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The Effect of Waste and Waste Management on the University of Maine and Community During the COVID-19 Pandemic

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THE EFFECT OF WASTE AND WASTE MANAGEMENT ON THE UNIVERSITY OF MAINE AND COMMUNITY DURING THE COVID-19 PANDEMIC

by

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ABSTRACT

The Covid-19 pandemic closed the University of Maine the second week of March. Quickly following, most of the country was on lockdown. The virus also has directly affected the University of Maine and its waste stream due to the drastic changes in population and the types of waste being produced. The purpose of this study is to first analyze the direct effects on the amount of waste produced per category on campus in 2019 compared to 2020. The main categories are municipal solid waste, single stream, compost, demo debris, metals, electronics, hazardous waste, universal waste, and biowaste. The second purpose of the study is to learn how the University of Maine community perceives waste and how the Covid-19 pandemic affected those perceptions of the waste. To address the first objective, I conducted an analysis of campus waste from data collected by the University of Maine facilities department in 2019 and 2020. To address the second objective of the study, an IRB-approved survey was distributed to people affiliated with the University of Maine campus (students, alumni, faculty, parents, and others) via social media and email. The results of this study revealed a large decrease in waste production on campus, but an increase in municipal solid waste production per University of Maine residential on-campus student. The study also showed that the University of Maine community is aware that waste and waste management should be of concern to the University and the country. The respondents also believed that the Covid-19 pandemic has increased the amount of waste they have produced. These results of the study could be helpful in further research on how pandemics affect waste and waste management, as well as, how to better prepare for the future. Further research, discussed

below, could be conducted on how waste and waste management is affected by a pandemic. With a more in-depth study over a longer period of time, suggestions on how to prepare for these future possible situations could be made.

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

Tables

Figures

CHAPTER 1

LITERATURE REVIEW: BIOLOGY OF THE COVID-19 PANDEMIC

The COVID-19 pandemic hit the United States in March 2020, schools were canceled, and quarantine began. COVID-19 is a mainly respiratory disease caused by the SARS-CoV-2 virus that has now affected millions worldwide. There have been over 213 million confirmed cases and 4.4 million deaths. The beginning stages of this virus put the world in shock as not much was known about its microbiology, path of infection and transmission, virology, etcetera. Another large unknown was, how does a pandemic affect the world, with transportation, work, schools, events, and even the waste we produce as humans.

Slowly as research developed, more about the biology of the disease became available over time. This exact strain of the virus was completely unknown before it started to spread; information about other coronaviruses was also limited until 2003. Before then, only two known strains were researched that could affect humans (Erwing, 2020). After 2003, other coronaviruses became known and researched; the most known was SARS-CoV, Severe Acute Respiratory Syndrome. SARS only lasted for about 8 months; however, it had a high mortality rate in the areas of infection. Since then, there had been no other SARS cases until MERS-CoV arose, Middle East Respiratory coronavirus. SARS and MERS both evolved from a bat coronavirus, leading us to SARS-CoV-2, which also arose from a bat coronavirus. However, SARS-CoV-2 has the highest mortality rate out of all of the past known coronaviruses (Erwing, 2020).

Coronaviruses belong to a larger family of viruses due to their structure; they are, +ssRNA, positive-sense single-stranded RNA viruses (Ryding, 2021). The virus has spike projections on the outer surface with a large 30kb size genome on the inside. The large genome self-replicates, but has a higher rate of recombination and mutation (Erwing, 2020). SARS-CoV-2 is an enveloped virus and ranges in size from 80-125nm. The virus has four main structural proteins on the 3-prime end of the RNA, E, M, S, and N protein (Sood, 2020). The N protein, is helically symmetrical and forms the helical capsid. The M proteins are membrane proteins that extend to the other surface. The E protein is a smaller membrane protein. The S protein spike projections are club-shaped and important to the virus as it plays a large part in the entry. The spike protein attaches with its receptor for entry through the plasma membrane. The receptors of SARS-CoV are at the C-terminal of the S1 spike protein. Once the virus is attached the RNA genome begins the process of replication (Sood, 2020).

The life cycle of the SARS-CoV virus took time for researchers and microbiologists to figure out the differences between this specific virus and other coronaviruses (Erwing, 2020). To begin, the receptors at the C-terminal of the S1 fusion spike protein bind to the ACE2 receptor to begin endocytosis, followed by fusion of the membrane with the viral coat. Once the virus enters into a cell, it begins with the 5-prime end of the genome getting translated. The 5-prime end of the RNA contains the open reading frame. The open reading frame is translated into a polyprotein that codes for formation of a replicase protein (Sood, 2020). This replicase protein and other enzymes that are coded for then leads to the complete replication of the full-length negative-strand RNA. This full-length RNA then serves as a template messenger RNA (mRNA) as well

as the leader and lagging strands of the RNA. The exact mechanism of the discontinuous transcription is not known at the time of this journal article (Sood, 2020). Following translation and transcription, the budding process begins; the budding into vesicles takes place where the virus is transported to the cell surface and then leaves the cell via the vesicle.

The path of infection is how the virus enters and spreads through the body. Contracting the virus typically means that the person was in close contact with someone who was still contagious with the virus. Being in close contact means being within 2 meters of someone for a prolonged amount of time (Erwing, 2020). The contracting of the virus can be split up into three main divisions, which begin with an asymptomatic state after the initial infection (Mason, 2020). The most likely mode of infection is through inhalation due to it being an airborne virus. Once the SARS-CoV-2 virus enters through mucous membranes, it will bind to the squamous epithelial cells of the nasal cavity to then begin replication. At this beginning point, there is a limited innate immune response; the virus can be detected by the body as well as by nasal swabs. The next step of the infection is within the next few days; the virus starts to move down the respiratory tract which then triggers a more powerful innate immune response. Stage 2 is when the symptoms are most likely to affect someone, including fever, cough, headache, and fatigue (Kabeerdoss & Danda, 2020). Around 80% of infected patients will remain at the second stage where the disease is mostly in the upper airways (Mason, 2020). These patients will stay at home and monitor themselves until a negative test is provided. However, about 20% of infected individuals will continue to the 3rd stage of infection, which is more severe and can result in fatality. In this stage, the virus moves down further

to gas exchange components of the lung and infiltrates the type II alveolar cells. The viral particles are released into these cells, and they will go through apoptosis and die, which results in alveolar damage. In order to recover from this stage 3 of infection, epithelial regeneration is required for healing.

Detection of the SARS-CoV-2 was complicated at first because even though someone has similar symptoms to COVID-19, it is not necessarily that virus. The symptoms are similar to other respiratory diseases; therefore, a detection technique was needed to determine the differences between other viruses. The most common type of detection is a nucleic amplification acid test (RT-PCR), but in some cases, other methods were also used that are discussed below. The samples are taken from the upper respiratory tract typically; but can also be taken from the lower respiratory tract. To administer the test, either a nasopharyngeal swab, nasal aspirate, or a pharyngeal swab is used for the collection. With the PCR testing, certain aspects of the virus are targeted for detection. The ORF1a and 1b gene, the RNA-dependent RNA polymerase, as the E, N, and S proteins are targeted (Harahwa, Lai Yau, Lim-Cooke, et al., 2020). This is a two-step method of testing single-step PCR is a quick way for COVID detection. Another detection mechanism is through a CT scan; in the beginning of the pandemic this method was used when there were short supplies of Covid-19 testing kits. The chest CT scans show a cross-sectional image of a patient's chest; the results are analyzed by a radiologist for anything abnormal. For the early stages of COVID, patients were seen with normal scans 56% of the time (Sood, 2020). Within 10 days, the infection developed into the lungs. The biggest findings on diagnosed patients were consolidation of the lungs, as well as ground-glass opacity. Another finding when the virus had progressed further was a

stone pattern on the lungs that represents fluid compressible lung tissue. CT scans are not used as often, due to diagnoses that overlap with other respiratory infections or viral infections like pneumonia. Another detection method is protein quantification. The advantage to this is the time taken with the testing; this is the shortest detection time without a scan. For this method of testing, the protein antibodies are used. At first, this method was not effective due to false-positive results because of other strains of coronaviruses. It was then changed to detect the presence of immunoglobulin G (IgG) and immunoglobulin M (IgM). Currently, rapid antigen tests are common at pharmacies due to a quick turnaround time, as well as, BinaxNow self-test. (Sood, 2020).

Once more information about the virus became known treatments then arose to help the infected patients; before treatment, level of severity had to be determined. Patients can be classified as asymptomatic, mild to moderate, severe, and critical cases (Kabeerdoss & Danda, 2020). Severe and critical cases cause pneumonia that is also associated with ARDS [acute respiratory distress syndrome]. Other complications from critical cases can result in organ failure. In the beginning, when severity of the disease was more unknown, it was difficult to figure out what classification of the disease a patient was experiencing. Now certain, more common, laboratory markers are used in predicting the severity of the illness is in the patient. For example, C-reactive protein, ferritin, and lymphocyte count in the body are markers of the disease. It was also noted the difference in immune response in females compared to males (Kabeerdoss & Danda, 2020).

As the COVID-19 pandemic continued to sweep the world faster and harder than most of us anticipated, it began to become a race to a treatment or protection from the

virus. As we all have lived through it, the first steps to try to stop the spread of the virus were quarantines (Harahwa, Lai Yau, Lim-Cooke, et al., 2020). In the last week of March and the beginning of April, the entire United States, as well as most other countries in the world, were on lockdown. The goal was that if everyone were to stay in their homes for at least two weeks or more, the virus would slow down its infection and would not spread. However, that was not the case. Hospitals began to be over-capacity due to COVID patients, but there was not a lot of treatment that could help them (Harvard, 2021).

Before vaccines became a factor in the pandemic, treatment for COVID-19, in the beginning, was difficult. Severe COVID-19 patients would end up hospitalized, but before hospitalization, there are a few options. To reduce the risk of hospitalization, rest and hydration are important due to the fatigue from COVID-19. An at-home medication is an acetaminophen, useful to reduce fever and ease body aches or pain (Harvard, 2021). There were no FDA-approved drug treatments for the virus until August of 2021. Before that other potential treatments were tried (Ryding, 2021). CTAP, a coronavirus treatment acceleration program was put in place. The purpose of CTAP was to move along new medications at the same time as figuring out if they were effective or harmful. Investigations of further treatment options were put in place; it was found that remdesivir and chloroquine were found to have an inhibitory effect on the virus (Sood, 2020). Remdesivir is a newer antiviral medication while chloroquine is an old antimalarial medication. Remdesivir is a nucleoside (adenosine) analog antiviral agent that was produced in 2017 by Gilead Science as a treatment for Ebola (Sood, 2020). These medications inhibit viral replication enzymes like RNA and DNA polymerase. In a

clinical trial, hydroxychloroquine was used with azithromycin to prevent bacterial contamination win patients with severe COVID-19 symptoms. Before the clinical trial, azithromycin was used as therapy in combination with antivirals in patients with MERS-CoV. Other options for treatment include monoclonal antibodies and convalescent plasma (Harvard, 2021).

What leaders in the United States believed would be a month or two of pandemic guidelines, turned into more than a year. To try to stop the spread of the virus other protections have been put in place. Requirements for masking in public, limited gatherings both inside and outside, limited businesses that were open depending on necessity, and travel restrictions/lockdowns. In 2021, vaccinations were starting to become available which led to some of the restrictions being lifted. Currently, the virus is changing and so have the restrictions along with it. Constantly different mandates are being put into place to keep up with COVID-19. With vaccinations, there is hope that the restrictions and mandates won't be in place forever.

CHAPTER 2

INTRODUCTION

Over 30 years ago, the Environmental Protection Agency started conducting research on waste and the impacts it has on the world that affects us daily (Armijo, Ojeda, Ramirez, et al., 2020). Waste and waste management are studied on large scales by the EPA, but not as often with smaller-scale studies. This study examines waste and waste management at the University of Maine campus. A definition of waste is needed because what one views as waste could be useful or resourceful to another. Waste is universally defined as the useless byproduct of human activities or a product useless to the producer (Amasuomo & Baird, 2016). Over time, the waste that humans have created has changed both in the composition and the amount due to our evolving surroundings. Almost all activities in our lives create waste: driving, grocery shopping, school, work, doctor's appointments, and other daily activities. Aspects of waste generation have been studied on an institutional level, for example, waste generation and management at an institution higher education (Smyth 2020) (Ashbrook, 2001). The three main types of waste are typically classified by their state, i.e., solid, liquid, and gaseous. The main focus that will be discussed in this study is solid waste, which can then be categorized as, municipal solid waste, biomedical, hazardous, and electronic waste. Of these categories, municipal solid waste is typically the one that is most generated and studied. Municipal solid waste (MSW) can be an array of different types, but the general consensus is that it is all forms of waste from households or other places if the waste is of the same category as household (Fan, Jiang, Hemzal, et al. 2021).

Higher education institutions, including the University of Maine, typically produce a large amount of MSW. Other studies of waste generation and management on college campuses have found that campuses generate a large amount of waste in many forms due to the different types of buildings and activities on campus (Smyth, 2020) (Ashbrook, 2001). Some of the types of waste from buildings are: food waste from various dining halls, residence hall waste, waste from large events such as games or shows, and even waste from classes. To evaluate waste on campus efficiently, waste characterization studies can be conducted. A waste characterization study looks at the waste stream in-depth, to determine certain opportunities for waste reduction (Smyth, 2020). The waste stream is analyzed by the type of waste and where it comes from to then find any areas of management that need improvement to reduce waste. The University of Northern British Columbia conducted a waste characterization study to further become closer to an environmentally friendly university. The findings of this study revealed that upwards of 70% of the waste stream could have been diverted from a landfill through other waste reduction efforts such as compost and recycling (Smyth, 2020). It was concluded that waste characterization studies are an important part of understanding waste management on campus. These practices are a step towards being a more sustainable higher education institution.

Other college campuses found that MSW is the type of waste in the most abundance. Globally, upwards of one billion metric tons of MSW are discarded currently while predictions of MSW production skyrocket to double by the end of 2025 (Vergara & Tchobanoglous, 2012). The problem with MSW is disposing of it properly, rather than open-dumping, which is largely dependent on the area of living. Today, highly populated

cities do produce more MSW, but typically have better ways of managing it with the disposal compared to lower populated areas. Cities with higher incomes have organized technological disposals (Vergara & Tchobanoglous, 2012). Mechanized pick-up and collection of the waste, sorting, and treatment of the waste are utilized (Vergara & Tchobanoglous, 2012). However, in low-income cities more traditional, labor-intensive practices are used. In the lowest developed areas, open dumping of MSW is still a common waste management practice. Waste management steps are important to be noted when investigating waste generation. There are four main principal technology steps for management; waste collection, transfer and transport, waste processing and transformation, and disposal (Vergara & Tchobanoglous, 2012).

Collection is the first step in waste management, determining the future of the waste; the University of Maine uses separation of waste for collection. The amount of separation of the waste is the biggest determinant in proper disposal. The most used separation is that of recyclables, compost, and landfill destined waste. At the University of Maine, the collection begins with bins in all of the buildings (*Casella*). There is a total of 355 University-owned buildings that undergo the waste management system. In all of these buildings, there are two different types of bins that serve for collection -- a blue bin for recyclable materials and a grey trash bin for waste. The University of Maine, as well as other communities, have been switching to single-stream recycling. This system simplifies recycling for the University, with no confusion about what can be recycled where. The University specifically uses the Casella Zero Sort Recycling system. The recyclable items that can go in the blue bin are plastics that are labeled #1-7, glass bottles and jars, empty metal aerosol cans, aluminum, metal cans, cardboard, paper, and

softcover books or magazines (*Resource Recovery*). Some items that are not zero-sort are plastic bags and utensils, hazardous waste, tissues and napkins, snack wrappers, light bulbs, and styrofoam.

Other than recycling, other forms of waste collection and management on The University of Maine campus include composting, material recovery, hazardous waste, trash disposal, and recycling. Composting is an important aspect of the University of Maine community as it reduces food waste. As a step to better food waste management, in 2012, the campus invested in Green Mountain Technologies for a 40-ft Earth Flow In-Vessel Composting System. This Earth Flow system is beneficial to the campus by reducing labor costs and producing resourceful compost in a fast and efficient manner, using pre-consumer waste from the Union and three dining halls which is then combined with horse bedding and wood chips from the Witter Center (*Resource Recovery*). The Earth Flow In-Vessel composts around 1 ton of food waste a day and redirects upwards of 400,000 pounds of food waste per year to compost (*In-Vessel*). This helps the environment and the students in understanding how to maintain a more sustainable lifestyle by using the compost directly on campus. Other wastes such as large bulky items, demo debris, and electronics are disposed of through the University of Maine Material Recovery Facility and the Office of Facilities Management.

Hazardous waste and universal waste are also generated on a daily basis at an open campus with in-person classes, but it is also affected when a pandemic shuts down the University. At the University of Maine, these are taken care of by the designated hazardous, biohazardous, or universal waste signs. These boxes are then also tracked, weighed, and transported with about five waste pickups per year. The model for

hazardous waste on most campuses, including the University of Maine, is based on the RCRA, the *Resource Conservation and Recovery Act*. The University of Missouri-Columbia uses the RCRA to protect the health and the environment of the institution (Ashbrook, 2001). The RCRA gives explicit guidelines on what is not allowed when dealing with hazardous waste, yet, does not give any good management programs. For academic institutions, the best management techniques are hard to implement because of the challenges that they face compared to other industries (Ashbrook, 2001). These challenges include a wide variety of smaller amounts of chemicals, turnover of staff and students with training, and the limited amount of faculty qualified to handle chemicals. The University of Missouri-Columbia put a direct program into place. The University of Maine now has put a similar training program into place that has guidelines for proper training procedures that will help reduce improper waste disposal (*Hazardous*). The training program guides you to contact the hazardous waste manager if it is not clear in the training. From there, the waste is disposed of depending on whether the specific category is biowaste, hazardous waste, and universal waste (*Personal Communication*).

Lastly, the largest category of waste on the University of Maine campus, municipal solid waste (trash, rubbish), is tracked weekly when it is picked up. The campus tries to recycle and compost as much as it can, but waste can not be avoided. However, the EPA states that upwards of 32% of MSW is recyclable material such as paper, plastics, and cardboard (*EPA*). At the University, the materials from the waste bins were collected and transported to Coastal Resources of Maine, a waste management facility seeking other forms of managing MSW by forming energy. Unfortunately, with the Covid-19 pandemic, Coastal Resources of Maine was shut down in May of 2020.

Coastal Resources of Maine has yet to reopen as it has been in negotiations with being sold to Delta Thermo Energy (JR, 2021). Due to that event, the University of Maine had to divert its waste to the local landfill until Penobscot Energy Recovery Center (PERC), the University of Maine's previous waste company, agreed to once again take the waste. Penobscot Energy Recovery facility burns the MSW to then produce electricity for residents in Maine. This is important because the waste is not going straight into a landfill. It was noted that PERC and Casella have seen an increase in the amount of MSW and single-stream entering the facilities since the COVID-19 pandemic (Abromovich, 2021*)*.

The COVID-19 pandemic due to the SARS-CoV-2 virus has affected the world in many different ways, including global shutdowns and an increase of disposable waste. The different effects of the waste are the amount of waste, the types of waste, and the distribution of the waste affecting transport and treatment (Fan, Jiang, Hemzal, et al., 2021). A large decision during the beginning of the pandemic was what to risk and what not to risk pertaining to the virus, for example, whether recycling was worth it or if the recycling should be added to MSW to avoid extra exposure to the virus. The worker who picks up the MSW could be at risk of exposure, the workers who transport the MSW, and then the workers who sort it. This is a similar concept that was investigated in a study with residents and MSW disposal. In residential areas in Toronto, Canada, it was found that MSW disposal was more difficult due to the risk of exposure (Ikiz, Maclaren, Alfred, et al., 2021). Residents were cautious in leaving their buildings, being around others in an elevator, and being in contact with people at a waste disposal center. These were all new

aspects which had to be considered with waste management during a widespread pandemic.

At the beginning of the pandemic, it became a concern of how to manage the waste we produce when the world comes to a stop (Fan, Jiang, Hemzal, et al., 2021). Over time, with more masks and other protective equipment being produced, workers could get back to business. But, with more personal protective equipment (PPE), also comes more waste being made. Daily facemask usage began to be the new normal all over the world, resulting in an increased demand for facemasks and PPE (Hantoko, Li, Pariatamby, et al., 2021). One study estimated that globally around 129 billion facemasks and 65 billion gloves were in demand monthly. China alone supplied 17.9 billion facemasks, 1.73 billion protective clothes, and 0.54 billion COVID-19 test kits between the start of the pandemic until October 20, 2020 (Hantoko, Li, Pariatamby, et al., 2021). North America alone had 2,346 tons/day of discarded facemasks and 781,950,383 facemasks used per day. Due to the lockdown, there was also a large increase in demand for food delivery and online groceries which caused a 44.8% surge in packaging. Plastic waste for medical use increased by 13.20%, with future increases expected in both of these categories (Hantoko, Li, Pariatamby, et al., 2021). In certain cities, such as China and Shanghai, there are notable differences in waste depending on where and what type (Fan, Jiang, Hemzal, et al., 2021 ; Hantoko, Li, Pariatamby, et al., 2021). For example, household waste in Shanghai was significantly reduced by around 23% since the beginning of the pandemic, but in Singapore, household waste increased by 3% (Fan, Jiang, Hemzal, et al., 2021).

On the other hand, medical waste has seen a large increase in difference. Sustainable waste management in the medical field is problematic to begin with, due to the amount of disposable equipment, and is only heightened in medical emergencies (28). On top of the increase in the amount of waste is also an increase in the risk of disease, infections, and toxicity when the medical waste can not be properly taken care of (Hantoko, Li, Pariatamby, et al., 2021). When the COVID-19 pandemic erupted, the number of products that needed immediate disposal skyrocketed, including gloves, masks, eye protection, and other personal protective equipment (Sarkodie & Owusu, 2021). In Barcelona, medical waste increased by 350% (Sarkodie & Owusu, 2020). A large concern that arose was waste management with both household and medical waste due to closures. With the closures, the increase in waste didn't receive proper disposal because of the global shutdown. The UK has a 300% increase in illegal waste disposal (Sarkodie & Owusu, 2020). Worldwide, overwhelming tons of waste were generated with not enough open facilities to manage necessary processing. This was also seen at the University of Maine, with the closure of Coastal Resources of Maine, mentioned previously.

With these circumstances, an investigation arose into how the COVID-19 pandemic also has affected the amount of waste and waste management on our campus arose. This is a topic that is not typically investigated in the past due to the fact that pandemics do not come around often. The last pandemic that shut down the US was in 1918 due to the flu pandemic. The world does not have experience with a large shutdown in this modern time, let alone how an institution of higher education handles a pandemic. The University of Maine, along with all other Universities, was shocked when the

shutdown occurred. At the end of the second week of March of 2020, the University of Maine closed. Most students returned home. A student at the University of Maine has looked into the waste management change due to the pandemic (Abromovich, 2021). This University of Maine article cited the changes that have occurred with Coastal Resources of Maine and PERC since the pandemic started, such as an increase in MSW. The article was also informative about an increase of volume with PPE that has led to MSW and recycling plants handling an influx of disposal. Furthermore, an investigation is important to better prepare for the future by looking at the amount of waste and the perception of the community.

The perception of the community towards waste is also important due to the large role it plays in successful waste management. In a study conducted in Bangalore City, India, found that the success of waste management depends on the willingness of the household for proper disposal. On average, 63% of people were willing to engage in better waste management through techniques including proper sorting, recycling, and collection (Kumar, 2013). The community also concluded that better guidelines for waste, including punishment for improper waste management should be put into place (Kumar, 2013). Similarly, Moi University, studying the college community revealed an awareness of the importance of waste management, but not enough guidelines were known (Starovoytova, 2018). This conclusion was also found in the Moi University study: community engagement would increase with greater awareness and campaigns for waste management (Kumar, 2013) (Starovoytova, 2018). Another study, comparing universities in Alabama and Hawaii, found there is both a knowledge gap and a commitment gap with students (Emanuel & Adams, 2011). Students are not informed, or

they are informed but will not commit to the proper waste management. The knowledge gap could be lessened by readily available information on how waste management contributes to sustainability. However, a commitment gap is harder to lessen if people are not concerned. With all three studies, better incentives for good management and/or punishments for bad waste management could be an improvement. Clearly the community's perception of waste and waste management is important for the success of waste reduction.

My study investigates how the COVID-19 pandemic has affected the University of Maine, and the surrounding communities' opinion, on how much waste was produced and how it was managed. The goal of this study is to try to answer two research questions through different data collection methods.

1. How has the amount of waste and the techniques for waste management on campus at the University of Maine changed over time from pre-COVID-19 to during the pandemic, taking into consideration the number of students and activities on campus?
2. How has a pandemic affected the surrounding community's perception of waste management during COVID-19?

METHOD

Design and Data Collection

To begin work on these two research questions I contacted Daniel Smith and Scott Foster at the University of Maine Office of Facilities Management about the waste management process and the MSW data on campus. The MSW data is to investigate research question 1, pertaining to waste pre-COVID to currently. Daniel Smith and Scott Foster also retrieved the data of the amount of waste produced for each category in both 2019 and 2020 in poundage. The data they retrieved included categorized sections for the waste streams on campus. The categories for 2019 and 2020 include MSW, single-stream, compost, demolition debris, electronics, and metals. The MSW data is broken down into every pick-up that was made on campus. For hazardous waste, biowaste, and universal waste, Peter Snow (Hazardous Waste Manager, Radiation Safety Officer, Safety Management) sent all of the raw data that was compiled of every waste pick-up and the type of waste. All of these data sets were compiled and then recorded on my laptop through Excel.

To obtain data on the number of people on campus, Robert Dana (Dean of Students), was contacted. He then cc'd the respective faculty, Debra Allen, Angela Michaud, and Glenn Taylor, to relay the number of students enrolled, the number of faculty, and the number of on-campus students. Debra Allen sent the number of students enrolled, which includes both undergraduate and graduate students that are part-time and full-time. Angela Michaud relayed the information of the total number of faculty employed by the campus regardless of whether they were working from home or on the campus. Glenn Taylor informed the study by the number of students living residentially

on the campus. I chose to consider the dates from March 13, 2019 - November 20, 2019, and March 13, 2020 - November 20, 2020. These were chosen because the campus was operating on a limited basis after March 13, 2020, due to Covid-19. Therefore, for comparison purposes, March 13, 2019, was chosen as well. November was chosen because the data that were available from the Office of Facilities Management for MSW pick-ups were only recorded until November.

To address the second research question, I developed and conducted a survey to study the community's opinion on waste and waste management on the University of Maine campus before and during the pandemic (Appendix B, University of Maine Institutional Review Board approval #2021-04-09). The survey, administered through Qualtrics, consisted of informed consent, 10 multiple choice questions, and an open-ended question (see Appendix C). The survey was sent out 2 times through campus-run social media accounts, including Facebook and Instagram on the *Natural Sciences, Forestry, and Agriculture* page. There was not a lot of interaction with the survey via social media with only 30 responses, so another route was taken through email. The communication specialists for the different University of Maine schools sent out emails to the students in their respective schools or colleges. These emails included the Honors College, the School of Biology, the College of Engineering, the Center for Undergraduate Research, and the College of Education and Human Development. This method was more successful and received 218 anonymous responses. These responses were recorded in Qualtrics and then exported into Excel for analysis.

Data Analysis

To start analysis, excel was used. For the data of the different waste categories, tables were created in excel to compare the 2019 and 2020 data sets. Then the sums of the total waste produced were calculated. The averages of the amount of MSW per month were then taken on the more detailed MSW data by using the AVG function in excel. To determine the production per person on campus, the data was broken down to the average of MSW produced per day on the entire campus and calculated using the on-campus occupancy. The data for the MSW produced between March 13, 2019, and November 20, 2019, were input into a linear graph to show the pickups over time. An F-test Two-Sample for Variances was conducted to determine if the variances of the MSW data set are equal. The Null hypothesis being that the variances of the two data sets are equal. The F-test was run on excel using the Analysis Toolpak. A T-test: Two-Sample Assuming Equal Variances was run to determine whether there were significant differences between the data sets to conclude there is statistical data to support that Covid-19 affected waste. The Null hypothesis is that between 2019 and 2020 there is not a statistical difference between the waste production. The data was split into further sections to represent the different times of year on campus. For the spring, the pickups between March 13 and May 15 were used. For the summer, May 16 to August 21 were used. For the fall, August 22 to November 20 were used. The test was to determine if there is a statistically significant difference in the average waste production between 2019 and 2020 at different times of year. The hazardous waste data were also analyzed in excel and put into a table. For every multiple-choice question on the survey, a table was created with the average,

standard deviation, and variance of all of the responses were calculated. The long answer option survey questions were saved on excel for information on the perception of waste management from the community with their opinions.

RESULTS

Waste Production

The amount of overall waste in 2019 compared to 2020 decreased on the University of Maine campus (Table 1). The total MSW produced decreased by 87,228 lbs. All of the other categories, seen in Table 1, also decreased by over half Most of the pickups are between 10,000 to 15,000 lbs with a calculated average of 13,485 lbs per pick-up, with a few outliers. In 2020 the average weight per pickup between March 13 and November 20 is 14,088 lbs. With the 252-day period, the average amount of waste produced per day decreased from 2019 to 2020 (Table 3). Then the average amount of MSW produced per person on campus occupancy was determined. These were done by using the on-campus occupancy which is the amount of people living on campus (Table 2). For 2019, the average MSW was produced per person, which then increased in 2020 (Table 3). Table 2 sows that the on-campus occupancy and the number of employees decreased. The amount of enrollment did go up, but with mostly all online classes at the time.

For the t-test the 2019 and 2020 MSW pick-up data sets, divided into seasons on campus, were used to compare. The sets were organized by each individual pick-up, which varied by week, between March 13 and November 20. The replicate for the t-test is the pick-up. The t-test is to determine if there is a statistically significant difference between the two sets. The t-test for the Spring of 2019 and 2020 resulted in t-critical two-tail values of -2.011 and 2.011 (Table 5). T-stat is 1.271, not within the rejection range. The t-test for the Summer of 2019 and 2020 resulted in t-critical two-tail values of -2.016 and 2.016. The T-stat is 0.491, which is also not within rejection range (Table 6).

However, the t-test for the fall of 2019 and 2020 showed slightly different results with t-critical two-tail values of -1.994 and 1.994. The t-stat for the fall is -2.309 which is within rejection range (Table 7). A significant t-test typically indicates the samples from the two years are significantly different from one another while a nonsignificant t-test infers the two samples did not reach the level of significance. Therefore, the null hypothesis of this t-test for the spring and summer failed to be rejected and there is no statistical difference between the 2019 and 2020 MSW data. However, the null hypothesis for the fall is rejected and there is a significant statistical difference between the fall of 2019 and 2020 with more MSW production in the fall. The hazardous waste results also showed a decrease in all three categories as seen in Table 3. In 2021 biowaste boxes automatically increased due to Covid-19 testing on campus, about 32 boxes a week for Covid-19 tests depending on the week.

Survey Responses

The survey collected 218 viable responses to the questions (results in Table 8). The majority of the respondents were current students, 78.9%, while the rest of the responses were divided between faculty/staff, alumni, parents, or others. On-campus, 94.95% of respondents believed that waste and waste management affects the environment, with a very low variance of 0.22. Over 95% of the respondents thought that waste management, including recycling, should be of concern to the University of Maine. The next question is asking where the most waste on campus was believed to be produced pre-COVID-19, the results varied in the responses; 61.75% of people believed

that dining halls created the most waste, 29.49% thought residence halls, 5.99% thought sporting facilities, and events, while the remaining percentage was split between Cutler Health Center and Academic Buildings. Response to COVID-19 impacting the amount of overall waste in the country had 57.34% of responses as definitely yes and 36.7% as probably yes, while the other majority of responses being might or might not. The following question addressed the issue of how much COVID-19 was viewed as having impacted waste at the University of Maine. This question had a high variance of 1.28, implying the respondents were less uniform in their opinions. With these responses, the majority of the answers were 4 for the scale, with a mean of 3.61; however, all other answers were close to each other. Regarding how much respondents personally think about the waste they produce daily, a high variance of 1.33 resulted with the majority being definitely and probably yes. This high variance indicates different opinions of respondents. On the scale of how much the pandemic has affected the amount of take-out meals, a variance of 1.14 and a mean of 3.42 on the 1-5 scale occurred. The next question was a similar scale, but addressed the amount of online shopping, which had a mean of 3.66 on the 1-5 scale with a lower variance compared to other scaled questions. The online shopping increase has a higher mean than take-out meals; compared to 2019, respondents believed their online shopping increased more than the amount of take-out meals they ordered. The last scaled question was about how much COVID-19 impacted the total waste produced weekly. These responses showed an average of 3.74; meaning there was a belief of an increase in the amount of waste produced by the respondents due to COVID-19.

The last question was open-ended for responses regarding the University of Maine community's opinions of waste and waste management. These responses varied with opinions for the University of Maine campus and for the country. Not every survey respondent answered this question, as it was optional. There are a total of 78 responses. A common response was the concern for the amount of packaging that is used in the country, mentioning packaging due to food, toys, and clothing. Another large theme was to have the government more involved in regulations of products with a push toward being both disposable and biodegradable. The responses that focused on the University of Maine during the pandemic were geared toward the dining hall and food waste. A student employee of the dining hall stated a clear increase in the trash due to packaging and an increase in food waste due to lesser food quality. Another food waste component mentioned by other students is that the food is pre-portioned out. Pre-pandemic that was not an issue; students could put as much or as little amount of food on their plates. However, during COVID-19 there is a set amount per student that can lead to more food waste. Another large mention was that of more information needed on campus for proper sorting. Students aren't confident in what to sort into what bin. Therefore, many students ended up throwing items away that could have been recycled. Overall, the responses all believed that waste is a growing problem both at the University of Maine and the country

DISCUSSION

This study was aimed at lessening the information gap of how waste can impact the University of Maine during Covid-19. Once the data was collected and analyzed, it was not what I expected. I predicted, because of all of the new disposable equipment, waste amounts would sky-rocket on campus. Although the MSW pick-up results showed no significant difference statistically from 2019 to 2020 in the spring and summer, waste production raised in the fall during the pandemic at the University of Maine. The waste production in the fall showed a significant statistical difference between 2019 and 2020. I believe that this may be because of the increase in the amount of disposable packaging and single-use waste on campus in the fall. During the spring and summer, there were not a large amount of students and faculty on campus because of online schooling. In the fall, students could return to campus and live residentially safely, although there were still some online classes. With this change came more use of disposable masks, gloves, packaging for food, and food waste. Therefore, an increase in the amount of MSW produced compared to the spring and summer resulted. This is an important aspect that the data became significant after time; showing that the pandemic had an impact on the amount of waste produced on campus. Accordingly, the MSW data does show an increase in the amount of waste produced per person. The survey also shows an overall concern for the waste production increase during the pandemic as well as waste being a concern to the University and the environment as a whole.

The results of the various waste amounts collected from University of Maine's Facilities Management indicated decreases in every category: MSW, single-stream, electronics, metals, demo debris, and compost. All categories other than MSW decreased

by more than half in 2020 compared to 2019. Looking at each category, we find an explanation for each decrease. Single stream decreased by more than half, partially due to the fact of the population on campus and with the stop of recycling. Although overall total enrollment increased from 2019 to 2020 from 11,561 students to 11,741, the number of people on campus decreased. On-campus occupancy and the number of people employed by the campus went down as seen in Table 2. Also, though the campus still had a large number of employees, most worked from home due to the pandemic. With that information, less recycling of single-stream possibly occurred because of fewer people and the campus did not recycle completely due to COVID-19 and the recycling plant. Electronic waste had an extreme decrease, most likely due to the campus closure with a slow reopening of people on campus. Metals and demo debris have a possible similar reason with the campus not having nearly as much as usual going on. These are speculative, but the COVID-19 waste increase study, the Toronto study, and findings in the University of Maine article, support these possible reasons (Hantoko, Li, Pariatamby, et al., 2021) (Ikiz, Maclaren, Alfred, et al., 2021). There were not large construction projects, demolition, and similar large-scale plans. Without these going on, there was not a large production of metal and demo debris waste. For compost, the decrease is also explained by the fact there were not enough people on campus to produce the same amount of food waste that goes towards compost.

The MSW decreased the least out of all of the categories of waste. This was also seen in the Toronto study due to the increase of facemasks and packaging (Hantoko, Li, Pariatamby, et al., 2021). In Toronto, other wastes didn't change as much, such as electrical products and transportation products. However, like in my study, MSW was of

the biggest concern due to more disposables. Though there was a decrease in the raw data on the amount of waste produced, there was an increase in the amount of MSW produced per person on campus. Fewer overall people on campus, yet an increase in waste produced per person occurred. This is most likely due to the number of disposable items that are used during the pandemic for sanitary and protective measures. Some of these items include masks, gloves, other PPE, take-out boxes, online order waste, and many others. Bournemouth University in the United Kingdom experienced similar results in a study they conducted (Filimonau, Archer, Bellamy, et al., 2021). The Bournemouth study investigated the difference in the University's carbon footprint during normal campus procedures compared to online classes. The result found that the University did have a decrease in carbon emissions just at the physical campus. However per capita/day usage of carbon remained around the same. The per capita usage is the same on top of the lower carbon emissions of the campus, resulting in a higher total carbon footprint. Although carbon footprint and exact MSW production are not the same; it is similar showing how the COVID-19 pandemic has affected sustainability and the environment as a whole. This increase of carbon footprint is important in comparison to my study as it also showed an increase in the amount of MSW production with the pandemic.

The survey conducted resulted in 218 respondents providing their opinions on waste and waste management. Overall, the respondents believe waste and waste management are affecting the environment and the University of Maine. Also, the results showed that the majority of respondents believe that the COVID-19 pandemic has impacted waste produced in the country and at the University of Maine. Almost 80% of respondents were students, which implies the students being concerned about waste on

their own college campus. Another study conducted at Gordon College yielded similar results with students (Asio, 2021). The Gordon study was conducted through a survey of the University's higher academically performing students who had a 85-89% grade point average that was labelled as "good". These students were aware of the different environmental consumptions and waste recycling during the pandemic. Also concluded through the survey was that the students at Gordon College were still conducting proper environmental care measures, even during the COVID-19 pandemic. These measures included correct trash disposal/sorting and recycling. Their perception of how to care for the environment was not largely changed by the pandemic. This is similar to the results of my study by seeing that students are knowledgeable and informed about how waste affects the environment. My study did show an increase in what respondents produce as waste during the pandemic. The result of my survey did show an overall belief that COVID-19 increased their waste production. This is also seen in another study on household waste in Toronto, Canada (Ikiz, Maclaren, Alfred, et al., 2021).). Household waste saw an increase of 5% and recycling increased by 2%. The residential area that was in the study also saw an increase of difficulty with managing their waste due to the pandemic and not wanting to be at risk for exposure. The majority of the residents did however note that they saw an increase in the garbage waste stream (Ikiz, Maclaren, Alfred, et al., 2021). The study also cited similar findings in other countries. In England, over 90% were reporting a higher than usual garbage amount with an increase of 75% in food waste. In Moroccan and Tunisian households, a decrease in the frequency of shopping suggests more food waste (Ikiz, Maclaren, Alfred, et al., 2021). These studies through other countries support the notion that respondents saw an increase in waste

production due to the COVID-19 pandemic. This is also supported by my survey with respondents that stated a noticeable increase in the short-answered response question.

Examining the last few questions on the survey focuses more on the household waste production of the respondents. Respondents believed that COVID-19 influenced take-out meals, online shopping orders, and the overall amount of waste they produced as a total. The majority of respondents' opinions were that the amount of household waste they were producing increased because of COVID-19. These respondents were mostly students, which with the further investigation could be determined if there is a correlation between being a university student and having a certain perception of waste. However, this is not always the case with awareness of waste and waste management. As mentioned previously, Bangalore City in India has an overall awareness of household waste and proper waste management techniques to be more sustainable (Kumar, 2013). But without the right guidelines, waste management is not where it could be if this information was widespread. Without proper guidelines for daily waste producers, such as what can be recycled and what can not be, there is still a knowledge gap. The knowledge gap was also noted by many respondents in the survey. There were multiple suggestions for more information on the campus on what can be recycled and what can not be. This knowledge gap here, like in other places, can be decreased with more information readily available to people. This information could include, but is not limited to, types of waste that can be recycled or disposed of, ways to lessen the amount of waste we produce, and how to properly dispose of all types of waste.

My study was helpful in understanding how a pandemic affects waste on the University of Maine campus and how it affects the community's perception of waste and

waste management. Of course, a study has limitations. One which is the time frame to collect and analyze data due to the process of an Honors thesis. In the future, given the longer time frame of another year, the collection and analysis of data from 2021 would be possible. The conclusions of the work might have been more constructive in how to better waste management on the campus if there was more substantial data such as which building created what amount of waste and more detailed information on the campus usage. The option of what building created what waste was limited due to the data already being collected by the Facilities Office. For campus usage, it would have been more informative if the amount of all people on and off campus could be known. This was another limitation of the study, not being able to track exactly who was on and off campus. The numbers stated in Table 2 were all that was kept track of on the campus. It is limiting because the results are not as informative as they could be if it was known the exact number of students taking in-person classes and the amount of faculty on campus were known. If that data was available, a more in-depth analysis of the types and amount of waste coming from each building could have been investigated, as well as, how the pandemic may have affected that. Another limitation is the data of the amounts of waste. For further study, an in-depth breakdown of the different types and amounts of waste over time could lead to a better understanding of what was affected by the pandemic. Such as in-depth breakdown was limited in this study due to the data not being collected directly. The MSW data was already broken down by the exact pick-up date and the amount. If it were to be done again, the location of the waste by building, type of the waste, and amount of waste would be informative. The outreach of the survey is another possible limitation. The survey received 218 respondents however; the University of

Maine has a lot more people involved on the campus than that. With more time, more than social media outreach and direct emails could have been sent to obtain more results. These responses could potentially have a bias as well, due to being educated college students and faculty around the same University.

Lastly, the study has limitations due to the pandemic surrounding us. If it were possible, outreach could have been conducted in person. Printed versions of the survey could have been directly handed out to students and employers. But the entire study had to be conducted online/virtually, that could not be done. However, though there are limitations with a pandemic, it is also a unique part of this study. Being able to collect and analyze data around an event while the event is continuing around us is uncommon. Doing so gives a different perspective of the study and an opportunity to become especially immersed in the work.

Another goal for potential future research would be to not solely investigate the University of Maine, but possibly the entire University of Maine System. Looking at all of the schools would give further insight into how the pandemic affected schools in different areas of the state of Maine. It would also give further data on the perception of waste in different areas of the state as well. It would be interesting to compare and see how the pandemic affected the University of Maine System with the direct amount of waste and opinion upon it. With those results, suggestions could be made to the University of Maine System to improve waste production and waste management strategies. Some possible suggestions could be how to improve waste management by a waste characterization study. This study could inform us as to what types of waste are coming out of certain places. The characterization study results would then help generate

suggestions on how to better waste production and management depending on the area on campus. Another suggestion would be to help inform the University of Maine campus as to what should be disposed of versus recycling. The CRM and Casella representatives stated that there is still a large amount of not properly sorted wastes during COVID-19 (Abromovich, 2021). With information to the University of Maine community, better sorting could be done. With these, the University of Maine could better waste production and waste management as a whole and during a pandemic.

CONCLUSION

The entirety of this investigation gave important insight and results to the University of Maine community. Every waste stream on the campus other than MSW decreased production by over 50% in 2020 compared to 2019. The MSW decreased the least of all categories and had an increase of production per occupant on campus from 1.24 lbs to 1.66 lbs. It is concluded that the MSW data between 2019 and 2020 is not fully statistically significant, though is significant in the fall and in regards to the campus and the world around us. The survey found that the University of Maine community believes that waste is a concern to the University and the country as a whole. The survey also relayed that the respondents believe that the COVID-19 pandemic has affected the amount of waste they produce. This information gathered could be used in future studies to determine how the COVID-19 pandemic impacted universities and the surrounding communities on a wider scale.

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APPENDIX A: Tables and Figures

Table 1. Weight (lbs) of Different Categories of Waste in 2019 and 2020

Source	**Weight produced in 2019 (lbs)**	**Weight produced in 2020 (lbs)**
Municipal Solid Waste	1,623,809	1,536,581
Single Stream	777,680	314,220
Electronics	17,557	6,629
Metals	288,100	39,000
Demo Debris	926,700	451,960
Compost	320,400	126,500

Table 2. Numbers of People Affiliated with the University of Maine

Category	**2019**	**2020**
Total Enrollment	11,561	11,741
Total Employees	2,437	2,372
On-Campus Occupancy	August - 3,452	January - 3,133 August - 2,697 November - 2,550

Table 3. Results of MSW on Campus

MSW	2019	2020
Total Weight (lbs) from March 13 - November 20	1,240,689	1,070,760
Average Weight (lbs) Per Pick-Up	13,485	14,088
Average Weight (lbs) Per Day	4,923	4,249
MSW Produced (lbs) Per Person On-Campus Occupancy	1.24	1.66

Table 4. Results of Hazardous Waste Data

Category of Waste	2019 Amount	2020 Amount
Universal Waste	10,101 lbs in 64 shipments	7,290 lbs in 45 shipments
Hazardous Waste	42,973 lbs in 212 shipments	14,989 lbs in 167 shipments
BioWaste	528 boxes	243 boxes
Total Cost for BioWaste Boxes	$ 42,415	$ 14,580
Average Cost per Month for BioWaste Boxes	$ 3,535	$ 1,215

Table 5. T-Test: Two-Sample Assuming Equal Variances of MSW Data from Spring 2019-2020 on Campus

	Variable 1	*Variable 2*
Mean	13627.3452	12357.7778
Variance	13858968	6977312.42
Observations	31	18
Pooled Variance	11369858.5	
Hypothesized Mean Difference	0	
df	47	
t Stat	1.27056616	
P(T<=t) one-tail	0.10506824	
t Critical one-tail	1.67792672	

P(T<=t) two-tail	0.21013648
t Critical two-tail	2.01174051

Table 6. T-Test: Two-Sample Assuming Equal Variances of MSW Data from Summer 2019-2020 on Campus

	Variable 1	*Variable 2*
Mean	12345.656	11842
Variance	14699819.8	7935322.11
Observations	25	20
Pooled Variance	11710855.7	
Hypothesized Mean Difference	0	
df	43	
t Stat	0.49058972	
P(T<=t) one-tail	0.31310547	
t Critical one-tail	1.6810707	
P(T<=t) two-tail	0.62621094	
t Critical two-tail	2.0166922	

Table 7. T-Test: Two-Sample Assuming Equal Variances of MSW Data from Fall 2019-2020 on Campus

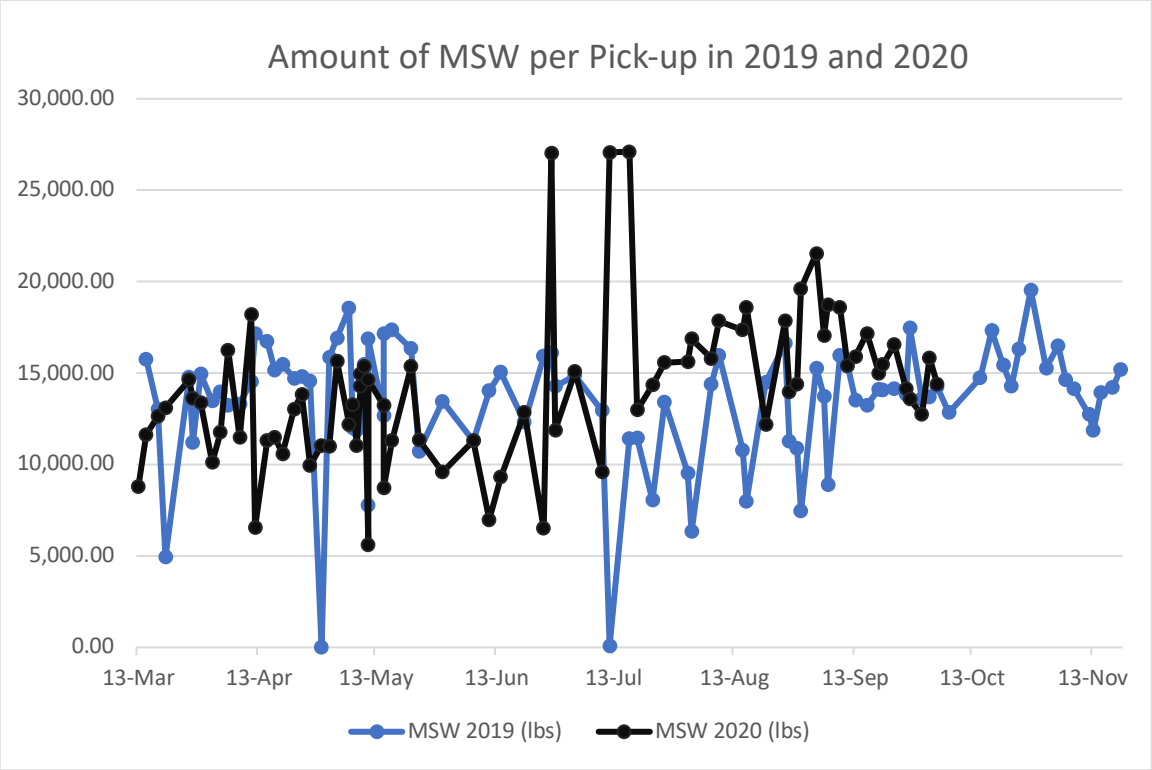
	Variable 1	*Variable 2*
Mean	14181.7143	16091.5789
Variance	5280220.5	19058154.2
Observations	35	38
Pooled Variance	12460270.5	
Hypothesized Mean Difference	0	
df	71	
t Stat	-2.3094217	

P(T<=t) one-tail	0.01191654
t Critical one-tail	1.66659966
P(T<=t) two-tail	0.02383308
t Critical two-tail	1.99394337

Table 8. Analysis Results of Survey Questions 2-10

Survey Questions – Answers on a Scale of 1-5 (1 being decreased or definitely no) (5 being increased or definitely yes)	**Mean**	**Standard Deviation**	**Variance**
2 – Belief of much waste affects the environment	1.09	0.47	0.22
3 – Should waste and recycling be a concern to the University of Maine	1.19	0.57	0.33
4 – Belief of where the most waste was produced on campus	2.81 (Dining Hall)	0.75	0.57
5 – COVID-19 impacting overall amount of waste in the country	1.50	0.64	0.42
6 – COVID-19 impacting the amount of waste on University campus	3.61	1.13	1.28
7 – Belief of how much respondents think about the daily waste they produce	2.21	1.15	1.33
8 – How did COVID-19 impact amount of take-out meals	3.42	1.07	1.14
9 – How did COVID-19 impact amount of online shopping	3.66	0.83	0.68
10 – How did COVID-19 impact waste produced daily of respondent	3.74	0.93	0.86

Figure 1. Amount of Waste (lbs) Per Pick-Up Throughout 2019 and 2020



APPENDIX B: IRB Approval Letter

APPLICATION COVER PAGE

- ***KEEP THIS PAGE AS ONE PAGE – DO NOT CHANGE MARGINS/FONTS!!!!!!!!!***
- ***PLEASE SUBMIT THIS PAGE AS WORD DOCUMENT***

APPLICATION FOR APPROVAL OF RESEARCH WITH HUMAN SUBJECTS
Protection of Human Subjects Review Board, 400 Corbett Hall

(Type inside gray areas)
PRINCIPAL INVESTIGATOR: Alexis Welch **EMAIL: alexis.welch@maine.edu**
CO-INVESTIGATOR: **EMAIL:**
CO-INVESTIGATOR: **EMAIL:**
FACULTY SPONSOR: Allison Gardner **EMAIL: allison.gardner@maine.edu**
(Required if PI is a student):
TITLE OF PROJECT: Covid-19 and its Effects on Waste at the University of Maine
START DATE: **PI DEPARTMENT: Biology**

STATUS OF PI: FACULTY/STAFF/GRADUATE/UNDERGRADUATE Undergraduate (F,S,G,U)

If PI is a student, is this research to be performed:

- ☒ for an honors thesis/senior thesis/capstone?
- ☐ for a doctoral dissertation?
- ☐ other (specify)
- ☐ for a master's thesis?
- ☐ for a course project?

Submitting the application indicates the principal investigator's agreement to abide by the responsibilities outlined in Section I.E. of the Policies and Procedures for the Protection of Human Subjects.

Faculty Sponsors are responsible for oversight of research conducted by their students. The Faculty Sponsor ensures that he/she has read the application and that the conduct of such research will be in accordance with the University of Maine's Policies and Procedures for the Protection of Human Subjects of Research. REMINDER: if the principal investigator is an undergraduate student, the Faculty Sponsor MUST submit the application to the IRB.

Email this cover page and complete application to UMRIC@maine.edu

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FOR IRB USE ONLY Application # 2021-04-09 Review (F/E): E Expedited Category:
ACTION TAKEN:

- ☒ Judged Exempt; category 2 Modifications required? Yes Accepted (date) 5/8/2021
- ☐ Approved as submitted. Date of next review: by Degree of Risk:
- ☐ Approved pending modifications. Date of next review: by Degree of Risk:
  Modifications accepted (date):
- ☐ Not approved (see attached statement)
- ☐ Judged not research with human subjects

FINAL APPROVAL TO BEGIN **5/8/2021**
Date

10/2018

APPENDIX C: Survey Questions

Q1. How are you affiliated with the University of Maine?

- Current Student
- Faculty/Staff
- Administrator
- Alumni
- Parent
- Other

Q2. Do you believe waste and waste management affect the environment?

- Definitely Yes
- Probably Yes
- Might or Might Not
- Probably Not
- Definitely Not

Q3. From your perspective, should waste management, including recycling, be of concern to the University of Maine?

- Definitely Yes
- Probably Yes
- Might or Might Not
- Probably Not
- Definitely Not

Q4. Where do you believe the most waste on campus was produced in 2019 (pre Covid-19)?

- Cutler Health Center
- Residence Halls
- Dining Halls
- Academic Buildings
- Sporting Facilities (including sporting events)

Q5. Do you believe Covid-19 has had an impact on the amount of waste produced overall in the country?

- Definitely Yes
- Probably Yes
- Might or Might Not
- Probably Not
- Definitely Not

Q6. On a scale of 1-5, how much do you believe Covid-19 has had an impact on the amount of waste produced on the University of Maine campus?
1 represents decreased a lot; 3 stayed the same; 5 increased a lot

- 1
- 2
- 3
- 4
- 5

Q7. Do you personally think about the amount of daily waste you produce?
Definitely Yes

- Probably Yes
- Might or Might Not

- Probably Not
- Definitely Not

Q8. On a scale of 1-5, how did Covid-19 impact the amount of take out meals you ordered per month?
1 being decreased a lot; 3 stayed the same; 5 increased a lot

- 1
- 2
- 3
- 4
- 5

Q9. On a scale of 1-5, how did Covid-19 impact your proportion of online shopping compared to shopping in store?
1 being decreased a lot; 3 stayed the same; 5 increased a lot

- 1
- 2
- 3
- 4
- 5

Q10. On a scale of 1-5, how did Covid-19 impact the total waste you produce weekly? (For example; disposable gloves, masks, takeout boxes, amazon boxes, plastic bags)

- 1
- 2
- 3
- 4
- 5

Q11. OPTIONAL open-ended question: Do you think waste is an issue on campus and in our country? What do you think a possible solution is? Any other thoughts/comments are welcome

AUTHORS BIOGRAPHY

Alexis Welch was born on July 19, 1999 in Calais, Maine. Her family moved to Boothbay Harbor at the age of 10. She attended all four years of high school at Boothbay Region High School. She then attended the University of Maine, where she is now a fourth-year undergraduate student, majoring in Biology with a concentration in Pre-Medical Studies. She is also a member of the Honors College. Following her undergraduate degree completion, she plans to take a year off to prepare for her next venture at a soon-to-be determined graduate program.