Does a Bag Ban Work? A Case Study of Consumer Bag Choices Following a Single-Use Plastic and Carryout Bag Ordinance in Kent, Washington

by

Jessica L. Kudlinski

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Jessica L. Kudlinski

has been approved for

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by

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Shawn Hazboun, Ph. D.
Member of the Faculty

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Date

ABSTRACT

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Carryout plastic bag bans have proliferated as a way to address the environmental and economic impacts of plastic pollution, yet they are not without controversy. Few observational studies conducted within retail stores have evaluated bag usage following a bag ban. Using observational data, the present study evaluates changes in consumer usage and behavior following a bag ban in Kent, Washington. Specifically, changes in bag demand were analyzed alongside various store and consumer characteristics hypothesized to be associated with behaviors around bag usage. Grocery, hardware, and pet supply retail stores (n=7) were observed over a 13 week period to assess the changes in bag usage between the pre- and post-ban periods. Each store was observed twice a week to record the number and type of bags consumers carried into and out of the store. In all, 1,111 observations were recorded pre-ban and 492 observations were recorded post-ban. Results indicated that customers used more bags per transaction within grocery stores than in hardware and pet supply stores throughout the study, however, those numbers significantly decreased in grocery and hardware stores after the ban was implemented. Although pet supply stores did not offer reusable paper bags during the study, grocery and hardware stores both had significant increases in customers purchasing reusable paper bags after the ban. In addition, grocery stores were the only store type to see an increase once the ban was implemented in the average number of bags a customer brought from home per transaction. Policy implications and suggestions for future research, such as that which will better help consumers understand the hidden costs of shopping bags, are provided.

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List of Acronyms and Key Terms

Bag Behavior	Consumer behaviors associated with bag usage, such as double-bagging purchased goods or carrying out items by hand without the use of bags
Bag Usage	The volume and type of bag which a consumer uses
Consumer	General person or group purchasing goods from a retail location.
Customer	Specific individual shopper being referred to
EPR	Extended Producer Responsibility
Pre-Ban Period	Period of time leading up to March 1, 2020; the implementation of the Kent Single-Use Plastic and Carryout Bag Ban.
Post-Ban Period	Period of time following March 1, 2020; the implementation of the Kent Single-Use Plastic and Carryout Bag Ban.
SUP	Single-use plastic
Transaction	Single interaction between paying customer and store clerk where goods are purchased and carried out.

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Chapter 1: Introduction

Plastics are as ubiquitous in the environment as they are destructive. Primarily produced from refined oil, or fossil hydrocarbons, plastics are highly durable and cheap to manufacture (Derraik, 2002; Geyer et al., 2017). Over time plastics have become more pervasive in our everyday life and a visual part of our natural landscape. Single-use plastics (SUPs) provided a throwaway lifestyle that has consequently turned our natural waterways and environments into hazardous trash bins. The desire for convenience has created a culture that depends heavily on SUPs, which are overwhelming waste and recycle management systems across the globe (Cole et al., 2011; Derraik, 2002; Nielsen et al., 2019). Plastics are created from a myriad of complex combinations, making the waste both difficult to manage and toxic to the environment (Wang, 2018).

In order to address plastic pollution concerns, municipalities have begun to implement plastic bag policies. These policies often involve fees, bans, and/or taxes that regulate bag choices and availability to consumers. Communities across the United States and the globe have shifted from their reliance on SUP bags to more sustainable or environmentally friendly alternatives. However, some parts of the United States (in many cases, with the support of the plastic and oil industries) have worked to prohibit the regulation of SUP bags at a municipal level.

Washington residents, in total, use roughly 2 billion SUP bags each year and only a small 6% of those bags are recycled, although globally this number drops to 1% (Gates, 2020; Waste Management, n.d.). The other 94% of those bags will either clog waste management machinery or end up in a landfill, while the rest become litter polluting

terrestrial habitats and waterways. Numerous studies and reports have documented the presence of plastics and plastic fragments within a multitude of organisms, providing substantial evidence that SUP bags can directly harm and kill wildlife (CBD-STAP, 2012; Derraik, 2002; Gall & Thompson, 2015; UNEP & NOAA, 2011). For example, necropsies of whales stranded on shores document the immense amount of plastic bags, ranging 30-100 pounds, in addition to other debris found within their stomachs (Hoare, 2016; Irfan, 2019; Prater, 2017). In 2010, a gray whale washed onto a West Seattle beach in Washington with more than 20 plastic bags in its stomach, in addition to other plastic fragments and debris (MSNBC Staff, 2010).

Only used for an average of 12 minutes, SUP bags can take hundreds of years to fragment in the environment, harming wildlife and damaging habitats in the process (CBD, n.d.; Waste Management, n.d.). The volume of SUP bags that Washingtonians use, combined with the minuscule amount of time that they are actively used, is one of the several driving forces behind implementing a SUP bag ban.

The purpose of this study is to examine shifts in consumer bag usage and behavior before and after the implementation of a SUP and carryout bag ban. I used the following three research questions in order to understand these shifts:

1. *What individual characteristics are associated with consumer bag usage and behavior?*
2. *What store characteristics are associated with consumer bag usage and behavior?*

3. *What significant changes in bag usage and behavior occur between the pre- and post-ban periods?*

I observed seven stores over the span of 13 weeks to analyze which of the following characteristics are associated with shopping bag usage and behaviors: (1) a customer's gender, age, and whether they brought kids or pets; (2) the store type and the individual which bagged the purchases; and (3) before and after implementation of the ban. I included 18 types of bags that a customer may use and categorized *bag behavior* by double-bagging and carrying out items by hand. I recorded these observations by hand within a 30-minute period, then transferred the information into Excel to be further analyzed.

My analysis revealed several significant relationships between bag usage and customer and store characteristics. First, the results suggested that females differ in bag usage, specifically regarding SUP bags and the total number of bags purchased at the store, brought from home, and used overall. Second, I also found a significant relationship between store type and bag usage and behavior, likely due to the types of goods and bags that are available to the customer. Although pet supply stores provide feed for pets and livestock, consumers may buy fewer items and less often from pet and hardware store than grocery stores.

Lastly, I found significant shifts from SUP to thicker plastic alternatives and recyclable paper bags, after the ban was implemented. That is, the ban was "successful." Customers also brought more bags from home after the ban than they did before. This research adds to the existing literature that plastic policies can be effective in reducing

plastic consumption and substantially change a consumer's bag usage and behavior (Hohmann et al., 2016; Homonoff, 2015; Taylor, 2019; Taylor & Villas-Bosas, 2015). Alternatively, this also highlights that the shifts in bag usage from SUP to replacement options need to be further explored, to ensure we are not swapping one bag problem for another.

The following chapter reviews the available literature to build a foundational understanding of the production, consumption, and fates of plastic products. This review will also summarize the wide-spread environmental and economic impacts of plastic pollution, the evolution of plastic bag policies, and Extended Producer Responsibility (EPR). Next, I will provide an overview of Kent, WA, as well as the methodology for this case study. Finally, the results will be interpreted and discussed through connecting trends and theories to the relevant literature.

Chapter 2: Background and Literature Review

Production and Consumption of Plastic Bags

In the late nineteenth century, plastics emerged as a replacement for natural resources and rarities including wood, bone, ivory, and linen (Science History Institute, 2019). Leo Baekeland, the inventor of the first fully synthetic plastic, Bakelite, discovered the endless uses of plastic while trying to find a better insulator for electronic wiring (Geyer et al., 2017; Science History Institute, 2019). It wasn't until after World War II, however, that plastics became one of the most common materials used to mass-produce everyday items (Geyer et al., 2017). LIFE magazine in August of 1955 promoted plastics with a story that ran the headline "Disposable Items Cut Down Household Chores" and stated "no housewife need bother" to wash and clean, shown in Figure 1 (BaleBid, 2018).

Figure 1. Debut of single-use plastics to markets in the United States. LIFE Picture Collection/Getty Images. (Peter Stackpole).

Since the 1950s, the demand for virgin material, petroleum, for plastic production has rapidly increased; half of which was produced only within the last 15 years (Geyer et al., 2017). In a study to understand the production, use,

and fate, of all plastic ever made, researchers found that “as of 2015, approximately 6300 Mt of plastic waste had been generated, around 9% of which had been recycled, 12% was incinerated, and 79% was accumulated in landfills or the natural environment” (Geyer et al., 2017, pp. 2-3). The same study also estimated that 30% of all plastics ever produced are currently still in use.

As the production of plastics increased and advanced, newer additives including fillers, plasticizers, and flame retardants were combined with plastic resins to make different forms of plastic polymers (Geyer et al., 2017). High- and low-density polyethylene plastics grew in popularity in the form of carryout plastic bags as an alternative to paper during the 1970s across the United States. Plastic bags, like many other plastics, are not truly biodegradable and persist in the environment as they break into smaller and smaller pieces through ultraviolet (UV) radiation (Rios et al., 2007; Schnurr et al., 2018; Wagner, 2017). To properly eliminate plastic materials, destructive thermal treatments are needed, such as combustion or pyrolysis (Geyer et al., 2017).

Although plastics are among the more durable and resilient materials ever manufactured, SUPs are designed to be disposed of after just one use. Plastic bags are an example of a SUP item that many people rely on daily. The average American household comes home with 1,500 SUP bags per year; each of those bags has a life expectancy of roughly 1,000 years but are used for an average of just 12 minutes (CBD, n.d.; Powers, 2008; Environmental Protection Authority, 2016). In 2012, Robb Krehbiel at Environment Washington Research and Policy Center conducted a study finding that in Washington, 12.5% of plastic bags that are used are littered and directly contribute to

local pollution. Washington State Department of Ecology also discovered that within the state, plastic bags and films are, by weight, one of the top ten most littered items along roadways (Single-Use Plastic and Carry Out Bag Ordinance, Appendix II). In response to the mass production and pollution of plastic bags, many local and regional municipalities are moving to ban SUPs to reduce litter and costs associated with managing plastic waste (Nielsen et al., 2019; Schnurr et al., 2018; Wagner 2017).

Impacts and Costs of Plastic Pollution

The persistence of plastic pollution has a wide range of negative impacts, including on organisms, the environment, economic wellbeing, and human health (Taylor & Villas-Bosas, 2015; Xanthos & Walker, 2017). Although researchers may not always be able to identify a plastic fragment's origin, it is a consensus among researchers that various types of plastics have similar detrimental impacts on the environment, and can be assumed that as a plastic bag breaks apart in the environment it behaves similarly to other plastic fragments (Andrady, 2011; Gall & Thompson, 2015; Ocean Conservancy, 2015; UNEP & NOAA, 2011). In this next section, plastic bag pollution impacts on wildlife, the environment, and economy are discussed, followed by the evolution of plastic policy strategies, and then alternatives to SUP bags are explored. Extended Producer Responsibility (EPR) is highlighted as an important tool to manage the plastic crisis, and finally the theoretical and practical framework which situates this research within the literature is discussed.

Wildlife Impacts

Entanglement

As plastic bags and other loose items float in the environment, they can entangle and harm animals. Trapped organisms can become injured, unable to catch prey or avoid predation, weak from malnutrition, suffocate, and die (Gall & Thompson, 2015; Laist, 1997; Laist & Liffman, 2000). Gall and Thompson (2015) reviewed 340 original publications on marine debris and the impacts on the marine environment, of which 292 included entanglement or ingestion interactions. The marine debris referred to in this review article includes various plastics, fishing gear, glass, metal, and a few other categories. Although it can be difficult at times to determine the origin of a plastic fragment, for example, whether it came from packaging film or a plastic bag, the impact of the fragment remains the same. Gall and Thompson (2015) also found that plastics were the most reported material within marine litter and accounted for 90% of total documented marine encounters (Laist, 1997; Ocean Conservancy, 2015). Entanglement was also reported 35% more than ingestion encounters, with over 30,000 individuals from 243 different species impacted (Gall & Thompson, 2015).

The 2015 International Coastal Cleanup report highlights the number of species found entangled in various debris, including plastic bags, during cleanup activities near shorelines, pelagic waters by boats, and seafloors surveyed by divers: 57 marine mammals; 440 fish; 22 sharks, skates, and rays; 46 sea turtles; and 17 corals and sponges. Each of these organisms were found within 13,360 miles of the survey area, which is only a small percentage of the oceans' volume (Ocean Conservancy, 2015). Consequently,

if an organism died due to plastic entanglement, the plastic will remain long after the animal decomposes and can continue to affect another animals; this is known as ghost fishing (Derraik, 2002; NOAA, 2018).

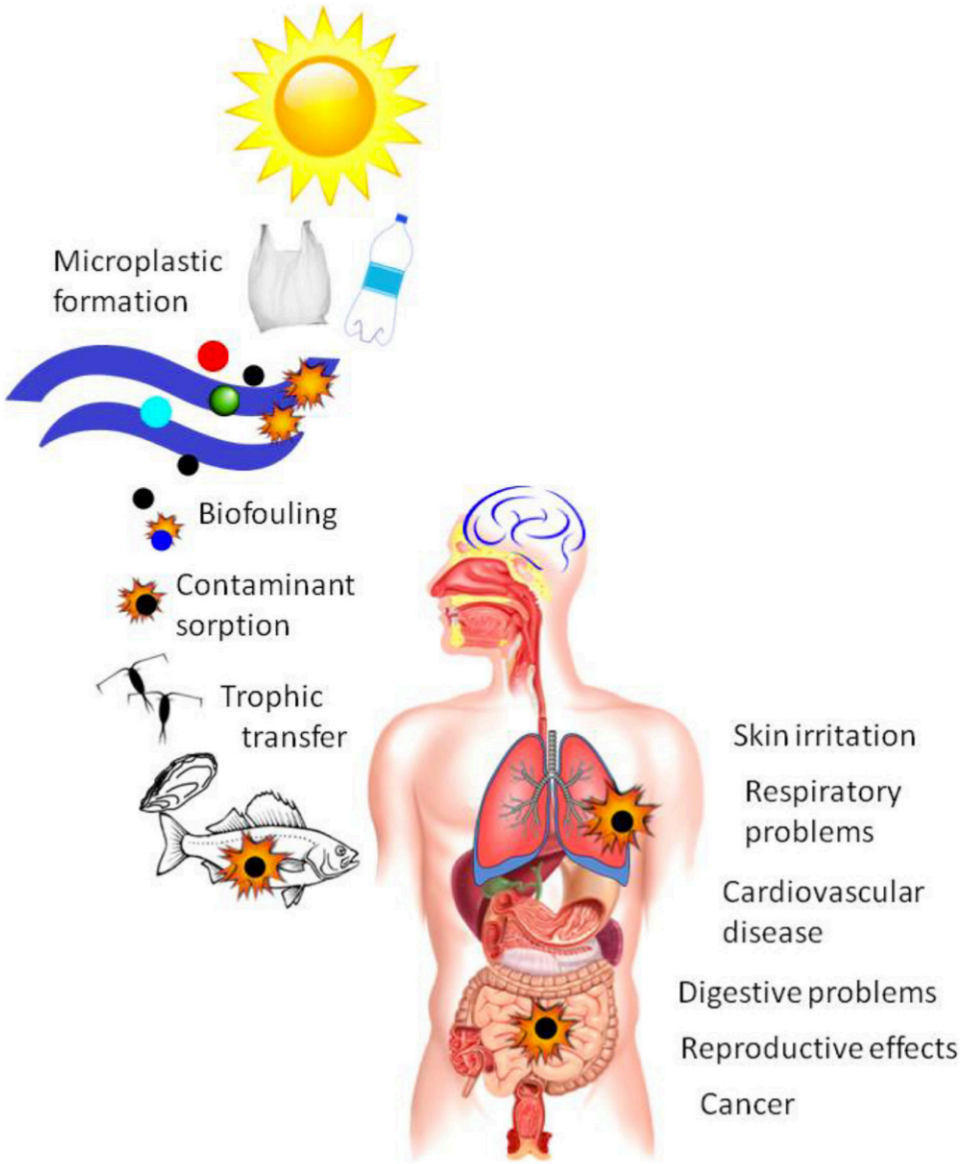
Ingestion

Littered plastic bags persist in terrestrial, aquatic, and marine environments, increasing the chances of organism interaction. Although plastic entanglement is more often reported, the number of organisms impacted from ingestion is substantially underestimated (CBD-STAP, 2012). Organisms mistake plastic pieces for prey, and when ingested these pieces can block digestive tracts and airways, leading to malnutrition, suffocation, and death (Gall & Thompson, 2015). Additional concerns with the ingestion of plastic particles include leaching of toxins into the tissues and bloodstream, causing numerous health implications (Derraik, 2002).

Kenyon and Kridler (1969) first recorded plastic ingestion in Laysan Albatross seasonally nesting within the Hawaiian Islands National Wildlife Refuge. They found several plastic fragments, caps, small toys, and transparent polyethylene plastic believed to be kitchen bags (Kenyon & Kridler, 1969). Since then, whales, turtles, birds, and numerous other species are consistently observed and reported to mistake plastic bags or pieces for prey (Bugoni et al., 2001; Derraik, 2002; Mattlin & Cawthorn, 1986). Tragically, plastics caused the death of 45 out of the 61 whales found floating or stranded around the shores of the Davao Gulf (Borunda, 2019).

Not only do organisms ingest plastic bags and particles accidentally, but humans have unknowingly been eating plastics through consumption of affected shellfish, filter

Figure 2. Plastics break apart over time and are ingested by the organisms we use as a food source. (Carbery et al., 2018).



feeders, and fish (Baechler et al., 2019; UNEP & NOAA, 2011; Xanthos & Walker, 2017). Figure 2 shows a schematic of a common pathway for plastics and toxins to move from litter to direct human consumption (Carbery et al., 2018). Even recent studies found microplastics in drinking water resources, salts, and beer, showing just how pervasive

plastics can be (Eerkes-Medrano et al., 2019; Kim et al., 2018; Koelmans et al., 2019; Peixoto et al., 2019).

Environmental Impacts

Researchers view plastics as a legacy pollutant that persist in the environment and food chains across the world (Andrady, 2011; Cole et al., 2011). Derelict and polluted plastics can have harmful, and at times deadly, impacts on natural and urban environments (Gall & Thompson, 2015; Geyer et al., 2017; UNEP & NOAA, 2011). Among other impacts, plastic pollution can sink to the depths of the ocean floor and alter benthic ecosystems, drift through currents across the oceans transferring invasive species, and float along the surface creating an eyesore for local communities (Chiba et al., 2018; Schlining et al., 2013).

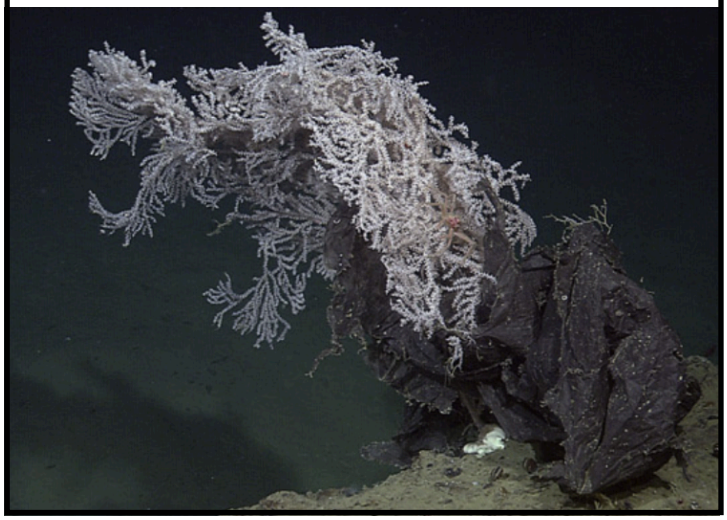
Sedimentation

Each type of plastic or debris item has its own density, causing it to float, sink, or remain neutral within the water column. Density increases as organisms and decaying matter, or biofoul, cover the plastic, eventually bringing it to the ocean floor (Andrady, 2015). This disrupts the photodegredation process and prolongs the breakdown of plastics. Along with these heavier particles, marine snow, or decomposing matter and fecal material, mixes with the particles that flow from areas higher in the water column to the ocean floor which organisms use as a food source. Once along the bottom and mixed with soft sediment, deep-sea fishes, epifauna, and infauna are exposed to this plastic debris, increasing their chance of plastic ingestion. Benthic ecosystems may also suffer from problems related to loss of nutrient turnover, lowered invertebrate biomass, and

hypoxic or anoxic environments due to the decreased exchange across the sediment−water interface (Derraik, 2002; Goldberg, 1994; Green et al., 2015).

Surveys of the deep-sea trenches and canyons from 1989-2010 in Monterey Bay, California reported that the levels of pollutants and contaminants found in species near the continental shelf were significantly lower than sediments and fishes living along the bottom of the deep sea (Schlining et al., 2013). During that survey, 37% of imaging done by underwater ROV showed encounters between invertebrates and demersal fishes, and debris; 33% of which were plastics. Figure 3 shows a plastic bag entangled around a deep sea gorgonian in Astoria Canyon, 2115 meters under the surface (Schlining et al., 2013). This study shows significant effects between debris and benthic ecosystems, however, only captured 0.24% of the entire survey area mapped by GPS (Schlining et al., 2013). In Tokyo Bay, Kanehiro et al. (1995) found that 80-85% of the seabed debris was plastics while studying the effects of plastics on the seafloor. Chiba et al. (2018) performed dive studies along the deep sea and reported that plastics accounted for just over 30% of debris items collected, and 89% of those plastic items were SUPs.

Figure 3. Deep sea rover image of a littered plastic bag wrapped around a deep sea gorgonian. Astoria Canyon; 2115m. (Schlining et al., 2013).



Each of these studies report the presence of plastics in our oceans, and how they

can collect within trenches, canyons, and along the seafloor. More recently, Maes et al. (2018) also found a large proportion of plastics within the Celtic and Greater North Seas among their stations; roughly 65-94%. Interestingly, during their 25 year study, they detected a significant decreasing trend in the proportion of plastic bags within trawls across all of their sample sites (Maes et al., 2018). The researchers suggest that this decrease in plastic bags is a result of new plastic bag policies being implemented in the surrounding regions.

Transport of Contaminants and Invasive Species

Wind and current-driven, plastics carry an accumulation of chemical pollutants from the various environments they have passed through (Carbery et al., 2018; Wang et al., 2019). Areas with high urban and agricultural runoff funnel pesticides, insecticides, pharmaceuticals, microplastics, and other hydrophobic contaminants into nearby waters, which are then readily available for adsorption on floating plastic particles (Carbery et al., 2018; Rochman, 2015). Plastics also leach the chemicals and additives used within its own polymer structure, creating a cocktail of contaminants that can negatively impact an organism's health once ingested or the sediment which the plastic has become embedded (Andrady 2011; Rios et al., 2007; Rochman, 2015).

Briefly mentioned earlier in this chapter, plastic fragments are accidentally ingested by several organisms, including humans, which poses serious health implications. As organisms ingest microplastics, pollutants accumulate in their tissues and bloodstream, and are then slowly released overtime to disrupt endocrine function, alter healthy reproductive processes, inhibit neurological activity, and cause mortality or

mutation from toxicity poisoning (Azzarello & Van-Vleet, 1987; Carbery et al. 2018; Derraik, 2002; Wang et al., 2019). As larger predators eat smaller organisms, the contaminants and microplastic particles are transferred up the food chain, increasing the pollutants in an organism (Carbery et al., 2018, Rochman, 2015; Wang et al., 2019).

These sturdy, high-resource plastic rafts become available habitat for alien species to move from one habitat to another (Derraik, 2002; Howell et al., 2012; Wang et al., 2018). Researchers historically observed the transport of alien species to non-native environments by way of natural debris, however, the increased availability of buoyant plastics in the water has increased the potential for transport (Barnes, 2002; UNEP & NOAA, 2011). Barnes (2002) estimates that the spread of subtropical and high-latitude fauna have doubled and tripled, respectively, due to increased plastics at sea.

Economic Impacts

Tourism

In previous research, plastic pollution has been reported to significantly impact tourist and fishing economies via habitat degradation, air and water pollution, ocean acidification, and climate change (CBD-STAP, 2012; Derraik, 2002; Gall & Thompson, 2015; Xanthos & Walker, 2017). Plastic bag litter also has a high economic cost; local communities sustain losses in tourism and recreational revenue when the environment is polluted and degraded (Chen, 2015; Gall & Thompson, 2015; UNEP & NOAA, 2011). Studies reviewing plastic pollution impacts on tourism suggest that marine debris has a significant effect on the decision of the expense someone is willing to pay to go to the beach, for example, if they decide to go at all (Newman et al. 2015). As a direct result of

plastic pollution, researchers estimate that the global loss in revenue from tourism, fisheries, and beach cleanups is USD $13 billion annually (Borrelle et al., 2017; Raynaud, 2014; Schnurr et al., 2018). Other studies have estimated costs between 3.2¢ and 7.9¢ per bag (Burnett, 2013), or $3.2 to $7.9 billion per year (Taylor & Villas-Bosas, 2015) for municipality plastic bag litter control. The loss in revenue from decreased tourism and the increased costs to control litter, will only continue to grow if behaviors and attitudes around plastic consumption are not changed.

Waste and Recycle Management

The average American household comes home with 1,500 SUP bags per year and only recycles one in every 200, or 0.5% (CBD, n.d.; Powers, 2008). Waste Management estimates that SUP bags are recycled at a slightly higher rate- 1%- meaning the average household before would have recycled 15 of those bags, compared to the more conservative estimate of eight bags recycled per year (Waste Management, n.d.). Even though a negligible amount of bags are returned for recycling, they can force substantial costs on waste management facilities to sort plastics for recycling, repair damaged machinery, and move recycled plastics in a varying and unpredictable market (Chen, 2015; Wagner, 2017).

Although many people may believe that all plastics, including SUP bags, are recyclable and are meant for the recycle bin, it's not always that simple. Each municipality may have their own recycling practices based on their infrastructure and available market to move recycled materials. This misconception of what is actually recyclable has led to unintended consequences from "wishful recycling", where recycle-

hopefuls contaminate items intended for recycling and then become landfilled (Boiko-Weyrauch, 2019; Helman, 2016). Of the facilities that take SUP bags, they generally request that they be rinsed clean and fully dry, like all other recyclables, before being placed in the bin to reduce contamination. Department of Ecology's study of their commingled residential recyclables, "Beyond the Curb", revealed that to separate plastic bags and films from other recyclables was roughly $700-$1000 per ton (Single-Use Plastic and Carry Out Bag Ordinance, Appendix II).

However, most facilities don't accept SUP bags because it causes damage and poses safety concerns for recycle and waste management personnel. It can be a difficult task for employees to remove tangled plastic from clogged machinery, often costing them 20-30% daily in labor costs (Krehbiel, 2012). These estimates resulted from a survey of Washington municipalities by Environment Washington Research and Policy Center, who also found that 83% of the recycling facilities experience issues related to plastic bags while only 40% of those facilities even accept plastic bags (Krehbiel, 2012). More recently, Washington's Department of Ecology has added SUP bags to the "never recycle" list and are working to educate residents on the correct items and practices for recycling (Department of Ecology, n.d.). Instead, municipalities encourage residents to bring SUP bags and other plastic films-empty, clean, and dry- to designated plastic film receptacles provided by various organizations that specialize in plastic film recycling (American Chemistry Council, n.d.)

Available and profitable markets for recycled plastics have shifted significantly since China announced that they would no longer be taking recycled materials from other

countries. Since 1992, most of the world, including the United States, shipped a large quantity of their recyclable materials to China; 45% of that material being plastic (Brooks et al., 2018). Robert Reed, a spokesperson for Recology out of San Francisco, CA shared that it was "$300-to-500 to ship a container of recycled plastic across the Pacific- a fraction of the $3,500-to-4,000 price tag for transporting that same container across the United States to plastic processing plants that are mostly located in the South" (Parker, 2018). Now faced with substantial costs to regionally handle recycled plastic materials, several municipalities are incinerating and landfilling plastics, and re-evaluating what their recycle programs will include (Brooks et al., 2018; Browning, 2018; Semuels, 2019).

Plastic Bag Bans, Fees, and Incentives

Bans, fees, and incentives are often debated as to which is more effective in creating a behavioral change (Taylor & Villas-Bosas, 2015; Wagner, 2017; Xanthos & Walker, 2017). There are a few differences in the approach and goals between these three different plastic policies, however, they each share a common goal of reducing plastic pollution. Bans take a command-and-control approach by removing an option from consumers, creating a direct 'controlled regulation' of behavior. On the other hand, fees keep the option available to the consumer, but at a cost per item (Taylor & Villas-Bosas, 2015). Incentives work similarly to fees but in the opposite direction; they financially reward good behavior of bringing an alternate option. The recent SUP bag ban in Kent, WA, for example, combined a ban SUP bags and placed fees on all alternatives provided

in the store. Plastic bag policies have evolved over the last several decades, but can vary in enforcement and associated costs, making the management of plastic bag waste, as a whole, inconsistent from region to region (Taylor & Villas-Bosas, 2015; Xanthos & Walker, 2017).

Evolution of Plastic Bag Policies

Overall, several regions across the globe from a local to national scale have banned SUPs in efforts to reduce plastic pollution. Starting at the local municipality level, plastic bag carrier levies were gradually introduced first in Sweden (1970s), followed by several other countries including Germany (1991), Denmark (1994), and Iceland (1995) (Clapp & Swanston, 2009; Nielsen et al., 2019). By 2010, 50 countries and/or major sub-national jurisdictions (>1 million inhabitants) had implemented plastic carrier bag policies, which is estimated to have tripled with the rapid increase in new regions passing plastic policies (Nielsen et al., 2019). The European Union even recently voted to ban the top ten[1] most polluting SUPs, which will phase out most of those items by 2021, and create highly efficient collection methods for used plastic items such as water bottles (Time, 2019).

Across the United States, however, there is a lot of variation in plastic policies. Washington State, for example, recently passed a state-wide plastic bag ban that will take effect January 1, 2021. Eight other states currently have SUP bag bans in place including California, Connecticut, Delaware, Hawaii, Maine, New York, Oregon, and Vermont

[1] *Zero Waste Europe;* beverage stirrers, cotton bud sticks, cutlery, expanded polystyrene food and beverage containers and cups, finishing gear (select kinds), oxo-degradable plastics, packets and wrappers, plates (including paper with plastic lining), straws, and sticks for balloons

(NSCL, 2019). The sample location of this study, Kent, WA was the 30th local government in Washington to pass a bag ban that aims to reach litter reduction goals and require a minimum of 8¢ per recyclable paper bag or alternative used at point of sale (Single-Use Plastic and Carryout Bag Ordinance, Appendix II). The Kent bag ban came to fruition after the first proposed state-wide SUP bag ban failed to pass in April, 2019.

Interestingly, 16 states in the U.S. have passed state-wide countermeasures, or preemptive laws, to ensure plastic and carryout bag bans are prohibited from being regulated at a local level: Arizona, Colorado, Florida, Idaho, Indiana, Iowa, Michigan, Minnesota, Mississippi, Missouri, North Dakota, Oklahoma, Pennsylvania, Tennessee, Texas, and Wisconsin (Nielsen et al., 2019; NSCL, 2019; Romer, 2019; Schnurr et al., 2018). These states argue that plastic bag regulation should be conducted at the state level, not the individual city level. Some scholars and critics allege that this type of countermeasure may stem from the oil and petrochemical industries, which are trying to get ahead of the SUP resistance by blocking city-level policies banning carryout bags and controlling future policy within the state (Fowler and Witt, 2019; Gibbens, 2019; Riverstone-Newell, 2017; Schnurr et al., 2018).

There is a wide range in the stringency of plastic bag bans, from harsh fines and jail time to a complete lack of consequences to either consumer or distributor. (Nielsen et al., 2019). For example, in Rwanda, there is a $150 fine for having a plastic carryout bag, and business owners can receive up to one year in prison for selling plastic bags (Nielsen et al., 2019). Regions may also be motivated to enforce plastic policy by public pressure and critical media coverage, as in the Global North, while overwhelming visibility and

first-hand interactions with plastic waste has motivated the Global South (Knoblauch et al., 2018; Nielsen et al., 2019).

Plastic bag bans have been shown to have an impact on overall pollution level. For example, reports from California show that, between 2010 and 2016, the percentage of plastic bags along beaches reduced from 7.42% to 1.73% after a plastic bag ban was implemented in across the state (Ocean Conservancy, 2017). This, combined with the reduction in plastics found in deep sea trawls mentioned in earlier in the chapter, suggest that the ban on single-use plastic bags is decreasing their prevalence in coastal communities (Maes et al., 2018).

Alternatives to SUP and Carryout Bags

There are several alternatives to using SUP and carryout bags including, but not limited to: paper, canvas and cotton, woven and non-woven polypropylene, hemp, and jute bags (Environment Agency, 2006). In order to avoid a regrettable substitution, consumers must understand the benefits and consequences of their shopping bag usage if they are to replace SUP bags. Reusable bags are meant to be just that- reusable- and they can require more resources to produce and distribute than SUP bags (Bisinella et al., 2018). For example, cotton reusable bags need to be used more than 50 times before reducing the global warming potential of a SUP bag before its end of life management (Bisinella et al., 2018). The same study found that thicker polypropylene plastic bags need to be used 30-40 times, paper 40 times, and organic cotton bags 150 times, although Edwards and Fry (2011) estimate organic cotton to be closer to 130 (Bisinella et al., 2018).

The increased use of an alternative bag type can produce unintended results, especially if we are mismanaging the use of the alternatives (Schnurr et al., 2018; Taylor, 2019; Taylor & Villas-Bosas, 2015). Several researchers have compared the impacts of paper and other alternatives to SUP and carryout bags. Paper, for example, has its own set of hidden costs such as (1) paper bags consume roughly 17 times more water and 40-70% more energy than plastic bags to produce (Chaffee & Yaros, 2007; National Geographic News, 2003), (2) paper production creates atmospheric and effluent pollution during pulping, (Hoffman et al., 2017), and (3) paper bags are on average nine times heavier than plastic bags which can generate higher GHG emissions from transportation trucks and landfills (Hoffman et al., 2017; Schnurr et al., 2018). Thus, implementing SUP and carryout bag bans may be trading one group of environmental concerns and costs for another if consumers are not reusing their paper bags before recycling, or if paper bags aren't properly recycled or disposed after one use (Barbosa et al., 2019; Environment Agency, 2006; Schnurr et al., 2018; Taylor & Villas-Bosas, 2015).

Studies have also shown that reusing shopping bags may present concerns of spreading pathogens or bacteria if not kept clean (Barbosa et al., 2019; Summerbell, 2009; Williams et al., 2011). Barbosa et al. (2019) analyzed the potential pathogen contamination of reusable plastic bags given at convenience markets and found that each of the sampled bags were fouled with microorganisms, foodborne pathogens, and several antibiotic (single and multi-) resistant strains. Reusable cloth and canvas bags can also transfer pathogens and contaminants, in addition to having higher production emissions than most alternative options (Edwards & Fry, 2011). Washing your reusable bag has

been shown to significantly reduce bacteria and can help prevent cross-contamination, especially between raw meats and produce (Williams et al., 2011).

Although these studies raise awareness of the hidden costs and concerns that alternatives bags may have, they also highlight the importance of reducing overall plastic production and consumption as the impacts of SUP bags are directly harming several communities' economies, municipalities, and environments. Plastic bags take significantly longer to decompose in both landfills and the environment compared to a majority of the available alternative options (CBD-STAP, 2012).

Extended Producer Responsibility (EPR)

Extended Producer Responsibility (EPR) is a concept and policy tool used to assign the original producer and seller the financial and/or physical responsibility of managing a product's end-of-life and waste costs (Walls, 2006). Although EPR policies are implemented and considered effective in several regions around the world, the United States is one of few countries without EPR for packaging programs (NERC & NEWMOA, n.d.; Prindiville, 2016). Some argue, that the opposition to EPR policies stems from multinational corporations shifting the costs to manage plastic waste to taxpayers (Prindiville, 2016). It is also often implied through marketing and opposition to new EPR policies that plastic pollution is a personal, consumer waste problem and that we, as taxpayers, should pay the government to manage the waste we create.

Across the U.S., the burden to create and fund plastic recycling and education programs is usually faced at a local level, and municipalities work to separate and move recyclable materials to available markets for repurpose or specialized disposal. This can

be helpful municipalities to create solutions that works within their available resources and infrastructure, however, complications arise when organizations are operating in multiple cities with varying plastic bag policies (Knoblauch et al., 2018; Nielsen et al., 2019). Still, the end result currently places the onus and financial burden on the consumer to manage plastic waste such as plastic bags.

EPR policies promote a circular economy and incentivizes producers to be more considerate of the environmental implications of their products and packaging (NEWMOA and NERC, n.d.). Some industries oppose the idea of using EPR as a way to manage resources, as it would threaten business growth by adding taxes and over-regulating businesses (Prindiville, 2016). For plastic producers, in particular, SUP and carryout bags are a minimal $1.2 billion portion that shouldn't significantly impact overall outputs in a $374-billion-dollar U.S. industry (Nielsen et al., 2019). A few of the top plastic and plastic bag producers and distributors include Exxon Mobil, Dow Chemical, Chevron, Lyondell Basell, and Novolex Holdings, Inc. (Crow 2018; Plastics Technology, n.d.).

Within the last year, Sen. Tom Udall (D-NM) and Rep. Adam Lowenthal (D-Calif.) collaborated on new legislation that would focus on waste minimization and create a circular approach to tackling plastic waste. This proposed EPR policy, the Break Free From Plastic Pollution Act (BFFPPA), outlined several key components to address concerns about plastic products and packaging, including SUP bags (Udall, 2019). This proposed legislation would include a carryout bag fee for non-reusable plastic and paper bags, in addition to a ban on SUP bags (Udall, 2019). Although the introduced bill has yet

to become law, more and more people are joining the conservation and working towards solutions for reducing plastic pollution.

Implications of Coronavirus Pandemic

During the evolution of this study, a global pandemic devastated communities, halted standard business operations, and shifted priorities of consumers and industries. Coronavirus (COVID-19) is a virus easily spread via contact with respiratory droplets from an infected individual, although there is still ongoing research to understand more about this infectious disease (Centers for Disease Control and Prevention, 2020; National Foundation for Infectious Diseases 2020; World Health Organization, 2020). As several businesses shut down in response to the health concerns of spreading COVID-19 within shared spaces, grocery stores and other select retailers, remained open as essential businesses to continue to provide necessities to the public.

One of the growing concerns associated with COVID-19 in grocery stores was the possible spread of the disease through customers bringing reusable bags from home into the store. There are a limited number of studies evaluating the spread of COVID-19 on shopping bags, however, van Doremalen et al. (2020) found that the virus could last up to three days on polypropylene plastic surfaces. To reduce the potential transfer of the virus, for example, to a store clerk picking up a customer's bag from home, several major grocery chains and municipalities moved to temporarily stop allowing customers to bring reusable bags. Lawmakers and city officials also have rescinded SUP bag bans in the meantime and are allowing stores to provide customers whatever bags they are able to

supply, and in some cases, at no charge to the customer. My sample location for this thesis project, Kent, WA, made this same decision to suspend the SUP bag ban just 20 days after it was implemented to address these health and safety concerns.

These pauses in plastic policy are concerning to some; founder of Beyond Plastics, Judith Enck, suggests that it may be allowing the plastic industry to "exploit a public health crisis" to push the demand for SUP bags (Tullo, 2020). Others are concerned that the increased demand in single-use products during this pandemic has shifted focus away from the proposed EPR policy (BFFPPA), while some hope that it will help raise awareness of the importance of efficient recycling and waste management systems (Boucher, 2020).

Theoretical Frameworks

There are two overarching theoretical frameworks which I will be using to connect my research questions and hypotheses. First, I am going to explain the role that gender plays in environmental engagement and support for green initiatives. I will be evaluating how bag usage varies between women and men, and whether there is a significant difference in bag usage based on gender. Next, I will discuss prospect theory and loss aversion, and how the implementation of a ban in the form of a tax or fee may lead to changes in bag usage and behavior.

Gender and Environmental Participation

The relationship between gender and engagement in environmental activities has been examined by many researchers, concluding that there are gender differences in

environmentalism (Dietz et al., 2002; Heidbreder et al., 2019; Ryan & Jewitt, 1996). Although there are varying theories and concepts explaining the causes behind these differences, after several decades, women are still found to be more likely to engage in environmentalism (Brough et al., 2016; Dietz et al., 2002; Gilligan, 1982; Heidbreder et al., 2019).

Values and priorities guide an individual's decisions and behaviors, including those related to the environment. Dietz et al. (2002) measured the prioritization of four general value orientations, t*raditionalism*, *altruism*, *openness to change*, and *self-interest,* by women and men in a random survey to understand gender differences in environmentalism. Researchers found women to prioritize altruism significantly higher than male respondents, indicating a higher probability of being pro-environmental (Dietz et al., 2002).

In a review of 187 literary resources, Heidbreder et al. (2019) sought to understand the varying human perceptions and behaviors associated with plastic consumption and disposal. They found several studies reporting differences in gender for plastic bag usage and that, overall, studies reported women to engage more in recycling, reducing, and reusing than men did (Kurisu & Bortoleto, 2011; Madigele et al., 2017; Ryan & Jewitt, 1996). Although these differences are strongly supported by various researchers, convenience can be a stronger influencer of decisions regarding plastic bag usage (Adane & Muleta, 2011; Braun & Traore, 2015; Sun et al., 2017).

Brough et al. (2016) takes this difference in behavior and attributes it to the need to maintain one's gender-identity; meaning the *green-feminine* stereotype may motivate

men's avoidance of green behaviors. The study continues to outline how both men and women perceive green or environmental behaviors as feminine, and that masculine branding and affirmation could help reduce men's inhibitions about environmental engagement (Brough et al., 2016). Researchers found that both men and women would classify an individual carrying a canvas bag out of a grocery store as feminine compared to a different shopper that was carrying a SUP bag (Brough et al., 2016). These perceptions may, even at times subconsciously, keep an individual from participating in environmental behavior, such as bringing a reusable bag or supporting a SUP bag ban.

For my study, I will be recording the gender of the customer, in addition to other demographic variables. If aligned with the consensus among researchers, my results would also reveal differences in bag usage and behaviors between gender. These differences may or may not be able to be specifically explained by my observations, however, they could suggest that the differences are strong enough to shift marketing and educational tools to increase support for SUP bag bans.

Loss Aversion

Another theory that this research relates to is loss aversion. Tversky and Kahneman (1991) proposed that "losses and disadvantages have [a] greater impact on preferences than gains and advantages" (p. 1039). Loss aversion is a concept that sits within a larger theoretical framework, prospect theory, which assumes that individuals value gains and losses differently (Tversky & Kahneman, 1991). Put simply, individuals are thought to be more likely to engage in risky behavior to avoid a 'loss' than they would to achieve some 'gain'. Loss aversion also explains the discrepancies between

gains and losses outlined in prospect theory; if changes are framed as gains they are less likely to shift behavior than framed as a loss (Fryer et al., 2012; Tversky & Kahneman, 1981).

In a study investigating loss aversion through SUP plastic bag policies, Homonoff (2015) found that changes in consumer behavior stemmed from the 5¢ tax on disposable bags compared to the 5¢ bonus for bringing reusable bags. That same study also found almost no difference in bag usage between stores that provided an incentive for bringing a bag and those that did not charge at all (Homonoff, 2015). Other studies were consistent with these findings, and that although bans encourage consumers shifting to reusable alternatives, significant behavioral changes occurred when there was a fee in place for obtaining alternative options compared to receiving a discount or incentive for bringing a bag (Romer & Tamminen, 2014; Schnurr et al., 2018).

In relation to my study, the theory of loss aversion suggests that a customer would avoid paying for a bag, or more bags than they may actually need, to reduce the money they lose having to purchase the bags. This would reduce the number of bags a customer purchased at the store by condensing more items into one or fewer bags, carry items out by hand, or bringing bags from home. Additionally, it would also be expected that stores that charge more for the same bag available at a different store charging less, would have a larger reduction in store provided bags.

Chapter 3: Methods

The main objective of this research was to evaluate the changes in bag availability and customer preference in stores subject to a ban on single-use and carryout plastic bags in Kent, WA. To conduct this research, I utilized observational studies at seven stores before and after the bag ban went into effect. All fieldwork was conducted in February and March of 2020. This methods chapter will first address the purpose behind choosing Kent for this case study, in addition to the selection of sample stores. Next, I will discuss the methodology used for the study and observation design to capture bag usage within stores. Finally, I will introduce the analysis used to answer my three research questions:

1. *What individual characteristics are associated with consumer bag usage and behavior?*
2. *What store characteristics are associated with consumer bag usage and behavior?*
3. *What significant changes in bag usage and behavior occurred between the pre- and post-ban periods?*

Study Site

This study was conducted in Kent, WA, which in August 2019 became the 30th city within Washington to implement a new plastic bag policy. Kent was an ideal study site primarily because the timeframe of the bag ban policy – known as the Single-Use Plastic and Carryout Bag Ordinance (Appendix II) - allowed sufficient time to conduct store observations before and after the ban. Interestingly, passing the bag ban became a top priority for the city when the state-wide SUP bag ban failed to pass the House of

Representatives (after it passed through the state Senate in April of 2019). Washington state did eventually pass a state-wide ban in early March 2020, removing the availability of SUP bags and a minimum charge of 8¢ for reusable alternatives.

Kent's 34 square miles of city is home to a total population of just under 130,000 people, averaging three people per household (Data USA, 2020). The median age and income of Kent's populations are 34 and $64,500, respectively (Data USA, 2020; U.S. Census Bureau, n.d). King County estimates that there are about 60,600 pets [cats and dogs] within Kent, and the average number of cats and dogs per pet-owning household is 2 (Regional Animal Services of King County, 2018). Although Kent contains a myriad of business, most of the locations observed within my study do not have duplicate stores, meaning each store potentially services the entire Kent community. Only one store (G1) had two additional locations on opposite ends of the city, suggesting that this store location may serve only part of the Kent population.

Store Selection

The City of Kent provided a list of all open businesses within city limits. Using that list, I grouped stores by business license types to randomly select stores based on two categories: grocery and retail. I gave each store within both categories a number, which I then included in a random number generator for selection of stores for potential sample sites. Initially, I randomly selected and reached out to gain permission from six grocery and six retail stores; however, due to a high rejection rate I had to continue to randomly select additional stores from each category until I had a proficient sample size. My final

store sample size consisted of seven selected stores made up of the following categories: grocery (3), pet supply (2), and hardware retail (2).

I provided each store manager with a letter of information about the study (Appendix III), in addition to the observation sheet used for data collection (Appendix IV). To ensure the privacy of my sample locations, I assigned every store a code that reflected their business type which contained both a letter (grocery "G"; hardware "H"; pet supply "P") and a number indicating each unique store.

Observational Procedures

The first portion of this study relies on observational data to evaluate changes in customer bag usage and preference during the time of the policy change. To collect observational data, I stood near checkout stands to record all direct observations of the number and type of bags consumers brought and/or purchased. I observed no more than two lanes at a time to ensure quality counting, and if a checkout stand closed I continued to observe the next closest stand for consistency. I collected observations in 30-minute shifts at randomly selected times during the week to capture a wide range of consumers. Observation shifts varied between 8 am - 4 pm on weekends and 2 pm - 8 pm on weekdays. In total, observations were made on 13 days over the span of seven weeks. Table 1 shows the number of transactions observed within each store during the 30-minute observation timeframe. Both pet supply stores [P1 & P2] do not include data during the first two dates due to delayed permissions to sample within the store. Hardware store H2 did not include observational data during the last three dates as a result of COVID-19 precautions.

Table 1. Total number of observed transactions within each store per observation date.

	Date	Grocery			Hardware		Pet Supply	
		G1	G2	G3	H1	H2	P1	P2
Pre-Ban	2-Feb	28	21	27	14	28	-	-
	5-Feb	26	21	14	13	14	-	-
	9-Feb	36	22	37	16	39	10	22
	13-Feb	26	23	26	13	16	9	14
	15-Feb	24	25	24	23	28	8	17
	20-Feb	20	22	30	9	31	5	11
	23-Feb	24	33	28	23	40	8	20
	27-Feb	30	16	30	15	32	5	15
Post-Ban	1-Mar	16	20	23	18	31	1	15
	5-Mar	19	18	26	2	22	6	13
	8-Mar	14	29	13	15	-	6	16
	12-Mar	13	14	11	9	-	4	9
	15-Mar	20	20	27	24	-	4	14

The research design necessarily modified mid-study due a global pandemic sparked by COVID-19, or the novel Coronavirus outbreak. Even though I intended to collect data into the end of March, I removed three collection dates [March 18, 22, 26] from this study due to the precautions being taken to prevent the spread of COVID-19 between stores. During this pandemic, Kent Mayor Dana Ralph, in collaboration with the Washington State Grocers Association, suspended the enforcement of the SUP bag ban until the declared state of emergency has been withdrawn. Although both pet stores in my study maintained the use of SUP bags following the initial implementation of the ban, the combination of all stores providing no-charge SUP bags, as well as abnormal consumer spending and behavior, may have skewed the results.

I captured a range of variables in these observations. I documented basic store information, whether there was a designated bagger or the customer was self-bagging, and to what degree the bagger double-bagged their purchases. I recorded consumer gender and age (estimated range) of the customer, as well as whether or not they had kids or pets with them. Although the gender variable was set as male or female for the

purposes of this study, I understand that this creates bias and excludes all other gender identities.

For the dependent variables, I recorded the type and number of bags purchased within the store (single-use plastic; recyclable paper; reusable plastic; reusable canvas or fabric), and those that the customer brought from home (single-use plastic, recyclable paper; reusable plastic; reusable canvas or fabric; backpack; purse; box; suitcase; other). Figure 4 provides a guide to how the bags were labeled and grouped during this study.

Figure 4. Main types of bags observed during the study.

				
single-use plastic bag	recyclable paper	alternative thick plastic bag	canvas or fabric bag	reusable plastic bag

An observation sheet was used to collect the above variables (Appendix IV), and the data were later entered into a Microsoft Excel spreadsheet. Any items that were as carried out by hand, cart, or some other method, were added to a continuous list for review during data analysis.

Data Management and Analysis

I entered the data I collected from daily observational sheets in a Microsoft Excel spreadsheet, and new variables were calculated to add total counts for store-provided bags, customer-provided bags, and total bags per transaction. To report the demographic data during the study, each of the variables were summarized based on the observational data. In order to perform more accurate statistical testing, however, I recoded several

variables including age, presence of kids, bagger, double-bagging, and carrying out by hand, as shown in Table 2.

Table 2. Recoded variables to satisfy assumptions of statistical tests.

Variable	Old Categories	New Categories
Age Range	Under 30	Under 50
	30-50	
	50-70	Over 50
	Over 70	
Kids or Pets Present	None Present	None Present
	Kids Only	Kids and/or Pets Present
	Pets Only	
	Kids and Pets	
Bagger	Check clerk	Store-bagged
	Additional store clerk	
	Self-bagged	Self-bagged
Double-Bagging	No double-bagging	No double-bagging
	Double bagged few	Double-bagging occurred
	All double bagged	
	All doubled or more	
Carry Out by Hand	Hand carry only	Hand carry without bag usage
	Other with no bag usage	
	Hand carry and bag usage	Hand carry and bag usage
	Bag usage only	Bag usage only

I first used JMP to analyze the distribution and normality of each variable before choosing the appropriate statistical tests. All variables were showing a non-normal distribution, with positive skewing and a right trailing tail. I used the Shapiro-Wilk test to assess normality, which yielded statistically significant results and suggested the sample populations were not normally distributed. Therefore, I used a non-parametric version of a t-test (Mann Whitney-U) and a non-parametric version of an Analysis of Variance (Kruskal Wallis H-Test) to compare various sample means. Chi-squared and contingency tables were used to analyzed categorical variables.

I conducted a Mann Whitney-U Test to compare how many bags were used by different groups in my sample (including gender, age, kids) as well as to compare before and after the ban period. Additionally, I used the Kruskal Wallis H-Test to analyze differences in the mean number of bags used by stores and store type. Finally, I used

contingency tables and a chi-squared analysis to analyze the association between the individual and store characteristics and (1) whether customers double-bagged or not, and (2) whether customers carried purchased items out by hand or not. I also used contingency tables to evaluate the relationship between these same two bagging behavior variables (double-bagging and carrying out by hand) and (1) store type and (2) ban period. All statistical tests were carried out with JMP Pro 14 statistical software. Tables were made using Microsoft Excel, and Apple Pages and Keynote.

Chapter 4: Results

The duration of this study included 91 hours of observations, 13 hours per store, and 1,603 total transactions. Overall, 46% of the observed population was female, and 54% was male, and 12% had brought kids shopping with them. More than half, 65%, of the observed sample population were thought by the researcher to be under the age of 50. Of all the shoppers observed in this study, 14% were observed shoppers at pet supply stores, and 3% of those shoppers brought their pets along. Hardware stores made up 30% of the observers shoppers, and grocery stores made up 56%. Table 3 displays the spread in demographics over the complete study, in addition to demographics by store type.

Table 3. Observed demographics of shoppers during study and grouped by store type.

		All		Grocery		Hardware		Pet Supply	
Variable	**Category**	**Count**	**% of Study**	**Count**	**% of Store**	**Count**	**% of Store**	**Count**	**% of Store**
Age Range	Under 30	176	11%	104	12%	33	7%	39	17%
	30-50	858	54%	473	53%	257	54%	128	55%
	50-70	465	29%	252	28%	159	34%	54	23%
	Over 70	103	6%	66	7%	26	5%	11	5%
Gender	Female	741	46%	508	57%	92	19%	141	61%
	Male	862	54%	388	43%	383	81%	91	39%
Kids or Pets Present	None Present	1344	84%	748	83%	434	91%	162	70%
	Kids Only	195	12%	147	16%	38	8%	10	4%
	Pets Only	59	3%	0	0%	3	1%	56	24%
	Kids and Pets	5	<1%	1	<1%	0	0%	4	2%

I recorded 18 different bag types and 12 other individual and store characteristics. Customers and checkers in my sample most commonly relied on SUP bags, especially during the pre-ban period, with 70% of bags used being SUP. Table 4 shows the observed number of bags provided by either the store or customer during the full study period. The "alternatives" grouping includes reusable plastic, canvas and fabric bags, while the "other" grouping includes boxes, purses, strollers, and full carts. Refer to Appendix 1

(Table A-1) for a complete table showing the count and percent of all bag types observed within the study.

Table 4. Total observed number of store- and customer-provided bags used during the study.

	Bag Type	Count	% of Study
Store	Single-Use Plastic	2823	70%
	Thicker Alternative Plastic	90	2%
	Recyclable Paper	671	17%
	Store Alternatives	34	1%
	Store-Provided Bags	**3618**	**90%**
Customer	Single-Use Plastic	15	<1%
	Thicker Alternative Plastic	7	<1%
	Recyclable Paper	7	<1%
	Customer Alternatives	370	9%
	Other	17	<1%
	Customer-Provided Bags	**416**	**10%**
	Total Bags	**4034**	**100%**

It is important to note that there were more transactions during the pre-ban period (1,111 transactions) than the post-ban period (491 transactions) due to the study being shortened once the COVID-19 social distancing restrictions were implemented. From these observed transactions, I was able to quantify customer bag usage and answer the research questions proposed in this study.

The sections below detail results, organized by research question. Results by individual characteristics are first analyzed, then results by store type are examined. Next, results by bagger are analyzed, and lastly bag use before and after the ban will be examined.

1. What *individual* characteristics are associated with consumer bag usage and behavior?

The nonparametric t-tests and contingency tables yielded several statistically significant results, as displayed in Table 5. Gender showed statistically significant differences in bag usage and behavior, while age was non-significant and the presence of kids was inconsistent across tests. Results indicated significant differences in the number of bags that females and males observed in the sample purchased from the store, for both

Table 5. Dual statistical table showing the results of both Mann Whitney-U Tests (p-values are listed above and S statistics are in parenthesis below) and Contingency Analyses (p-values above and Pearson χ2 statistics below).
p-value < 0.05*; p-value < 0.001; p-value < 0.0001*****

Variable	Mann Whitney-U Test				Contingency Analysis	
	Single-Use Plastic	Store-Provided	Customer-Provided	Bags Used per Transaction	Double Bagging	Carry Out by Hand
Gender	<0.0001*** (630621.5)	<0.0001*** (651413)	<0.0001*** (629587)	<0.0001*** (679529.5)	0.9216 (0.010)	<0.0001*** (74.173)
Age	0.1143 (468025.5)	0.5298 (449902)	0.6243 (457552.5)	0.6844 (451748)	0.1528 (2.044)	0.8641 (0.292)
Kids	0.0002** (230867)	0.0003** (231542)	0.8576 (208367)	0.0005** (230845)	0.4818 (0.495)	0.0271* (7.218)

the number of SUP bags per transaction (p<0.0001) and the total number of store-provided bags per transaction (p<0.0001), with females using more bags than males (Table 5). There is also statistical evidence that there is a difference between the number of bags males and females bring from home (p<0.0001), in addition to the total number of bags used overall (p<0.0001), with females consistently bringing more bags on average than males (Table 5).

Although there was not a difference in how likely females and males were to double-bag, females were significantly less likely than males to carry out their items instead of using bags (p<0.0001, Table 5). When this result was examined further by store type, gender was associated with carrying out items by hand in grocery stores (Table A-3; Pearson χ2=9.978, p=0.0068) and pet supply stores (Table A-4; Pearson χ2=18.117, p=0.0001), but not hardware stores (Table A-5; Pearson χ2=3.306, p=0.1915) (Appendix I). All complete contingency tables are available in Appendix I.

There were no significant differences in bag usage or behavior between those under and over 50 years old. However, after testing the raw (untransformed) age data, there was a significant but slight difference detected in age groups bringing reusable bags

from home (p=0.0352). Age groups 30-50 and 50-70 exhibited higher bag usage, on average, than those under 30 and over 70. The presence of kids or pets with the purchaser showed significant differences in the number of SUP bags (p=0.0002), store-provided bags (p=0.0003), and total bags used (p=0.0005) compared to those without kids or pets present. Additionally, the presence of kids or pets was associated with carrying out items by hand (p=0.0271), although this may not have practical significance (Table 5). When controlling for store type, however, pet store shoppers that brought kids or pets with them were significantly less likely to only carry out items by hand (Pearson $\chi 2=13.640$, p=0.0011) (Appendix I Table A-6).

2. What *store* characteristics are associated with consumer bag usage and behavior?

Of the 1,603 transactions observed during this study, 56% were within three grocery stores, 30% within two hardware stores, and 14% within two pet supply stores (Table 6). To evaluate the relationship that store characteristics can have with a consumer's bag usage and behavior, the store, store type, and bagger (clerk- or self-bagged) were examined.

Table 6. The number of transactions observed within each store during the study period.

Store	Grocery			Hardware		Pet Supply	
	G1	G2	G3	H1	H2	P1	P2
# of Transactions	296	284	316	194	281	66	166
% of Study	18%	18%	20%	12%	18%	4%	10%

The Mann Whitney-U Tests (Table 7) analyzing the difference in bag usage by bagger revealed statistically significant differences in the number of bags provided by the

Table 7: Dual statistical table showing the results of both Kruskal Wallis H-Test (p-values are listed above, while both the χ2 statistic and degrees of freedom are in parenthesis below) and Contingency Analyses (p-values above and Pearson χ2 statistics below).

Variable	Kruskal Wallis H-Test				Contingency Analysis	
	Single-Use Plastic	Store-Provided	Customer-Provided	Bags Used per Transaction	Double Bagging	Carry Out by Hand
Bagger	0.6824 (402593)	<0.0001*** (451410)	<0.0001*** (426108.5)	<0.0001*** (472732.5)	<0.0001*** (24.487)	<0.0001*** (31.571)
Store Type	<0.0001*** (182.4848 df= 2)	<0.0001*** (529.3175 df=2)	<0.0001*** (87.2330 df=2)	<0.0001*** (764.0741 df=2)	<0.0001*** (27.409)	<0.0001*** (534.479)
Store	<0.0001*** (208.2230 df=6)	<0.0001*** (576.1364 df=6)	<0.0001*** (134.4755 df=6)	<0.0001*** (881.4277 df=6)	<0.0001*** (24.696)	<0.0001*** (638.684)

store (p<0.0001), brought from home (p<0.0001), and used overall per transaction (p<0.0001) between those that self-bagged and those where a store-designated clerk bagged the purchases. The average number of bags per transaction for those that self-bagged was four, while transactions where a clerk bagged the items had an average of two. Only two of the stores, G2 and H2, had observations of self-bagging during the data collection periods.

I detected several significant results in bag usage based on store type. Store type was significantly associated with consumer bag usage and behaviors (Table 7). Post hoc tests using the Dunn Method for Joint Ranking revealed that hardware and pet supply stores have similar distributions in bag usage and behaviors, but differ greatly from grocery stores. For example, both pet and hardware stores had transactions with no more than 4 bags used for the duration of the study, while 22% of grocery stores transactions involved the use of anywhere from 5-38 bags per transaction.

The contingency analysis looking at stores and store types in relationship to double-bagging (p<0.0001) or carrying out items by hand (p<0.0001) also yielded significant results (Table 7). For example, double-bagging only occurred at grocery stores

during the study, and at one store more so than others; store G2 (2.7%) was most likely to have double-bagging occur, in comparison to G1 (0.6%) and G3 (0.6%) (Appendix I Table A-7). Customers were more likely to only carry out items by hand (17.3%) in hardware stores, while grocery shoppers primarily used only bags (29.8%), or a mixture of hand carrying and the use of bags (22.6%) (Appendix I Table A-8).

3. What significant changes in bag usage and behavior occurred between the pre- and post-ban periods?

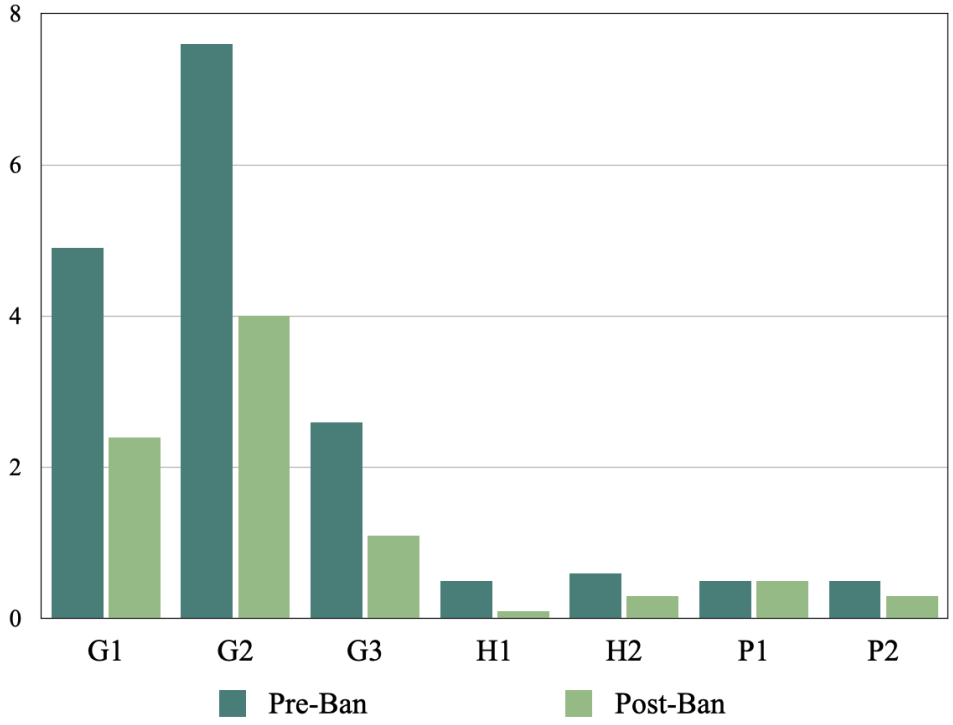
Next, I evaluated changes in bag usage and behaviors before and after the ban was implemented. For bag usage, each bag type collected during the study was analyzed by

Table 8. Mann Whitney-U Test results on ban period and bag type used during study. p-value < 0.05*; p-value < 0.001; p-value < 0.0001*****

	Bag Type	Pre-Ban Count	Post-Ban Count	S Statistic	p-value
Store	SUP	2793	30	229487.5	<0.0001***
	Thicker Alternative Plastic	0	90	425692	<0.0001***
	Cooler	0	3	395695	0.0336*
	Reusable Plastic	0	6	396806	0.0026*
	Recyclable Paper	231	440	449834.5	<0.0001***
	Canvas or Fabric	5	8	395025.5	0.6725
	Box	5	0	393846	0.2491
	Other	7	0	392862	0.0778
	Total Store-Provided Bags	**3041**	**577**	315869.5	<0.0001***
Customer	SUP	3	12	398291.5	0.0024*
	Thicker Alternative Plastic	0	7	396250.5	0.0092*
	Cooler	6	5	395576.5	0.3699
	Reusable Plastic	97	95	406466	0.0007**
	Recyclable Paper	7	0	393846	0.2491
	Canvas or Fabric	107	60	400474	0.0678
	Box	0	1	395139.5	0.1333
	Backpack	5	2	394465	0.9034
	Purse	5	3	395020.5	0.6760
	Briefcase	0	1	395139.5	0.1333
	Total Customer-Provided Bags	**230**	**186**	415789	<0.0001***
	Total Bags per Transaction	**3271**	**763**	336703.5	<0.0001***

ban period (Table 8). Of the 18 bag types recorded - 21 including the total number of bags used from the store, brought from home, and used overall - 11 showed significant differences in the pre- and post-ban periods. The most significant differences ($p<0.0001$) were found with the usage of store-provided SUP, thicker alternative plastic, recyclable paper, in addition to the total number of bags provided by the store, customer, and used overall (Table 8). Figure 5 shows the decrease in the average number of bags used per transaction at each store throughout the study. Cooler ($p=0.0336$) and reusable plastic

Figure 5. Average number of bags used per transaction at each store before and after the ban.



bags ($p=0.0026$) purchased at the store both showed moderately significant increases in usage after the ban. Customer-provided SUP ($p=0.0024$), thicker alternative plastic ($p=0.0092$), and reusable plastic ($p=0.0007$) bags also reflected an increase post-ban.

Interestingly, females and males responded differently to the ban implementation when comparing the difference in the number of reusable bags brought from home between ban periods. I found that women, on average, brought the same number of bags from home before and after the ban ($p=0.0526$), while men brought significantly more bags from home after the ban than they did before ($p<0.0001$). In regard to the number of store-provided and total bags used per transaction, males and females both used significantly less bags after the ban was implemented ($p<0.0001$).

The previous analysis of ban period influencing bag usage was repeated by store type. This analysis revealed no significant differences in any of the bag types used within pet supply stores pre- and post-ban, even for SUP bags (p-value=0.1524). Hardware stores had significant differences in the pre- and post-ban period in the number of SUP ($p<0.0001$), store-provided ($p<0.0001$), and total bags used ($p<0.0001$).

Grocery stores yielded the most differences in bag use pre- and post-ban. The most significant differences ($p<0.0001$) were in the usage of store-provided SUP, thicker alternative plastic, recyclable paper, in addition to the number of total, store- and customer-provided bags (Appendix I Table A-9). There were also statistically significant differences in store-provided cooler ($p=0.0374$) and reusable plastic bags ($p=0.0032$), in addition to customer-provided thicker alternative plastic ($p=0.0108$) and reusable plastic bags ($p=0.0006$) between ban periods. Most surprising was the significant increase in the number of SUP bags ($p=0.008$) customers brought from home to reuse in the store (Appendix I Table A-9).

Taking into consideration the differences in cost for paper and thicker plastic alternatives across stores, only G3 had a significant ($p<0.0001$) increase in the number of bags brought from home. H2 did see a slightly significant ($p=0.228$) increase in bags brought from home between ban periods, however, the rest of the stores showed no change within their respective stores. G3 charged 15¢ for paper bags and 30¢ for the thicker plastic alternative; all other stores that sold paper bags charged 8¢, and 10-24¢ for the thicker plastic alternatives.

Finally, to understand if the pre- and post-ban periods were associated with customers double-bagging and carrying out by hand behaviors, I used a contingency analysis as shown in Table 9. Although few customers were still double-bagging their items after the ban was implemented (0.1%), customers were significantly more likely to double-bag (2%) within the pre-ban period (Appendix I Table A-10). For those carrying items out by hand, there is statistical evidence that supports an association with ban period ($p<0.0001$) (Table 9; Appendix I Table A-11). Further analysis had shown that pet stores did not have an association between carrying out by hand and ban period (Pearson $\chi2=2.005$, $p=0.3670$), whereas grocery (Pearson $\chi2=44.668$, $p<0.0001$) and hardware (Pearson $\chi2=38.855$, $p<0.0001$) stores did.

Table 9. Table of ban and bag behavior Contingency Analyses (p-values are listed above and Pearson χ2 statistics are in parentheses below).
p-value < 0.001; p-value < 0.0001*****

Variable	Contingency Analysis	
	Double Bagging	Carry Out by Hand
Ban	0.0015** (10.052)	<0.0001*** (53.329)

In review, the results indicate that gender, bagger, store type, and ban period are all significantly related to bag usage and behavior. Not only did the average number of bags used by consumers decrease over the duration of the study, they were bringing more reusable bags from home. There was also a higher proportion of customers carrying out items by hand after the ban, whereas before the ban, they were more likely to use only shopping bags.

Chapter 5: Discussion and Conclusion

This final chapter discusses the results within found within my study, and interprets their significance to make connections to relevant theoretical frameworks and research explored in Chapter 2. Following the discussion, the limitations of the methodology outlined in Chapter 3 are addressed and suggestions for future research are provided. Next, policy implications are provided to help policy makers and consumers understand the hidden costs of shopping bags, and to conclude I will share brief and final remarks.

Discussion

SUP bag bans are implemented for many reasons, but a driving motivation is to reduce plastic consumption and promote environmental activities. My results suggest that the use of SUP bags is significantly reduced when a ban is implemented, but only if store management removes these items from their stores. For stores following the bag ban protocols, several variables are associated with bag usage besides the change in bag availability, such as gender, customer bagging, and the presence of kids or pets. Other variables had little to no effect on the number and type of bags used either from the store or brought from home.

Individual Characteristics and Bag Usage

Bag usage was consistently gendered in this study. Females were observed to, on average, use more bags than males across all sample stores. Males were significantly more likely to carry out items only by hand than females, even within grocery and pet

stores. Hardware stores didn't share this difference, which may be due to the store characteristic being a stronger influence than gender.

The observations of gender and bag usage in this study are supported by previous literature on shopping behaviors and environmental social science that has found a division by gender in pro-environmental attitudes and behaviors (Brough et al., 2016; Dietz et al., 2002; Hohmann et al., 2016; Homonoff, 2015; Taylor and Villas-Bosas, 2015). Brough et al. (2016) tested several hypotheses concerning the association between environmentalism and feminine or masculine identity, and found that men avoid engaging in environmental activities in part because they mentally connect feminism and environmentalism. Other studies have also concluded that there are gender differences in environmental behaviors; Dietz et al. (2002) found that women significantly prioritized altruism over men, which happens to be the value closest aligned with environmentalism. In this present study, women were found to used more bags from home, while men were more likely to carry items out by hand.

Age was not a significant factor for bag usage in this study. Age also didn't show an association to double bagging or carrying out items by hand. However, the raw (untransformed) data show that age may be associated with whether or not customers bringing their own bags from home, and age groups 30-50 and 50-70 were significantly similar but both different from those under 30 and over 70. These results echo some previous studies; Wiernik et al. (2013) performed a meta-analysis on age and environmental sustainability, and found that although most age groups are similarly

engaged in environmental activities, older individuals would be slightly more likely to engage in environmental behaviors than younger individuals.

Documenting the presence of kids or pets during a transaction was examining whether or not those individuals would be using more bags, or less likely to carry things out by hand. There was a slightly significant difference between shoppers that brought kids or pets and those that did not, and when further analyzed by store type, the significance between those two groups increased. This suggests that, especially in pet stores, customers shopping with pets and kids may be more likely to use a bag. In a study examining the effect of carryout bag bans on unregulated bags, Taylor (2019) concluded that customers purchasing pet or baby items were significantly more likely to also buy more trash bags to replace SUP bags that were no longer available, for example, to collect and dispose of pet waste.

Store Characteristics and Bag Usage

Most sample stores had a designated bagger, either the check clerk or a secondary bagger, and did not offer a self-checkout station. Three stores in the sample offered self-checkout in different ways. G1, which offered four self-checkout stations, did not contain any observations involving this process and are therefore grouped with the other four stores (G3, H1, P1, and P2). H2 offers mixed stations with self-checkout and clerk assistance on standby, which resulted in observations of both self- and clerk-bagged transactions. The average number of bags used per transaction by those that self-bagged was higher than those that were clerk-bagged in H2. On the other hand, G2 has store clerks perform the checking of purchases but rely solely on customer self-bagging.

Although G2 was able to reduce their bag usage along with the other stores, this specific location maintained a significantly higher average number of bags used per transaction than the other stores. These cumulative results suggest that individuals may be more likely to use more bags than if a store clerk had bagged them.

Based on these observations, it appears that the type of store greatly determines the number and type of bags a customer may need or want. Customer bag use at grocery stores greatly differed from customer bag use at hardware and pet supply stores, which can be partially explained by the type of goods those stores provide. Hardware and pet stores can have large, heavy, and packaged items that are unable to fit into, or require the use of, a carryout bag. A few examples of these observed items from hardware stores include home appliances, power tools, wood paneling, and garden supplies. Pet stores also sell goods such as animal feed, grooming supplies, and large pet accessories that are usually carried out of the store.

Alternatively, the need for carryout bags is often higher while shopping at grocery stores, though that depended on the goods the consumer is purchasing; consumers were consistently bagging produce, meat products, toiletries, and smaller cleaning supplies, among several other items. According to Starovoytova (2016), 75% of survey respondents shopped for food-related items and 43% shopped weekly in a study looking to help explain consumer-perception on polyethylene shopping bags. The average number of bags used per transaction was four in grocery stores, whereas hardware and pet supply stores on average used one bag for every two transactions. It is also important to note, that, there was no difference in the number of bags used per transaction between the two

hardware and two pet supply stores while each of the three grocery stores were statistically different from one another. G2 had the highest average number of bags used per transaction (μ=6), followed by G1 (μ=4) and G3 (μ=2).

With grocery stores using more bags than hardware and pet supply, it came as no surprise that grocery stores had fewer consumers carrying out items by hand. Hardware and pet supply stores, as discussed earlier, have more goods that may not be suitable for carryout bags, nonetheless, during observations shoppers at these two store types also carried out items by hand even when they could have fit everything into just one bag.

Ban Period and Bag Usage

I expected significant changes in several measures before and after the implementation of the ban. First, I expected use of SUP bags to decrease between pre- and post-ban periods. This indeed occurred for both grocery and hardware stores, as these two store categories in my study pulled all remaining SUP bags from the sales floor and provided alternatives. Pet supply stores, however, continued to offer SUP bags at no cost to the customer after implementation of the ban and resulted in no behavior change in bag usage.

As SUP bags were removed from stores, except for pet supply stores, recyclable paper and/or thicker plastic bags were made available to consumers. Hardware stores provided recyclable paper bags, which significantly increased in usage after implementation of the ban. Grocery stores also shared this change, in addition to the increased use of thicker plastic bags. Similarly, Taylor and Villas-Bosas's (2015) study results reflected significant increases in paper bag consumption in response to the

elimination of SUP and carryout bag options during a newly implemented ban in Richmond, California.

After implementation of the ban, bags cost 8¢ or more, which seems to have significantly suppressed total bag usage across grocery and hardware stores. It's not clear if the increased efficiency or the new cost of the alternative bags is responsible for the decrease in double bagging observed throughout the study, although the observations suggest that the increased number of customers carrying items out by hand is a result of the bag charge. The reduction in double bagging may also be a result of this new tax, however, there is also a possibility that the decreased double bagging is due to the usage of more durable bags and less fear of bag breakage. I noted that both the store and individual bagger were able to put several more items into these new bags compared to SUP bags because of their increased size and strength.

Additionally, the decrease in the number of bags used per transaction at stores charging more for alternatives (15¢ or more) was greater than the stores charging less (8¢ minimum). This is consistent with the loss aversion theory (Homonoff, 2015; Tversky & Kahneman, 1991), in which consumers are more sensitive to losses than to gains. In this study, consumers are likely responding to the fees (losses) by changing their behavior and using fewer bags. One store, G3, charged the most for paper and thicker plastic alternative bags and showed a significant increase in the number of bags brought from home, representing another way that consumers keep from paying a fee. This may also support the future use of taxes, in comparison to incentives, for SUP bag policies because

consumers are more likely to change behaviors from having to pay for a bag rather than receive a discount for bringing one (Homonoff, 2015; Tversky & Kahneman, 1991).

My study sample showed a change in bag usage behavior in a pre- and post-ban period. Customers in my study used fewer bags per transaction and brought more bags from home after the ban. Other studies have found similar results after a ban (Homonoff, 2015; Taylor, 2019; Taylor & Villas-Bosas, 2015), and some highlight the "spillover effect", where consumers are more likely to support other plastic policies after participating in a SUP bag ban. For example, after studying waste awareness among people living in England, Wales, and Scotland, researchers found that individuals who supported plastic bag policy were more likely to have increased their support for additional plastic policies (Thomas et al., 2019). Overall, the results in my study suggest that consumers were changing their bag usage and behavior as a result of the ban, and that the shifts in demand on paper and thicker reusable plastic alternatives should be considered when implementing a SUP and carryout bag ban.

Limitations and Future Studies

There were a few limitations of the observational design that could be improved upon to reduce observer bias. As I was unable to obtain specific sample demographics from non-interactive observations, I used my best judgement to assign gender and age to the customer. Many individuals identify their gender as being male or female, but this excludes several others that identify in other ways including transgender and non-binary. The age of a shopper was also limiting because individuals may look different to others close in age, reducing accuracy of age estimate. Additionally, the estimated age of the

shopper could be debated between observers and inconsistent without confirming their actual age. Future studies could involve observations combined with brief intercept surveys to more accurately represent the sample population.

Another expansion of this study could include retail transaction data to evaluate potential impacts of carryout bag bans on unregulated bags, similar to Taylor (2019). Individuals that reuse SUP bags as bin liners, pet waste bags, or in other ways would potentially need to purchase replacements including garbage bags, ziplock-style bags, pet waste bag packs, or other unregulated plastic bags. Alternatively, researchers could draw similar conclusions through repeated surveys of consumers' shopping purchase history before and after the implementation of a SUP and carryout bag ban.

Policy Recommendations

The removal of SUP bags shifts the demand to substitutes including paper and thicker plastic alternatives. A higher charge for alternatives, as found in my and other studies (Homonff, 2015; Taylor & Villas-Bosas, 2015), results in a greater decrease of the number of bags purchased at point-of-sale. The higher charge would also help cover costs for complying with the carryout bag ban that may not be covered by the minimum. Several municipality and state bag bans require a 5¢ minimum charge, which I suggest be increased to a minimum of 15¢ to partially (a) provide greater funds to go to retailers for ban compliance and (b) support environmental programs geared towards reducing plastic pollution. These programs would include educational outreach, pollution mitigation projects, and continued research on the impacts of plastic pollution.

Additionally, Extended Producer Responsibility and creating a circular economy for plastics should be considered for future plastic policies. EPR policies shift the burden to manage plastic waste from consumers and local governments to plastic producers and manufacturers. This policy motivates the plastic industry to produce plastics in a way that conserves raw materials, incorporates more recycled materials, and increases overall recyclability. Future EPR policies should also include standards for recycled content for plastic produced materials, and place a sliding tax depending on the producer's compliance with that standard. Then, plastic producers that are creating products with greater recycled content and less virgin material would pay less in taxes than those producing plastics primarily with raw materials.

Conclusion

SUP and carryout bag policies have been shown to effectively and significantly reduce consumption of plastic bags and plastic bag pollution. Reports and surveys have also highlighted the changes in consumer behaviors and policy support in regard to using alternatives to SUPs. Opponents fear that bag bans may only address larger issues with short-term solutions, and avoid providing long term changes.

Perceived challenges or critiques to plastic bag bans include a lack of environmentally responsible alternatives, accessibility to SUPs in neighboring communities, reusability of carryout bags, and resistance from manufacturers and larger government bodies. Amidst all the criticisms, there is an undeniable truth that plastics can have irreparable damages to the environment, wildlife, and economy of local communities. There is also a considerable amount of scientific research that provides

extensive evidence that pollution from the entity of the plastic life cycle threatens biodiversity and contributes to climate change. Therefore, it is important that we say no to plastic bags and support future plastic policies that reduce plastic consumption and pollution in the environment.

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Appendices

Appendix I. Additional Tables

Table A-1. Total observed number of all store- and customer-provided bags used during the study.

	Bag Type	Count	% of Study
Store	SUP	2823	70%
	Thicker Alternative Plastic	90	2%
	Cooler	3	<1%
	Reusable Plastic	6	<1%
	Recyclable Paper	671	17%
	Canvas or Fabric	13	<1%
	Box	5	<1%
	Other	7	<1%
	Store-Provided Bags	**3618**	**90%**
Customer	SUP	15	<1%
	Thicker Alternative Plastic	7	<1%
	Cooler	11	<1%
	Reusable Plastic	192	5%
	Recyclable Paper	7	<1%
	Canvas or Fabric	167	4%
	Box	1	<1%
	Other	7	<1%
	Purse	8	<1%
	Briefcase	1	<1%
	Customer-Provided Bags	**416**	**10%**
	Total Bags	**4034**	**100%**

Table A-2. Gender and carrying by hand contingency table; significant results given the Pearson χ2 test statistic (74.174) and *p*-value (<0.0001).

Gender	Carry Out by Hand			
	Hand Carry Only	Hand Carry and Bags	Bags Only	% of Whole
Female	8.7%	15.2%	22.3%	46.2%
Male	20.7%	13.4%	19.7%	53.8%
Total	29.3%	28.6%	42.1%	100.0%

Appendix I. Additional Tables (continued)

Table A-3. Gender and carrying by hand within grocery stores contingency table; significant results given the Pearson χ2 test statistic (9.978) and *p* -value (0.0068).

Grocery	**Carry Out by Hand**			
Gender	Hand Carry Only	Hand Carry and Bags	Bags Only	% of Whole
Female	2.2%	23.8%	30.7%	56.7%
Male	3.9%	16.7%	22.7%	43.3%
Total	6.1%	40.5%	53.4%	100.0%

Table A-4. Gender and carrying by hand within pet supply stores contingency table; significant results given the Pearson χ2 test statistic (18.117) and *p* -value (<0.0001).

Pet Supply	**Carry Out by Hand**			
Gender	Hand Carry Only	Hand Carry and Bags	Bags Only	% of Whole
Female	31.5%	7.3%	22.0%	60.8%
Male	28.0%	6.9%	4.3%	39.2%
Total	59.5%	14.2%	26.3%	100.0%

Table A-5. Gender and carrying by hand within hardware stores contingency table; non-significant results given the Pearson χ2 test statistic (3.306) and *p* -value (0.1915).

Hardware	**Carry Out by Hand**			
Gender	Hand Carry Only	Hand Carry and Bags	Bags Only	% of Whole
Female	9.7%	3.0%	6.7%	19.4%
Male	48.6%	10.3%	21.7%	80.6%
Total	58.3%	13.3%	28.4%	100.0%

Appendix I. Additional Tables (continued)

Table A-6. Presence of kids or pets and carrying by hand within pet supply stores contingency table; significant results given the Pearson χ2 test statistic (13.640) and *p* -value (0.00111).

Pet Supply	**Carry Out by Hand**			
Kids or Pets Present	Hand Carry Only	Hand Carry and Bags	Bags Only	% of Whole
No	46.9%	7.8%	15.1%	69.8%
Yes	12.5%	6.5%	11.2%	30.2%
Total	59.4%	14.3%	26.3%	100.0%

Table A-7. Grocery stores and double-bagging contingency table; significant results given the Pearson χ2 test statistic (24.487) and p-value (<0.0001).

Grocery	**Double-Bagging**		
Store	Yes	No	% of Whole
G1	0.6%	32.5%	33.0%
G2	2.7%	29.0%	31.7%
G3	0.6%	34.7%	35.3%
Total	3.8%	96.2%	100.0%

Table A-8. Store type and carrying out by hand contingency table; significant results given the Pearson χ2 test statistic (534.5) and p-value (<0.0001).

Store Type	**Carry Out by Hand**			
	Hand Carry Only	Hand Carry and Bags	Bags Only	% of Whole
Grocery	3.4%	22.6%	29.8%	55.9%
Hardware	17.3%	3.9%	8.4%	29.6%
Pet Supply	8.6%	2.1%	3.8%	14.5%
Total	29.3%	28.6%	42.1%	100.0%

Appendix I. Additional Tables (continued)

Table A-9. Mann Whitney-U Test results on ban period and bag type used within grocery stores during study.
p-value < 0.05*; p-value < 0.001; p-value < 0.0001*****

	Bag Type	Pre-Ban Count	Post-Ban Count	S Statistic	p-value
Store	SUP	2548	0	55751	<0.0001***
	Thicker Alternative Plastic	0	90	144089.5	<0.0001***
	Cooler	0	3	127538.5	0.0374*
	Reusable Plastic	0	6	128151.5	0.0032*
	Recyclable Paper	231	426	152978	<0.0001***
	Canvas or Fabric	1	8	127704.5	0.0612
	Box	2	0	126642.5	0.3372
	Total Store-Provided Bags	2782	533	91025.5	<0.0001***
Customer	SUP	2	10	128482.5	0.008*
	Thicker Alternative Plastic	0	7	127845	0.0108*
	Cooler	6	5	127444.5	0.4045
	Reusable Plastic	95	95	133442	0.0006**
	Recyclable Paper	7	0	126501	0.2393
	Canvas or Fabric	104	59	129973	0.0799
	Backpack	4	0	126359.5	0.1738
	Purse	1	1	127090.5	0.5763
	Briefcase	0	1	127232	0.1417
	Total Customer-Provided Bags	219	178	136987.5	<0.0001***
	Total Bags per Transaction	3001	711	96877.5	<0.0001***

Table A-10. Ban and double-bagging contingency table; significant results given the Pearson χ2 test statistic (10.052) and p-value (0.0015).

Ban	Double-Bagging		
	Yes	No	% of Whole
Pre	2.0%	67.3%	69.3%
Post	0.1%	30.6%	30.7%
Total	2.1%	97.9%	100.0%

Appendix I. Additional Tables (continued)

Table A-11. Ban and carrying by hand contingency table; significant results given the Pearson $\chi 2$ test statistic (53.329) and p-value (<0.0001).

Ban	Carry Out by Hand			
	Hand Carry Only	Hand Carry and Bags	Bags Only	% of Whole
Pre	17.8%	18.3%	33.3%	69.3%
Post	11.5%	10.4%	8.8%	30.7%
Total	29.3%	28.7%	42.1%	100.0%

Appendix II. Kent Single-Use Plastic and Carryout Bag Ordinance (4331).

ORDINANCE NO. 4331

AN ORDINANCE of the City Council of the City of Kent, Washington, amending the Kent City Code to create a new Chapter 8.02 regulating the distribution of carryout bags, prohibiting the distribution of single-use plastic bags, requiring retail businesses to collect a pass-through charge from customers, and establishing penalties for noncompliance.

RECITALS

A. The Washington State Legislature in chapters 70.93 and 70.95 RCW has established waste reduction as a priority in the collection, handling, and managing of solid waste for the benefit of public health and for a healthful, clean and beautiful environment.

B. The State Legislature, in RCW 70.95.010(4), found that it is "necessary to change manufacturing and purchasing practices and waste generation behaviors to reduce the amount of waste that becomes a governmental responsibility."

C. The Legislature, in RCW 70.95.010(6)(c), has also found that it is city governments that are "to assume primary responsibility for solid waste management and to develop and implement aggressive and effective waste reduction and source separation strategies."

Appendix II. Kent Single-Use Plastic and Carryout Bag Ordinance (4331). (continued)

D. Plastic bags are made of nonrenewable resources. They do not biodegrade and can take hundreds of years to break down into small, toxic particles which can seep into the soil, waterways, lakes, and bays, posing a threat to animal life and the natural food chain.

E. The United States Environmental Protection Agency estimates that 380 billion plastic bags and wraps are consumed in the United States, annually, while only approximately 5% of plastic bags and wraps are recycled.

F. The Washington State Department of Ecology's litter survey states that plastic bags and film are one of the ten most littered items along roadways in Washington State, by weight.

G. Ecology's "Beyond the Curb" study of commingled residential recyclables from the Southwest Region estimates that it takes $700-$1,000 per ton for recycling centers to remove plastic bags and films from other recyclables.

H. It is the City's desire to conserve resources, reduce greenhouse gas emissions, waste, litter, and marine pollution, and to protect the public health and welfare, including wildlife, all of which increase the quality of life for the City's residents.

I. Decreased reliance on single-use carryout bags contributes toward the goals of conserving energy and natural resources while reducing greenhouse gases and litter.

Appendix II. Kent Single-Use Plastic and Carryout Bag Ordinance (4331). (continued)

J. The City Council finds that it is in the best interest of the health, safety, and welfare of the citizens of the City that regulations prohibit the use of single-use plastic carryout bags, and require a pass-through charge on recycled content paper carryout bags and reusable plastic film bags to encourage greater use of reusable bags, reduce the cost of solid waste disposal by the City, and protect the environment.

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF KENT, WASHINGTON, DOES HEREBY ORDAIN AS FOLLOWS:

SECTION 1. - *Amendment*. Title 8 of the Kent City Code is amended to add a new Chapter 8.02, entitled "Single-use plastic and carryout bags," as follows:

CHAPTER 8.02

Single-Use Plastic and Carryout Bags

Sec. 8.02.010. Definitions.

A. "Carryout bag" means any bag that is provided by a retail establishment at home delivery, the check stand, cash register, point of sale, or other point of departure to a customer for use to transport or carry away purchases. Carryout bags do not include:

1. Bags used by consumers inside stores to:

a. Package bulk items, such as fruit, vegetables, nuts, grains, candy, greeting cards, or small hardware items such as nails, bolts, or screws;

b. Contain or wrap items where dampness or sanitation might be a problem including, but not limited to:

Appendix II. Kent Single-Use Plastic and Carryout Bag Ordinance (4331). (continued)

i. Frozen foods;

ii. Meat;

iii. Fish;

iv. Flowers; and

v. Potted plants;

c. Contain unwrapped prepared foods or bakery goods;

d. Contain prescription drugs; or

e. Protect a purchased item from damaging or contaminating other purchased items when placed in a recycled content paper carryout bag or reusable carryout bag; or

f. Newspaper bags, door hanger bags, laundry/dry cleaning bags, or bags sold in packages containing multiple bags for uses such as food storage, garbage, or pet waste.

B. "Recycled content paper carryout bag" means a paper carryout bag provided by a store to a customer at the point-of-sale that meets all of the following requirements:

1. has a material weight of larger than eight-pounds and contains an average of 40% postconsumer recycled materials;

2. is accepted for recycling in curbside programs in a majority of households that have access to curbside recycling programs in the City;

3. is capable of composting in a commercial composting facility; and

4. is clearly labeled with the minimum percentage of postconsumer content.

C. "Retail establishment" means any person, corporation, partnership, business, facility, vendor, organization, or individual that sells or provides

Appendix II. Kent Single-Use Plastic and Carryout Bag Ordinance (4331). (continued)

food, merchandise, goods, or materials directly to a customer including home delivery, temporary stores, or vendors at farmers markets, street fairs, and festivals.

D. "Reusable carryout bag" means a bag made of cloth or other durable material with handles that is specifically designed and manufactured for long term multiple reuse and meets the following requirements:

1. Has a minimum lifetime of 125 uses, which for purposes of this subsection, means the capacity of carrying a minimum of 22 pounds 125 times over a distance of at least 175 feet,

2. Is machine washable or made from a durable material that may be cleaned or disinfected; and

3. If made of film plastic:

a. Be made from a minimum of 40% postconsumer recycled material;

b. Display the minimum percentage of postconsumer content in print on the exterior of the plastic bag;

c. Have a minimum thickness of no less than 2.25 mils; and

d. Display wording that the bag is reusable.

E. "Pass-through charge" means a charge collected by retailers from their customers when providing recycled content paper carryout bags and reusable carryout bags made of film plastic, and retained by retailers to offset the cost of bags and other costs related to the pass-through charge.

Appendix II. Kent Single-Use Plastic and Carryout Bag Ordinance (4331). (continued)

F. "Single-use plastic carryout bag" means any bag that is made from plastic that is less than 2.25 mils thick and is designed and suitable only to be used once and disposed.

Sec. 8.02.020. Distribution of carryout bags. Except as otherwise provided in this Chapter, effective March 1, 2020, all retail establishments within the City are subject to the following requirements:

A. Retail establishments shall not provide a single use plastic carryout bag to any customer.

B. No retail establishment shall distribute a single-use plastic carryout bag at any City facility, City-managed concession, City-sponsored event, or City-permitted event.

C. Retail establishments shall not provide to any customer at the point-of-sale a paper bag or reusable carryout bag made of film plastic that does not meet recycled content requirements.

D. A retail establishment must collect a pass-through charge of eight cents for every recycled content paper carryout bag with a manufacturer's stated capacity of one-eighth barrel (882 cubic inches) or greater or reusable carryout bag made of film plastic it provides. A retail establishment may make reusable carryout bags available to customers through sale.

E. A retail establishment must keep all revenue from pass-through charges. A retail establishment must show all pass-through charges on any receipts provided to customers.

Appendix II. Kent Single-Use Plastic and Carryout Bag Ordinance (4331). (continued)

Sec. 8.02.030. Exemptions.

A. No retail establishment may collect a pass-through charge from anyone using a voucher or electronic benefits card issued under food assistance programs including, but not limited to, Women Infants and Children (WIC); Temporary Assistance to Needy Families (TANF); Federal Supplemental Nutrition Assistance Program (SNAP), also known as Basic Food; and the Washington State Food Assistance Program (FAP).

B. Food banks and other food assistance programs are exempt from the requirements for this chapter but are encouraged to take actions to reduce the use of single-use plastic carryout bags.

C. The Director may exempt a retail establishment from the requirements of this chapter for up to a one-year period, upon a request by the retail establishment showing that the conditions of this chapter would cause undue hardship. An "undue hardship shall only be found in:

1. Circumstances or situations unique to the particular retail establishment, such that there are no reasonable alternatives to single-use plastic carryout bags or a pass-through charge cannot be collected; or

2. Circumstances or situations unique to the retail establishment, such that compliance with the requirements of this chapter would deprive a person of a legally protected right.

Sec. 8.02.040. Violations.

A. *Civil infraction.* A retail establishment that violates any provision of this chapter may be issued a class 1 civil infraction as set forth in RCW

Appendix II. Kent Single-Use Plastic and Carryout Bag Ordinance (4331). (continued)

7.80.120, as currently enacted or hereafter amended. An infraction issued pursuant to this section shall be filed in the Kent Municipal Court and processed in the same manner as other infractions filed in the Kent Municipal Court.

B. It shall be a violation of this chapter for any retail establishment to penalize, discipline, or discriminate against any employee for performing any duty necessary to comply with this chapter.

SECTION 2. – *Reporting*. The Director of Public Works shall evaluate the effectiveness of this ordinance and report to City Council one year from the date of effectiveness of this ordinance.

SECTION 3. – *Severability*. If any one or more section, subsection, or sentence of this ordinance is held to be unconstitutional or invalid, such decision shall not affect the validity of the remaining portion of this ordinance and the same shall remain in full force and effect.

SECTION 4. – *Corrections by City Clerk or Code Reviser*. Upon approval of the city attorney, the city clerk and the code reviser are authorized to make necessary corrections to this ordinance, including the correction of clerical errors; ordinance, section, or subsection numbering; or references to other local, state, or federal laws, codes, rules, or regulations.

SECTION 5. – *Effective Date*. This ordinance shall take effect and be in force 30 days from and after its passage, as provided by law.

_____	August 20, 2019
DANA RALPH, MAYOR	Date Approved

Appendix II. Kent Single-Use Plastic and Carryout Bag Ordinance (4331). (continued)

ATTEST:

KIMBERLEY A. KOMOTO, CITY CLERK

August 20, 2019
Date Adopted

August 23, 2019
Date Published

APPROVED AS TO FORM:

TAMMY WHITE, DEPUTY CITY ATTORNEY

Appendix II. Kent Single-Use Plastic and Carryout Bag Ordinance (4331). (continued)

CITY OF KENT
NOTICE OF ORDINANCE
PASSED BY THE CITY COUNCIL

The following is a summary of an ordinance passed by the Kent City Council on August 20, 2019.

ORDINANCE NO.4331 - AN ORDINANCE of the City Council of the City of Kent, Washington, amending the Kent City Code to create a new Chapter 8.02 regulating the distribution of carryout bags, prohibiting the distribution of single-use plastic bags, requiring retail businesses to collect a pass-through charge from customers, and establishing penalties for noncompliance.

This ordinance shall take effect and be in force 30 days from and after its passage, as provided by law.

A copy of the complete text of this ordinance will be mailed upon request of the City Clerk.

Kimberley A. Komoto, City Clerk
253-856-5725
CityClerk@KentWA.gov

Appendix III. Letter of Information on Observational Study.

Dear **[Participant]:**

I am a student at The Evergreen State College. As part of my coursework in the class, Thesis Workshop, I will be conducting a research project titled "Case Study: The Impacts on Consumer Choices Following Kent Plastic Bag Ordinance". The purpose of my project is to understand the effects of the plastic bag ban on consumer bag choices through grocery stores in Kent, WA. I will be conducting this research through observational data and interviews with various stakeholders involved with the Kent City Single-Use Plastic and Carryout Bag Ordinance.

Any risks to you are minimal, and would likely include non-identifying observations in my final paper. I plan to keep your identity anonymous as this is intended only to inform the initial effects of this ban. There will be no compensation of any kind available for your participation, which is completely voluntary. You may withdraw your participation at any point or skip any question you do not wish to answer without penalty. You may not directly benefit from this research; however, we hope that your participation in the study may provide insight into the effects of a single-use plastic and carryout bag ban.

I will maintain privacy and confidentiality while performing these randomized observations, and will not share any identifying information while presenting this research in any capacity. Once no longer needed for this thesis project, identifying information will be deleted and remain confidential. I may share part or all of this research with the City of Kent and the Washington State Recycling Association in the form of presentations and continued anonymity of interviewees.

As mentioned above, I will use my observations as resource material for my research project on the single-use plastic and carryout bag ban in Kent, WA. At your request, I will provide you with a copy of the thesis paper presentation materials which I am providing to my faculty and Kent City Council members.

My observations, collected as part of the research, could be used for future research studies or distributed to another investigator for future research studies, with all identifiable information removed, without additional informed consent from the subject or the legally authorized representative.

If you have any questions about this project or your participation in it, you can email me at kudjes31@evergreen.edu. If you have questions concerning your rights as a research subject or experience problems as a result of your participation in this project, contact Karen Gaul, IRB administrator at The Evergreen State College, Library 2008, Olympia, WA 98505; Phone 360.867.6009.

Thank you for your participation and assistance!

Sincerely,

Jessica Kudlinski

Appendix IV. Observation Sheet for Data Collection.

Observation Sheet

Store Information	**Date**	**Time**	**Store Size**	**Ban Period**												
					Recycle Collection Available?		Bagger Present: 1/Clerk; 2/ Bagger; 3/Self	Double Bagged: 0/None; 1/Few; 2/All; 3/Triple+	Age Range: 1/Under 30; 2/30-50; 3/50-70; 4/70+	Kids/Pets: 0/None; 1/Kids; 2/Pets; 3/Both	Notes below on general hand carried items					
	Transaction	Transaction	Transaction	Transaction	Transaction	Transaction	Transaction	Transaction	Transaction	Transaction	Transaction	Transaction	Transaction	Transaction	Transaction	Transaction
Transaction ID #																
Store Provided Bag Type & Count																
single-use plastic																
reusable plastic																
reusable paper																
canvas or fabric bag																
box																
other (0^N / 1^Y) (please specify)																
Total number of bags																
Customer Provided Bag Type & Count																
single-use plastic																
reusable plastic																
reusable paper																
canvas or fabric bag																
box																
backpack																
purse																
suit/briefcase																
carry out by hand (0^N / 1^Y)																
other (0^N / 1^Y) (please specify)																
Total number of bags																
Bagger Present (1-3)																
Double bagged (0-3)																
Age Range (1-4)																
Gender (m/f/o)																
Kids/Pets? (0-3)																
***Additional Notes**																