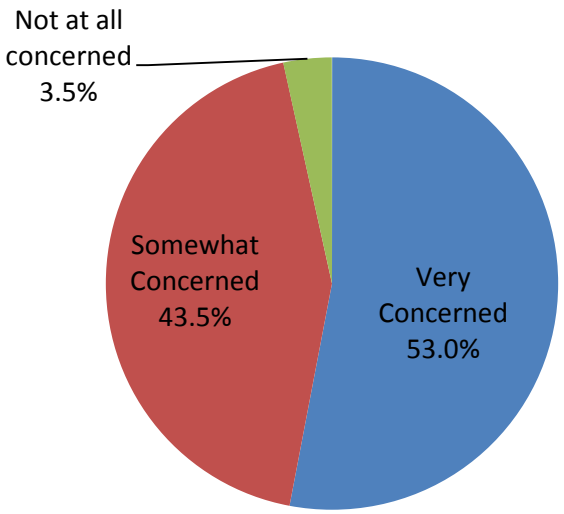
□ ***Very concerned***

□ ***Somewhat concerned***

□ ***Not at all concerned***

Question 1 asked respondents to indicate their level of concern for the environment. Our results indicate that the majority of respondents exhibit some concern for the environment, with 53 percent indicating that they are very concerned (CI 95%[0.501, 0.559], SE = 0.014) and 43.5 percent indicating that they are somewhat concerned (95% CI[0.407, 0.464], SE = 0.014). Only 3.5 percent stated to have no concern for environmental problems (CI 95%[0.025, 0.047], SE = 0.05).

In general, how concerned are you with environmental problems?



We were also interested in learning whether a person's concern for the environmental affected their responses to certain questions. Particularly, we hypothesized that even people who claim to be concerned about the environment would completely understand the environmental implications of food waste. Stamm et al. found that though people often "care" about environmental problems, they tend not to realize or fully understand the consequences of those problems [62].

The questions we felt would be most relevant for this hypothesis are questions 3, 7, 11, and 12. Tests of independence between these questions and question 1 can be found under the sections for question 3, question 7, question 11, and question 12, respectively.

We took the average response for each county in order to map environmental concern across California. The map and county averages can be found in Appendix F.

QUESTION 2

Please indicate which of the following issues is most important to you.

□ ***Health effects of pollution***

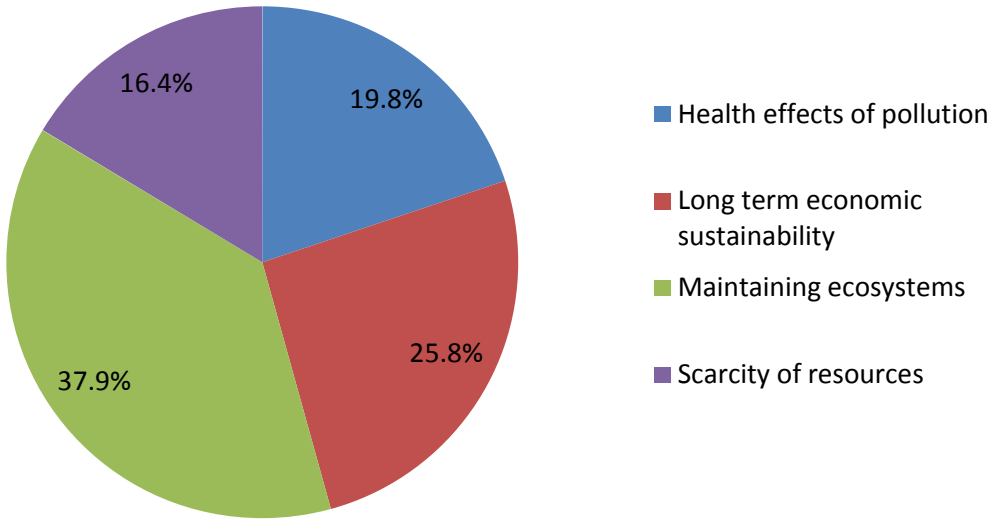
□ ***Long term economic sustainability***

□ ***Maintaining ecosystems (nature, plants, and animals)***

□ ***Scarcity of resources we consume***

In order to determine the most effective type of messaging to inform consumers about the environmental impacts of food waste, we asked them which environmental issue they were most concerned about. Our results indicate that concern is spread fairly evenly among the given environmental issues. 19.8 percent of respondents selected health effects of pollution as their primary concern (95% CI[0.176, 0.223], SE = 0.012). The majority of respondents, 37.9%, indicated maintaining ecosystems as their primary concern (95% CI[0.352, 0.408], SE = 0.014). Scarcity of resources was the least selected issue, but still garnered 16.4% of the responses (95% CI[0.143, 0.186), SE = 0.011). The relatively even distribution of responses indicates that a variety of messaging types should be used to effectively target consumers.

Please indicate which of the following issues is most important to you.

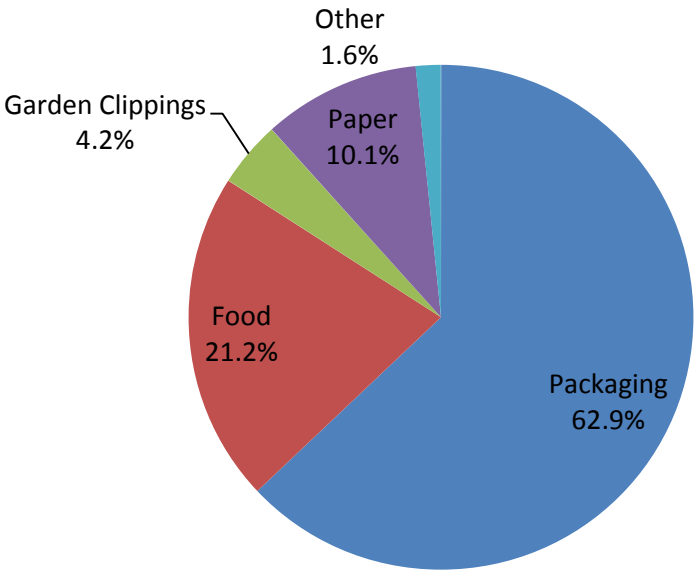


QUESTION 3

What do you think is the largest component of waste (by weight) in the average household garbage bin?

- □ ***Garden clippings***
- □ ***Packaging***
- □ ***Food***
- □ ***Paper***
- □ ***Other (please specify)***

We were interested in learning whether or not most consumers are aware that food is the largest component of household waste. Our results indicate that most people, 62.9%, selected packaging as the largest component of household waste (95% CI[0.601, 0.657], SE = 0.014). 21.2 percent correctly selected food as the largest component (95% CI[0.189, 0.236], SE = 0.119). Paper (10.1% with 95% CI[0.084, 0.120] and SE = 0.009) and garden clippings (4.2% with 95% CI[0.032, 0.056], and SE = 0.006) were the least selected categories. These results indicate that there is a significant opportunity to educate the public about the quantity of food being wasted in American homes and illuminate the scale of the food waste problem in this country.



We were also interested in learning whether or not there was a relationship between a respondent's concern for the environment (Question 1) and their knowledge of the breakdown of household waste. Our results indicate that there is no relationship between concern for the environment and knowledge of household waste components. We grouped respondents into 2

categories (Correct or Incorrect) based on their response to the question, and then ran a Chi-squared test to test for independence. Our calculations indicate that these two variables are independent (p-value = 0.686)—respondents who indicated concern for environmental issues were no more likely to answer the question than those who reported no concern for the environment.

QUESTION 4

Please estimate the value of the food your household throws out each year.

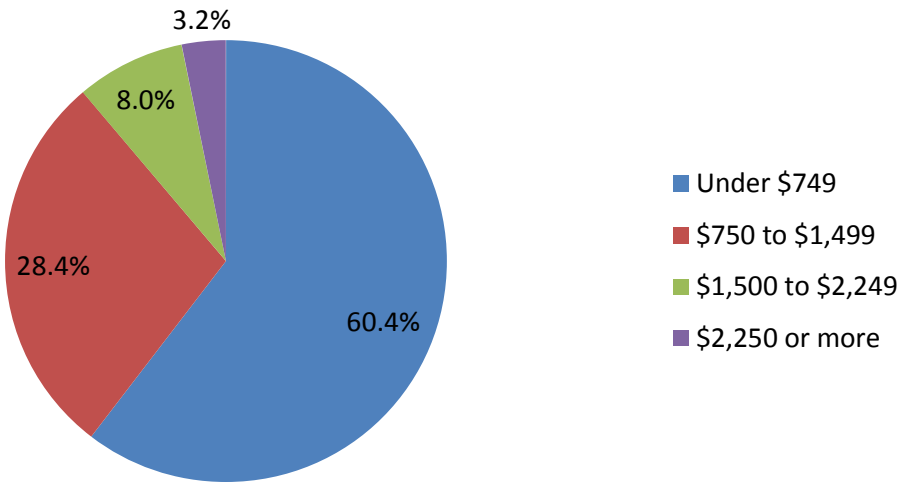
□ ***Under $750***

□ ***$750 to $1,499***

□ ***$1,500 to $2,249***

□ ***$2,250 or more***

We were interested to see if consumers were aware of the value of the food they throw away each year. We did not actually measure the amount of food thrown away by each consumer to compare with their response. Instead we wanted to compare the average response of our sample to the known amount thrown away by the average American household. We asked respondents to estimate the value of food thrown away by their household each year. The median response of our sample was the answer choice "Under $749". This category was also the most selected, comprising 60.4% of responses (95% CI[0.576, 0.632], SE = 0.014).



Due to the fact that answer choices were in the form of ranges of dollar amounts, we were unable to calculate the exact mean of the responses. We therefore employed two different methods to estimate the average. First, we used the lower bounds of the ranges to calculate the mean response. Using this method, we calculated the average response to be $163.43 per person. Then we use the upper bounds of the ranges (using $5,000 as the upper bound of the last range) and calculated the average. Using this method we estimated the average response to be approximately $535.26. We then compared these estimates to data on the actual amount of food thrown away per person per year. In his book *American Wasteland*, Jonathan Bloom asserts that the average American household (family of four) throws out $1365-$2275

each year, which translates to $341-$568 per person per year [38]. Comparing the lower bound of this range with our lower bound average, it appears that consumers generally underestimate the value of food they throw away. Comparing the upper bound of this range with our upper bound average, yields the same result: consumers generally underestimate the value of food they throw away.

The way this question was asked imposed limitations on our analysis of the responses. As stated above, we were unable to calculate a precise average response due to the fact that response choices were ranges. In creating the question, we felt that it was necessary to allow respondents to select a range in order to give them some idea of the magnitude of the figure. We felt that if we had simply asked respondents to enter an amount, they would significantly underestimate the amount of food they waste annually. Another flaw in the question is that the prompt does not give the survey-taker any guidance on how to estimate the dollar value of his or her annual food waste. Furthermore, since data was not collected to quantify how much each respondent *actually* wastes, there is no way to compare the stated range to the actual amount.

QUESTIONS 5 and 6

In regard to food labels, which of the following do you think best describes what is meant by the "best before" date ("use by" date for Question 6)?

- □ ***Food must be eaten or thrown away by this date***
- □ ***Foods are still safe to eat after this date as long as they are not damaged, deteriorated, or perished***
- □ ***Food must be sold at a discount after this date***
- □ ***Other (please specify)***

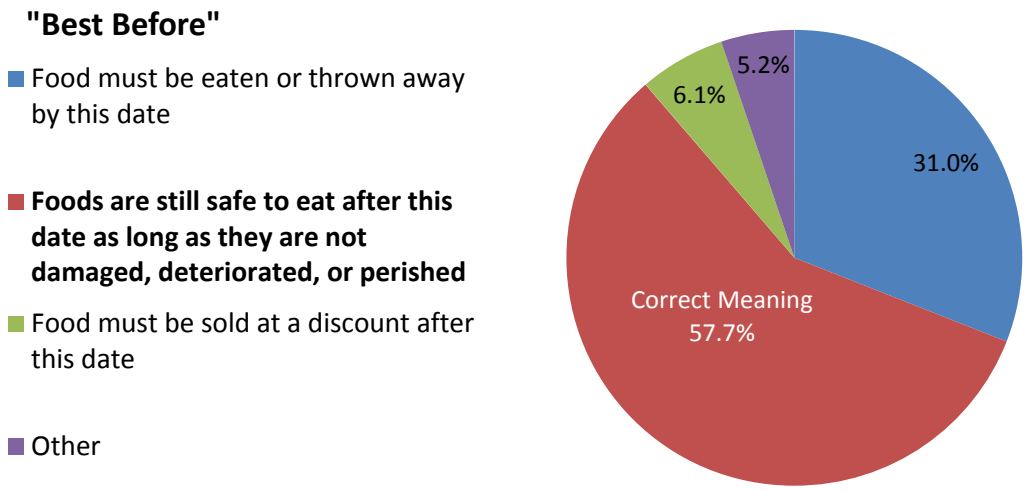
We were interested in testing whether or not consumers could correctly identify the meaning of various date labels, specifically if they would be able to distinguish the difference between "best before" and "use by" labels. We hypothesized that most consumers are not aware of the true meanings of common date labels. However, our survey results indicate that the opposite is true: consumers understand the meaning of "best before" and "use by" dates. 57.7% of respondents correctly identified the meaning of "best before" labels (foods are still safe to eat after this date as long as they are not damaged, deteriorated, or perished). The 95% confidence interval for this result is [0.548, 0.606], with a standard error of approximately 0.0144. Our results do indicate that there is still some confusion about the meaning of "best before" as nearly a third of respondents (30.9%) incorrectly selected "Food must be eaten or thrown away by this date" as the meaning of this label. We calculated a standard error of approximately 0.0135 for this result and a 95% confidence interval of [0.2836807, 0.3372697].

Similarly, most people (59.6%) were able to identify the correct meaning of "use by" dates (food must be eaten or thrown away by this date), while over a third (33.9%) confused the correct meaning with that of "best before" labels. For the 59.6% figure, we calculated a confidence interval of [0.567, 0.624] and a standard error of approximately 0.0138. For the 33.9% figure we calculated a confidence interval of [0.312, 0.367] and a standard error of approximately 0.0143.

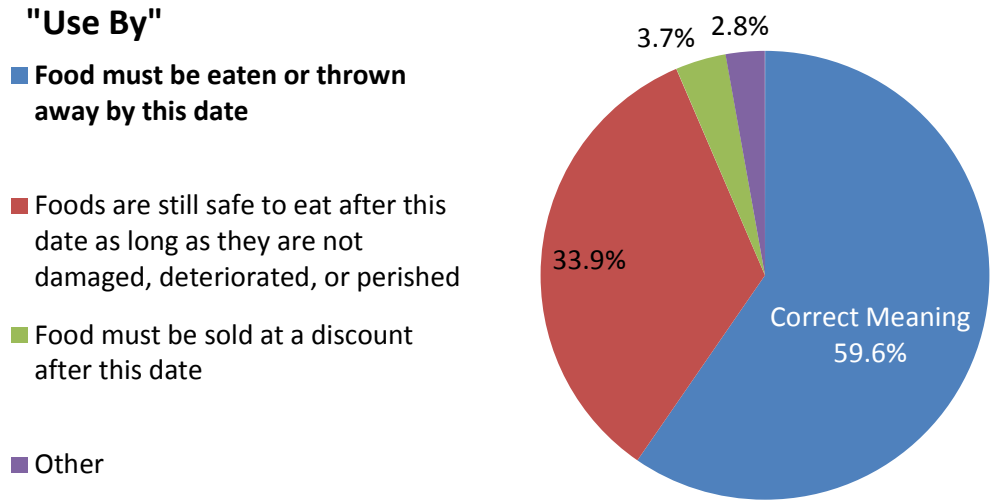
Other studies have found results that are contradictory to those of our survey. For example, a survey performed by the UK group WRAP found that true understanding of data labels was low. Roughly two thirds (62%) of study participants gave a generic definition which did not distinguish between different types of date labels. WRAP reports "There seemed to be very little shared understanding of date labels across the sample, with participants often reporting highly personalized and idiosyncratic practices around their interpretation and use of date labels" [63]. In general, participants gave responses that were reflections of their practical application of date labels, rather than an understanding of the different label types [63]. The same study found that older people were less likely to throw out products based on date labels

and rather to rely on their own judgment. This finding could account for the incongruity between our results and those of other, similar studies, as our sample was slightly biased toward an older demographic of respondents. Furthermore, our analysis examined only two of many varieties of date labels, and therefore does not provide a complete picture of date label confusion.

*In regard to food labels, which of the following do you think best describes what is meant by the **"best before"** date?*



*In regard to food labels, which of the following do you think best describes what is meant by the **"use by"** date?*



QUESTION 7

Below is a list of statements about food. Please indicate the extent to which you agree or disagree with each of them.

1 Strongly disagree 2 Disagree 3 Neither agree nor disagree 4 Agree 5 Strongly agree

□ ***Food that could have been eaten by people is not wasted if it is composted***

□ ***Wasting food contributes to climate change***

□ ***Americans don't waste much food***

□ ***The energy, water, and fertilizer that are used to grow, process, and transport food are wasted if food is purchased but not eaten***

□ ***Busy lifestyles make it hard to avoid wasting food***

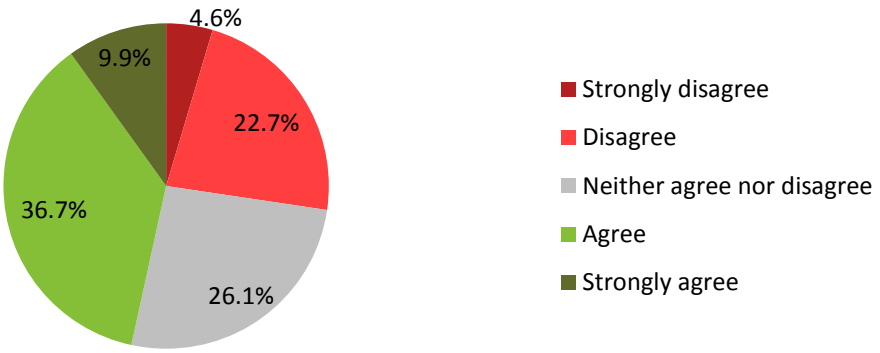
In order to assess general awareness of the environmental impacts of food waste, we asked our respondents to indicate the extent to which they agree or disagree with certain food-related statements. The statements and results are below.

Food that could have been eaten by people is not wasted if it is composted.

It is the view of this group that this statement is false. For the purposes of this project, food is considered wasted if it is not consumed. This is because the inputs (water, fertilizer, etc.) were needlessly expended if the food is not consumed. Therefore, diverting food into compost, while still preferable to landfilling, is still considered a waste of food.

The mean response for this question was 3.25 (as indicated in the text of the question above, 1 represents the "Strongly disagree" response, 2 represents "Disagree", 3 represents a neutral response, 4 represents "Agree", and 5 represents "Strongly agree"). This figure indicates that the average response is very close to neutral ("Neither agree nor disagree"), though on the "Agree" side of neutral. This finding suggests that there is not a strong feeling among respondents on the validity of this statement.

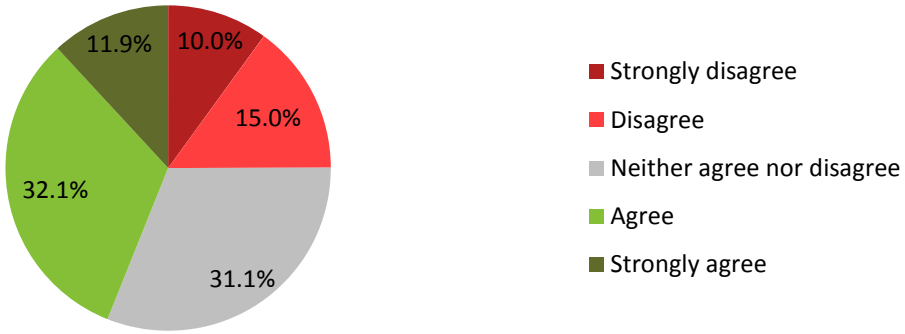
A plurality of respondents in our sample (nearly half) agrees with this statement. 36.7 percent agree (95% CI[0.339, 0.395], SE = 0.014), and 9.9% strongly agree (95% CI[0.083, 0.118], SE = 0.009). 4.6 percent strongly disagree (95% CI[0.035, 0.060], SE = 0.006), 22.7 % disagree with the statement (95% CI[0.204, 0.253], SE = 0.012), and 26.1% neither agree nor disagree (95% [0.236, 0.287], SE = 0.013). These results indicate that there is some opportunity to educate consumers about wasteful behaviors and their associated impacts.



Wasting food contributes to climate change.

As discussed in the environmental impacts section of this report, this statement is true. The mean response for this question was 3.21. This figure indicates that the average response is very close to neutral ("Neither agree nor disagree"), though on the "Agree" side of neutral. This finding suggests that there is not a strong feeling among respondents on the validity of this statement.

A plurality of respondents indicated that they agree with statement, with 32.1% selecting "Agree" (95% CI[0.294,5 0.348], SE = 0.014), and 11.9% selecting "Agree Strongly" (95% CI[0.101, 0.139], SE = 0.009). However, the majority of respondents either disagree (32.1% disagree, with 95% CI[0.130, 0.172] and SE = 0.010, and 11.9% strongly disagree, with 95% CI[0.084, 0.119], and SE = 0.009) with this statement or are neutral (95% CI[0.285, 0.339], SE = 0.013), which identifies a significant opportunity to raise awareness about the impacts of greenhouse gas emissions associated with food waste.

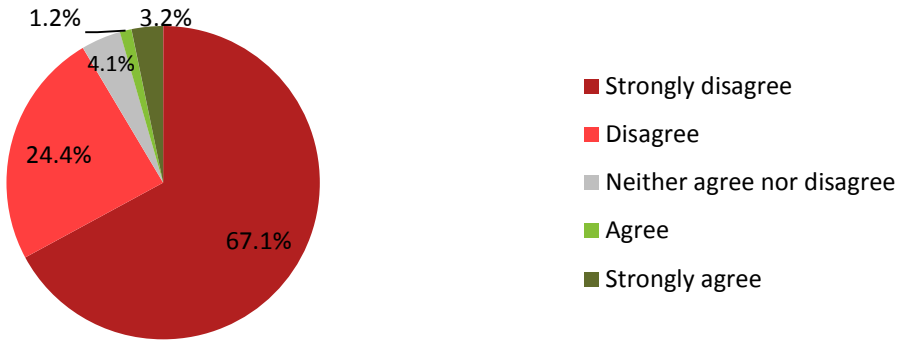


Americans don't waste much food.

As discussed earlier in this report, this statement is false (18.8% of all food produced in the United States is ultimately thrown away by consumers). The mean response for this question was 1.49. This figure indicates that the average response is somewhere between "Strongly

disagree" and "Disagree". This finding suggests that the average respondent in our sample is aware that Americans waste a large magnitude of food.

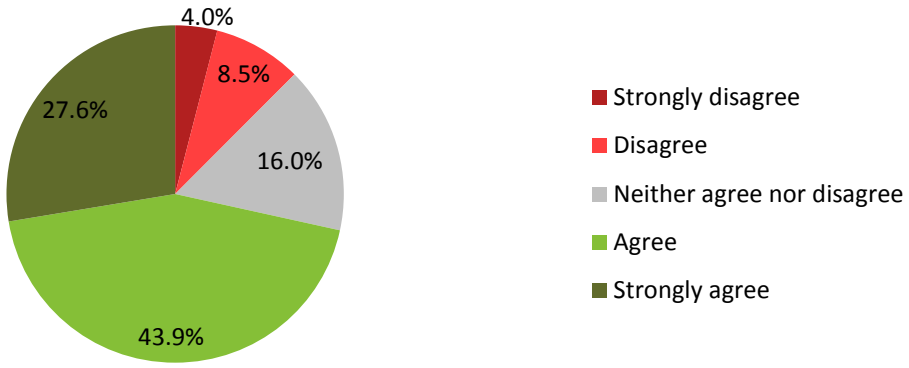
67.1 percent strongly disagree with this statement (95% CI[0.643, 0.698], SE = 0.014), and 24.4% disagree (95% CI[0.219, 0.269], SE = 0.012). Only 3.2% strongly agree (95% CI[0.023, 0.045], SE = 0.005), 1.2% agree(95% CI[0.007, 0.021], SE = .003), and 4.1% neither agree nor disagree (95% CI[0.0301, 0.054], SE = 0.006). These results indicate that most people believe that Americans waste a significant amount of food; however there still may be an opportunity to reach consumers by educating them about the magnitude and impacts of the problem in in order to motivate behavior change.



The energy, water, and fertilizer that are used to grow, process, and transport food are wasted if food is purchased but not eaten.

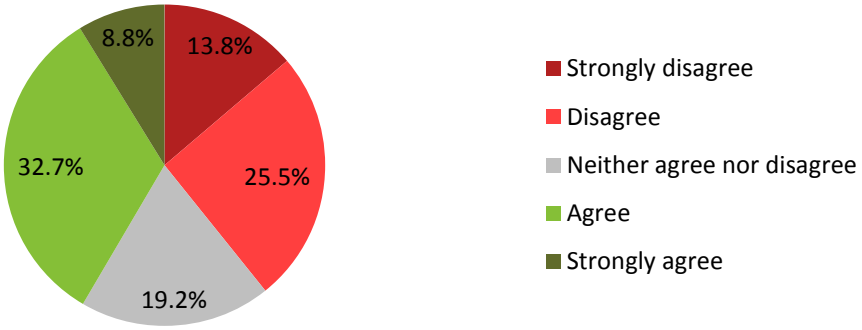
This question was asked in order to determine whether or not people consider that resources the go into producing food are wasted if food is not consumed. Our results indicated that people are aware that resources are wasted when food is thrown out: The mean response for this question was 3.83, which indicates that the average respondent agrees with this statement, but not strongly.

43.9 percent of respondents say they agree with the statement (95% CI[0.411, 0.468], SE = 0.014) and 27.6% say they agree strongly (95% CI[0.251, 0.303], SE = 0.013). Only 8.5% indicated that they disagree with the statement (95% CI[0.070, 0.102], SE = 0.008) and even fewer indicated that they disagree strongly (95% CI[0.030, 0.053], SE = 0.006). 16 percent neither agree nor disagree with the statement (95% CI[0.140, 0.182], SE = 0.011). These results indicate that it is not necessary to inform consumers that essential resources are wasted when food is thrown away, but that there may be an opportunity to educate them about the magnitude of these losses.



Busy lifestyles make it hard to avoid wasting food.

The mean response for this question was 2.97 which almost exactly equates to a neutral response ("Neither agree nor disagree"). This finding is also demonstrated in the breakdown of responses. The proportion of people who agree with the statement is roughly equal to those who disagree. 32.7 percent of respondents stated that they agree with statement (95% CI[0.301, 0.355], SE = 0.014) and 8.8% selected "Strongly Agree" (95% CI[0.073, 0.106], SE = 0.008), meaning that 41.5% of respondents agree with the statement to some degree. 25.5 percent of respondents stated that they disagree with statement (95% CI[0.230, 0.281], SE = 0.013) and 13.8% selected "Strongly Disagree" (95% CI[0.119, 0.159, SE = 0.010), meaning that 39.3% of respondents disagree with the statement to some degree. Nearly one fifth of respondents (19.1%) indicated that they neither agree nor disagree with the statement (95% CI[0.170, 0.216], SE = 0.0114). These results indicate that there is significant opportunity to educate the public about practices and tips that could help to reduce food waste while balancing a busy schedule.



We were also interested in learning whether or not a person's awareness of the issues represented by the above statements would be related to their concern for the environment (Question 1). We hypothesized that concern for the environment might be a predictor of responses to these questions. We again grouped respondents into categories (Disagree, Agree, or Neutral) based on their response to the question and performed a Chi-squared test to test

for independence. Our results indicate that responses for all but one of the statements are dependent on the respondent's concern for the environment. Responses to the statement, *Food that could have been eaten by people is not wasted if it is composted,* was found to be independent of respondents' reported concern for the environment. The p-values for these results can be found in Appendix D.

QUESTION 8

Think about why food might be wasted in your household. Please select at least 1 and up to 3 options.

□ ***Food is left too long in the fridge or freezer***

□ ***Food goes bad before the "use by" or "best before" date***

□ ***We don't tend to eat leftovers or use leftover ingredients in other meals***

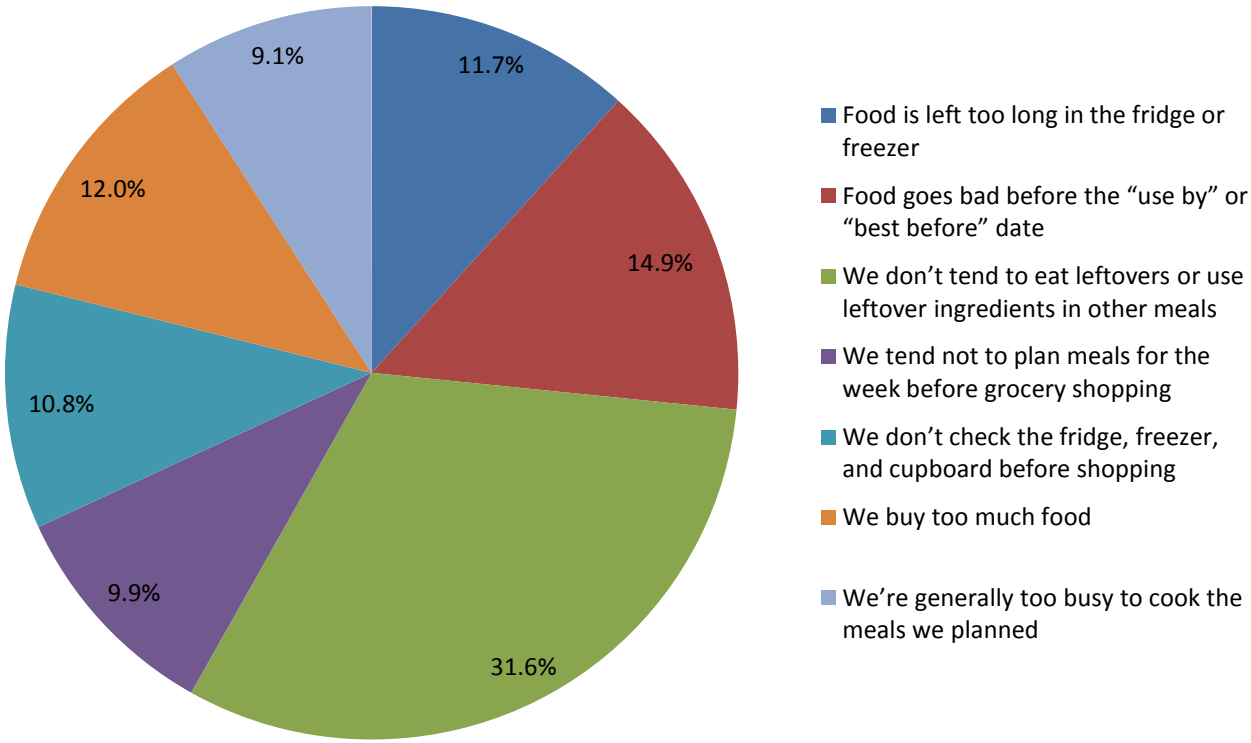
□ ***We tend not to plan meals for the week before grocery shopping***

□ ***We don't check the fridge, freezer, and cupboard before shopping***

□ ***We buy too much food***

□ ***We're generally too busy to cook the meals we planned***

We were interested in identifying the main reasons that people waste food, in order to design effective messaging and provide tips to modify those behaviors. Results indicate that no one behavior is most responsible, and that instead, many behaviors are commonplace. "We don't tend to eat leftovers or use leftover ingredients in other meals" was the most selected reason with 31.8% (95% CI[0.298, 0.334], SE = 0.009). The other behaviors have a fairly even distribution as shown in the chart below. This serves as an indication that all of these behaviors contribute to food waste and that an awareness campaign should encourage consumers to curb all of these behaviors. Confidence intervals and standard errors for the remaining behaviors can be found in Appendix D.



QUESTION 9

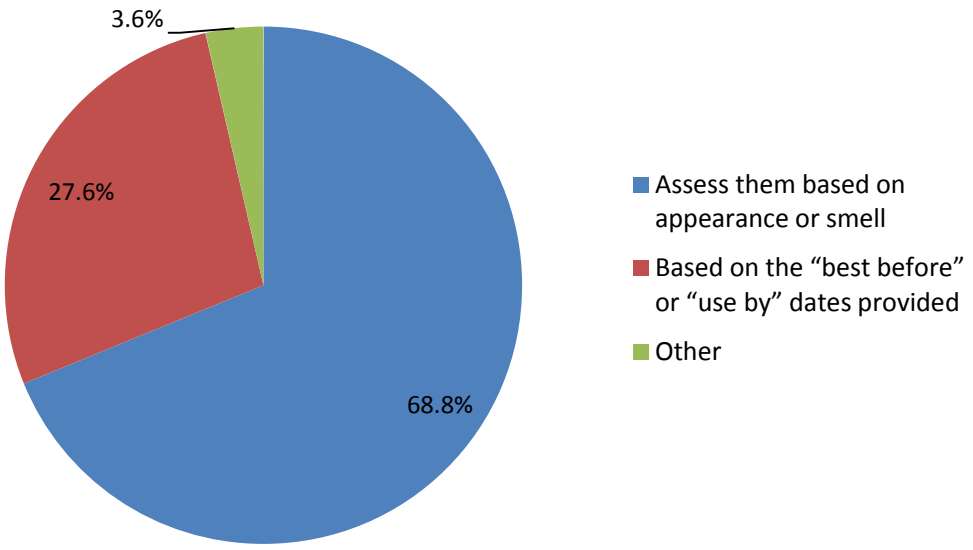
How do you typically determine when to throw out dairy products?

□ ***I throw out dairy products based on the "best before" or "use by" dates provided.***

□ ***I throw out dairy products after assessing them based on either appearance or smell.***

□ ***Other (please specify)***

We were interested to see whether respondents threw away dairy products based on the provided date label or based on their own judgment. Our results indicate that the majority, 68.8 percent, of respondents claim to throw dairy products out after assessing their smell or odor (95% CI[0.660, 0.714], SE = 0.0136), while 27.6% say they go by the date provided (95% CI[0.251, 0.303], SE = 0.0131). While most people report that they throw out their dairy products based on visual or olfactory cues, there is still an opportunity to inform the remaining ~30% that many dairy products remain safe to eat past their provided dates.



Other surveys on this topic have had conflicting results. For example, a survey performed by the Food Marketing Institute in 2011 found that 59 percent of consumers throw out food items (not specifically dairy products) based purely on the provided date label without assessing the state of the product [64].

QUESTION 10

If your household sometimes buys more food than you actually need, what are the top reasons? Please select at least 1 and up to 3.

□ ***I buy items in bulk and cannot finish them in time***

□ ***I like to have more food or ingredients available than not enough***

□ ***I am tempted by supermarket values (e.g. 2 for 1)***

□ ***I like fresh ingredients and don't keep older/blemished ingredients***

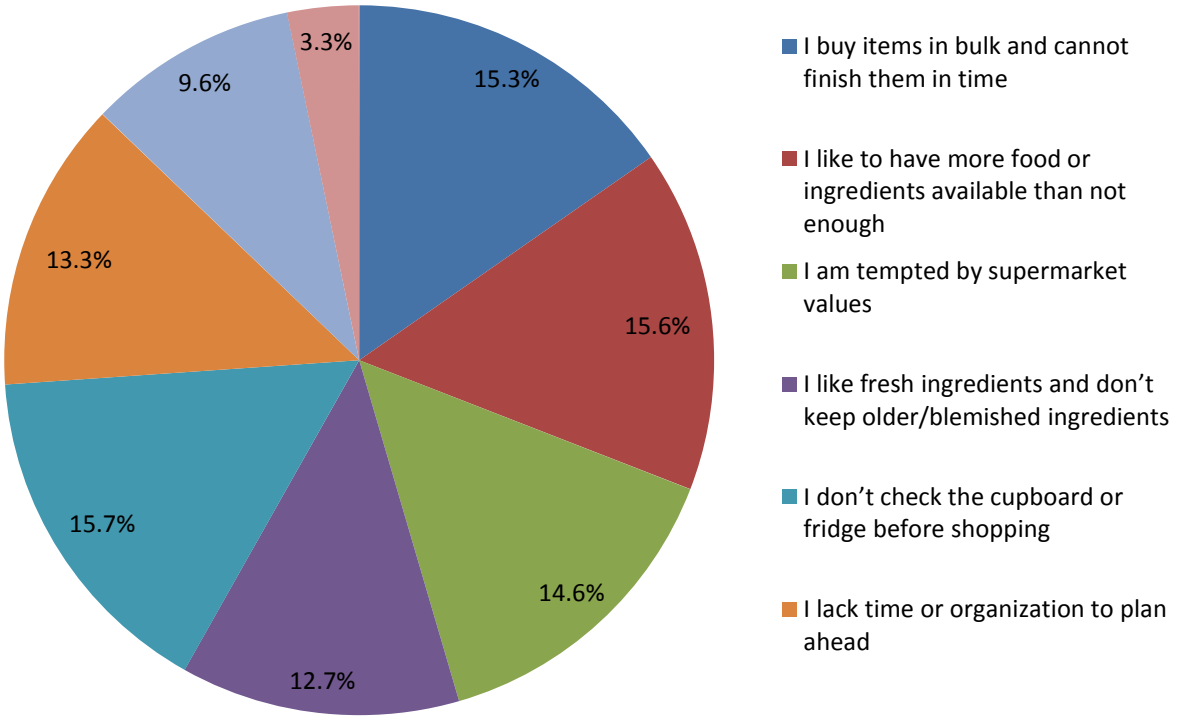
□ ***I don't check the cupboard or fridge before shopping***

□ ***I lack time or organization to plan ahead (e.g. no list or meal plan)***

□ ***Not applicable (I consistently purchase the right amount of food)***

□ ***Other***

We were interested in identifying the main reasons that people buy more food than they need, in order to design effective messaging and provide tips to modify those behaviors. Our results indicate the behaviors have a fairly even distribution, as shown in the chart below. Confidence intervals and standard errors for these results can be found in Appendix D.



QUESTION 11

Overall, how willing are you to make the following changes in order to reduce your household's food waste?

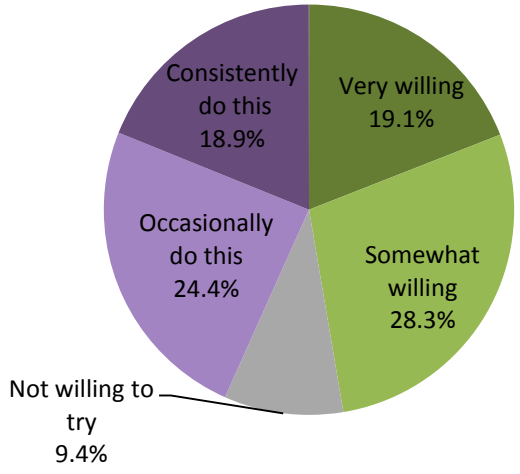
1 Not at all willing 2 Somewhat willing 3 Very willing 4 Occasionally do this 5 Consistently do this
6 I am not the primary purchaser of food for my household

- □ ***Plan a weekly menu***
- □ ***Write a shopping list based on a menu plan***
- □ ***Use leftover food for other meals (Answer whether or not you are the primary food purchaser)***

We wanted to assess the how willing people were to adopt certain practices to help reduce their waste in order to identify any low-hanging fruit targets for our messaging. We asked respondents to indicate their willingness to adopt new behaviors or to indicate that they already practice these activities (and how consistently they do so). The results of our analysis are below.

Activity: *Plan a weekly menu*

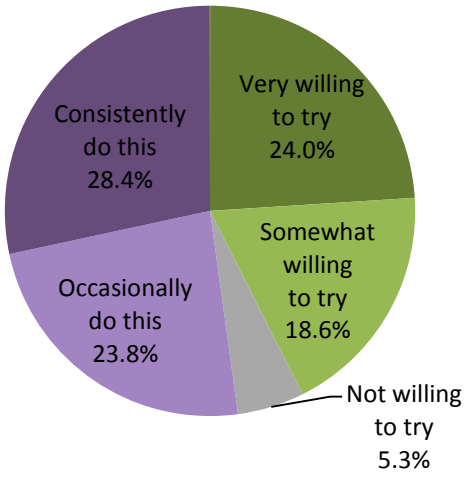
Our results indicate that many respondents (43.3%) already plan a weekly menu, and of those that do not, most are willing to try the activity. A breakdown of respondents' responses can be found below [see Appendix D for confidence intervals and standard errors of these results]. These results are encouraging for our campaign and indicate that educating people and providing meal planning tips to this receptive audience will be a worthwhile endeavor.



Activity: *Write a shopping list based on a menu plan*

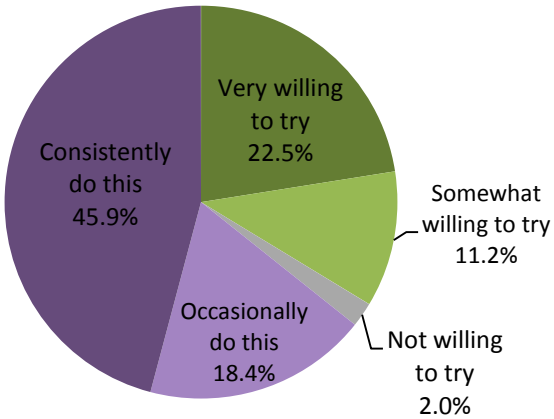
Our results indicate that the majority respondents (52.2%) already write a shopping list based on a menu plan, and of those that do not, most are willing to try the activity. A breakdown of respondents' responses can be found below [see Appendix D for confidence intervals and

standard errors of these results]. These results are encouraging for our campaign and indicate that our audience will be receptive to learning about effective shopping techniques.



Activity: *Use leftover food for other meals*

Our results indicate that the majority respondents (64.3%) already use leftover food for other meals, and of those that do not, most are willing to try to do incorporate this practice into their cooking. A breakdown of respondents' responses can be found below [see Appendix D for confidence intervals and standard errors of these results]. These results are encouraging for our campaign and indicate providing consumers with recipes and other tips for using leftovers will be well-received by our audience.



We were also interested to see if a person's concern for the environment (Question 1) was correlated with the above behaviors. We hypothesized that concern for the environment

would be correlated with these behaviors. We again grouped respondents into categories (Willing, Not willing, or Already do this) and performed a Chi-squared test to test for independence. Our calculations indicate that responses for one of the activities (*Use leftover food for other meals*) were independent of concern for the environment, while responses for the other two activities (*Plan a weekly menu* and *Write a shopping list based on a menu plan*) were dependent on respondents' indication of their environmental concern. Please see the Appendix D for p-values for these results.

We were also interested to see if certain demographic groups were more likely to be willing to adopt these food-waste reducing behaviors in order to identify potential targets for our messaging. However, our analysis, found in Appendix E, indicates that no particular demographic groups stand out as most willing to change their behavior.

QUESTION 12

Consumer food waste has negative impacts on the environment. For example, the decomposition of food releases greenhouse gas emissions which contribute to climate change. Food waste also leads to inefficient use of resources such as water, energy, and land. Consumer food waste also negatively impacts American families financially. The average American household discards food valued between $1300 and $2275 each year. Which of these two issues represents a larger problem to you?

□ ***The environmental impacts***

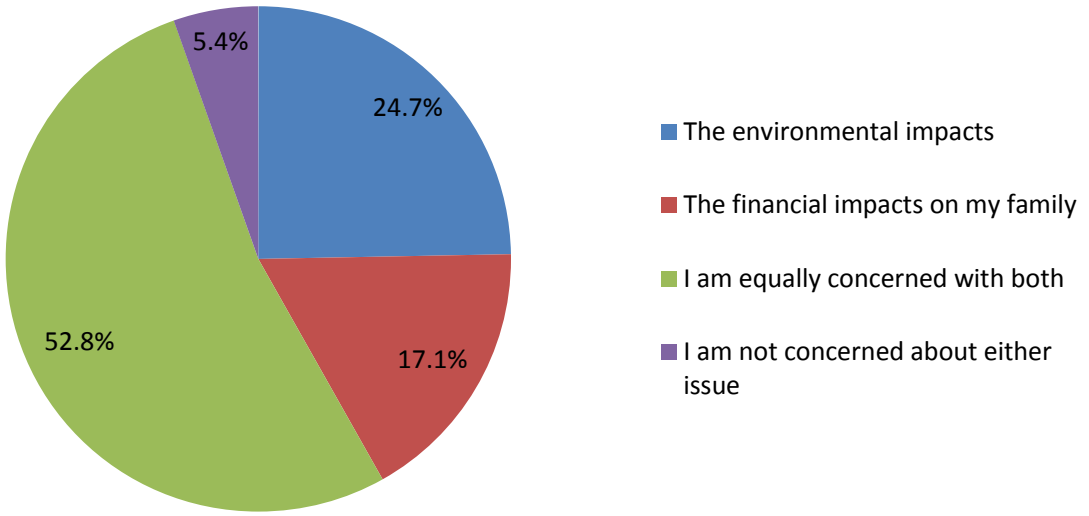
□ ***The financial impacts on my family***

□ ***I am equally concerned with both***

□ ***I am not concerned about either issue***

In order to determine the type of messaging that would be most resonant with consumers, we sought to understand whether people were more concerned about the environmental impacts of food waste or the financial impacts on their family. We primed respondents with a short statement about the environmental impacts of food waste and the monetary value of food thrown away in the average American household. The majority of respondents (52.8%) indicated that they were equally concerned with environmental and financial impacts (95% CI[0.498, 0.557], SE = 0.0147). 24.7 percent of respondents indicated that they were more concerned with environmental impacts (95% CI[0.2226, 0.273], SE = 0.0127), while 17.1% were more concerned about financial impacts (95% CI[0.150, 0.194], SE = 0.011). 5.4 percent of respondents were not concerned about either issue (95% CI[0.042, 0.069], SE= 0.007). These results indicate that messaging about the environmental impacts and the financials impacts will each be valuable in helping to reach consumers.

Which of these two issues represents a larger problem to you?



We were also interested to whether or not a respondent's indicated concern for the environment (Question 1) would be correlated with their response to this question. Using a Chi-squared test, we determined that responses to this question were dependent upon respondents' indicated concern for environmental problems (p-value < 2.2e-16).

Environmental Communications

Published in the fall of 1962, *Silent Spring* by Rachel Carson was the first media offering to repackage previously known scientific information for the public. Since Carson's landmark publication, others have followed in her footsteps to raise awareness of environmental issues. More recently, issues such as climate change have dominated the realm of environmental communications, as like-minded scientists, academics, and politicians seek to inform the public of important issues they may not fully understand. Several films on the topic, such as *An Inconvenient Truth*, have been instrumental in informing the masses of the implications of our actions on the natural world, and ultimately on ourselves and future generations [65]. However, much has changed since the time when *Silent Spring* first caused a national uproar – now, in addition to films, books, and news, people also look to the internet and social media platforms for information. Similarly, the number of organizations and stakeholders trying to raise awareness about various environmental issues – everything from hydrofracking to biodiversity loss – has also increased. The result is a crowded space with an abundance of causes and communication forms all competing for public attention.

In order to be heard amongst the noise, environmental communications campaigns need to be thoughtfully crafted and utilize the most effective channels. Since households are responsible for the greatest proportion of preventable food waste, it has been recommended that public awareness campaigns be constructed to target household decision makers [41]. After careful planning, we opted to communicate our campaign, The Food Waste Project, through a short film, website, and Twitter feed. We believe that this combination can help us reach the largest audience, and the design of each of these elements has been informed and supported both by the findings of our statewide survey and wider research.

Without regard to specific channels, Mendelsohn (1973) writes that public information campaigns have a relatively high success rate if they adhere to three principles [66]. First, campaign developers must assume that most audiences are likely to be only mildly interested in the message. We are well aware that until now, interest in issues surrounding food waste has been minimal. However, we believe that new research regarding the sheer amount of food waste and its implications, as well as the attention it is starting to garner internationally can help to change that. Only recently has research measuring the financial cost of food waste to consumers emerged, and it is likely that a proposition to save money by reducing food waste will resonate with consumers. Second, realistic yet challenging goals for raising awareness should be set. Research shows that exposure to clear and simple messaging can lead to changes in behavior and that making people aware of food waste has a direct impact on food

waste related behaviors [67] [68]. Finally, the target audience needs to be thoroughly investigated in terms of demographics, lifestyles, values, and mass-media habits. Using our survey, we were able to collect demographic information as well as information about environmental values and food waste-related behaviors.

Due to the mass appeal of film and its ability to serve as a powerful change agent, we felt that a short film should be an integral part of our communications campaign. We were selected to participate in the University of California, Santa Barbara's Green Screen Program in which student groups write and produce environmental films. Our narrative film, entitled *I Am the 40%*, follows our main character, a two-legged carrot, from the farm, all the way to the landfill. The film shows the audience how food waste occurs at each step of the carrot's journey from farm to fork. The carrot, whose only endeavor is to be eaten rather than wasted, is eventually discarded because he spoils. The film ends with the carrot lamenting his fate at a local landfill followed by text of relevant statistics regarding food waste in America.

Choosing to create a narrative film rather than a documentary provided our team with an increased degree of artistic freedom and the ability to present the material in a dramatic fashion. According to research conducted by Bahk (2010), dramatic presentations can be an effective means of eliciting empathic, emotional reactions from the audience while providing them with vicarious life experiences [69]. In his study, two groups of students were randomly divided into an experimental group and control group before watching fictional films. The experimental group watched *Medicine Man*, a film about a biochemist looking for an herbal cure in a forest ready to be deforested. The control group viewed *Three of Hearts*, a romantic comedy that lacks any environmental content. At the end of viewing, both groups of students filled out a survey that measured attitudes towards forest preservation. The results showed that participants in the experimental group were significantly more favorable to forest preservation than those in the control group. Bahk (2010) concluded that the results of this study suggest that works of fiction can influence public attitudes toward environmental issues [69]. It is our hope that making a fictional film where the audience comes to care about and empathize with a food item and his fate will encourage them to change their behaviors. We ultimately decided to use a misshapen carrot as our main character for two primary reasons. First, studies have concluded that produce is, by weight, the most highly wasted food type [34]. Secondly, doing so allowed us to bring attention to a separate issue within the supply chain – the fact that much produce which does not meet arbitrary aesthetic standards is typically discarded before it ever reaches consumers.

Shooting locations in our film, such as a grocery store and a character's kitchen, are meant to resonate with the audience and motivate behavioral changes that result in a reduction food

waste. Researchers such as Craik (1981) and Tulving (1979) believe that effective memory recall of a film's message is improved by portraying relatable events in familiar settings [70] [71]. This research motivated many of the scenes in our film, particularly those that occur in the grocery store, where key purchasing decisions are made, as well as those shot in a home setting, where consumptive decisions are made.

In addition to our film, we have also crafted a website and integrated Twitter feed. Research has found that new communication technologies such as email and websites are perceived as competitively superior to traditional media in spurring public action [72]. The food waste reduction tips mentioned during our narrative film will also be provided on the campaign website. Our website (www.TheFoodWasteProject.com) will relay a variety of information as well as showcase our narrative film. This information includes recent news relating to food waste, our mission, a section labeled 'What You Can Do' which will highlight tips for consumers to reduce in-home food waste, a resources section that highlights smartphone apps and additional literature pertaining to food waste, our Twitter feed, and team biographies and contact information. The website was designed to provide consumers with simple, effective tips and strategies for reducing food waste while simultaneously explaining the benefits of doing so. Research has shown that in order to change behavior, consumers need to be presented with specific solutions [73]. As 75.3% of people in the United States had access to the internet in 2007, we are confident that this channel can help our message reach a large audience in a cost effective way [74]. Creating a web presence that permeates various social media outlets such as Facebook and Twitter is an important step for media messaging, as consumer networks have become increasingly connected and useful for implementing change. Our website also features our infographic developed to inform consumers of some of the impacts of food waste. Infographics are useful for communicating information in a way that puts information into context by combining both facts and visuals [75].

Recommendations for Consumers

There are several steps that consumers can take to reduce the amount of food waste they produce:

Creating shopping lists
Creating shopping lists prior to grocery store visits helps cut down on gratuitous purchases that are more likely to ultimately be discarded.

Taking inventory of what is available at home
Consumers should adopt the habit of taking stock of ingredients they have at home before purchasing food. This helps to ensure that duplicate purchases are avoided and could encourage consumers to utilize items in meals that they already have.

Buying only what is needed
After consumers develop the habit of creating shopping lists, it is important that they adhere to the list. Doing so helps consumers resist partaking in promotions (e.g. "buy one get one free") that have been linked to higher food waste rates [76]. Similarly, consumers should be weary of buying items in bulk in an attempt to save money. Often food bought in bulk spoils before it is consumed.

Using smartphone applications
There are a number of useful grocery applications available for smartphone users [77] [78]. One particular application called "Out of Milk" combines a grocery list and a pantry list into one application. The grocery list stores things you plan on buying while the pantry list keeps stock of items already at home to reduce double buying.

Buying loose produce
Consumers should also try to buy loose fruits and vegetables instead of prepackaged amounts of produce. By buying individual pieces, consumers can buy only what they need and reduce the amount of packaging waste.

Utilizing and understanding expiration dates
Checking for and knowing the difference between expiration dates can also help consumers reduce food waste. There are currently a multitude of date label types that can be found on supermarket shelves, which often leads to misunderstanding about the meaning of each label. There is presently no regulation of date labels, but ideally date label schemes will be

streamlined and standardized in the near future. In the meantime, there are a number of things that consumers can do to maximize the shelf life of their food. Buying perishable items that have later expiration dates will decrease the likelihood of spoilage. Consumers can usually look further back on the shelf to find products that have later expiration dates. Certain foods, such as dairy products, may be safe to eat after the date on the provided date label. These foods should be assessed by sight or smell to check for spoilage. The freshness of other foods like meat, poultry, and eggs is not as easily assessed and consumers should give deference to the given date. The USDA advises that, if a "use-by" date is provided, that date should be followed [79]. If the product has a "sell-by" date or no date, the following guidelines should be followed:

Product	Storage Times After Purchase*
Poultry	1 or 2 days
Beef, Veal, Pork, and Lamb	3 to 5 days
Ground Meat and Ground Poultry	1 or 2 days
Fresh Variety Meats (Liver, Tongue, Brain, Kidneys, Heart, Chitterlings)	1 or 2 days
Cured Ham, Cook-Before-Eating	5 to 7 days
Sausage from Pork, Beef, or Turkey (Uncooked)	1 or 2 days
Eggs	3 to 5 weeks

Table 4: Refrigerator Storage of Fresh or Uncooked Products [79]
*Cook or freeze the product by this time

Planning meals

Planning meals ahead can help consumers save money and reduce the amount of food that they waste. Having the foresight to plan meals, buying the proper amount of ingredients, and then cooking the right proportion of food will make the most of the food purchased.

Consuming leftovers

Consumers should take home leftovers when eating out and should also save any food left over from meals prepared at home. These can serve as meals at a later time, and in case there is not a sufficient amount to constitute a full meal, there are online recipe generators that consider user inputs such as ingredients available, cook time, and cuisine type to generate a recipe [80]. By using what is readily available in conjunction with a recipe generator, ingredients that may have otherwise been discarded can be used in new dishes.

Storing food properly

The shelf life for food, especially for produce, can be highly dependent on its storage conditions. Several websites and resources exist to inform consumers of proper storage techniques for varying food which helps to ensure they stay fresh for as long as possible.

Next Steps

It is our desire to see the continuation of studies and campaign efforts about food waste based on the work we were able to do over the course of 2012-2013. We believe that it would be especially beneficial for a group or organization, using our methodology, to go a step further and measure the level and length of effectiveness of a food waste mitigation campaign by analyzing periodic waste audit data before and after exposure to a customized education campaign. One proposal involves deploying our campaign at the University Center Dining Commons at UC-Santa Barbara. Our short film would be aired on the television screens positioned around the cafeteria area at different times depending on area capacity and time of day. A new study or project of this nature could provide the foundation for a measurement framework to be used for food waste campaigns throughout the United States and would advance the science behind the phenomenon.

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Appendices

Appendix A: Food Waste Estimates

Percent of Total Food Production Lost at Each Stage of the Supply Chain

	Grain Products	Seafood	Fruits & Vegetables	Meat	Milk
Production losses	2%	11%	20%	3%	3%
Postharvest, handling & storage losses	2%	0.5%	3%	2%	0.25%
Processing and packaging losses	10%	5%	1%	4%	0.5%
Distribution and retail losses	2%	9.5%	12%	4%	0.25%
Consumer losses	27%	33%	28%	12%	17%

Source: Food and Agriculture Organization, 2011 data for North America

Percentage of total production reaching consumer stage:

Grain Products
1*0.98*0.98*0.90*0.98 = 0.847

Seafood
1*0.89*0.995*0.95*0.905 = 0.761

Fruits & Vegetables
1*0.80*0.97*0.99*0.88 = 0.676

Meat
0.97*0.98*0.96*0.96 = 0.876

Milk
0.97*0.9975*0.995*0.9975 = 0.960

Percent of remaining food lost at consumer stage:

Grain Products
0.847*0.27 =0.227

Seafood
0.761*0.33 = 0.251

Fruits & Vegetables
0.676*0.28 = 0.189

Meat
0.876*0.12 = 0.105

Milk
0.960*0.17 = 0.163

Average = 18.8%

Appendix B: Food Waste Infographic

Data Sources:

Figures	Source(s)
20% Food Waste Figure	Appendix A
Annual Domestic Methane Emissions	Agency USEP
Value of food discarded food	Buzby and Hyman, Total and per capita value of food loss in the United States
2010 State GDP Data	Bureau of Economic Analysis
State population data	United States Census Bureau
Food security data	Coleman et al.
Energy waste data	Webber, M
Energy use by state	United States Energy Information Administration
Associated water waste	United States Department of Agriculture Economic Bulletin eIB-16
Becharof lake volume	United States Geological Service
State sizes	Nation Atlas
Land used to grow food	United States Department of Agriculture Economic Bulletin eIB-14

Appendix C: Classification of Counties

Respondents' counties were classified as either Urban, Suburban, Rural, or Agricultural based on the following criteria:

Agricultural: Greater than 55% land area dedicated to agriculture
Rural: Population density < 0.2 people per acre
Suburban: Population density between 0.2 and 1 people per acre
Urban: Population density > 1 person per acre

Data Sources:

"California County Data." California State Association of Counties. UScounties.org. Web.

County Summary Highlights: 2007. Rep. United States Department of Agriculture. Web.

"Population QuickFacts: California." *California QuickFacts from the US Census Bureau*. 10 Jan. 2013. Web.

Appendix D: Survey Results and Analysis

QUESTION 1

In general, how concerned are you with environmental problems?

Response	Proportion	Standard Error	95% Confidence Interval
Very Concerned	0.5299578	0.01449873	(0.5010678, 0.5586513)
Somewhat Concerned	0.435443	0.01440325	(0.4070492, 0.4642603)
Not at all concerned	0.03459916	0.00530918	(0.02524561, 0.04708087)

Response Rate: 1185/1185 (100%)

QUESTION 2

Please indicate which of the following issues is most important to you.

Response	Proportion	Standard Error	95% Confidence Interval
Health Effects	0.1984797	0.0115915	(0.1763489, 0.2225969)
Economic Sustainability	0.2584459	0.01272273	(0.2339114, 0.2845692)
Maintaining Ecosystems	0.379223	0.01410065	(0.3516038, 0.4076353)
Scarcity of Resources	0.1638514	0.01075699	(0.1434620, 0.1864583)

Response Rate: 1184/1185 (99.9%)

QUESTION 3

What do you think is the largest component of waste (by weight) in the average household garbage bin?

Response	Proportion	Standard Error	95% Confidence Interval
Packaging	0.6294416	0.01404744	(0.6011032, 0.6569286)
Food	0.2115059	0.01187823	(0.1887739, 0.2361410)
Garden Clippings	0.04230118	0.005854395	(0.03186515, 0.05581084)
Paper	0.1006768	0.008752133	(0.08440572, 0.11959860)
Other	0.01607445	0.003657973	(0.009983736, 0.025480883)

Response Rate: 1182/1185 (99.7%)

QUESTION 4

Please estimate the value of the food your household throws out each year.

	Response	Proportion	Standard Error	95% Confidence Interval
1	Under $749	0.6042373	0.01423574	(0.5756133, 0.6321746)
2	$750 to $1,499	0.2838983	0.01312586	(0.2584947, 0.3107274)
3	$1,500 to $2,249	0.07966102	0.007882352	(0.06515566, 0.09696870)
4	$2,250 or more	0.03220339	0.005139275	(0.02319190, 0.04437687)

Median: 1 (Under $749)

Response Rate: 1180/1185 (99.6%)

QUESTION 5

In regard to food labels, which of the following do you think best describes what is meant by the "best before" date?

Response	Proportion	Standard Error	95% Confidence Interval
1	0.3098472	0.01347329	(0.2836807, 0.3372697)
2	0.5772496	0.014393	(0.5484067, 0.6055828)
3	0.06112054	0.006979525	(0.04843638, 0.07674567)
4	0.05178268	0.006456149	(0.04014812, 0.06642796)

1) Food must be eaten or thrown away by this date
2) Foods are still safe to eat after this date as long as they are not damaged, deteriorated, or perished
3) Food must be sold at a discount after this date
4) Other (please specify)

Response Rate: 1178/1185 (99.4%)

QUESTION 6

In regard to food labels, which of the following do you think best describes what is meant by the "use by" date?

Response	Proportion	Standard Error	95% Confidence Interval
1	0.5960884	0.01430852	(0.5673468, 0.6241949)
2	0.3392857	0.01380658	(0.3123720, 0.3672623)
3	0.03656463	0.005473161	(0.02689356, 0.04937175)
4	0.02806122	0.004815807	(0.01969462, 0.03963742)

1) Food must be eaten or thrown away by this date
2) Foods are still safe to eat after this date as long as they are not damaged, deteriorated, or perished
3) Food must be sold at a discount after this date
4) Other (please specify)

Response Rate: 1176/1185 (99.2%)

QUESTION 7

Below is a list of statements about food. Please indicate the extent to which you agree or disagree with each of them.

Food that could have been eaten by people is not wasted if it is composted.

	Response	Proportion	Standard Error	95% Confidence Interval
1	Strongly Disagree	0.04615385	0.006095144	(0.03517113, 0.06021166)
2	Disagree	0.2273504	0.01217531	(0.2038397, 0.2526774)
3	Neutral	0.2606838	0.01275302	(0.2359281, 0.2870323)
4	Agree	0.3666667	0.01399886	(0.3391130, 0.3951065)
5	Strongly Agree	0.0991453	0.00868169	(0.08291706, 0.11806235)

Mean: 3.245299 (CI[3.184704, 3.305894], SE = 0.03068825)

Response Rate: 1170/1185 (98.7%)

Wasting food contributes to climate change.

	Response	Proportion	Standard Error	95% Confidence Interval
1	Strongly Disagree	0.1	0.008714893	(0.08370379, 0.11897904)
2	Disagree	0.1495726	0.01036061	(0.1298825, 0.1716042)
3	Neutral	0.3111111	0.01344848	(0.2848225, 0.3386559)
4	Agree	0.3205128	0.01355671	(0.2939805, 0.3482386)
5	Strongly Agree	0.1188034	0.009399217	(0.1011022, 0.1390569)

Mean: 3.208547 (CI[3.143074, 3.274020], SE = 0.03315888)

Response Rate: 1170/1185 (98.7%)

Americans don't waste much food.

	Response	Proportion	Standard Error	95% Confidence Interval
1	Strongly Disagree	0.6709402	0.01364961	(0.6430605, 0.6976833)
2	Disagree	0.2435897	0.0124695	(0.2194475, 0.2694393)
3	Neutral	0.04102564	0.005761983	(0.03071196, 0.05445516)
4	Agree	0.01196581	0.003158624	(0.006821933, 0.020515824)
5	Strongly Agree	0.03247863	0.005149558	(0.02339087, 0.04475347)

Mean: 1.491453 (CI[1.440336, 1.542570], SE = 0.02588836)

Response Rate: 1170/1185 (98.7%)

The energy, water, and fertilizer that are used to grow, process, and transport food are wasted if food is purchased but not eaten.

	Response	Proportion	Standard Error	95% Confidence Interval
1	Strongly Disagree	0.04017094	0.005704187	(0.02997317, 0.05349146)
2	Disagree	0.08461538	0.008084763	(0.06960619, 0.10241579)
3	Neutral	0.1598291	0.01064517	(0.1395463, 0.1823834)
4	Agree	0.4393162	0.01441745	(0.4106995, 0.4683361)
5	Strongly Agree	0.2760684	0.01298667	(0.2508029, 0.3028239)

Mean: 3.826496 (CI[3.766153, 3.886839], SE = 0.03056072)

Response Rate: 1170/1185 (98.7%)

Busy lifestyles make it hard to avoid wasting food.

	Response	Proportion	Standard Error	95% Confidence Interval
1	Strongly Disagree	0.1376068	0.01000722	(0.1186500, 0.1589867)
2	Disagree	0.2547009	0.01265672	(0.2301541, 0.2808805)
3	Neutral	0.1923077	0.01144886	(0.1703395, 0.2163278)
4	Agree	0.3273504	0.01363144	(0.3006487, 0.3552001)
5	Strongly Agree	0.08803419	0.00823106	(0.07272673, 0.10610862)

Mean: 2.973504 (CI[2.903601, 3.043407], SE = 0.03540224)

Response Rate: 1170/1185 (98.7%)

QUESTION 8

Think about why food might be wasted in your household. Please select at least 1 and up to 3 options.

Response	Proportion	Standard Error	95% Confidence Interval
1	0.1171565	0.006409102	(0.1049850, 0.1305127)
2	0.1489277	0.007094849	(0.1353665, 0.1635737)
3	0.3157268	0.009262807	(0.2976692, 0.3343519)
4	0.09928515	0.005959474	(0.08802023, 0.11179157)
5	0.1076251	0.006175933	(0.09592418, 0.12054098)
6	0.1199365	0.006474478	(0.1076329, 0.1334160)
7	0.09134234	0.005741275	(0.0805162, 0.1034354)

1) Food is left too long in the fridge or freezer
2) Food goes bad before the "use by" or "best before" date
3) We don't tend to eat leftovers or use leftover ingredients in other meals
4) We tend not to plan meals for the week before grocery shopping
5) We don't check the fridge, freezer, and cupboard before shopping
6) We buy too much food
7) We're generally too busy to cook the meals we planned

Response Rate: 1168/1185 (98.6%)

QUESTION 9

How do you typically determine when to throw out dairy products?

Response	Proportion	Standard Error	95% Confidence Interval
Based on Date	0.2759212	0.01308429	(0.2506284, 0.3027088)
Based on Smell/Sight	0.6880891	0.01356133	(0.6604918, 0.7144324)
Other	0.03598972	0.005452487	(0.02636838, 0.04877648)

Response Rate: 1167/1185 (98.5%)

QUESTION 10

If your household sometimes buys more food than you actually need, what are the top reasons? Please select at least 1 and up to 3.

Response	Proportion	Standard Error	95% Confidence Interval
1	0.1531279	0.007780838	(0.1382762, 0.1692405)
2	0.155929	0.007838686	(0.1409592, 0.1721495)
3	0.1456583	0.007622082	(0.1311304, 0.1614746)
4	0.1269841	0.007194093	(0.1133266, 0.1419993)
5	0.1573296	0.007867275	(0.1423013, 0.1736033)
6	0.1325864	0.007327449	(0.1186580, 0.1478515)
7	0.09570495	0.006356419	(0.08374102, 0.10914346)
8	0.03267974	0.003841623	(0.02574005, 0.04134412)

1) I buy items in bulk and cannot finish them in time
2) I like to have more food or ingredients available than not enough
3) I am tempted by supermarket values (e.g. 2 for 1)
4) I like fresh ingredients and don't keep older/blemished ingredients
5) I don't check the cupboard or fridge before shopping
6) I lack time or organization to plan ahead (e.g. no list or meal plan)
7) Not applicable (I consistently purchase the right amount of food)
8) Other

Response Rate: 1165/1185 (98.3%)

QUESTION 11

Overall, how willing are you to make the following changes in order to reduce your household's food waste?

Plan a weekly menu.

Response	Proportion	Standard Error	95% Confidence Interval
Not at all willing	0.09028375	0.008403649	(0.07474025, 0.10859504)
Somewhat willing	0.2717111	0.01304415	(0.2465118, 0.2984388)
Very Willing	0.183147	0.0113418	(0.1615644, 0.2068562)
Occasionally do this	0.2347377	0.01242816	(0.2108636, 0.2603892)
Consistently do this	0.1814273	0.0113003	(0.1599314, 0.2050615)
Not primary food purchaser	0.03869304	0.005655325	(0.02867198, 0.05186804)

Response Rate: 1163/1185 (98.1%)

Write a shopping list based on a menu plan.

Response	Proportion	Standard Error	95% Confidence Interval
Not at all willing	0.05073087	0.006434888	(0.03915361, 0.06536627)
Somewhat willing	0.1788478	0.01123735	(0.1574833, 0.2023681)
Very Willing	0.2312984	0.01236446	(0.2075600, 0.2568373)
Occasionally do this	0.2295787	0.01233219	(0.2059090, 0.2550605)
Consistently do this	0.2734308	0.0130699	(0.2481755, 0.3002029)
Not primary food purchaser	0.0361135	0.005470889	(0.02645944, 0.04894300)

Response Rate: 1163/1185 (98.1%)

Use leftover food for other meals (Answer whether or not you are the primary food purchaser).

Response	Proportion	Standard Error	95% Confidence Interval
Not at all willing	0.01977644	0.004082693	(0.01286889, 0.03001235)
Somewhat willing	0.1092003	0.009145599	(0.09214749, 0.12888782)
Very Willing	0.2192605	0.01213231	(0.1960153, 0.2443876)
Occasionally do this	0.1797077	0.01125843	(0.1582991, 0.2032661)
Consistently do this	0.4471195	0.01457933	(0.4183393, 0.4762531)
Not primary food purchaser	0.02493551	0.004572313	(0.01706265, 0.03608396)

Response Rate: 1163/1185 (98.1%)

QUESTION 12

Consumer food waste has negative impacts on the environment. For example, the decomposition of food releases greenhouse gas emissions which contribute to climate change. Food waste also leads to inefficient use of resources such as water, energy, and land. Consumer food waste also negatively impacts American families financially. The average American household discards food valued between $1300 and $2275 each year. Which of these two issues represents a larger problem to you?

	Response	Proportion	Standard Error	95% Confidence Interval
1	Environmental Impacts	0.246988	0.01265132	(0.2226379, 0.2730342)
2	Financial Impacts	0.1712565	0.01105174	(0.1502799, 0.1944424)
3	Both	0.5275387	0.0146456	(0.4983601, 0.5565332)
4	Neither	0.05421687	0.006642934	(0.04222395, 0.06924382)

Response Rate: 1162/1185 (98.1%)

CORRELATION ANALYSIS – Question 1 with Other Responses

In order to determine whether or not there was a relationship between concern for the environment, and responses to other questions, we performed Chi-squared tests to test for independence. The results are below. A p-value greater than 0.05 indicates that the two variables are independent of one another. A p-value less than or equal to 0.05 indicates that there a relationship between the two variables.

Independent Variable: Question 1 Response

Dependent Variable	**p-value**
Question 3*	0.6856
Question 7 – 1*	0.172
Question 7 – 2*	< 2.2e-16
Question 7 –3**	2.135e-07
Question 7 – 4**	1.171e-05
Question 7 – 5**	0.004707
Question 11 – 1***	0.002317
Question 11 – 2***	0.01797
Question 11 – 3***	0.06591
Question 12	< 2.2e-16

*Respondents were grouped into 2 categories based on their response:

Correct: "Food" response

Incorrect: All other responses

**Respondents were first grouped into 3 categories based on their response:

Disagree : "Disagree Strongly" or "Disagree" response

Agree: "Agree Strongly" or "Agree" response

Neutral: "Neither Agree nor Disagree" response

***Respondents were first grouped into 3 categories based on their response:

Willing: "Somewhat willing" or "Very willing" response

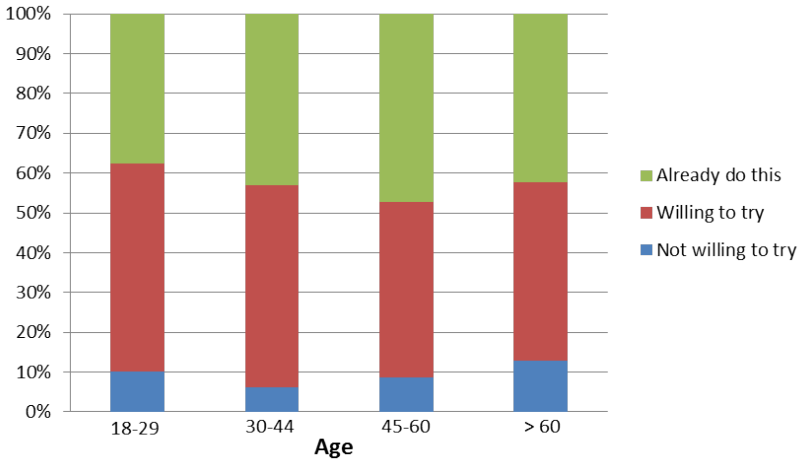
Not willing: "Not at all willing" response

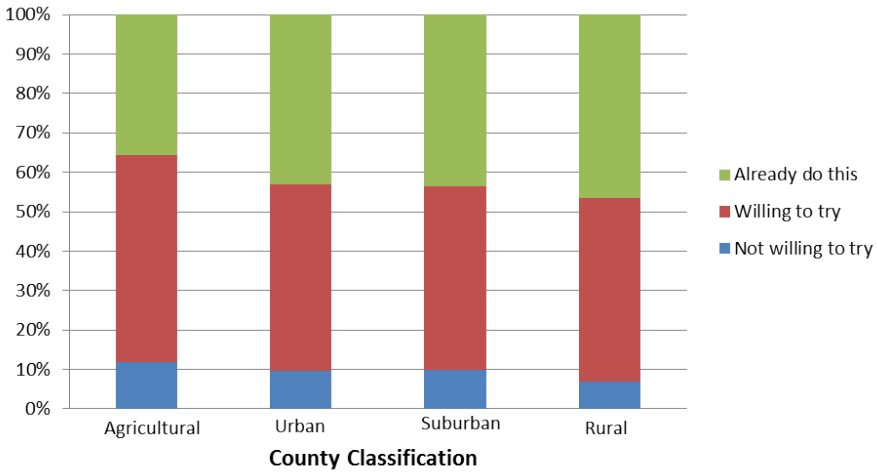
Already do this: "Occasionally do this" or "Consistently do this" response

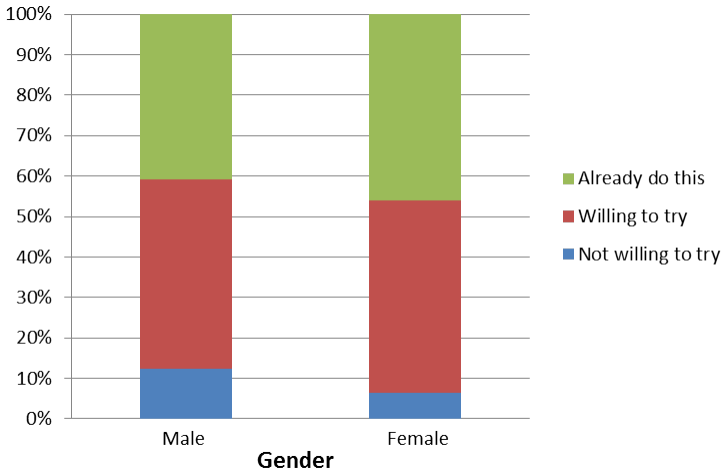
(Respondents who answered "I am not the primary purchaser of food for my household" were excluded from this analysis)

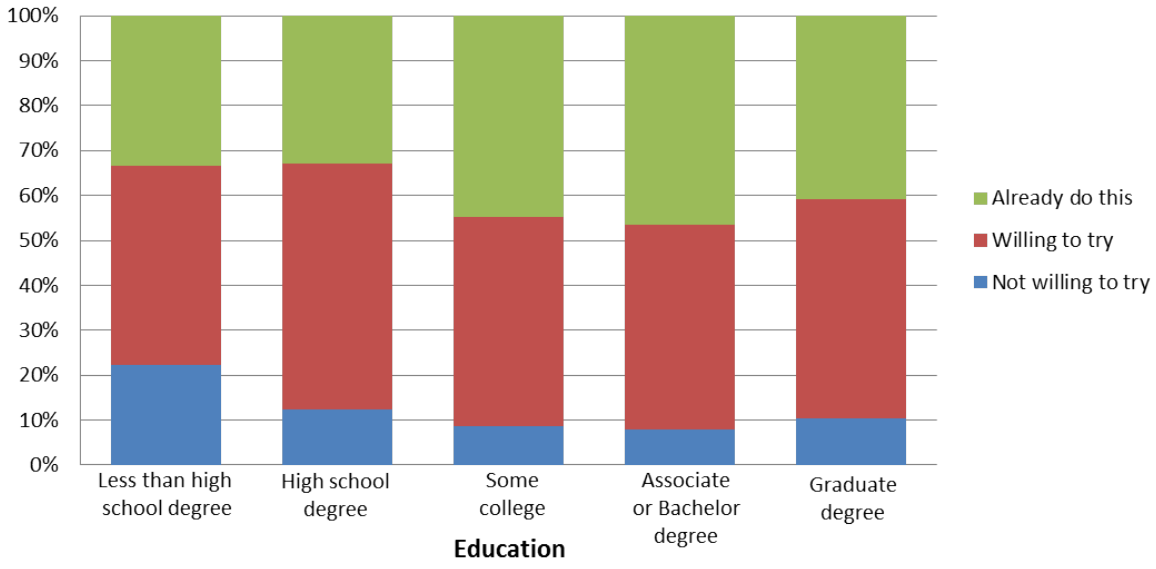
Appendix E: Question 11 Demographic Analysis

Plan a weekly menu

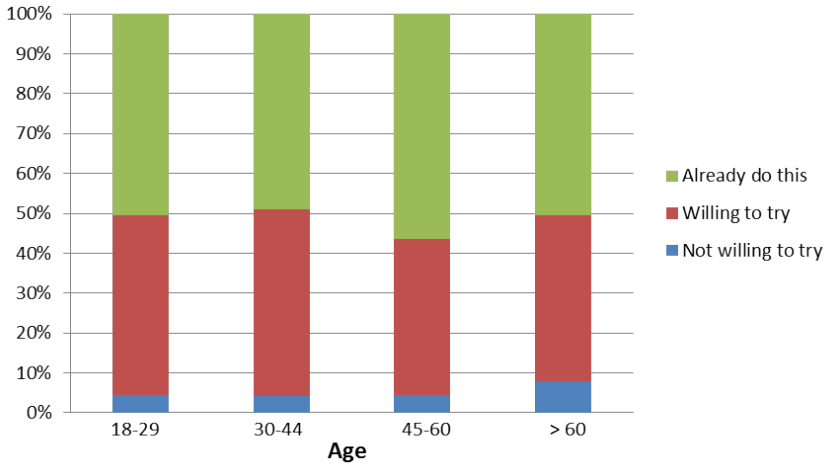


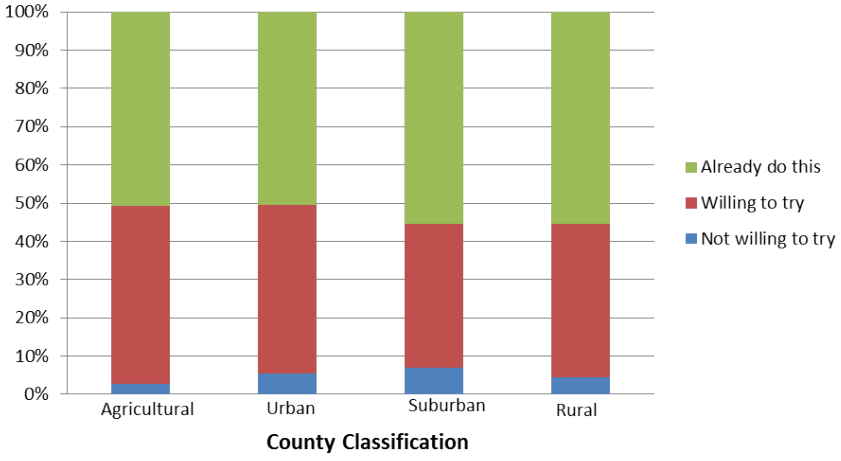


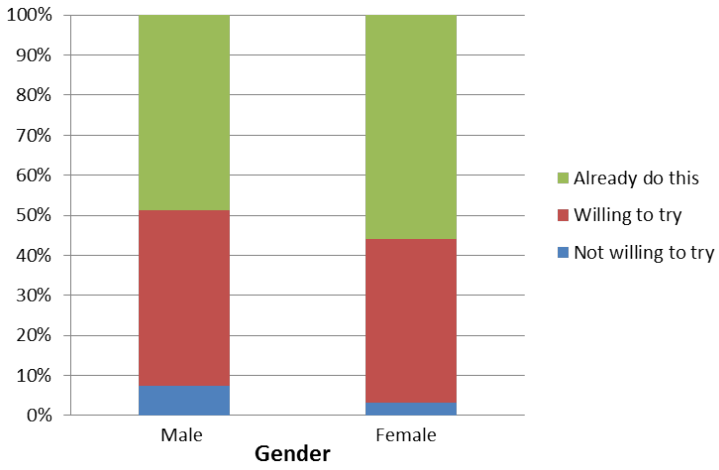


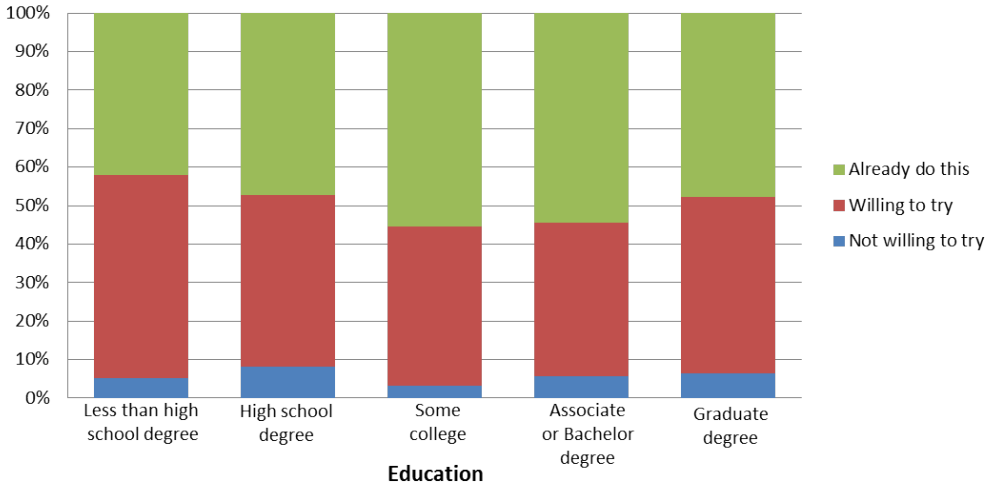


Write a shopping list based on a menu plan

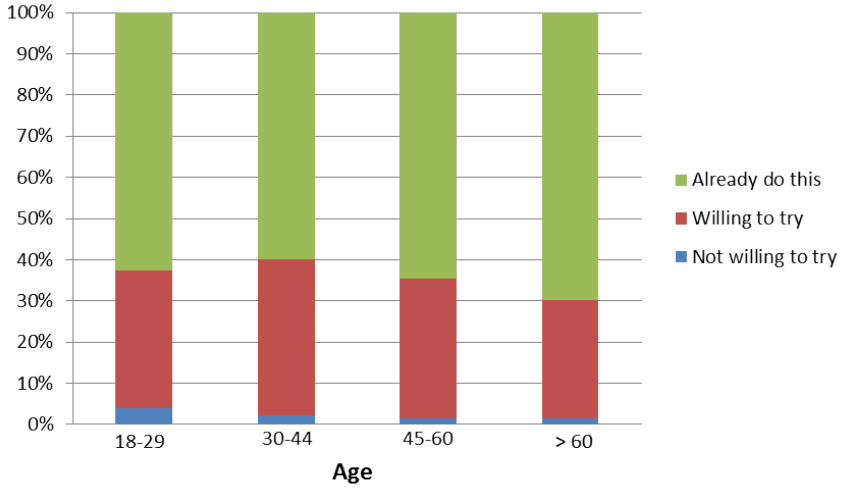


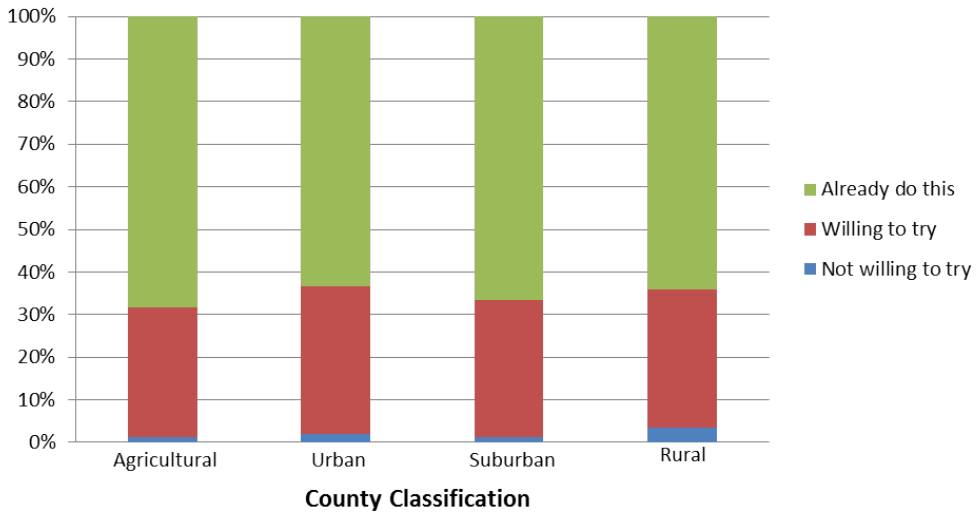


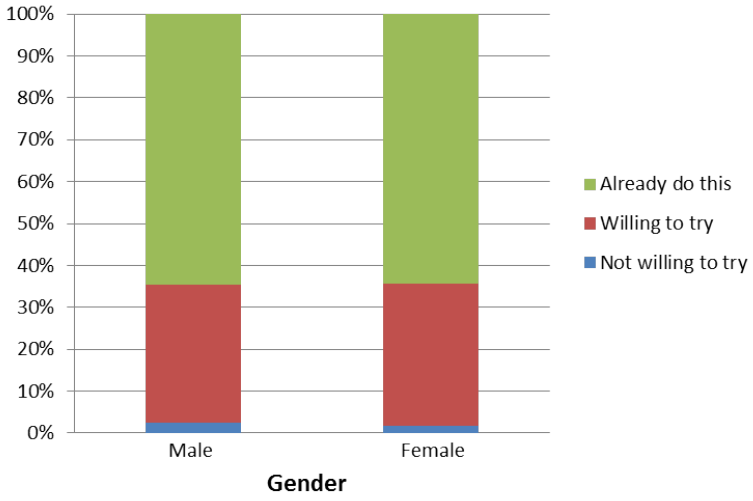


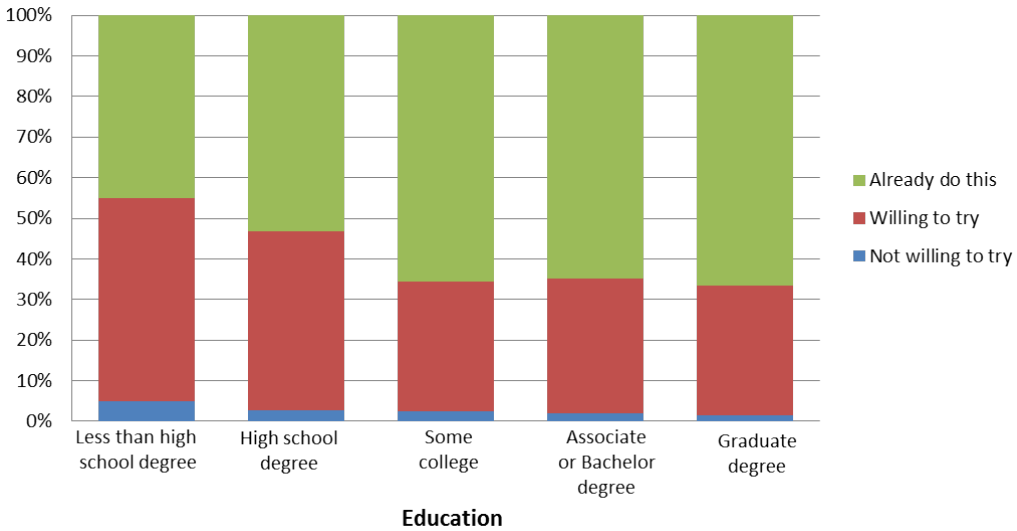


Use leftover food for other meals




100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Agricultural
Urban
Suburban
Rural
Already do this
Willing to try
Not willing to try
County Classification


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Male
Female
Already do this
Willing to try
Not willing to try
Gender


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Less than high school degree
High school degree
Some college
Associate or Bachelor degree
Graduate degree
Already do this
Willing to try
Not willing to try
Education

Appendix F: Survey Text

This survey consists of 15 questions regarding some of your behaviors and attitudes toward food waste. Please answer them as accurately as possible. Participation is entirely voluntary and consent to participate may be withdrawn at any time without prejudice.

CONFIDENTIALITY:
By completing the survey you are giving consent for the use of the data obtained. The data collected will not be linked to any individual person in anyway. The raw data will be tied only to the UCSB graduate students working on this project and property of UCSB and no raw data will be displayed publicly. Only overall statistical results of the survey will be visible publicly.

BENEFIT:
The survey will help the student team understand how California residents feel about waste and to create an educational campaign to raise awareness about reducing waste behavior. There will however be no direct benefit to you from your participation in the study.

RISK:
There are no foreseeable risks from this survey, however you are able to quit the survey at any time should you feel any risk, discomfort or inconvenience in responding to the survey.

Thank you for your time.

1. In general, how concerned are you with environmental problems?
   - □ Very concerned
   - □ Somewhat concerned
   - □ Not at all concerned

2. Please indicate which of the following issues is most important to you.
   - □ Health effects of pollution
   - □ Long term economic sustainability
   - □ Maintaining ecosystems (nature, plants, and animals)
   - □ Scarcity of resources we consume

3. What do you think is the largest component of waste (by weight) in the average household garbage bin?
   - □ Garden clippings
   - □ Packaging
   - □ Food
   - □ Paper
   - □ Other (please specify)

4. Please estimate the value of the food your household throws out each year.
   - □ Under $750
   - □ $750 to $1,499
   - □ $1,500 to $2,249
   - □ $2,250 or more

5. In regard to food labels, which of the following do you think best describes what is meant by the “best before” date?
   - □ Food must be eaten or thrown away by this date
   - □ Foods are still safe to eat after this date as long as they are not damaged, deteriorated, or perished
   - □ Food must be sold at a discount after this date
   - □ Other (please specify)

6. In regard to food labels, which of the following do you think best describes what is meant by the “use by” date?
   - □ Food must be eaten or thrown away by this date
   - □ Foods are still safe to eat after this date as long as they are not damaged, deteriorated, or perished
   - □ Food must be sold at a discount after this date
   - □ Other (please specify)

7. Below is a list of statements about food. Please indicate the extent to which you agree or disagree with each of them.

1 Strongly disagree 2 Disagree 3 Neither agree nor disagree 4 Agree 5 Strongly agree

□ Food that could have been eaten by people is not wasted if it is composted
□ Wasting food contributes to climate change
□ Americans don't waste much food
□ The energy, water, and fertilizer that are used to grow, process, and transport food are wasted if food is purchased but not eaten
□ Busy lifestyles make it hard to avoid wasting food

8. Think about why food might be wasted in your household. Please select at least 1 and up to 3 options.

□ Food is left too long in the fridge or freezer
□ Food goes bad before the "use by" or "best before" date
□ We don't tend to eat leftovers or use leftover ingredients in other meals
□ We tend not to plan meals for the week before grocery shopping
□ We don't check the fridge, freezer, and cupboard before shopping
□ We buy too much food
□ We're generally too busy to cook the meals we planned

9. How do you typically determine when to throw out dairy products?

□ I throw out dairy products based on the "best before" or "use by" dates provided.
□ I throw out dairy products after assessing them based on either appearance or smell.
□ Other (please specify)

10. If your household sometimes buys more food than you actually need, what are the top reasons? Please select at least 1 and up to 3.

□ I buy items in bulk and cannot finish them in time
□ I like to have more food or ingredients available than not enough
□ I am tempted by supermarket values (e.g. 2 for 1)
□ I like fresh ingredients and don't keep older/blemished ingredients
□ I don't check the cupboard or fridge before shopping
□ I lack time or organization to plan ahead (e.g. no list or meal plan)
□ Not applicable (I consistently purchase the right amount of food)
□ Other

11. Overall, how willing are you to make the following changes in order to reduce your household's food waste?

1 Not at all willing 2 Somewhat willing 3 Very willing 4 Occasionally do this 5 Consistently do this 6 I am not the primary purchaser of food for my household

□ Plan a weekly menu
□ Write a shopping list based on a menu plan
□ Use leftover food for other meals (Answer whether or not you are the primary food purchaser)

12. Consumer food waste has negative impacts on the environment. For example, the decomposition of food releases greenhouse gas emissions which contribute to climate change. Food waste also leads to inefficient use of resources such as water, energy, and land. Consumer food waste also negatively impacts American families financially. The average American household discards food valued between $1300 and $2275 each year. Which of these two issues represents a larger problem to you?

□ The environmental impacts
□ The financial impacts on my family
□ I am equally concerned with both
□ I am not concerned about either issue

13. Please enter the number of people in your household in the box below.

14. How much total combined money did all members of your HOUSEHOLD earn last year?

□ $0-$24,999
□ $25,000-$49,999
□ $50,000-$99,999
□ $100,000-$149,999
□ $150,000+
□ Prefer Not to Answer

15. Which county do you live in?

□ Alameda
□ Alpine
□ Amador
□ Butte
□ Calaveras
□ Colusa
□ Contra Costa
□ Del Norte
□ El Dorado
□ Fresno
□ Glenn
□ Humboldt
□ Imperial
□ Inyo
□ Kern
□ Kings
□ Lake
□ Lassen
□ Los Angeles
□ Madera
□ Marin
□ Mariposa
□ Mendocino
□ Merced
□ Modoc
□ Mono
□ Monterey
□ Napa
□ Nevada
□ Orange
□ Placer
□ Plumas
□ Riverside
□ Sacramento
□ San Benito
□ San Bernardino
□ San Diego
□ San Francisco
□ San Joaquin
□ San Luis Obispo
□ San Mateo
□ Santa Barbara
□ Santa Clara
□ Santa Cruz
□ Shasta
□ Sierra
□ Siskiyou
□ Solano
□ Sonoma
□ Stanislaus
□ Sutter
□ Tehama
□ Trinity
□ Tulare
□ Tuolumne
□ Ventura
□ Yolo

Thank you for participating in the survey. We have contracted with Survey Monkey to protect the confidentiality of your records.

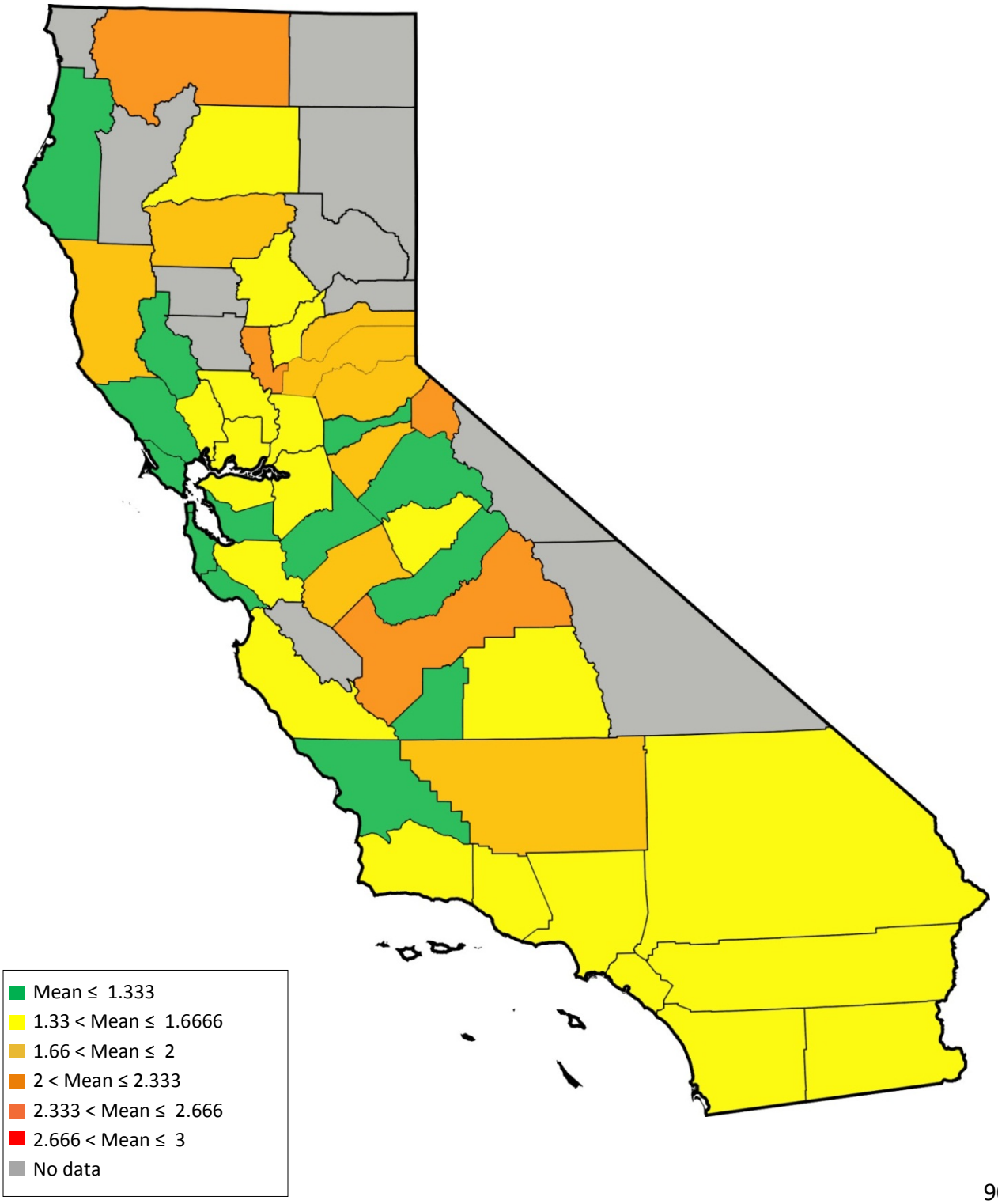
This survey is intended to gather information about the attitudes and behaviors surrounding consumer food waste in order to create a public awareness campaign.

If you have any questions, do not hesitate to contact the research team at cream@bren.ucsb.edu. The research team consists of graduate students at the University of California, Santa Barbara, Brooke Malik, Holly Capell, Travis Lee, Adam Knox, and faculty advisor Gary Libecap. The Human Subjects Committee for this project can be contacted at 8058934188 or hsc@research.ucsb.edu.

Appendix G: Average Environmental Concern by County

In general, how concerned are you with environmental problems?

1 Very concerned
2 Somewhat concerned
3 Not at all concerned



County	Mean Response
Alameda	1.262295
Alpine	2
Amador	1.333333
Butte	1.571429
Calaveras	1.666667
Colusa	No Data
Contra Costa	1.413043
Del Norte	No Data
El Dorado	1.666667
Fresno	2
Glenn	No Data
Humboldt	1.166667
Imperial	1.5
Inyo	No Data
Kern	1.785714
Kings	1
Lake	1
Lassen	No Data
Los Angeles	1.520492
Madera	1.25
Marin	1.3125
Mariposa	1.5
Mendocino	1.666667
Merced	1.666667
Modoc	No Data
Mono	No Data
Monterey	1.545455
Napa	1.5
Nevada	1.714286

County	Mean Response
Orange	1.655556
Placer	1.714286
Plumas	No Data
Riverside	1.577778
Sacramento	1.5625
San Benito	No Data
San Bernardino	1.536585
San Diego	1.559633
San Francisco	1.25
San Joaquin	1.590909
San Luis Obispo	1.25
San Mateo	1.325581
Santa Barbara	1.47619
Santa Clara	1.530303
Santa Cruz	1.333333
Shasta	1.5
Sierra	No Data
Siskiyou	2
Solano	1.466667
Sonoma	1.214286
Stanislaus	1.2
Sutter	2
Tehama	1.666667
Trinity	No Data
Tulare	1.6
Tuolumne	1
Ventura	1.541667
Yolo	1.5625
Yuba	1.5