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Dear Reader,

We are proud to introduce the second edition of the MESH Magazine. MESH (Master's of Engineering, Sustainability, and Health), is a higher education program through the University of San Diego. The program maintains a deep focus on encouraging a multi-disciplinary approach to many of the problems the world faces today. The coursework took students on a journey through sustainable water, food, and energy as well as through the topics of waste, environmental justice, and just transitions, and challenged us to see how these systems are all intertwined. By acknowledging the interconnected nature of systems in our world, we've come to understand how the factors contributing to issues today are vast and complex, and such problems require thoughtful and comprehensive solutions. Such solutions are easier to develop when differing perspectives are taken together through collaborative, interdisciplinary approaches, highlighting the urgent need for boundary spanners in our world today. This coursework culminated into a final capstone project for each student, which focused on a specific topic of the student's choosing within one, or many of the coursework categories, and challenged students to approach questions with a beginner's mindset: how can we recognize and unlearn preconceived notions to better see what is in front of us?

The cohort for this issue comprised of six graduate level students of different disciplines, backgrounds, and geographies. Our diversity provided a strong foundation for formative discussion and unique perspectives, allowing us to appreciate the value and necessity of collaborating with others from various experiences to form thoughtful/extensive solutions. Though the program was online, an emphasis on discussion, collaboration, and teamwork created a space where ideas and opinions were encouraged, and insights and experiences from our own local communities could be shared to paint a larger picture in our collective understandings. These were consistently met by the rest of the cohort with curiosity and an understanding that each individual provided a perspective that was unlike their own.

The following text presents each of the six cohort member's capstone projects. The goal of presenting the papers in this format is to first and foremost honor the exploratory work of the group over the last nearly two years. By sharing our projects, we hope to give you a glimpse into the journey we've each taken to "mesh" the various considerations to be taken into account in case studies and circumstances in our surrounding world. We welcome you to look through our thought processes and learning experiences through our projects and hope this may even serve as inspiration to consider becoming a more involved citizen in your own living community.

MESH Magazine Vol II Editorial Team

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Examining Barriers to Community Gardens in San Diego County: An Analysis of Perspectives from Four San Diego Community Gardens.



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Abstract

Nutrient insecurity is a prominent issue in many communities across the country and throughout the world. San Diego County is one of those areas, with 1 in every 4 of its residents qualifying as nutrient insecure. While there are a large number of supportive services and organizations working to combat the unequal access to nutrient dense food, the sheer number of individuals experiencing this insecurity highlights the need for a drastic restructuring of our food system. This study aims to explore the role community gardens can have in increasing access to nutrient dense foods by developing more localized, accessible, and sustainable community growing spaces. This paper investigates the barriers to the development of community growing spaces in San Diego County and compares these barriers to those existing in other areas across the country. Relevant data is collected by conducting semi-structured interviews with multiple community garden board members in various geographic and demographic areas throughout the county. This interview data and the data collected by the literature review was then compared in an analysis to uncover dominant themes regarding community garden barriers across all data sets. This thematic analysis revealed interview results congruent with the results of the literature review studies. The comparative analysis of the collection of this data highlighted the most prominent barrier as being government support/policy, followed by land access, water, cost, and the lowest perceived barriers being garden insurance, community support, and technical training. These results outline similarities between the primary barriers to community growing spaces and urban agriculture across the country, as well as specifically within San Diego County. This information can be used to explore ways to reduce these barriers and create more land, resources, funding, and government support for these multi beneficial projects in San Diego County.

Introduction

Every human being needs specific nutrients for optimal bodily function, but in many places across the globe, access to these nutrients are limited or entirely non-existent. In San Diego County, 1 in 4 people are nutrient insecure, but this insecurity is not distributed among individuals equally ([San Diego Hunger Coalition, n.d.](#)). Black, Indigenous, People of Color (BIPOC) are significantly more at risk of being or becoming nutrient insecure due to structural inequalities, the impacts of redlining, and numerous injustices in our food and governing systems ([SD Food Vision 2030, 2021](#)). We will discuss these inequities in depth throughout this paper as we analyze the barriers that exist between BIPOC and low-income communities, nutrient security, and community growing spaces.

It is important to note that food security does not necessarily equal nutrition security or vice versa. Many nutrient insecure communities have access to highly processed foods, fast foods, and other empty calorie foods. Empty calories are derived from solid fats and/or added sugars which increase calories and satiate hunger but have little to no nutritional value. Examples include cakes, cookies, donuts, sodas, energy drinks, ice cream, sausages, hot dogs, bacon and most fast food ([MHealthy Nutrition and Weight Management Program, 2012](#)). Unfortunately, these foods are often some of the most shelf stable, inexpensive, and accessible forms of food for many people, especially underrepresented communities. Over the last twenty years the number of deaths related to obesity has tripled in the United States and over 42% of the population are currently considered obese ([American Heart Association, 2023](#)). Research suggests that there is a correlation between the increased production and consumption of highly processed empty calorie foods and obesity (American Heart Association, 2023). Our current food system is broken and marginalized communities that have been historically underserved are the most vulnerable to the dangers associated with neighborhoods devoid of access to nutrient dense foods like fruits and vegetables. Improving access to these foods in a socially just and equitable way is vital to combating the epidemic of communicable and noncommunicable diseases experienced in underrepresented communities.

While there are a large number of supportive services and organizations working to combat the unequal access to nutrient dense food, the sheer number of individuals experiencing this insecurity highlights the need for a diverse collection of approaches to reduce nutrient insecurity and a drastic restructuring of our food system. This restructuring must be rooted in social and distributive justice aimed at empowering the communities who have been disproportionately impacted by systemic racism, redlining, and inequality. This paper will outline the role community gardens play in improving our local food system by improving nutrient security while empowering communities and individuals who have been historically marginalized. Failing to address the injustices contributing to marginalized communities' limited access to nutrient dense foods, green spaces, community gardens, and political capital may perpetuate these injustices and exacerbate food insecurity and the associated health disparities.

The purpose of this paper is to analyze the multitude of barriers to nutrient security and community gardens by utilizing qualitative and quantitative data collected through ethnographic note taking, conducting semi-structured interviews, reviewing existing literature, and analyzing various forms of secondary data. The themes uncovered by the semi-structured interview process align with the barriers outlined in the literature reviewed for this project including issues related

to secure access to land, high cost and lack of funding, liability insurance, gaining access to water, lack of municipal support and clear policy, and difficulty navigating local regulations ([Diaz, et al., 2018](#); [Castillo, et al., 2013](#); [Cohen & Reynolds, 2014](#)). The conclusion of this study will argue that the primary barriers to community garden development need to be addressed at a local government level. Initiatives to develop these spaces are met by a multitude of barriers that could be reduced by improved local government support, clear policy, supportive services, and equitable access to political capital.

Literature Review

The term “food desert” has been widely used to describe areas with limited access to affordable and nutritious foods like fresh fruits and vegetables. In the United States, these areas tend to be located in both urban and rural low-income neighborhoods. The [USDA](#) defines a food desert as an area with low-income and low-access, specifying that low-income is equal to or greater than a poverty rate of 20 percent or a median household income below 80% of the statewide or metropolitan area median family income ([Ploeg et al., 2011](#)). Low-access is outlined as an area where at least 33% of the population and/or 500 people live 1 mile or more from the nearest grocery store (Ploeg et al., 2011). Individuals living in food deserts who experience limited to no access to nutrient dense produce and other healthy foods are more likely to experience a host of negative health outcomes. This includes but is not limited to malnutrition, nutrient deficiencies, diabetes, obesity, heart disease, hypertension, and cardiovascular disease ([National Research Council, 2009](#)). Each of these health conditions could exist individually or as a collection and could also contribute to the development of other communicable and noncommunicable diseases. While these factors are two of the primary factors influencing nutrient insecurity, this definition neglects to acknowledge the role racial prejudice plays in access to food. A handful of studies have pointed out the links between race, ethnicity, and inequitable food access and the consequent health disparities ([Stowers et al., 2020](#); [Baker et al., 2006](#); [Morland et al., 2002](#)). According to an article published by the *American Journal of Preventive Medicine* titled [Neighborhood characteristics associated with the location of food stores and food service places](#), there are more supermarkets and gas stations in wealthier neighborhoods, there are 3 times fewer places to drink alcohol in the wealthiest compared to the poorest neighborhoods included in the study, and there are 4 times more supermarkets in white neighborhoods compared to black neighborhoods (Morland et al., 2002). A different study exploring racial differences in perceived food deserts as they relate to dietary habits brings forward another important term, “food swamps” (Stowers et al., 2020). According to the [article](#), a food swamp is an area where unhealthy, cheap, subsidized, over processed food is the most easily accessible source of sustenance (Stowers et al., 2020). While this article goes on to address the role race, ethnicity, geographic location, and socioeconomic status have on food access, there is one final definition that needs to be included in this discussion. Karen Washington, a farmer and food justice advocate working in New York City coined the term, “food apartheid.” On her [website](#) she encourages readers to consider the “root cause of inequity in our food system on the

basis of race, class, and geography,” highlighting the unwavering accessibility of healthy food in wealthy neighborhoods and the absence of those same foods in poor neighborhoods ([Karin Washington, n.d.](#)). Lastly, Washington underscores the role that decades of discriminatory planning and policy decisions has had on our food system (Karin Washington, n.d.). For the remainder of this paper I will be utilizing the term food apartheid and will discontinue the use of the phrase “food desert” unless it is in the title of an article being referenced or it is located within a direct quotation. It is my intention to push against the dominant narrative being perpetuated by the utilization of the verbiage “food desert,” as I agree with the perspectives shared by Karin Washington. It is my hope that this paper will positively contribute to the literature that supports the development of community growing spaces rooted in social justice to empower the communities being impacted by food apartheid.

“The word “desert” also makes us think of an empty, absolutely desolate place. But there is so much life, vibrancy, and potential in these communities.”

-Karin Washington

In conjunction with restricted access to healthy foods, low income and marginalized communities are more likely to experience limited access to active living and health infrastructure like parks and playgrounds, green spaces, and nature trails ([Nicoletti et al., 2022](#)). Access to green spaces is associated with “increased physical activity, physical or mental restoration and reduced stress, higher social capital, and ecosystem services, such as better air quality, less traffic noise, less heat-island effects, and more biodiversity” ([Rojas-Rueda et al., 2019](#)). The development of community gardens in areas lacking access to all of these resources could dramatically improve the overall health and wellbeing of individual participants while simultaneously improving community resilience, ecosystem health, and mitigating the impacts of climate change. A study published by the [International Journal of Behavioral Nutrition and Physical Activity](#) outlined the evidence suggesting a connection between community garden participation and increased consumption of fruits and vegetables ([Barnidge et al., 2013](#)). The study results indicated that individuals frequently participating in community gardens reported “eating food that is fresher (less packaged food), spending less money on food, being better able to provide food for family and self, eating less fast food, caring more about the environment, and feeling better about where one’s food comes from” (Barnidge et al., 2013). In addition to these individual benefits, community gardens can benefit entire communities by acting as third places. Urban sociologist Ray Oldenburg identifies third places as gathering spaces outside of home (place 1) and work (place 2) where individuals can interact with others, offer each other support, promote social equity, and provide habits of public association ([Project of Public Spaces, 2008](#)). Community gardens are third places where community members can come together to socialize, learn from each other, grow together, share with one another, and be together. In order for communities to have access to all of these benefits, the barriers impacting community garden

development and access must be addressed and removed. The first step to this process is uncovering what the most prominent barriers are and outlining possible solutions to said barriers.

Barriers to Community Gardens

In this section of my literature review, I will outline three different studies that were conducted with the aim of building a consensus surrounding the primary barriers to community gardens and urban agriculture in Florida, Chicago, and New York City. The first article I will be discussing is [*Barriers to community garden success: Demonstrating framework for expert consensus to inform policy and practice*](#) by John M. Diaz, Susan T. Webb, Laura A. Warner, and Paul Monaghan. This article outlines a study conducted using the Delphi technique to form a consensus surrounding the primary barriers to community garden formation and maintenance in Florida. The second article I will be discussing is [*Regulatory and other barriers to urban and peri-urban agriculture: A case study of urban planners and urban farmers from the greater Chicago metropolitan area*](#) by Sheila Castillo, Curtis R. Winkle, Stephen Krauss, Amalia Turkewitz, Cristina Silva, and Edie S Heinemann. This study defines seven perceived barriers to urban and peri-urban agriculture in the metropolitan area of Chicago. Lastly, the third paper I will be discussing is [*Resource needs for a socially just and sustainable urban agriculture system: Lessons from New York City*](#) by Nevin Cohen and Kristin Reynolds. This study also aims to understand the barriers to urban agricultural development and outlines a number of similar barriers as the other studies. However, this study also highlights a gap in literature, specifically aimed at researching and addressing the racial, gender, and socio-economic barriers that are contributing to the unequal distribution of the necessary resources for community garden and urban agriculture development.

Barriers to community garden success: Demonstrating framework for expert consensus to inform policy and practice.

This [study](#), designed and developed by John M. Diaz and his colleagues, utilizes the Delphi technique to better understand the core set of barriers existing for community gardens during the establishment period and maintenance of gardens. The authors highlight the importance of recognizing that these barriers will vary greatly depending on geographic location, policy, and access to resources. However, one of the group's main objectives was to determine whether a core set of barriers existed across the geographic locations included in the study. According to the article, the Delphi technique is a "research-based approach used to solicit, collate, and direct responses to achieve consensus among a group of experts and has been cited as an effective means for structuring a group communication process so that the process is effective in allowing a group of individuals to address a complex situation" ([Diaz, et al., 2018](#)). The technique utilizes multiple feedback cycles that allow participants to reassess their initial judgments and perspectives as they move from phase to phase. The study uses this technique by interviewing a panel of garden stakeholders from across the state of Florida. Davis formed an advisory committee consisting of representatives from state agencies, non-profit organizations, institutions of higher education, and various school systems who were asked to create a list of

potential study panel members from various communities, demographics, and types of organizations with varied perspectives (Diaz, et al., 2018). 75 participants were nominated and a total of 53 of the individuals agreed to participate. The participants were from a range of backgrounds including but not limited to educators, administrators, professional development individuals, garden team members, and volunteers (Diaz, et al., 2018). The study identified “lack of available and committed volunteers, challenges in dedicating the amount of time necessary for community engagement, issues of site selection and access, and inadequate community support” as the most prominent barriers present in community garden development and maintenance in Florida. (Diaz, et al., 2018). However, the authors mention that although “a lack of municipal support and difficulties navigating local regulations in addition to challenges associated with garden maintenance was eliminated from further analysis, they should remain a consideration as they have been cited in other research” (Diaz, et al., 2018). The early removal of these barriers was quite shocking to me, largely due to their prevalence in many other pieces of literature. Additionally, lack of municipal support and challenges with policy has been a recurring theme in the conversations I have had with a small collection of farmers and community garden stakeholders in San Diego County. While the study mentions it has pulled participants from a collection of demographics, I question if the barriers outlined reflect one demographic group's views over another. While I am left considering the potential gaps this study has in terms of outlining the most prominent barriers for communities the most in need of support combatting said barriers. I do, however, still think this holistic approach to consensus building resulted in the genuine needs that resonated with a collection of community garden stakeholders across the state of Florida. As I previously stated, these barriers will vary geographically and demographically, but this study outlines a valuable collection of perspectives and a data collection technique that was deeply influenced by community members. Including measures to give value and voice to underrepresented communities is crucially important, as they are disproportionately impacted by nutrient insecurity and simultaneously face barriers to community garden development.

Regulatory and other barriers to urban and peri-urban agriculture: A case study of urban planners and urban farmers from the greater Chicago metropolitan area.

In their [case study](#), authors Castillo, Winkle, Krauss, Turkewitz, Silva, and Heinemann outline seven barriers to urban agricultural development in the metropolitan area of Chicago. The study utilized perspectives collected from a total of 25 urban farmers and 13 urban or county planners. This combination of participants offers insight from both the farming and policy perspectives, but I think this scope is rather limited. Including community garden members, advocates, and even organizations working through the process of getting approval could add valuable insight that is currently missing from this study. The urban farmers who were interviewed for this study came from a collection of farming operations ranging from small community gardens to 500-acre farms ([Castillo, et al., 2013](#)). The study concluded, “the major barriers are a lack of clear and inclusive ordinances, zoning issues, limited land access, costs, access to training and certification, water issues, and insurance” (Castillo, et al., 2013). It is also

important to mention that both urban planners and urban farmers indicated that local policy surrounding urban farming was unclear, unfriendly, and in some cases even unregulated (Castillo, et al., 2013). The large scope of this study, which included 131 municipalities and 244 special districts outlined a large-scale consensus on the major barriers to urban and peri-urban agriculture, left gaps in the research within specific regions, demographics, and socioeconomic groups. I have found a host of large-scale studies, and while I see the value in the data collected from these studies, continuing this research with a narrower geographic region such as a county or city, could result in a better understanding of localized barriers to urban agriculture and community gardens.

Resource needs for a socially just and sustainable urban agriculture system: Lessons from New York City.

I was happy to find this [study](#), as it was one of the first pieces of literature that I have read thus far that has included the unequal distribution of resources as a barrier to urban agriculture and community gardens. The 2-year study conducted by Nevin Cohen and Kristin Reynolds took place in New York City which is home to over 700 food producing community gardens, 117 school gardens, and an increasing number of non-profit and commercial farms ([Cohen & Reynolds, 2014](#)). The study included the majority of the same barriers that were discussed in the two previous studies, however, Cohen and Reynolds not only discussed, but emphasized the need to consider and address the racial inequality that interviewees point out as one of the major barriers to urban agricultural development in communities of color. Several interviewees claimed that “public resources were more difficult to attain by organizations led by people of color, who were often less connected with political leaders and groups with financial resources (e.g., foundations, private donors), or that those resources were simply unavailable to these groups” (Cohen & Reynolds, 2014). Removing these disparities and dismantling the structural forms of racial, gender, and economic oppression the unequal distribution of these resources perpetuate is crucial to create an equitable and sustainable urban agriculture system. One aspect of this research paper that I appreciated was the last section which included recommendations for supporting socially just and sustainable urban agriculture. Addressing the resource disparities previously mentioned was one of the major components to this section and was also very relevant to my case study.

Throughout this paper I will use this literature to conduct a comparative analysis of the perceived barriers outlined throughout each of these studies in contrast to the results of semi-structured interviews conducted with four community garden board members located in different geographic regions throughout San Diego County.

Methods

A variety of methods were used during this case study including the collection of qualitative and quantitative data through ethnographic note taking, conducting semi-structured interviews,

reviewing existing literature, and analyzing various forms of secondary data. In each of the following sections I will discuss the way each of these methods were utilized to create a robust collection of datasets to address the research question and enhance the overall understanding of the intersectionality of nutrient insecurity, community gardens, food justice and sustainability.

Field Notes at Wild Willow

Early in this project I started interning at [Wild Willow Farm and Education Center](#) in San Diego to gather information, technical skill, and a better understanding of sustainable food systems and regenerative agriculture principles. During the internship I collected data using ethnographic [field notes](#), in the form of journal entries, photographs, and illustrations. Throughout my time at Wild Willow various individuals educated me about a collection of key stakeholders who are active participants in the food justice movement in San Diego County. Interning here allowed me to gather information about technical farming skills and the ecological benefits of sustainable growing practices, but also increased my knowledge about other local food justice organizations like [Project New Village](#) and [The San Diego Food Systems Alliance](#), farms like [Solidarity Farms](#), [Community Roots Farm](#), [Foodshed Cooperative](#), [Coastal Roots Farm](#), [Pixca Farm](#), and many others, as well as a large collection of community gardens, food access tools like [Find Good Food](#) and numerous workshops. This collection of resources and the many others allowed me to gather a better understanding of the different initiatives, organizations, and resources that are working together to create a more sustainable and equitable food system in San Diego.

Gathering Secondary Data

After gathering information from my time spent at Wild Willow I felt prepared to begin volunteering at various community gardens throughout the county to gather more information about these growing spaces in particular. I spent time at 2 primary community gardens where I gathered further information regarding food justice, community gardens, and nutrient insecurity. During this stage of the project I began collecting data and compiling a list of community gardens located throughout San Diego County. To do this I gathered garden names and locations from various sources including the individuals I was volunteering with at various community gardens, [The San Diego Community Garden Network](#), [San Diego Master Gardeners](#), and [Google Maps](#). During the collection process I ran into a problem regarding the accuracy of the information on the largest list provided, as it had not been updated since 2008. For this reason, I cross referenced the information found on this list with the other sources, as well garden websites when applicable. After the list was completed I began reaching out to various community gardens located in different geographic regions throughout the county. Once I received responses from garden board members I began gathering additional secondary data in the form of nutrient insecurity levels, proximity to the closest produce selling store, and population demographics including race, poverty level, and income, for the city and zip code associated with each garden location. I wanted to ensure the inclusion of a diverse collection of gardens and perspectives

from different nutrient security levels, geographic regions, and demographics. I utilized maps produced by the [San Diego Hunger Coalition](#) to gather data for nutrient insecurity levels in San Diego County, the [USDA Food Access Resource Atlas](#) to gather data regarding supermarket accessibility, and the [United States Census Bureau](#) to gather data surrounding demographics including race and ethnicity, poverty level, and population. I would like to take this opportunity to discuss the very limited lens applied to poverty in this census data. While the primary form of poverty discussed and quantified most often is associated with financial poverty, there are more forms of poverty that are relevant to this study. Reframing the narrative of poverty is valuable in many aspects, but it is incredibly important to consider other forms of poverty that impact people's wellbeing in relation to food access, grocery store access, access to parks and green spaces, and community socialization. [The Poverty Institute of Canada](#) outlines three major forms of poverty including material poverty, social poverty, and spiritual poverty. The organization's website defines material poverty as a lack of material and financial resources, social poverty as a lack of formal and informal support, and spiritual poverty as a lack of meaning and purpose ([Canadian Poverty Institute, 2024](#)). Throughout this paper, I will discuss the different ways community gardens can play a role in improving these various forms of poverty.

This collection of resources has supported my decision-making process regarding which organizations will be included in my interview process and data collection phase. I have conducted 5 semi structured interviews with key stakeholders in community gardens throughout San Diego County to gather data about the most prominent barriers each location has experienced in the past or is currently experiencing. I have chosen a collection of community garden programs with a range of geographic locations, garden design, size, and community demographics to ensure varied perspectives are included in this study. Figure 1 below shows the nutrient insecurity levels throughout San Diego County based on zip code according to data gathered by the [San Diego Hunger Coalition](#).

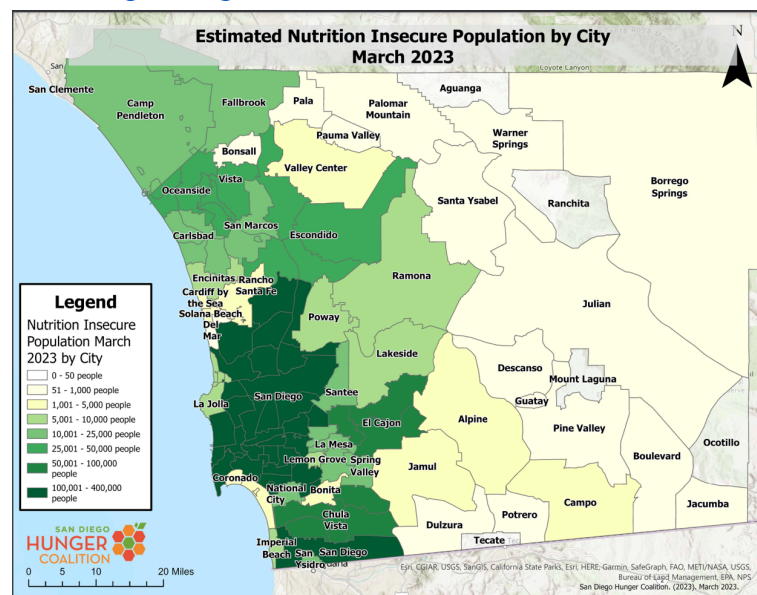


Figure 1. (San Diego Hunger Coalition, 2023)

Reviewing Existing Literature

Reviewing existing literature surrounding the barriers to community gardens and urban farming informed the structure of my interview and supported the overall development of my project. Examining different studies and their subsequent methods offered insight into the relevant forms of data collection, and also provided the necessary data for the comparative analysis I will outline later. While the three studies I included in my literature review had larger geographic regions and data pools, comparing the findings to the barriers collected by the interviews conducted for this project could contribute to the understanding of community garden barriers on a smaller, more localized scale in relation to statewide studies.

Semi-Structured Interviews

After reviewing the existing literature and the interview or survey questions used to collect data in each study, I began building the script for my semi structured interview sessions. In addition to the literature I reviewed, the development of my project was influenced by the epistemological framing known as social constructivism. [Social constructivism](#) is defined as, “the manner in which people or groups socially construct the world of experience and make meaning of it,” and proponents of this epistemological view “seek to understand the world of lived experience from the perspective of those who live it” (Walker, 2012). I was interested in collecting data surrounding the barriers to community growing spaces, but I also wanted to be intentional about including the experience of the individuals I was interviewing. Especially because of the multidimensional nature of the benefits these spaces offer for communities as a whole, as well as individuals. It was my intention to build an interview script that would humanize the process as much as possible, build trust and relationships with participants, and gain insight into individual experiences, views, and interests of each of the participants and the associated community garden. Alongside these interview questions (Table 1), and with the permission of board members, each of the gardens was photographed for photo-documentation purposes. These photos will be shared in the results and discussion sections of this paper.

Table 1

Interview Questions
I am going to start off by asking you to share your name, the organization or garden you are a part of, and your favorite fruit or vegetable to grow and/or eat?
What are the primary benefits of this garden and/or community gardens in general?
Based on your experiences, what do you see as the primary barriers to community gardens?
What do you see as the key challenges to sustaining this community garden specifically?
What policy changes do you think are needed, and how do you expect these changes would

help to reduce or eliminate these barriers?
I am interested in exploring this topic further and want to conduct research that is beneficial to projects like yours. Could you share what research questions and data would be most beneficial for your growing space, and explain their significance?"
What is something you would like to share with the public about this wonderful space and everything happening here?
What can people who want to support projects like this do to get involved?
Finally, I'd like to ask: What is your favorite aspect of this space?
Before we wrap up is there anything else you would like to share?

Data Analysis

I will continue to use a social constructivist theoretical approach to analyzing the data collected throughout my case study as I believe the interpretive nature of the data set will include diverse perspectives and subsequent answers that inform the social reality surrounding community gardens throughout San Diego County. I have had firsthand conversations with a handful of community members thus far during my volunteering and internship, but I think this more structured interview process and analysis will help me form a better understanding of the multitude of barriers these spaces and community members are facing. Leaning into this perspective as I generate my own conclusions will encourage me to be mindful of my own biases as I examine the results of my case study. I will have to once again, return back to a beginner's mind and let the voices of the participants truly inform the conclusions generated by this project. Additionally, utilizing a thematic analysis alongside a content analysis of the interviews will encourage me to consider how the individual community gardens and their members are experiencing barriers differently while forming a consensus on the most prominent barriers within each group (Al-Saraf, 2023). According to [Dovetail](#), thematic analysis is a method of analyzing data that, “involves reading through a data set and looking for patterns to derive themes” (Dovetail Editorial Team, 2023). This form of analysis appears to be the most appropriate for this project as I am seeking to form a consensus surrounding the major barriers and benefits of community gardens. Overarching themes found within datasets in existing literature, as well as in interview data can support the development of this consensus.

I will use an [inductive thematic analysis](#) approach to analyze the data collected from each of the interviews. Inductive thematic analysis is outlined by [Dovetail](#) as, “deriving meaning and identifying themes from data with no preconceptions” (Dovetail Editorial Team, 2023). This process will consist of step by step process of transcribing each of the recorder interview sessions, ensuring the transcription is accurate, creating codes and hand coding each of the interviews, grouping sets of codes into themes, and finalizing subsequent codes, themes, and findings. These codes, themes, and findings will then be used in a comparative analysis,

comparing these results with the results provided by the existing literature and studies included in the literature review section.

Results



(Michelle Wolf, 2023)

Garden #1

Garden #1 includes raised beds, an outdoor classroom, a greenhouse, a native plant garden, a collection of fruit bearing trees and vines, and a community herb garden. One of my favorite parts of this space is the beautiful hand painted bird boxes located throughout the garden. A local resident who took notice of the community garden development wanted to contribute to the space and painted the most amazing bird houses. One of which already has become home to a local bird and their little baby bird. I was lucky enough to participate in a few volunteer days during the construction of this space, and I watched as a plot of flat dirt was transformed into a wonderful community gathering space. One of the most incredible parts of being a part of this process was getting to see first-hand how many local residents were ready and willing to offer support to this project. During the interview, the interviewee mentions their

favorite part of the garden being the rock garden, because it reminds them of all of the different people from the community who came together to make this project work. After or during volunteer shifts, individuals were asked to paint a rock to leave in the garden, so the rock garden they are talking about has a little piece of everyone who volunteered.

Demographics

Nutrient Insecurity

12,964 people	26% of the population
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Income

Median household income	\$94,540
Families	\$106,365
Married-couple families	\$113,274
Nonfamily households	\$56,896

Financial Poverty by Age

Under 18 years	14.6%
18 to 64	11.3%%
65 years and older	13.3%

Financial Poverty Rate

12%

Race / Ethnicity

Total Population	46,686
American Indian and Alaska Native	501
Asian	9,272
Black or African American	2,437
Hispanic or Latino	13,256
Native Hawaiian and other Pacific Islander	205
Not Hispanic or Latino	18,955
Unlisted Race	6,688
Two or More Races	6,372
White	21,211

Data sourced from San Diego Hunger Coalition and United States Census Bureau



(Michelle Wolf, 2023)

Escondido Community Garden

Garden #2 is a beautiful non-profit community growing space that has been in operation for the last 30 years. The space consists of 115 4' by 20' plots that are rented by members for \$60 dollars a year. This dues helps support the maintenance of the garden infrastructure, other projects, tools, garden insurance, and the cost of water when the garden is required to pay it. There is a bathroom located in the garden, a tool shed that is open to garden members, shaded sitting areas, and even a BBQ for special events. The garden is located in an area surrounded by apartment buildings, where some of the community garden members live. Without this space, these individuals would not be able to garden as they have limited access to space, sun, and the necessary resources to grow their own food. The garden has a waitlist of at least 20 people at all times, which indicates that there is a demand to participate in this space.

One of the first things you see when you walk into the garden is a charming seating area nestled under a large tree sitting beside a pollinator garden teeming with life. On the day I visited the garden, the monarch butterflies were in abundance, and I was pleased to see them fluttering so elegantly from flower to flower. In the center of the pollinator garden stands a giant welcome

sign sculpture that is written in the 12 different languages spoken at the garden. During the interview, the interviewee highlighted the multiple ways in which this space reflects the community. Discussing how wonderful it is to see so many people from so many walks of life, from different cultures, demographics, and age groups, coming together to grow food together, share seeds and produce, and learn from one another. As we walked the garden it was amazing to see all of the different foods being grown in so many different ways.

Demographics

Nutrient Insecurity

Entire City	52,782 People
In area code surrounding garden	12,165 People 26% of Population

Income

Median household income	\$87,664
Families	\$90,589
Married-couple families	\$115,169
Nonfamily households	\$61,526

Financial Poverty by Age

Under 18 years	15.1%
18 to 64	10.7%
65 years and older	11.9%

Race / Ethnicity

Total Population	151,038
American Indian and Alaska Native	2,708
Asian	11,974
Black or African American	3,602
Hispanic or Latino	78,226
Native Hawaiian and other Pacific Islander	394
Not Hispanic or Latino	50,693
Unlisted Race	43,817
Two or More Races	25,294
White	63,249

Financial Poverty Rate	11.8%
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Data sourced from San Diego Hunger Coalition and United States Census Bureau



(Michelle Wolf, 2023)

Garden #3

Garden #3 is a community garden that consists of 4' by 10' raised beds, beautiful community flower beds, and a shared herb garden. The entire perimeter of the garden is planted with a combination of California native plants and fruit trees including loquats, limes, and two varieties of mandarin oranges. When they are ripe and ready for picking, these fruits are available for anyone passing by, garden member or not. Like all of the others, this space is full of a diverse collection of people, plants, and wildlife. During this interview, I once again saw the familiar fluttering of the monarch butterflies in the garden. They quickly became a recurring theme throughout each of the garden interviews and tours. One of the key takeaways from this interview was the passion the interviewee and his fellow board members have for creating a space where anyone can learn to grow food, regardless of whether they have a space in the garden or not. The interviewee emphasized the importance of empowering others to learn about growing healthy foods, getting outside, and building community. One of the primary barriers to garden member success in community gardens can be lack of technical skills which can quickly lead to overall garden failure. Garden #2 combats this by offering workshops to community

members and offering support to ensure individuals have all the tools and knowledge they need to successfully grow their own food.

Demographics

Nutrient Insecurity

7,160 People	26% of Population
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Income

Median household income	\$77,833
Families	\$88,750
Married-couple families	\$108,876
Nonfamily households	\$44,533

Financial Poverty by Age

Under 18 years	11.3%
18 to 64	9.5%
65 years and older	10.1%

Financial Poverty Rate **10%**

Race / Ethnicity

Total Population	27,627
American Indian and Alaska Native	377
Asian	2,476
Black or African American	3,337
Hispanic or Latino	12,850
Native Hawaiian and other Pacific Islander	278
Not Hispanic or Latino	7,479
Unlisted Race	6,316
Two or More Races	5,083
White	9,760

Data sourced from San Diego Hunger Coalition and United States Census Bureau



(Michelle Wolf, 2023)

Carlsbad Community Garden

Garden #4 is a 40-year-old community garden that is made up of 65 in ground plots, 39 of the plots are 20' by 30' while the other 26 are 10' by 15'. The annual fee to be a member at this garden is \$120 for Carlsbad city residents and \$350 for non-residents. The organization that runs and operates this garden also manages two other community gardens that are also located on city owned property, and the waitlist for these gardens collectively is over 400 people long. There is obviously a large demand for community gardens and collective growing spaces in the city of Carlsbad, and potentially the surrounding cities as well. Oceanside for example, only has a single community garden and during the interview, I was told that numerous residents from Oceanside have put their name on the waitlist to get a garden plot in one of the gardens. However, because Carlsbad residents are paying taxes in the city of Carlsbad, these residents are given priority for available plots. This outlines a need for the development of programs similar to

the one present in Carlsbad to be repeated in cities like Oceanside. This would require a feasibility study and numerous other measures, but it appears that the demand expands beyond the city of Carlsbad. Every single one of the gardens I interviewed had a constant waitlist.

When I arrived at the garden, I was greeted by yet another collection of monarch butterflies and to my surprise, an abundance of California Poppy flowers. The garden was teeming with life, including birds, bugs, butterflies, flowers, fruit trees, amazing vegetables, sunflowers over 6 feet tall, and a beautiful crochet covered tree. The vibrancy in this space was electrifying, and I couldn't help but smile as I walked up and down each row of garden spaces in awe of the spaces, the plants, but also as I listened to the amazing stories about all of the people growing here.

Demographics

Nutrient Insecurity

Entire City	17,560
In the area code Surrounding the garden	5,664 20% of the population

Income

Median household income	\$146,596
Families	\$176,228
Married-couple families	\$183, 945
Nonfamily households	\$88,168

Financial Poverty by Age

Under 18 years	2.3%
18 to 64	5.8%
65 years and older	10.0%

Financial Poverty Rate	5.6%
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Race / Ethnicity

Total Population	114,746
American Indian and Alaska Native	676
Asian	9,176
Black or African American	1,340
Hispanic or Latino	17,302
Native Hawaiian and other Pacific Islander	215
Not Hispanic or Latino	79,201
Unlisted Race	5,535
Two or More Races	14,540
White	83,264

Data sourced from San Diego Hunger Coalition and United States Census Bureau

Barrier Related Interview Data Collected

After completing each of the interviews, the recorded conversation was transcribed into a text-based document and thematically coded. Codes were created based on prominent themes found in the interview transcript including barriers related to water, land access, cost, insurance, community support, government support, and technical training. Table 2 below shows the color associated with each of the themes that can be seen coded in the interview results (Table 3) as well as the literature review results (Table 4). One of the primary barriers that appeared throughout the existing literature and interview data was government support and clear policy. Because each of these gardens rely on government support to various degrees, each garden was given the option to be anonymized to ensure said government support is not affected by this study. Two gardens chose to remain named; one chose to be anonymous, and the other was made anonymous when a response was not received. Therefore, the interview question responses were randomized and placed together in the table below to remove any potential connection.

Table 2

Water = Blue	Community Support = Purple
Land = Brown	Government = Pink
Cost = Green	Technical Training = Yellow
Insurance = Orange	

Table 3

-Lack of understanding is one of the biggest barriers from government officials. That's the barrier if you can get the first one to show how it's a benefit to the community.
-Cost -Water -Vague Language in instructions / policy from the city / various agencies.
-First, it was trying to find the support from the city that they would even accept the idea. -Liability Garden Insurance / waiver through parks and rec -Water / Agriculture Rate, city pays the water up to a certain amount -Finding the core group of people who are generally interested.
-Land Access -Space, private property could be sold, school/closes during summer -Funding, membership fee, low cost of operations, goal is to not pass on costs to the members. -. Lack of technical gardening training. -Biggest expense is community garden liability insurance

Table 4

Article #1	<ul style="list-style-type: none"> -Challenges with dedicating the amount of time necessary for community engagement -Lack of available and committed volunteers -Issues in site selection and gaining access to appropriate land (location, landowner permission, water access, free of contaminants, bathroom facilities and storage) -Inadequate Community Support
Article #2	<ul style="list-style-type: none"> -Lack of clear, agriculture-inclusive ordinances -Zoning that makes agriculture a special use is overly specific -Limited access to land -High cost and lack of funding -Lack of farmer training and certification -Limited access to water and dealing with water runoff -Finding insurance
Article #3	<ul style="list-style-type: none"> -Growing space (with secure tenure) -Clean soil, compost, and fertilizer -Financial support -Community support -City agency services -Technical assistance

The table below combines all of the results from coding all four of the interviews, in addition to the coding results from each of the articles included in the literature review. Now that all of the themes have been pulled together, it will be easier to build a consensus surrounding the most prevalent themes across all datasets.

Table 5

	Water	Land	Cost	Insurance	Community Support	Policy / City Services	Technical Training
Article #1	X	X			X		
Article #2	X	X	X	X		X	X
Article #3		X	X		X	X	X

Interview						X	
Interview	X		X			X	
Interview	X			X	X	X	
Interview		X	X	X			X
TOTAL	4	4	4	3	3	5	3

Discussion

The themes uncovered by the semi-structured interview process align with the barriers outlined in existing literature including issues related to secure access to land, high cost and lack of funding, liability insurance, gaining access to water, lack of municipal support and clear policy, difficulty navigating local regulations, and community support ([Diaz, et al., 2018](#); [Castillo, et al., 2013](#); [Cohen & Reynolds, 2014](#)). Below, I will discuss each of these barriers in greater detail based on the findings from the comparative analysis as well as the discussions I had during the interview process.

Policy / City Services / Government

In the process of conducting this study, the power and influence city government has over the development and overall success of community gardens became increasingly apparent. This conclusion was influenced by the literature reviewed but also by the interviews conducted with community garden board members. Government related barriers were the single most referenced theme consistent throughout the interviews conducted as well as the literature review. Three of the four community gardens I interviewed mentioned having strong relationships with local government officials and discussed the many ways these relationships helped sustain their spaces. Despite this fact, the most commonly recurring barrier theme was related to policy, government support, and city services. This contradicts the results of the article, *Barriers to community garden success: Demonstrating framework for expert consensus to inform policy and practice* which removed municipal support and difficulties navigating policy as a barrier (Diaz, et al., 2018). While the authors mentioned this barrier had been cited in other research and still should be considered relevant, the removal of this barrier is contradictory to the conclusion made in this paper based on interview data from community garden board members and other existing literature. The interviews conducted with San Diego community garden leaders outlined the importance of combating the prevalence of this barrier, especially in communities experiencing food apartheid and for individuals or organizations that do not have these existing relationships with local governments.

During the interview process, it was also mentioned that while it is understandable that many city agencies have much to do, that there is a lack of understanding of the benefits community gardens have to offer communities, individuals, local environments, and cities.

Spreading awareness about these benefits could not only improve the understanding of these spaces but could also help support the development of city policy that is more clear, concise, and easier to navigate for individuals working to build more of these spaces. The frequency of which interviewees mentioned the necessary support of local government officials indicates an additional need to educate city officials about the benefits of these spaces, develop community garden city support services and local initiatives, create policy that is easier to navigate, and reduce the abundance of barriers to these spaces. While government support may not be the only challenge these spaces face, “a city’s commitment of staff, financial, and in-kind resources is critical to the success of community gardens” (Twiss et al., 2003). In the article [*Community Gardens: Lessons Learned From California Healthy Cities and Communities*](#), the authors point out the necessary government interventions needed to support these projects. This includes, “long-term investments—policymaking, funding, staffing, and acquiring in-kind resources” that “are needed to support planning, implementation, and evaluation” (Twiss et al., 2003). Intentionally developed and social justice based government initiatives and supportive services could effectively reduce the severity of the most prominent barriers to community garden development that will be outlined in the following paragraphs. However, it is important to consider the distribution of access to political capital, government agencies and the services they provide. If community garden development is going to be equitable, the services supporting these initiatives need to be designed to empower the individuals who have been negatively impacted by our current food system. Special care should be taken to ensure that these spaces are designed with the local populations and stakeholders who will be utilizing them. Ethnographic research and community participatory research could be used to gather insight from communities and individuals about what their needs and wants for these projects are.

Land Access

While it was only highlighted as a barrier for one individual garden, each interview discussed the challenges of land access. It was explained in multiple interviews that land access can be a major barrier for individuals and organizations for multiple reasons, which corresponds to an observation made by Castillo et al. regarding land access. In their study, Castillo and his colleagues point out that many of the participants who mentioned land access as a barrier stated it was the biggest challenge they faced (Castillo et al., 2013). It can be challenging to find and lease land with the necessary resources for community gardens and/or urban agriculture including, contaminant free soil, water access, and proper sun exposure (Diaz, et al., 2018). Additionally, acquiring tenure and having land security can be even more challenging than finding the land itself. This can become a devastating problem if property owners decide to sell their land, redevelop, or ask a garden to leave for whatever reason. Developing a community garden requires a significant amount of time, energy, and resources to build the necessary infrastructure, not to mention to establish a functioning and productive garden. Without having land security, all of these resources could be at risk at any time. Therefore, land acquisition is one of the primary barriers to community garden development. However, I learned that each of the

gardens I interviewed were situated on city owned property. After discussing this with the interviewees, it is my understanding that working together with city officials to acquire land that can be rented through the city for a reasonable rate can be a way to ensure the longevity of a community garden. This contributes to the perspective shared by Diaz et al. that, “promoting the development of local policies that alleviate issues of land ownership and facilitate increased access to compatible quality land will provide a larger footprint for possible community gardens” (Diaz, et al., 2018). The gardens I interviewed for this study are an example of why this is so important. Each of these spaces were able to develop and maintain land use largely due to partnerships with or support from local agencies. This collaboration can also alleviate another major barrier that was outlined in this study, which is overall cost.

Cost

The cost to develop and maintain community gardens and urban agriculture was another recurring theme throughout the barriers identified. There was a range of costs associated with the development of each of the gardens included in the interview process, ranging from a few thousand dollars to upwards of \$200,000. Two of the gardens were developed so long ago that the development associated costs were unavailable, but operating costs were discussed in the interview. The costs associated with the development of community gardens included contractor fees, permits, insurance, licenses, material costs, construction, architect fees, and a collection of other costs. These costs, especially as they relate to the \$200,000 dollar project, highlight how cost prohibitive these projects can get. It also points to a serious need for the development of a streamlined, affordable, and repeatable process, especially when considering the development of these spaces in low income and food apartheid impacted neighborhoods throughout the county.

The cost of maintaining a community garden can also create challenges. Costs include staffing, water, liability insurance, tools, seeds, garden inputs, and infrastructure maintenance (Diaz, et al., 2018; Castillo et al., 2013). Improving equitable access to consistent funding for community garden projects could help mitigate the costs of these materials and services and benefit the longevity of these projects. These costs can also be mitigated through various government programs like the no-cost water policy for gardens on city property in Escondido, the city of Berkley’s Food and Nutrition Policy that support small-scale sustainable agriculture like community gardens, and other policies that provide no or low-cost city permits and land use (Twiss et al., 2003). Additionally, grants and funding from nonprofit organizations, government agencies, and private entities can also support and increase the success of these projects. However, reduced costs for primary barriers including land access and water access and cost can be directly reduced by government programs like those outlined above. These programs can significantly reduce the prominence of these high-level barriers.

Water

Water is another resource that is absolutely necessary for the functionality and overall sustainability of a garden and was a prominent barrier identified in this study. Every plant needs

water, soil, nutrients, and sun to grow and produce nutrient dense foods. Gaining access to the necessary quantities of water can be a barrier to community growing spaces, but this barrier can also be compounded by the cost of building out irrigation systems, maintaining those systems, and the cost of the water itself. This finding is consistent with the results of existing literature and could prove to be increasingly challenging in areas experiencing drought or water scarcity. This can also be a particularly challenging issue in areas where water is transported long distances. If the distance is long enough and the water loses enough pressure, the system could require a pump to move the water which would require additional cost and maintenance. On the other hand, if the infrastructure is already in place and no additional cost is necessary. It is worth mentioning that there are a number of ways to reduce water usage, like using drip irrigation systems, collecting rainwater, improving soil health and water holding capacity, utilizing compost and mulch, and watering in the early morning before temperatures are high ([Egerer et al., 2018](#)). There is a particular emphasis put on overall soil health in a collection of literature that has connected poor soil health to a host of issues that ultimately lead to an increase in water use. Soil that is lacking organic matter, containing chemical contaminants, or is devoid of a diverse microbial community is more likely to have a lower water storage capacity. This soil is much more susceptible to climate related changes, soil erosion, and drought. This highlights the importance of building soil health in community gardens and ensuring that proposed plots are contaminant free. These factors should be strongly considered when government services and initiatives are being developed and implemented.

Benefits of Community Gardens

While the primary focus of this paper has been identifying the primary barriers to community garden development, I have been incredibly inspired by the benefits these spaces offer. The data collected that influenced these findings was gathered from my own observations during time spent at various community gardens and garden related events over the last two years as well as various academic articles and semi-structured interviews. The key findings in terms of the benefits of community gardens found in this case study include: community building and social cohesion, increased food security, cross cultural and cross generational relationship building, connecting with nature and being outside, gaining a better understanding of food systems and local ecology, and garden therapy. These findings are consistent with and contribute to the existing list of benefits outlined in various studies examining community garden benefits such as

[*Growing urban health: Community gardening in South-East Toronto, Community Gardening Increases Vegetable Intake and Seasonal Eating From Baseline to Harvest: Results from a Mixed Methods Randomized Controlled Trial, and Association between community garden participation and fruit and vegetable consumption in rural Missouri.*](#) While it was not included in the interview responses, feelings of pride, accomplishment, and self-reliance have also been cited as benefits to community gardens ([Wakefield et al., 2007](#)).

Summary

A thematic analysis of data collected from interviews with four community gardens located throughout San Diego County and a review of three pieces of relevant literature concluded that the most prominent barriers to community garden development are: 1. government support and clear policy 2. land access 3. cost and 4. water access. The theme of government related barriers occurred with the most frequency, and it was highlighted by many of the interviewees that strong government support can be a beneficial tool for combatting the other barriers outlined in this study. While not every community garden outlined government support as a primary barrier, each of the four gardens mentioned the utilization of government support to meet a variety of needs and/or the benefits of strong relationships with local officials. This collective reliance and emphasis on local government outlines the important role government and policy plays in the development and success of these valuable third places. The prominence of this barrier and the important role the government can play in reducing the persistence of other barriers outlined in this case study highlights the need for the development or improvement of supportive services, policy, funding, and initiatives within local government agencies. However, this data also calls attention to the importance of ensuring equitable access to government support and these resources, especially in nutrient insecure areas and neighborhoods experiencing food apartheid. Without equitable access to these resources and a focus on developing these spaces in historically underserved communities, the development of community gardens could end up perpetuating the injustices that fueled the development of our deeply discriminatory food system in the first place.

Future Research

This study could be improved upon by including a larger data set in literature reviewed and in the number of semi-structured interviews conducted. A more diverse collection of individuals who act as stakeholders at various levels within community gardens could be added to draw out possible barriers not included in this study. Understanding the barriers that impact participants of these community gardens could also be helpful to ensuring the benefits of these interventions are sustainable for individuals. Future research should also be done to gain a better understanding of the way these barriers are experienced in communities experiencing food apartheid specifically. While consideration was given to ensure a diverse collection of perspectives were received for this case study, a more meticulously designed study that focuses on uncovering these barriers in underserved communities specifically could uncover additional barriers that need to be addressed. Finally, further research about how government support and policy change could influence each of these barriers could be used to advocate for action within local municipalities.

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University of San Diego - MESH Capstone Project

Analyzing the Sustainability Impacts of Pharmaceutical Research & Development

Author: Daniel Madsen



Abstract

In this case study/capstone paper, I will analyze the environmental impacts of the pharmaceutical research industry, specifically taking waste generation and energy consumption into consideration. I will employ a multifaceted approach gathering both qualitative and quantitative data in an effort to draw connections between behavioral and systemic factors which have propagated the ecological intensiveness of the industry. I hope that my work will contribute new and innovative understandings of the underlying systemic factors which propagate the sustainability impacts of the biopharmaceutical industry and expand the reach of sustainability professionals within biopharma and other private industries. This paper uses the terms “biopharmaceutical, biopharma, and pharmaceutical research” interchangeably, referring to the pharmaceutical research and development industry.

Introduction

Throughout the industrialization of the global north, private organizations have reaped the benefits of environmental degradation to acquire incredible amounts of financial gains, the Biopharma industry is no exception. Every year, the Biopharma industry generates over 300 million tons of plastic waste and 300 thousand metric tons of hazardous waste while consuming 15 times the amount of energy of comparatively sized industries (kWh per square foot of building footprints). The Biopharma industry has numerous additional environmental and public health impacts such as GHG emissions, water consumption, and chemical pollution, making it one of the most environmentally detrimental industries per GDP globally (Kaylor, 2024, Fairbanks, 2018). The current positionality of the Biopharma industry prioritizes profitability and innovation, driven by venture capitalists and private investors to achieve economic gain often at the expense of the environment. In order to create a future that protects environmental and public health, it is imperative that the Biopharma industry shifts this positionality and begins allocating their vast financial resources towards developing sustainable solutions to ecological problems, challenging the narrative of corporate greed and ecological negligence while promoting systemic evolution in the environmental stewardship landscape.

To analyze how and why the biopharma industry can be so ecologically detrimental, I will be using the laboratory/Biotech company I am employed at as a focal point for my case study. It is important for me to recognize how my role in the company and passion for public health innovation may contribute to some personal biases throughout my study, particularly when gathering subjective data related to my research question. To limit the effect my personal

biases have on my case study, I will continuously consult with my peers to snuff out and challenge any bias embedded in my data collection or analysis formulation. In order to answer the question(s) “why/how is the Biopharma industry so ecologically intensive, and how can we address this issue?”, I will use collaborative efforts between the NGO “My Green Lab”, the municipal waste vendor and the energy providers in the company’s geographical location, and internal organizational teams such as scientists and mechanical engineers, identifying a nexus between all the aspects that contribute to the industry’s ecological intensiveness and probing at possible options to challenge or change this operational affect.

Through this study, I hope to highlight the challenges and opportunities related to the Biopharma industry’s energy intensiveness and high prevalence of hazardous and municipal waste generation by analyzing quantitative data from waste and energy audits and subjective data from scientist interviews then drawing a connection between the two. Through both quantitative and qualitative data collection, I aim to identify systemic factors in the behavioral, technical, and organizational levels of the Biopharma industry which have propagated the detrimental environmental impacts of pharmaceutical research and development. As a result, I hope to have sparked curiosity and ignited newfound passion for sustainability professionals in not only the Biopharma industry, but other industries as well, empowering them to promote a new narrative that challenges the preconception that financial gain must come at the detriment of our environment.

Literature Review

In the following comprehensive literature review, I hope to identify contributors to the ecological intensiveness of the Biopharma industry as well as any potential gaps in the understanding of this problem, describing where research may be lacking to better inform possible solutions and to lay the groundwork for my case study. I will try to discuss each aspect of my paper in its own section (ie. waste and energy), analyzing specific causal factors which may be contributing to environmental impacts.

Biopharmaceutical Waste Generation

The biopharmaceutical industry produces life-saving drugs and incredible improvements in individual human health determinants; however, the industry also generates significant amounts of plastic waste which negatively impacts public health determinants through ecosystem destruction and environmental pollution. Additionally, every year, the biopharmaceutical industry ships about 6 million tons of contaminated plastic waste to treatment and disposal

facilities where the plastic is incinerated, releasing toxic air pollutants, and the remnants are subsequently buried in landfills (Hollands, 2023). Companies elect to use these treatment and disposal facilities to handle contaminated waste to remain compliant with regulatory requirements, which are enforced by the Environmental Protection Agency and its subsidiaries in order to prevent chemical and biological contamination of our ecosystems and incidents like [Love Canal](#) from ever occurring again (EPA, 2024). Additionally, the requirement of sterile, single use plastics for quality control management in the research and development process of drug formulation creates problems when attempting to adopt circular economy practices, which is a unique circumstance to the biopharma and healthcare industries (Hollands, 2023). There are also studies that show the adoption of single use plastics and technologies in drug manufacturing and R&D processes use 75%-95% less water, 23% less electricity, and do not require the use of harsh decontamination chemicals such as sodium hydroxide or sulfuric acid (which create environmental and human health challenges in their own right) when compared to reusable technology counterparts (Sarkis et al., 2024). So, with regulatory requirements in place to prevent ecosystem pollution/contamination, quality control/sterility requirements for drug formulation processes, and studies showing decreased water, energy, and human health impacts from the employment of single-use plastics, can we justify removing single-use plastics from the biopharmaceutical industry's processes? If not, how do we reduce plastic waste and its related environmental impacts while still meeting stringent requirements for creating life-saving medication?

I believe the answer might lie within the Waste Hierarchy Pyramid, promoting a re-think, re-design, reduce, and reuse mindset within laboratories to find innovative ways to reduce plastic waste generation. Organizations like [My Green Lab](#) are partnering with biopharmaceutical companies and government organizations to promote more sustainable research and development of pharmaceuticals, and address complex issues like the prevalence of single-use plastic waste generation within the industry (My Green Lab, n.d.). Promoting behavioral change which contradicts hegemonic, unsustainable research practices will be no easy feat for sustainability professionals in the biopharma industry, requiring partnerships with NGO's like My Green Lab and other organizations to develop and share best practices throughout the industry. I hope to elaborate more on the challenges and successes of reducing plastic waste by employing anthropogenic and behavioral methodologies in the action phase of my research project.

Biopharmaceutical Energy Consumption

Biopharma laboratories consume 3 to 5 times more energy than equivalently sized commercial buildings (DiMambro, 2020). For example, Harvard University lab spaces occupy a

total 22% of the university's real estate but account for 46% of the university's total energy consumption (Gilly, 2016). Not only does this high energy intensity create economic stressors for the biopharma industry in the form of electric bills, but it also has massive implications in greenhouse gas emissions, community health, and social justice impacts. For example, it is well known that marginalized communities are disproportionately impacted by climate change and face the highest burdens associated with climate change (air pollution, economic stressors, etc.). By reducing energy consumption and demand, we reduce GHG emissions, lessen the social impacts from conventional and renewable energy sources, and stabilize electricity prices and volatility (EPA, 2023). But why are biopharma laboratories so energy intensive, and how can we begin to address this issue?

Figure 1

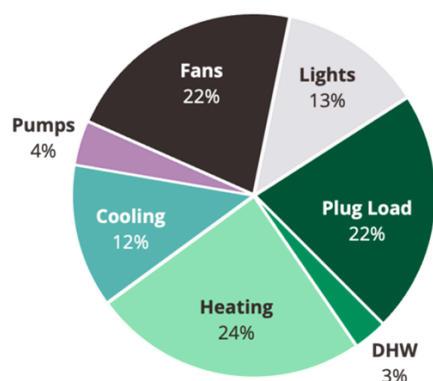


Figure 1 depicts the distribution of energy consumption in a typical biopharmaceutical laboratory setting, derived from a study done by the EPA in Bethesda, Maryland in 2001 (EPA, 2001).

An article published by Nicole Kelesoglu and Labconscious corroborates the data depicted in figure one, with heating, ventilation, and cooling systems making up about 60% of a laboratory building's energy consumption (Kelesoglu, 2023). Based on this information, we can assume that the majority of energy consumption occurring in biopharmaceutical labs will be coming from the HVAC system (fans, temperature control, and ventilation), accounting for about 60% of total energy consumption. The other 35% originates from plug load and lighting. Plug load refers to lab equipment like freezers, centrifuges, and water baths which are plugged into wall outlets. See figure 2 for associated energy consumption for typical lab equipment.

Figure 2

Typical Energy Consumption By Common Lab Equipment

EQUIPMENT TYPE	AVG HRS OF USE PER DAY	ENERGY CONSUMPTION RANGE (PUBLISHED)	ENERGY CONSUMPTION RANGE (kWh/YR)
-80°C Freezer	24	3900 – 13,666 kWh/year	3900 – 11,100
-20°C Freezer	24	1690 – 4876 kWh/year	1690 – 4876
Refrigerator	24	199 – 2686 kWh/year	199 – 2686
Fume Hood	24	30 – 60 kWh/day	10,950 – 21,900
Fluo Microscope	3	0.5 – 1 kWh/day	183 – 365
Centrifuge	3	3.2 – 57 kWh/week	166 – 2964
Water Bath	13.5	2025 – 3850 kWh/year	2205 – 3850
Heating Block	3	243 kWh/year	243
PCR Machine	4	788 kWh/year	788
Incubator	24	13.1 – 167 kWh/week	681 – 8684
Shaker	3	42 kWh/week	2184
Autoclave	3	32 – 630 kWh/week	1664 – 32760
Vacuum Pump	3	0.09 kWh – 7.5 kWh/day	33 – 2730
Tissue Culture Hood	4	60 – 88 kWh/week	3120 – 6862

Image Credit: Center for Energy Efficient Laboratories

Figure 2 is a table created by Beresini et al. based on a case study for sustainable lab interventions. The table shows associated energy consumption for different pieces of equipment which are typically found in lab spaces (Beresini et al, 2015).

As we can see, energy consumption can have large differentials depending on the piece of equipment and the average amount of hours it is used per day. Some of the largest energy consumers such as fume hoods and ultra-low temperature (-80) freezers must remain on 24 hours a day, consuming tens of thousands of kWh throughout the year for each unit. So, addressing challenges for laboratory energy intensiveness should also include both plug load interventions as well as HVAC solutions. Dan Doyle and Vytenis Milunes conducted a case study on several labs where they implemented different energy efficiency initiatives and recorded their results. Essentially Doyle and Milunes found that by implementing more practical and efficient ventilation rates for laboratory spaces, labs saw an average 15% decrease in energy consumption (Milunes, Doyle, 2016). By using the Milunes and Doyle approach as well as other sustainability practices and by partnering with engineers and lab users within my organization, NGO's like My Green Lab, and municipal energy providers to find energy efficiency solutions for the laboratory that I work at, I hope to address some of the energy intensiveness challenges that the biopharma industry faces, and share any successes and challenges as part of my research project.

In order to support a systemic change within the industry to adopt more energy efficient initiatives, or begin to implement more sustainability initiatives in general, it will be imperative that there is a publicly accessible framework to share best practices and learnings. This will be the focus of the next section of my literature review.

Biopharmaceutical Corporate/Systemic Factors

In their case study, *Carbon footprint of the global pharmaceutical industry and relative impact of its major players*, Lotfi Belkhir and Ahmed Elmeligi analyzed the greenhouse gas emissions (GHGE) intensity of the top 15 global biopharmaceutical companies, revealing that the pharmaceutical industry is significantly more GHGE intensive than the automotive industry, 55% more intensive, to be exact (Belkhir, Elmeligi, 2019). Belkhir and Elmeligi's case study sheds light on the significant environmental impacts of the Biopharma industry, and its contribution to the global warming issue, however, this study included only 15 of the more than 20,000 recorded biopharmaceutical businesses globally as of 2022 (Research and Markets, 2022). With this radically diluted pool of participants, it's hard to definitively say if the Belkhir and Elmeligi study is an accurate representation of the biopharmaceutical industry's carbon footprint and begs the question of how we can better understand the industry's ecological impacts. In comes environmental reporting, and the role it has to play in understanding and addressing the ecological intensiveness of the biopharmaceutical industry.

Environmental Social Governance (ESG) reporting is a form of corporate performance management and communication with investors to disclose a business's environmental, social and corporate governance data to improve investor transparency (Tocchini, Cafagna, 2022). In these voluntary reports, companies will sometimes disclose metrics such as GHG emissions, company specific sustainability initiatives, or net-zero pledges, however, as described by Belkhir and Elmeligi, these reports have no standardized framework and are not a requirement by any United States government entities. Without a government-backed standardized framework, there are too many inconsistencies within biopharmaceutical industry ESG reports to identify benchmarks or trends, which would allow for deployment of equitable net-zero policies like carbon pricing (Belkhir, Elmeligi, 2019). Additionally, the lack of standardization leaves room for systematic greenwashing, in which biopharmaceutical companies will project falsified or unrealistic environmental performance metrics in an effort to increase stakeholder investments. A recent study conducted by Calciolari et al. using a bibliometric analysis of financial reports found that despite its significant role in promoting healthcare and the improvement of human life, the biopharmaceutical industry had a lower prevalence of environmental and sustainability reporting than comparative industries. This may be due to the underlying positionality and

expectations of biopharmaceutical stakeholders and investors, prioritizing profits, and other aspects of corporate responsibility over sustainability practices and environmental reporting (Calciolari et al., 2024). The lack of participation in environmental and sustainability reporting and systematic greenwashing prevalent in the biopharmaceutical industry is suggestive of underlying capitalistic business practices which have hegemonically neglected environmental health in order to promote higher profits. In order to address the ecological intensiveness of the biopharma industry, it's imperative that companies are held accountable by standardized frameworks to provide accurate environmental metrics and sustainability reports in order to promote knowledge sharing, deployment of environmental policies, and best practices to address climate change causalities. A good example of how corporate responsibility and reporting can be a catalyst for systemic change is seen in the "Quality Revolution".

The industrial revolution brought an ever-increasing demand for productivity in the manufacturing of goods, and as productivity continued to increase throughout the 20th century, companies saw a breakdown in the quality of those goods. Eventually, the "Quality Revolution" was sparked when the quality of Japanese manufactured goods surpassed those of the United States and Europe in the 1970's. In order to regain a competitive edge in the market, action was taken to develop and implement quality management systems such as the highly-regarded Six-Sigma process and other continuous improvement methods (Juran, 2020). As companies tried and tested quality improvement methods, best practices and knowledge were shared through the development of required and regulated quality management certification systems, and within 30 years, the quality control and management aspects of businesses were well adopted at every level of organizations throughout the world (Juran, 2020). As Belkhir and Elmeligi suggest in their case study on the carbon footprint of the biopharmaceutical industry, the adoption of regulated or standardized environmental reporting frameworks, such as environmental social governance reports, could catalyze a rapid systemic change in the corporate environmental and sustainability landscape (2019).

How does this case study contribute to current literature?

Throughout my literature review, it became aware to me that there is very little research regarding sustainability interventions and best practices in biopharma. This could be indicative of a lack of knowledge sharing within the industry, or just a lack of sustainability professionals present in the industry, but I hope that my project can help my peers see the value of sustainability and the positive impact it can have on research, community, and environmental health. By implementing an energy efficiency initiative and identifying ways to reduce plastic waste, I hope to find new and innovative ways to conduct pharmaceutical research which

combats the societal narrative of chasing economic gain at the expense of the environment. I would also like to add more anthropogenic research methodologies and analysis of the sustainability issue in biopharma literature. It seems that there is a lack of input from the end users (the scientists) of sustainability initiatives, and by including the lab users in my research project, there might be some new findings or knowledge gained which highlights factors that contribute to the industry's ecological intensiveness. Lastly, an analysis of the systemic factors which might be propagating certain individual and organizational behaviors could help current literature with a more holistic understanding of the issue.

Methodology

Research Question - How can we better understand the energy and waste intensiveness of the biopharmaceutical industry? What possible solutions are there to this ecological dilemma?

In order to better understand the energy and waste intensiveness of the biopharmaceutical industry, I developed the above research question(s) to help guide my case study. I aim to employ a multifaceted approach to answer the above research question(s) by taking a look into the day-to-day operations of the particular biopharmaceutical laboratory I am employed at, using quantitative methods to collect energy consumption and waste generation data and qualitative methods to engage with front line researchers to gather insights and a more holistic understanding of the environmental risks the industry poses. Thus far in my research, I have been able to collect a substantial amount of data regarding the energy consumption and waste generation of the laboratory as part of a quantitative research approach, the analysis of the accumulated data suggests that the understanding of the ecological intensiveness of the biopharma industry might be grossly underestimated. For example, multiple articles estimate laboratory energy consumption to be anywhere from 5 to 10 times more than that of an equivalently sized office building (DiMambro, 2020, Kelesoglu, 2023). However, the biopharmaceutical laboratory that I've used as a basis for my research consumed an average of 105,000 kWh every month in 2023, an equivalently sized office building in the exact same geographical area as the laboratory consumed an average 1100 kWh every month. The energy consumption data gathered in my study would suggest that biopharmaceutical laboratories consume a staggering 100 times more energy than office buildings, not 5 to 10 times more as current literature suggests. I wouldn't say this is necessarily what I wanted to find out, but I think it emphasizes the gravity of the problem I am trying to better understand through my case study. It also highlights misconceptions regarding the ecological intensiveness of the biopharmaceutical industry which are created by the dominant narrative or "single story" of the industry and

propagated by industry leaders. I will elaborate more on my quantitative findings later in this article.

Relevant epistemology concepts:

Pragmatism, or pragmatic research, is the key epistemological foundation which I believe will be relevant to my research project. Pragmatism is a flexible and adaptive way of gaining insight to a problem which emphasizes the application of both theoretical knowledge and technical knowledge to create innovative solutions to complex problems. As described by Leanne Kelly and Maya Cordeiro in their research article, the principles of pragmatism can be useful paradigm for qualitative research on organizational processes, allowing researchers to integrate multiple methods of inquiry, such as qualitative and quantitative approaches to gain more holistic understandings of issues (Kelly, Cordeiro, 2020). The application of pragmatism in my research project aligns with the common theme of employing multiple methodological approaches to better understand the ecological intensity of the biopharmaceutical industry and generate meaningful insights on how to begin to address the problem.

Theoretical framings employed in this study:

Systems Thinking - Systems thinking is a holistic approach that examines the interrelationships between various components of a system to better understand a problem (Six Sigma, 2024). In the context of my research project, systems thinking can help me understand how different factors (e.g., production processes, supply chains, regulatory frameworks) contribute to the energy and waste intensity of the biopharmaceutical industry. This approach can also guide the synthesization of qualitative data (e.g., stakeholder interviews, case studies) and quantitative data (e.g., energy consumption metrics, waste production statistics) to form a more holistic, comprehensive view of the issue.

Socio-Technical Systems Theory – This theoretical framework employs the idea that the design and performance of any organizational system can only be understood and improved if both ‘social’ and ‘technical’ aspects are brought together and treated as interdependent parts of a complex system (Leeds University Business School, 2024). This framework will help me employ both qualitative and quantitative data to create a more nuanced understanding of the biopharmaceutical industry’s energy and waste intensity by examining how social, organizational, and technical factors interact to reveal systemic issues and potential solutions.

Specific methods used to obtain qualitative data and quantitative data:

In order to obtain qualitative data, I will be performing a case study of the biopharmaceutical lab I support, examining research processes, procedures, and technology which might be contributing to energy use and waste generation. I also plan to conduct interviews with front line researchers to explore the different perspectives, practices, and challenges which might provide insight to organizational/systemic propagators of energy consumption and waste generation. I would also like to form a focus group from a diverse group of laboratory personnel, including researchers, engineers, operations, and environmental health professionals to discuss the ecological impacts of the industry, identify common themes, and employ a pragmatic approach to understanding the problem. To accomplish this, I used a combination of participatory methods.

Participatory methods refer to a set of approaches and techniques used to engage individuals and communities actively in decision-making processes, problem-solving, and development initiatives. These methods aim to empower participants, promote inclusivity, and ensure that diverse perspectives are considered in the decision-making and implementation processes. Participatory methods are widely used in various fields, including community development, research, planning, education, and governance (Rotmans, 2001). Collaborative decision-making is an example of a participatory method that could be useful in developing adaptive environmental solutions within the biopharma industry, and is an approach I've relied heavily on to create and facilitate a sustainability focus group for my case study project. Collaborative decision-making can be defined as engaging stakeholders in collaborative discussions and deliberations to reach consensus or make collective decisions. The EPA has a great article discussing collaborative decision-making and addressing environmental issues in which they also describe the benefits and limitations of this method. For example, during information exchange, stakeholders are able to be more interactive by sharing knowledge and expertise which promotes more adaptive solutions to "what if" scenarios or proposals (EPA, 2015). One limitation discussed by the EPA is that even though participation by stakeholders is needed for collaborative decision-making, it is not guaranteed that all stakeholders will accept or support final decisions made (EPA, 2015). In conclusion, participatory methods can be very effective at addressing adaptive environmental challenges and promote collaboration to develop more holistic understandings of environmental problems and promote adaptive, sustainable solutions to said problems.

Quantitative data will be obtained through a comprehensive energy and waste audit of the biopharmaceutical lab. Data will then be analyzed and utilized to create graphs and identify trends which might supplement qualitative findings.

Theoretical lenses and epistemological assumptions employed while analyzing data obtained from this case study:

I would like to use an analytical and empirical approach that recognizes the downfalls associated with dominant narratives, and which challenges societal power dynamics which have emphasized the industry's role in advancing medical science and improving health outcomes while neglecting the substantial environmental impacts of biopharmaceutical research and development. Interpreting my project through this lense will challenge the dominant narrative associated with the industry and its environmental impacts while promoting a more comprehensive and balanced understanding of the issue.

Case Study Discussion – Qualitative Interviews

For my qualitative research process, I decided I would go with the romantic conception approach when talking with my interviewees. The romantic conception approach prioritizes building a strong rapport with the interviewee to facilitate a more casual and free-flowing discussion, which aligns with my personal style of creating genuine connections through communication with people in general, so it was natural for me to employ this method. But that was not the only reason I chose this method, by taking a friendly and informal approach to the interview process, it reduces the potential for intimidation or discomfort which is characteristic of classic interview styles. This also greatly reduces the power dynamics associated with typical interviewer and interviewee relationships, nullifying any authoritative or hierarchal influences. When you build a rapport with the interviewee, they feel trusted and respected, and by taking a friendly and informal approach to the conversation, it creates an equal footing which will reduce social desirability bias (where interviewees might tailor their responses to what they think the researcher wants to hear) and make the conversation overall more enjoyable. The goal of the romantic conception approach is to encourage interviewees to share their true thoughts and feelings, leading to richer and more authentic qualitative data.

Qualitative data analysis

In both interviews I conducted, one with a cell sciences researcher and one with a biomarker scientist/director, I had a fantastic conversation. By taking an informal approach to the

interview process, and having already built some rapport with the interviewees through work, I felt that the conversations were not forced whatsoever. It also felt as if the interviewees were giving me their honest thoughts and answers to my questions. Here are some of the interesting findings:

When asked, "Would your company be willing to sacrifice additional profits to prioritize environmental protection if given the opportunity?", both interviewees laughed and answered "no". I think the fact that posing this question to them prompted a comical response says a lot about the way the industry operates. I could get into all the different nuances of how or why they laughed before answering the question, but at the end of the day their answer was "no". Much like any other private organization within our capitalistic society, I'd think I'd be hard pressed to find anyone working at the company that would confidently answer "yes" to the above question.

When asked, "what are the most significant environmental impacts caused by the biopharmaceutical industry?", both interviewees mentioned single use plastics as being the biggest risk to the environment. Single-use plastics are utilized in almost every step of the research and development of a pharmaceutical, from the shipping materials used to send samples and chemicals, the petri dishes for cell culture processes, and the batch manufacturing of drug itself, plastics are deeply imbedded in the biopharma industry. As a follow up to this question I asked how we might go about reducing plastic waste within the industry, which the interviewee's mentioned recycling programs as a good way to help divert plastic from landfills, however this seems like more of a solution to a symptom of the problem rather than a solution for the underlying causes. As a MESH student, we've learned that recycling is actually one of the last steps in the waste hierarchy, and that by redesigning our processes and rethinking our approaches to waste, we can effectively reduce the amount we produce. However, we can't expect everyone to have a Master's degree in sustainability and health, and this approach might not be well-known to biopharma researchers. So maybe there is a knowledge gap in sustainability solutions which contributes to the high volume of plastic waste in the industry?



The above photo is an example lab plastic recycling program the lab has employed in an attempt to divert single-use plastics from landfill.

Through continued discussions with Biopharma professional at all levels within the organization of the Biopharma company I am employed at, I found some interesting common themes which I believe might be propagating the environmental issues we see in not only the Biopharma industry but other industries as well.

For example, when asked, “Does your department often consider sustainability concepts when discussing new or ongoing projects?”, the most common answer was “No, not really...”. Firstly, within the organizational context, this response could reflect a lack of prioritization of sustainability in decision-making processes. Often, businesses prioritize short-term financial gains or immediate technological advancements over long-term environmental impacts. This can stem from corporate cultures that emphasize profit margins and competitive pressures, sidelining sustainability as a secondary concern. Moreover, it may indicate a gap in awareness or education within the company regarding the broader implications of unsustainable practices on environmental degradation and social responsibility. Societally, the response also underscores broader systemic challenges. Many industries operate within regulatory frameworks that prioritize economic growth and innovation without stringent environmental oversight. This regulatory environment can inadvertently encourage businesses to prioritize profit maximization over sustainable practices, especially if compliance with environmental standards is perceived as costly or restrictive. Additionally, societal norms and market expectations may prioritize

convenience, cost-efficiency, and product performance over sustainability metrics, reinforcing the status quo of unsustainable practices.

However, when asked if employees thought climate change was a problem, or if sustainability initiatives were important, the most common answer was “Yes”. The affirmation that climate change is a problem and sustainability initiatives are important reflects a general awareness and recognition of global environmental challenges among the interviewees. This acknowledgment likely stems from broader societal trends where issues like climate change have garnered significant attention in public discourse, scientific research, and policy agendas. It indicates that individuals within the organization are not necessarily ignorant or dismissive of sustainability issues but may perceive them as separate from immediate project planning and decision-making processes. Conversely, the response indicating a lack of consideration for sustainability in project discussions suggests that within the organizational context, there are barriers or competing priorities that prevent the integration of sustainability into daily operational practices. Together, these contrasting responses indicate a potential gap between awareness and action within the organization regarding sustainability. While there is recognition of the importance of sustainability on a global scale, translating this awareness into concrete practices and decision-making processes within the company remains a challenge.

When analyzing the responses of my qualitative interviews, I couldn't help but think about a concept we learned in our ESH Environmental Justice class called “socially organized denial” developed from a qualitative study done in Norway by Kari Norgaard. Kari Norgaard describes socially organized denial as, “...ignoring information about global warming takes place in response to social circumstances and is carried out through a process of social interaction.” (Norgaard, 2006, pg. 351). Norgaard then goes on to relate this definition of socially organized denial to “implicatory denial”, in which lack of knowledge or awareness is not the issue but knowing what to do with the knowledge and applying it to real world scenarios/actions is. Thus, people continue to go about their normal lives as if the existential crisis of global warming doesn't even exist, which Norgaard exemplifies in her research on the Norwegian community's response to global warming.

One commonality I found between Norwegian citizens' reactions to the climate change issue in Norgaard's case study and that of bay area biopharma professionals in my case study is that they often need to “sit down and think” about climate change/global warming. That the issues regarding this environmental crisis are not involved in their everyday lives, and therefore they never need to think about them. I believe that this is the result of extensive specialization within industrialized countries. Societal structures within industrialized/capitalistic societies

support people who are very good at one specific thing (scientists, plumbers, electricians), and the better a person is at their specific trade/skill, the more rewarded they are in our capitalistic society. This has resulted in a society which feels siloed, where everyone is isolated to their industry, solely focused on their work and providing monetary value to their company/organization, and where a sense of community is lacking. This isolation and lack of broadened education allows people to live under false pretenses that climate change is the problem of policy makers and environmental professionals, and that somehow, they will develop some solution to the problem without the help of their communities. Additionally, being able to ignore or deny the impacts of climate change is a luxury of wealthy and privileged communities. Wealthy populations are able to afford to live in more desirable places, ones that experience the impacts of climate change the least and have the most resources available to address said impacts. This continued segregation of wealthy vs poor and privileged vs underserved through societal structures is another factor that propagates environmental issues, and is an underlying contributor to Biopharma's ecological intensiveness which will continue to exacerbate the climate change and environmental justice problems we see today.

Case Study Discussion – Cross Functional Sustainability Team

Implementing a Sustainability Focus Group

In an effort to employ participatory research and collaborative decision-making methods in my case study, I decided to facilitate the creation of my company's first "sustainability team" (or sustainability focus group). I didn't mandate any criteria for members to be able to join the focus group, and in order to promote inclusivity, I made participation in the focus group 100% voluntary. Within a few days of notifying the lab members and support teams of my idea, I had a cross-functional team of 12 individuals, including myself, who all worked within different levels/departments of the organization, and who all had an interest in sustainability and environmental health. Through this cross-functional focus group, I planned to bridge the gap between climate awareness and climate action discussed by Norgaard's concept of "climate denialism". By facilitating in-depth discussions regarding the ecological intensiveness of the biopharma industry and our specific lab/unit of analysis, I hoped to identify sustainability issues related to my case study while driving a cultural shift towards more environmentally responsible research practices within the laboratory. I held meetings on a bi-monthly basis within a conference room at the laboratory, and although I already had twelve individuals on the team (and the conference room wasn't very large), there was always an open invitation for other lab

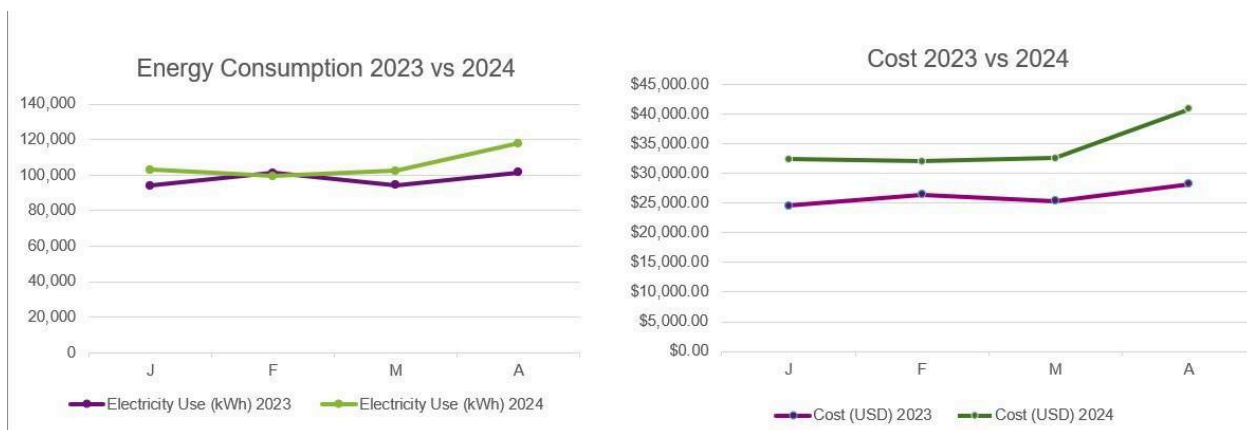
members to join the meetings, again in an attempt to promote inclusivity. During these meetings I utilized a participatory/collaborative decision-making approach known as Dynamic Facilitation, which we covered in depth during our ESH 530 Just Transitions class. Dynamic Facilitation is a collaborative decision-making process that aims to address complex and contentious issues by fostering creativity, empathy, and shared understanding among participants. This approach was developed by Jim Rough in the 1980s and is particularly useful when traditional decision-making methods, such as voting or negotiation, have proven ineffective or when there is a need for innovative solutions. Dynamic Facilitation/Choice-Creating Approach emphasizes the importance of open dialogue, active listening, and empathy to address complex and contentious issues. It values the creativity that arises from diverse perspectives and seeks to find solutions that are not only effective but also respectful of all participants' concerns and values. This approach can be particularly useful when a high degree of buy-in and creativity is required to find innovative solutions.

Examples of Sustainability Focus Group Discussions / Projects

Green Team Improvements Summary

- Implemented Cross-Functional Sustainability Focus Group
 - 32 [Leveroni](#) Energy Audit and Data Collection
 - HVAC Air Change & HEPA Filter Project
 - Plug Load Energy Efficiency Project
 - My Green Lab Freezer Challenge
 - Lab Safety/Sustainability Training
 - Composting Program
 - Single-Use Plastic Waste Diversion Project
 - Styrofoam Recycling Program
 - Hazardous Waste Reclassification Project
 - Sustainable Procurement Training
- 

A list of some of the projects that the sustainability focus group was able to work on throughout the last 6-7 months. The sustainability focus group was also commonly referred to as the “green team” at my work.



An example slide I would use to communicate an environmental topic/issue the green team would be discussing for their meeting that day. These slides were meant to guide or facilitate discussion for the green team meetings, however, I never wanted to force certain topics for the discussion and actually encouraged members to ask unrelated questions during meetings if they had new ideas or different topics they'd like to discuss. I also found that when facilitating a cross-functional working group like this one, it's important to understand your team members and what resonates with them. For example, most of the team members are chemists, biologists, engineers, or molecular scientists, so when presenting them with an issue, I found much more success by doing so with quantitative data to facilitate dynamic discussions.

This cross-functional focus group was a ton of fun to create and be a part of, and luckily, my supervisors and leadership within my company were very appreciative of the extra effort taken. I am fortunate enough to work at a company that has allowed me to allocate a significant amount of time in leading sustainability initiatives despite the fact that there is no real scope of work for this kind of profession. Most of the work I've done with this sustainability focus group and other projects like the HVAC efficiency project I discussed in my diary post a few weeks back have actually been things I've translated directly from the MESH program. One thing I wonder is if I had never worked at my company, how long it would've taken for someone else to start a "green team" or for the company to begin implementing sustainability initiatives. Are in-house sustainability professionals part of the solution to addressing corporate environmental negligence? Something I might be able to expand on in my final project paper.

Case Study Discussion – Energy Data Analysis

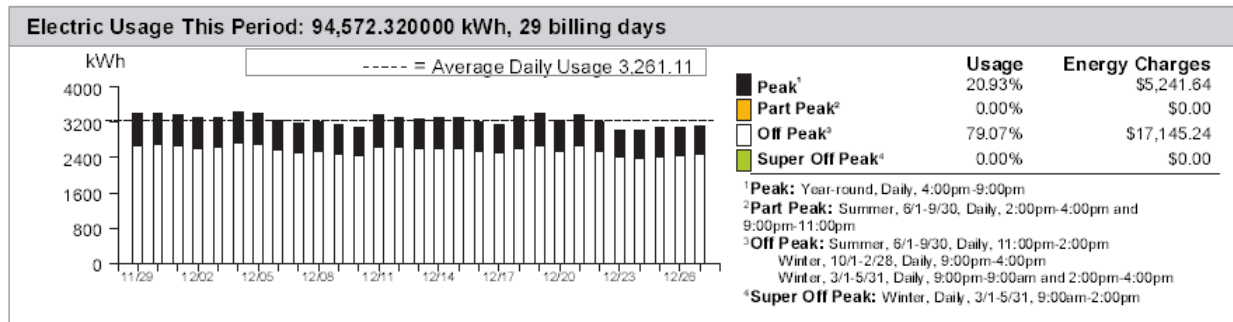


Figure 1 shows research and development lab's daily energy consumption for the month of December. Average daily usage of 3,261 kWh.

We see here that 80% of the total energy being consumed by the lab occurs between 9pm-4pm, and 20% is consumed between 4pm-9pm. An interesting takeaway from this graph is the steadiness of consumption throughout the week, with no variation between weekdays and weekends despite employees typically not using the lab areas on the weekends. This will be important to note when developing action plans to reduce consumption. Additionally, power consumption seems to be relatively proportionately distributed throughout the day, signified by the off-peak and peak hour consumption rates. This tells me that even during company off hours (nights and weekends), the lab continues to consume a consistent amount of energy. And a considerable amount at that.

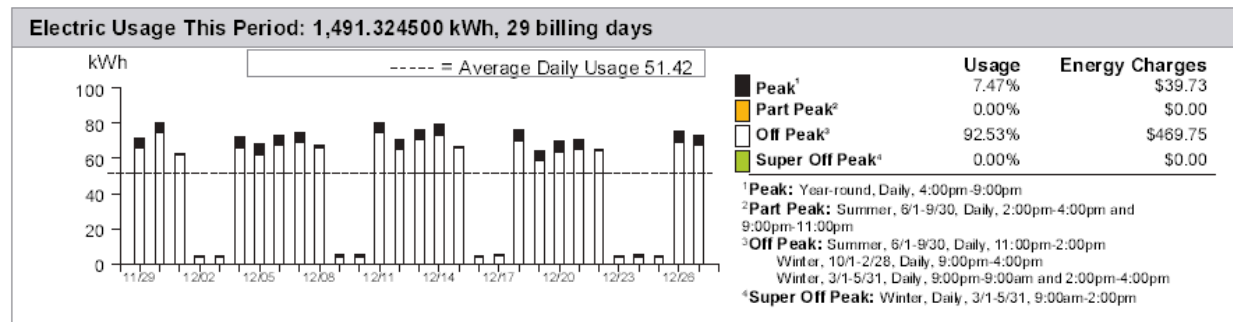


Figure 2 shows equivalently sized office building located directly next to research and development lab 1 daily energy consumption for month of December. Average daily usage of 51 kWh.

I included energy data from an office area of similar size in order to differentiate between the consumption rates. Figure 1 and 2 show the laboratory building is consuming an insane **64 times**

more energy on average than the equivalently sized office building for the month of December, 2023. Both buildings are located in the same geographical area and are exposed to the exact same weather conditions, meaning that the excessive energy consumption of the lab must be due to systems and appliances being used in laboratory buildings/environments.

Lab Equipment Energy Consumption Metrics				2024 average cost per kWh = \$0.30			
Equipment Name	kWh / Day	kWh / Month	kWh / Year	Equipment Name	Cost / Day	Cost / Month	Cost / Year
MSD Plate Reader	3.6	108	1314	MSD Plate Reader	\$ 1.08	\$ 32.40	\$ 394.20
60C Oven	7	210	2555	60C Oven	\$ 2.10	\$ 63.00	\$ 766.50
Chilled Centrifuge	1	30	365	Chilled Centrifuge	\$ 0.30	\$ 9.00	\$ 109.50
TSX Lab Bench Fridge	3.5	105	1277.5	TSX Lab Bench Fridge	\$ 1.05	\$ 31.50	\$ 383.25
Thermo Cycler/Mixer	0.3	9	109.5	Thermo Cycler/Mixer	\$ 0.09	\$ 2.70	\$ 32.85
Water Bath	0.5	15	182.5	Water Bath	\$ 0.15	\$ 4.50	\$ 54.75
BSC	10.5	315	3832.5	BSC	\$ 3.15	\$ 94.50	\$ 1,149.75
ULT Freezer (-80)	17	510	6205	ULT Freezer (-80)	\$ 5.10	\$ 153.00	\$ 1,861.50
Fume Hood	45	1350	16425	Fume Hood	\$ 13.50	\$ 405.00	\$ 4,927.50

To better understand the energy intensiveness of laboratory equipment, I purchased electricity usage monitors and monitored each compatible piece of lab equipment one-by-one for a 24 hour period. I then calculated the total energy consumption by month and then by year. Then I obtained the average cost of electricity in 2024 from the company's energy provider "PG&E" and used that to calculate the associated cost for each piece of equipment. Not only did this allow me to identify the highest energy consumers in the laboratory, but it also helped my sustainability focus group make informed decisions about where to focus our energy efficiency efforts.

Month	Electricity Use (kWh) 2023	Electricity Use (kWh) 2024	% Change	Cost (USD) 2023	Cost (USD) 2024	% Change
January	94,067	103,099	↑ 10.49%	\$24,522.90	\$32,399.20	↑ 32.12%
February	101,113	99,344	↓ 1.75%	\$26,460.94	\$32,029.36	↑ 21.04%
March	94,425	102,299	↑ 8.33%	\$25,346.55	\$32,619.26	↑ 28.69%
April	101,482	117,753	↑ 16.03%	\$28,188.35	\$40,825.65	↑ 44.83%
May	110,853	108,534	↓ 2.10%	\$30,268.94	\$35,205.70	↑ 16.31%
June	118,989			\$37,273.19		
July	123,127			\$40,167.62		
August	121,190			\$40,362.12		
September	113,266			\$37,424.13		
October	113,825			\$34,088.83		
November	112,831			\$32,472.44		
December	94,572			\$27,254.84		

Figure 3 depicts the energy consumption and associated cost for the research and development lab building throughout the entire year of 2023 and a side-by-side comparison with available data for 2024. The average monthly consumption rate for the laboratory building in 2023 was 108,207 kWh while average associated monthly cost was \$31,531. Total energy consumption by the lab in 2023 was a whopping 1.3 GWh with an associated cost of \$378,369. Figure 3 also shows that energy consumption is much higher during the summer months (July – September). This is likely due to temperature control systems having to work harder to provide a comfortable environment for employees during the warmer time of year. Another interesting finding from this particular data is that even though the lab was able to reduce energy consumption in certain months of 2024 when compared to 2023, the associated costs in 2024 are still significantly higher than they were in 2023.

Case Study Discussion – Energy Efficiency Interventions

As mentioned before, the energy consumption data gathered in my study would suggest that biopharmaceutical laboratories consume a staggering 60-100 times more energy than office buildings, not 5 to 10 times more as current literature suggests. In order to better understand why the quantitative data I've been collecting was not aligned with other research studies, I decided to do a little bit more digging to find out if there were any deviating circumstances causing the lab in my case study to have a much higher average energy intensity.

Analyzing the HVAC System

In order to better understand how the lab was consuming such large amounts of energy, I first started by looking into the HVAC system, which is responsible for the lab building's temperature control and ventilation. As discussed in the literature review section of this article, temperature control and ventilation account for about 65% of energy consumption for typical lab spaces and will have the greatest opportunity for conservation programs (EPA, 2001). After spending ample time studying the building's HVAC system designs, floor plans, mechanical sets, and air supply settings, I was able to calculate the ventilation rate for each lab room in order to get an idea of the workload being put on the HVAC system. See below.

32 Leveroni 1st Floor Air Change Rates

Room	SQ. FT	Volume	Cooling CFM			Air Changes/Hour	Heating CFM	Air Changes/Hour	
			Min	Max	Med				
Tissue Prep 1025	200	1900	350	1100	725	23	435	14	
Glasswash 1024	378	3591	380	1290	835	14	525	9	
Cell Culture 1023	209	1985.5	640	1205	922.5	28	480	15	
Test Article Prep 1022	198	1881	CAV			1105	35	1105	35
Bioreactor Room 1021	214	2033	630	1635	1132.5	33	640	19	
Mass Spec 1020	808	7676	CAV			1250	10	1250	10
Common Lab 1017	2141	20339.5	519	918	3592.5	11	2500	7	
Freezer Room 1018	193	1833.5	150	765	457.5	15	320	10	
Shipping/Receiving 1013	211	2004.5	310	305	307.5	9	300	9	

Air change data and calculations have been made based on the 2020 RSAnalysis HVAC Test and Balance Report

$$\frac{CFM * 60}{Room Volume}$$

Laboratory 1st floor air change calculations.

32 Leveroni 2nd Floor Air Change Rates

Room	SQ. FT	Volume	Cooling CFM			Air Changes/Hour	Heating CFM	Air Changes/Hour	Min Cooling AC/Hour
			Min	Max	Med				
Common Lab 2013	2402	24020	630	851	3702.5	9	3150	8	8
Cell Culture 2014	602	6020	1025	1798	1411.5	14	500	5	10
Tissue Prep 2015	203	2030	350	1304	827	24	340	10	10
Microscopy 2016	93	930	105	255	180	12	100	6	7
Virus Lab 2018	97	970	155	405	280	17	220	14	10
Freezer Room 2017	293	2930	290	500	395	8	290	6	10
Controlled Equip. Lab 2019	295	2950	515	890	702.5	14	500	10	10
Cell Culture 2020	397	3970	660	1520	1090	16	670	10	10

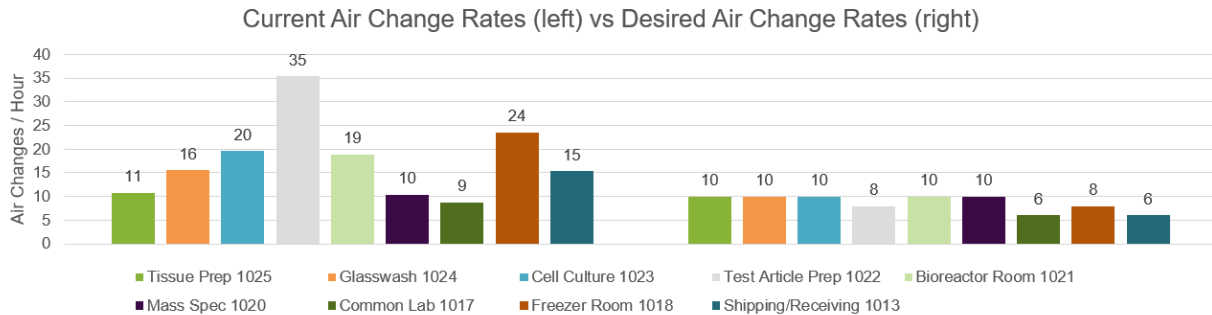
Air change data and calculations have been made based on the 2020 RSAnalysis HVAC Test and Balance Report

$$\frac{CFM * 60}{Room Volume}$$

Laboratory 2nd floor air change calculations.

Air change rates for laboratory areas should be between 6-10 air changes per hour as set by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE, 2018). As you can see in the tables provided above, I calculated air change rates up to 35 in some rooms, and almost every room was operating at above 10 air changes per hour, the maximum you would ever need for a laboratory area.

Energy Interventions – HVAC System



Current Air Change Rates vs Desired Air Change Rates of the 1st Floor Lab Area

This finding could explain the significant amount of energy consumption occurring in my case study. In order to address the air change issues and ultimately reduce energy demand from the HVAC system, I will use an approach developed by Dan Doyle and Vytenis Milunes in their article “*How to Reduce Energy Use in Your Labs by Up to 50%*” (2016). Essentially, Doyle and Milunes recommend that a lab ventilation risk assessment be done of each laboratory room, identifying potential inhalation hazards such as asphyxiant gases or chemical fumes, and setting appropriate air change/ventilation rates based on the hazards present. Following this approach, I will likely be able to reset most of the room ventilation rates (with the help of a third party vendor) to less than 10 air changes per hour, significantly reducing the energy demand from the HVAC system.

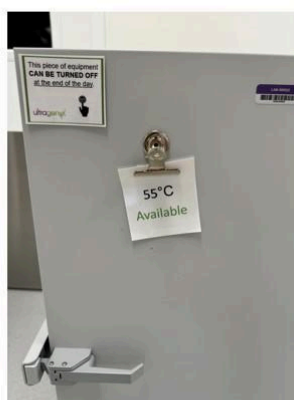
In addition to the excessive air change rates, the HVAC system also has 22 HEPA filters located throughout the ventilation ducts. The presence of these filters increases the static pressure in the system, which in turn makes it more cumbersome for the HVAC motors to push air through the building. The cross-functional focus group I created to look into the building’s energy consumption took time to analyze these HEPA filters and decide whether or not they were necessary for the lab’s research operations, which led to the ultimate decision that the filters were unnecessary. It is our belief that since the lab was commissioned during the Covid-19 pandemic, that the original building engineers designed the lab in a way that would make it as safe as possible for the researchers, providing high quality and quantity air to prevent the potential spread of Covid-19 to our research team. Now that Covid-19 has mostly passed, it was the cross-functional group’s decision that this system is entirely over-designed, which is causing

extreme stress on the HVAC system and consequential high energy consumption. Throughout this case study, I have been working with the cross-functional team to get most of the HEPA filters removed in addition to adjusting the air change rates. Through this program, we hope to see a significant reduction in the lab's energy consumption. If this engineering solution proves successful, it will be applied to the company's 5 other lab buildings. Unfortunately, at the time of writing this paper, the HVAC project has not yet been completed, so I won't be able to share the results.

Energy Interventions – Plug Load Efficiency Projects



ULT Freezer Energy
Efficiency Project (Lab Ops)



Equipment Shut Off
Program



Shut the Sash Program

Another example of solutions different green team members came up with to address the lab's high energy consumption. The lab equipment operations team members volunteered to lead a 3-month energy efficiency project for our ultra-low temperature freezers in partnership with the "NGO My Green Lab" (left). Our protein sciences team came up with the idea of shutting off equipment when it's not in use, like our 60-degree ovens (middle). And our facilities team members applied energy efficiency stickers on our fume hoods in the lab (right). Without initiating a discussion regarding the energy consumption of the lab, none of these projects would have been implemented, which speaks to the value to dynamic/collaborative decision making to address environmental issues.

Case Study Discussion - Systemic Factors

Over the last few weeks, I've had the opportunity to gather and analyze both quantitative and subjective data regarding the environmental impacts of biopharmaceutical research. The quantitative data reveals the energy and waste intensiveness of the industry, and the subjective

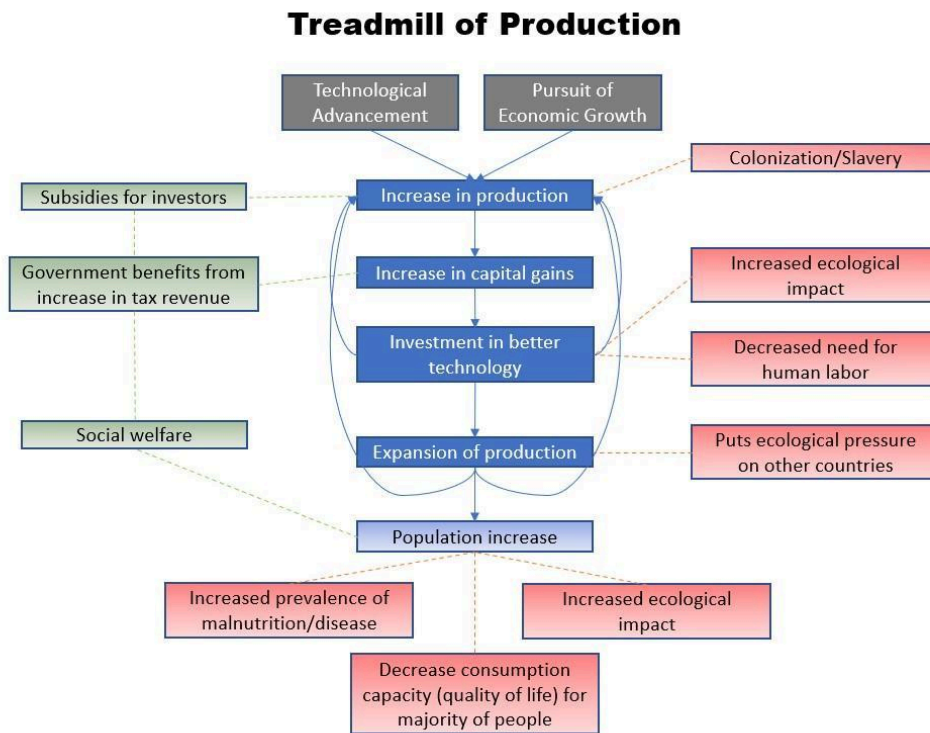
data derived from interviews with biopharma professionals reveal a gap between understanding environmental risks and taking action to mitigate those risks. So, in this last diary post, I would like to dig a little deeper into some of the possible underlying factors which might be propagating the ecological intensiveness of the industry to more holistically understand the issue at hand.

Systemic Environmental Negligence

As an industry that's purpose is to advance human health and push the boundaries of medical knowledge, it seems counterintuitive that the same industry is also one of the most environmentally damaging. For example, in their case study, *Carbon footprint of the global pharmaceutical industry and relative impact of its major players*, Lotfi Belkhir and Ahmed Elmeligi analyzed the greenhouse gas emissions (GHGE) intensity of the top 15 global biopharmaceutical companies, revealing that the pharmaceutical industry is significantly more GHGE intensive than the automotive industry, 55% more intensive, to be exact (Belkhir, Elmeligi, 2019). Is it possible that there is a general misconception amongst biopharma industry leaders/stakeholders regarding the complexities of the human and environmental health relationship, and how their interrelation directly effect one another? Perhaps there is a lack of readily accessible knowledge on this matter, but I think the issue stems deeper, and is propagated by hegemonic societal behaviors and governance methods that have predominantly valued economic growth at the expense of environmental and human health.

The role of capitalism and the unsustainable pursuit of economic growth in our planets ecological descent is undeniable. Our society has been molded into a well-oiled machine with one perpetual function – to maintain a constant state of economic growth. This is a concept known as “The Treadmill of Production”, which was developed by Schnaiberg and Kenneth to describe the cyclical feedback loop of a capitalistic society, and how it negatively impacts human and environmental health. The two main drivers of a capitalistic society (or the treadmill of production), as described by Schnaiberg and Kenneth, are the endless pursuit of economic growth, and technological advancement and subsequent use of increased technological capacity to in order to provide economic support for the population (Schnaiberg, Kenneth, 2009). The government serves as a hypothetical maintenance worker, keeping the treadmill of production functional and always speeding up. Our political system in the US is designed to look after two “constituents”, investors and workers, which both benefit to some extent through economic growth. The government also benefits from increased capital gains by an increase in tax revenue, thus making our government partial to the way our economy works, often opting to support economic growth at the expense of ecological health. If the government notices the treadmill

“slowing down”, they can use tax revenue to create subsidies for investors, allowing more resources to be allocated and in turn increase production. If the population/workforce is struggling to keep up with the never-ending and increasing demands of the treadmill, the government can invest in social welfare to maintain the blistering pace of economic growth (Schnaiberg, Kenneth, 2009).



The biopharmaceutical industry has significantly benefitted from the economic growth and technological advancements as a result of this societal structure. Geoffrey Joyce explains the relationship between capitalism, the US government, and large pharmaceutical companies in his article “Blame Capitalism? Why Hundreds of Decades-Old Yet Vital Drugs Are Nearly Impossible to Find” (2023). A clear example of the way capitalism and our government economically benefit biopharma companies is through brand drug development. When a pharmaceutical company creates a new medication (brand drug), the government grants it an exclusive patent for up to 20 years. During this time, patents enable drugmakers to recoup their research and development costs and achieve profits without facing competition from other companies producing the same drug. In an effort to maximize profits, biopharmaceutical companies and their investors push drugs through the research and development process as quickly as possible, often times utilizing an enormous number of resources and energy to achieve

this (Joyce, 2023). This enablement of biopharma companies to monopolize a drug product is why the United States has some of the highest brand drug prices in the developed world, and why the biopharma industry is amongst the most ecologically intensive despite its “goal” of advancing human health. I put “goal” in quotes because the real goal of biopharmaceutical companies within the United States economic system (treadmill of production) is to create a profit for employees and shareholders (workers and investors).

Understanding the interconnected relationships between underlying societal structures, company expectations, and employee behaviors helps bring my MESH project into a broader lens. For example, in a capitalistic society which measures success solely through GDP/profits, companies will be expected to find ways to increase these metrics, typically by prioritizing a drop in expenses and an increase in profits. In order to achieve this, companies apply pressure to their employees in numerous ways, such as prioritization of productivity or efficiency (this often comes at the expense of employee and environmental health), use of cheaper, less sustainable materials, or by neglecting environmental impacts in general. This trickle-down effect of the prioritization of economic growth in not only the biopharma industry, but all industries is what propagates the environmental degradation we see around the world today. We cannot holistically address the ecological intensiveness of the biopharma industry without taking action to change the underlying societal contributors to the problem.

Summary

Key Findings

When discussing the results of this case study, I believe there are a few key indicators of ecological negligence which might be propagated through the hegemonic, unsustainable pursuit of economic growth. For example, the lab did not have adequate systems in place to divert waste from landfills, even though the implementation and management of these systems is relatively undemanding. This included both general waste and hazardous materials that could be recycled or disposed of more sustainably. Additionally, lab spaces were found to be overdesigned, leading to excessive energy consumption. HVAC systems, lighting, and equipment were often running at higher capacities than necessary, or for longer periods than necessary, contributing to higher energy use and operational costs. Finally, there was a general lack of awareness and understanding among staff about how their research activities impacted the environment. This misunderstanding led to practices that were not aligned with sustainability principles, such as purchasing excess chemicals or duplicate pieces of equipment. These findings help highlight why the pharmaceutical research and development industry is so ecologically intensive, and by

proactively addressing the underlying systemic factors which contribute to unsustainable research practices, such as through stakeholder engagement strategies, we can begin to holistically address the environmental issues related to pharmaceutical research and development.

The pharmaceutical industry claims that it plays a major role in the advancement of human health, however, it seems counterintuitive to make this claim while subsequently having a major impact on the environment. The relationship between human and environmental health are so complexly intertwined, that one cannot say that they are holistically improving one if they are detrimentally impacting the other. This case study was done to address this gap and make an attempt at reducing the pharmaceutical industry's environmental impacts while continuing to research and develop life-saving medications. I believe that this case study highlights the importance of cross functional collaboration within and between organizations in order to develop sustainable solutions to environmental problems. Facilitating these cross-functional meetings and leading sustainability projects and programs can be very cumbersome and requires a very specific set of skills and knowledge which is why I think it is imperative that organizations retain sustainability professionals or subject matter experts, who are qualified to conduct this kind of work. I would be interested to see however, if there are other case studies done that take a different approach to addressing environmental responsibility within their organization. Lastly, it is imperative to consider systemic factors like the capitalistic "treadmill of production" and unsustainable pursuit of economic growth and their role in propagating the biopharma industry's ecological intensiveness. Without pressure for organizations to address their environmental impacts, it's hard to see how sustainability professionals alone will be able to make the changes necessary to address the detrimental impacts of climate change and it's impacts on human health.

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The Food Landscape of Warren County, Missouri:

A Case Study of a Peri-Urban Food Desert

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MESH 540: Capstone

Willy Oppenheim, Ph.D

11 August, 2024

ABSTRACT

Access to healthy, nutritious foods is a global opportunity that humanity faces. The following research project focuses on a specific subset of the Warren County, Missouri population who live in a census tract that is identified as a food desert. There is currently a gap in research of peri-urban regions and food access opportunities those regions face. Furthermore, there has been little investigation into the context of food access in peri-urban Missouri regions. The question the project proposes is what are the factors influencing food access and food desert classification for Warren County, Missouri, and what are data driven suggestions to increase food access in the region. To address these questions, archival research techniques were used by gathering relevant local newspaper articles, organization information, university reports, and prominent literature to form an argument. The geography of Warren County is highlighted as a peri-urban region, holding unique characteristics that separate it from urban and rural regions. A community mapping exercise, levels of analysis diagram, and data mining exercise of food desert atlas data were methods used to analyze the data that was gathered. Two main findings are highlighted: 1) there is a gap in residents receiving SNAP benefits versus residents who are eligible for the benefits and 2) there is a lack of farm direct-to-consumer sales in the county. The key argument from the research points to improving food access through increasing SNAP benefit usage and increasing community-based agriculture systems in Warren County. Additionally, 38 food deserts throughout the state of Missouri were identified to have similar qualities to Warren County, calling for similar actions to be taken throughout the state.

INTRODUCTION

For many people in the United States (U.S.), the thought of where their next meal will come from never comes to mind. For many, this is a daily struggle. The United States Department of Agriculture (USDA) reported 17 million U.S. households experiencing food insecurity in 2022, up slightly from 2021 metrics (1). The grim reality of food access in the country has warranted endless programs aiming to bring an equitable level of food access to all people living in the country. However, millions still find themselves in difficult situations with accessing healthy, affordable, and nutritious foods on a daily basis. Only in recent decades has the issue of food access been understood as a problem that involves many social, cultural, and political factors. The inclusion of anthropologically created systems in the analysis of food access broadens the opportunities for what is needed to increase food access across different regions of the country. There is simply not one factor that needs to be altered to bring food to all people. Rather, an understanding of the diverse network of factors influencing food access needs to be understood to provide solutions that work for each unique circumstance.

The state of Missouri is no exception to the broad range of factors that need to be accessed to improve food access. The state boasts a large farming industry as one of the mainstays in U.S. grain production (2). However, Missouri is home to 240 USDA recognized census tracts that qualify as food deserts (3). Feeding America estimates 900,000 residents of Missouri are food insecure, many of whom live in these identified food deserts (4). Within this long list of food desert census tracts, many appear in urban centers, many in rural regions, and many lay in the peri-urban space between. Each region experiences its own unique set of political factors, racial disparities, poverty levels, retail food options, farm fresh options, and more that cause complexities when working to eradicate food deserts.

Rather than working to understand the complex web of factors that influence all food deserts across the state, this study will act as a case study analysis on one of the 240 recognized food desert census tracts in the state of Missouri. While there are disparities from area to area, the analysis and recommendations made based on a singular food desert will provide a glimpse into the understanding and solutions that could be useful in increasing food access for other food deserts. The work done in this writing will be used to draw similarities for more widespread action that can be effective outside of the subjected food desert. The subject of the case study is census tract 29219820102, located in Warren County, Missouri, a peri-urban region in eastern central Missouri. The research question this project is working to address goes as follows:

What are the factors that classify Warren County census tract 29219820102 as a food desert and are there opportunities to improve access to healthy, nutritious foods to the group of people that live within this census tract? Additionally, can these solutions be applied to other similar regions across the state and country?

This research is important to the context of food desert research in Missouri for a few reasons. First, the access to healthy, adequate food is often reviewed as a basic human right for all people (5, 6, 7). It is a widely accepted concept that everyone deserves equal access to nutritious foods, affordable foods, sufficient food sovereignty, and no food insecurity. Second, as I have mentioned previously, the lack of sufficient access to healthy, nutritious foods can have deleterious impacts to human health. This is especially prevalent in the state of Missouri. Reviews from the MU Extension shows diabetes and obesity rates are higher than the national average in the state (8, 9). Both reviews attribute much of these high non-communicable disease

rates towards a lack of fresh fruit and vegetable consumption. While the direct impact of this study aims to increase food security in a singular census tract in Warren County, Missouri, the implications are much larger. Similarities can be drawn between a Warren County food desert and other food deserts across the state. Factors identified and proposed solutions will be assessed on their potential to be widespread in their implementation.

Drawing on literature and the data gathering methods performed, this paper makes the argument that Supplemental Nutrition Assistance Program (SNAP) benefits and community-based agriculture solutions should be explored to increase food access in the region. To make this argument, this writing will first explore literature on the topic of food deserts, Missouri food access, and other pertinent aspects of the project. Then, I will work to lay out the methodology of the report to explain the research methods that were performed throughout the course of the project. I will then discuss findings from my research on the Warren County food desert and will discuss paths forward to increase food access in the subjected food desert. Lastly, I will draw conclusions between the Warren County food desert and other food deserts in the state, with the aim of providing recommendations to increase food access beyond Warren County.

IDENTIFYING GAPS IN MISSOURI FOOD ACCESS RESEARCH

Food Access and Health

The importance of food access is a topic that has been widely studied. An individual's access to food and their security level surrounding food has a deep influence on many factors in that individual's life. Firstly, it is important to understand that food access has a direct relationship to diet ([10](#), [11](#)). The types of food that are near where people live and work are most often consumed by those people. The types of foods come in many forms, but to name a few common examples, these could be supermarkets, farmer's markets, fast food restaurants, and convenience stores. A spatial relationship between people, food options, and consumption patterns is sensible because of the ease people often look for when purchasing food. Additionally, an individual's diet has a direct correlation to physical health outcomes ([10](#), [12](#)). Many studies have shown that access to food is a direct indicator of many unfavorable health outcomes, including chronic, non-communicable diseases such as obesity, heart disease, and diabetes ([13](#), [14](#)). Food and diet are a leading source of 4 of the top 10 leading causes of death in the United States, further emphasizing the necessity of the availability of healthy foods and the consumption of a healthy diet ([11](#)). As I have mentioned, chronic disease rates in Missouri are above average, and the negative health outcomes associated with food further solidify the need to investigate equitable access to food in the region.

The harmful effects of food access and food insecurity are not solely confined to physical health outcomes. An individual's level of food security can have a large influence on the state of their mental health. A review of literature on the topic found multiple studies where the effects of food insecurity correlated to levels of depression and stress ([15](#)). These can be affected by someone not knowing where their next meal is coming from or feeling distressed from stigmatized forms of obtaining food, and these often compound on stressors that are already typical to exist in people who lack access to food. Poor access to food can present contributions towards a person's social wellness. Various social determinants of health have been reviewed to deduce the impact socioeconomic status has on an individual's health ([16](#), [17](#), [18](#)). Social determinants of health extend beyond physical health as well. They include social support

systems, social inclusion and exclusion, stress levels, and more (16). There is strong correlation to these social factors in a given community and the quality of health that the community's people experience. While many circumstances in a person's life affect social determinants of health, food access sits firmly as an aspect that has high influence. General access to food can be linked in a plethora of ways to detrimental physical, social, and mental health outcomes. The concepts discussed relating food access to health outcomes are universal in nature. Understanding the importance of food access at a more common level provides context into the harmful effects a lack of food access can have in Warren County, Missouri.

Food Deserts

The census tract being studied is identified as a food desert through the USDA, therefore it is vital to explore definitions of food deserts and their history to grasp the classification the region has received. The term "food desert" was first reported to be used in the early 1990's in Scotland and was used as a descriptor to refer to areas that had poor access to food, which included food affordability and health qualities (10). Since its origination, the term food desert has taken many forms and meanings across different academic forums, governments, and organizations. Because of the term's expansive usage, it often lacks a specific definition. In one study, food deserts were defined as urban areas with fewer than 10 food retail stores, with no stores exceeding 20 employees (19). Another study defines them as "poor urban areas where residents cannot buy affordable, healthy food" (20). These definitions show clear differences. Quantity of food retail stores is a common factor in definitions for the term. It is also common for the definition to include affordability and income levels. In many cases, the term has expanded to include factors such as access to transportation, the presence of healthy foods, demographics, income levels, urbanity, rurality, regional policy, and arguably the most important factor, an area's proximity to food retail stores (10, 21, 22). Blanchard and Matthews provide an important addition to the definition that includes the concept of quality and quantity of food available. They note that food deserts can exist in regions where food may be available, but it is important to factor the types of food that are available, noting access to convenience and fast foods often increases price but also creates a greater risk of previously mentioned negative health outcomes (23). Both rural and urban food deserts often share a characteristic of being low-income, which is often used as a part of the definition of a food desert (10, 21).

A key component of food desert research has been geographic location. Most studies relate food deserts to either urban or rural areas, noting that urban neighborhoods and small, rural towns are typically spaces that are considered food deserts (22, 24). Urban and rural food deserts have many key differences. Urban food deserts are typically seen as neighborhoods that are further than a distance of one mile to the nearest supermarket, however the argument against this arbitrary distance has been made. A set distance to the nearest supermarket negates the importance of public and individual forms of transportation for an individual to reach the supermarkets (24). Rural food deserts are often considered towns located in rural areas that are further than 10 miles away from the nearest supermarket (24). The same dispute has been made for this definition because of the exclusion of the transportation factor (24, 25). The definition of rural food deserts can be skewed as well simply because of the loose definition of the term rural. The U.S. Bureau of Census operates under the definition that urban areas are all urban regions with 50,000 or more in population, or urban clusters of 2,500-49,000 in population. Rural regions are simply everything that does not fit into these buckets (26). This arbitrary and loose grouping of regions has led many scholars to call for the inclusion of a third area to be

considered in this: peri-urban regions (27, 28).

Peri-Urbanity

Similar to urbanity and rurality, peri-urbanity is difficult to define. Peri-urban regions hold characteristics of both urban and rural areas. While a singular definition is not agreed upon, a few important characteristics that are commonly referenced when referring to peri-urban regions are proximal location to large urban centers, access to basic services and public utilities, diverse usage of land, and strong urban influence (27, 28, 29). They are often the space between suburban regions and true open rural spaces, or as one scholar states “a transitional zone between cities and hinterlands” (27). Because a definition of these areas is not fully established and seen as a relatively new inclusion into the zoning of geographical regions, peri-urban regions are not well studied. As a result, they often lack support from development, social, and political systems that enable them to thrive. Saberi notes “peri-urban areas seem to fall through the cracks, as they escape both the administrative purview of urban municipalities and the legislative focus of rural areas at the state and federal levels” (28). Recent research has shown peri-urban regions are a key part of the greater food system. They are often home to food processing, food storage, and small scale agriculture practices, making them an integral part of supplying food to the greater masses (27, 28). However, there is a large gap in research of food deserts located in peri-urban regions, likely because of the urban and rural groupings that have been used by most analyses on food access.

Contextualizing Food Access in Missouri

The state of Missouri presents a unique and complex situation for food access to its residents. Like much of the midwestern U.S., the state is a hotbed for farming in the region with an estimated 90,000 farms in operation covering nearly two-thirds of the state’s land (29). However, and rather ironically, the state has a large percentage of its population living in food insecurity and many recognized food deserts throughout the state that come in many shapes, sizes, and geographies. A report from the University of Missouri Extension explains that although the state has an above average number of grocery stores per capita, there is unequal distribution of those grocery stores from region to region (8). Most of this inequality of grocery stores occurs in urban and rural regions throughout the state. These urban and rural areas have a higher presence of convenience stores, fast food restaurants, and dollar stores, which all provide food that does not meet health standards in terms of amounts of fats, sugars, and caloric intake needed to sustain a healthy diet (8).

One proven avenue to improve food access is through government supported nutrition assistance programs. One study surveyed Missouri residents to determine effectiveness of the Special Supplemental Nutrition Program for Women Infants and Children (WIC). WIC aims to supplement dietary needs for women, infants, and children by providing assistance for qualifying healthy, nutritious foods at supermarkets. They discovered a few individual barriers that hindered food access, even with a government program in place. Notable barriers they state are not finding WIC approved items, access to technology, time off work, and childcare (30).

There have been many solutions-based studies performed on food deserts. Many of these have focused on the effectiveness of supermarkets in food deserts as a method of providing food security. Multiple studies have shown that the problem of food insecurity specifically in food deserts is not simply solved by placing supermarkets in those regions (31, 32). These studies suggest the solution to eliminating food deserts is more complex. There are a few findings that

are provided by these studies. First is that supermarkets are more likely to be successful projects and be effective at providing food to the region if they are collaboratively placed, managed, and supported by the local community (31). Community engagement in the process proved to be much more promising. It has also been shown that supermarkets often make no difference, and this is largely attributed towards income levels in the food desert remaining the same whether or not a supermarket exists. Scholars name race and poverty as two social factors that are often overlooked in the food desert equation (32). Suggestions to include these are working towards anti-poverty systems such as raising wages, price support, and increased government assistance (32). Community based solutions are also an emphasis in this field. Farmer's markets, community supported agriculture, and community gardening are all methods that have been studied as effective solutions for increasing food access in food deserts (32).

A common theme across literature is that there is a unique quality to all food deserts across Missouri and across the country. While comparisons can be drawn between them, ultimately each food desert has its own unique culture, groups of people, policy, geography, social settings, economic status, and more that contribute towards local residents accessing healthy, nutritious food. While some solutions may span food desert borders, each food desert should be treated as its own unique opportunity to increase food access.

Gaps Identified

There are a few very important gaps in academic literature that this research attempts to address. As I have previously mentioned, peri-urban regions are widely understudied, leaving a large portion of the country without significant resources and understanding of the current situation. There is currently a lack of research challenging the food desert qualification from compartmentalizing all regions into either urban or rural. Contextualizing the issue in Missouri, while there has been research performed on food deserts in major urban centers and some rural areas, there has been little research performed on the spaces in between. As I have previously stated, this study will focus specifically on one of these food deserts that lies in the peri-urban space between urban and rural. The study aims to assess the situation of the food desert and works to better understand unique factors that influence its food desert status, as well as provide suggestions towards increasing food security in the region.

METHODOLOGY

There were many ways to approach the identified gaps in research. I have chosen to perform a case study analysis on a singular food desert region in Missouri to address these gaps. The food desert was chosen from the USDA's Food Desert Atlas, an online tool created by the department. The food desert identification tool utilizes census data to determine food access based on many generic factors that it uses to assess all census tracts and their relation to food access.

A census tract in Warren County, Missouri was chosen for a few reasons. The choice was initially influenced by my perception of the region. Throughout the course of the program, I have been researching rural areas for most of my projects and research in all courses, with the aim of the culminating project to also focus on rurality to some degree. At the time of deciding to study Warren County, I believed it to be rural. However, Warren County, Missouri is technically categorized as an urban region. I will discuss the spatial categorization of the area in more detail in a later section of this paper. Additionally, the choice of Warren County was made because I

have somewhat of a personal connection to this area. Growing up not far from the food desert, I have been to this area many times and have had personal relationships with people that live in and around this tract. Much of my family has lived and currently resides in similar regions close to the area, and I felt that even though the food desert qualification may not hold true for the regions me or my family lives in, there are likely similarities that hold true from region to region. The initial decision to study this region was greatly informed by my positionality towards the subject. Having a personal connection to the area has left me in a space where I am coming into the project with a level of recognized bias. Growing up in the area and visiting the region, I have already developed a personal perspective on the region, the food access, and the type of people that live here. This subjectivity is inevitable in this research. The archival work I have done is aimed to provide different perspectives alongside my own. These sources of data through media and literature inherently come with their own bias as well. My research provides a combination of many perspectives that presents a unique view of the issue of food access in peri-urban regions in Warren County and throughout Missouri.

The choice to perform a case study was made in an effort to simplify the larger problem of food access. The causal factors of food deserts are expansive globally and attempting to identify factors and solutions to food deserts at this scale would not be effective. Placing a magnifying glass in one specific region is a more effective way to identify factors preventing food access and draw similarities from region to region. The timeline of the project also required a high level of specificity in order to gather data and develop an argument based on findings. Additionally, a case study is a proven way to intensely study one specific area or region and then draw similarities between this region and other regions that share the same characteristics. Therefore, while this study focuses specifically on a census tract in Warren County, Missouri, I will explore how the results can be applied across other food deserts in Missouri. Techniques used to perform the case study and gather data were mostly archival. Beyond previously published academic studies on the topic, this study utilizes information from food access organizations in the region, local Missouri newspaper publications, maps and data from Missouri universities, and government maps and reports on food access in the region. Much of the data gathered for the study is from a public food desert atlas and a large goal was to utilize this data and investigate the information in ways that have not been explored, providing a unique perspective from an existing resource.

An important step in developing this research project was developing an epistemological stance. Ultimately, this study will focus on performing a critical analysis of existing data and literature on the topic to draw conclusions of the issue being studied. While much of the data gathered is quantitative, it is approached with curiosity, and it is not assumed that there is a straightforward relationship between data and the people who live in the region. There is inherently a level of subjectivity to all data gathered for this study that is important to consider. However, the collection of perspectives analyzed together in this research provides a unique perspective in its own to make the argument of the project.

DATA ANALYSIS AND DISCOVERIES

Demographics

Data that was gathered throughout the project showed many themes and causal factors were present in the community that is categorized as a food desert. First, it is important to understand the subset of the Missouri population that lives in the Warren County census tract

being studied. The census tract has a total of 8412 people residing in its boundaries. Of the population, 26 percent are kids aged 0-17, 17 percent are seniors above the age of 65, and the remaining percent are adults that fall in the middle of these age groups. The tract's racial makeup is majority white, with 94 percent of the population falling into this racial category. Hispanic or Latino, Black, and Asian account for the majority of the remaining 6 percent of the population. Income levels in the tract are below national averages. The Warren County food desert's residents experience poverty at a rate of 15.9 percent, with a median family income just over \$60,000. In 2022, the U.S. Census Bureau reported a national poverty rate in the United States of 11.5 percent (33). Unemployment in the county sits at 3.8%, or just below the national rate (34). With the exception of the Covid-19 pandemic in 2020, the county has seen steady unemployment levels around similar rates as it currently is for the last 8 years.

Warren County, Missouri sits geographically between major urban centers in the state. It is roughly 65 miles west of one of the two major urban hubs in the state, St. Louis, and is about the same distance from a smaller, but substantial urban hub in the state, Columbia, Missouri. The land between St. Louis and Columbia is mostly rural. Population is scarce, the large agriculture industry has taken hold of much of the space, and a few small towns and suburban regions lay in the gap and line the outskirts of the major cities.

Mapping the Community

Many factors play into food accessibility. To analyze these, a community mapping exercise was performed to understand resources that are available in and around the Warren County food desert. The goal of the mapping exercise was to identify physical resources that exist or do not exist throughout the region that can have an impact on food access. The map can be seen in Figure 1.

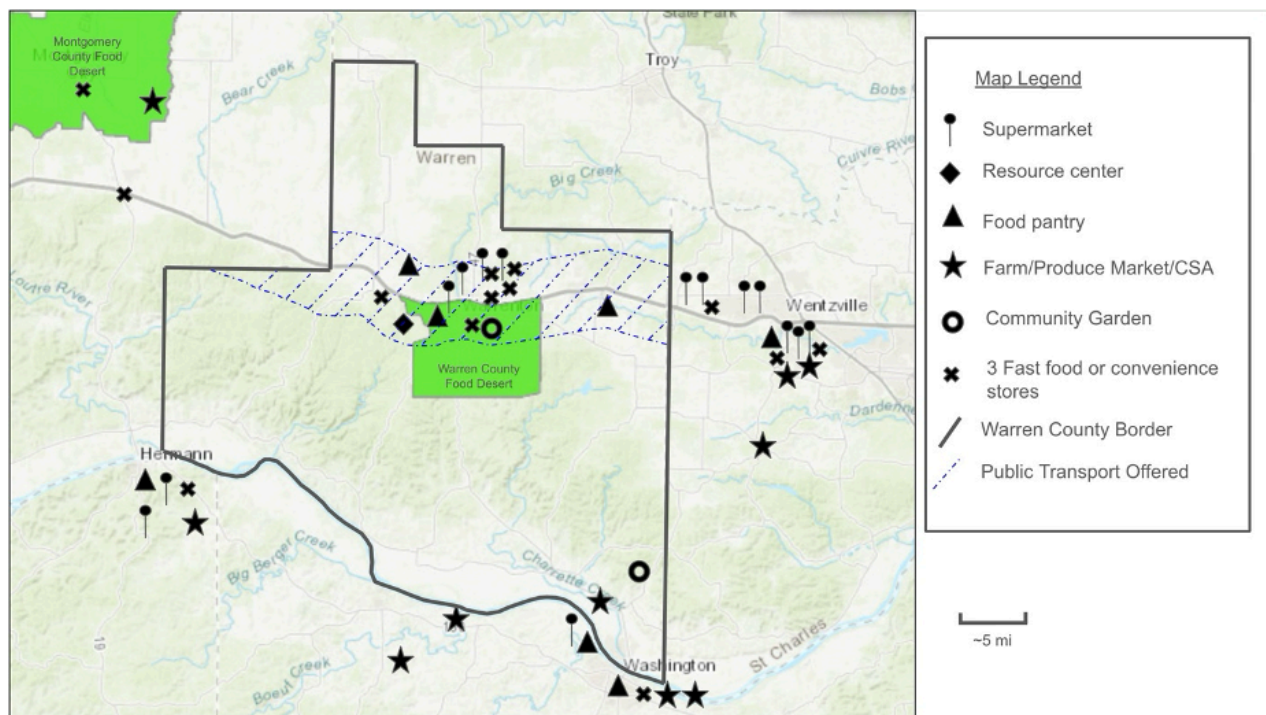


FIGURE 1

Supermarkets

The first topic within this map that I will discuss is supermarkets. The USDA Food Desert Atlas classifies Warren County and the census tract being studied as an urban region (3). This is important for one main reason. The food desert classification system has a few main factors that it uses to determine food access, with the most important of those being the distance of a region to the nearest grocery store. For urban areas, a distance of more than 1 mile to the nearest grocery store is used to determine if food access is poor. For rural areas, the tool uses a distance of 10 miles to determine high or low access to food. This is one of the factors that was found that makes Warren County unique in this scenario. The county is spatially spread out, much of the acreage is farmland, and the population density is relatively thin, which makes the region similar in many ways to rural spaces. However, because population numbers fall within the qualifications for urban regions, the food desert falls under an urban categorization. The map shows four large supermarkets both in and near the food desert. These supermarkets sell the same products that can typically be found in large supermarkets, with fresh produce sections, meat counters, and processed foods available for purchase. The atlas reports 45% of the region living further than 1 mile from a grocery store, labeling these residents as low access (3). However, only 2% of the population that is considered low access does not have an individual vehicle to get to one of these grocery stores (3).

Transportation

For the small number of residents in the census tract without access to an individual vehicle, public transportation is an option for some. A local government owned and supported public transportation system does not exist in this region. Public transportation in a traditional sense (i.e.: buses, trams, light rails, and subways) often does not make financial sense for many peri-urban regions and therefore come with many challenges (35). These challenges mostly come in the form of economic ability to stand up a system and then having enough riders to justify the economic investment. Public transportation can look different in these regions. In Warren County, the sole public transportation system offered is the non-profit corporation Operating Above the Standard Transit (OATS). OATS serves much of the St. Louis area and its outlying metropolitan regions, including Warren County. However, this form of public transit is only available for pick up or destinations within three miles of highway 70, the major roadway on the northern border of the food desert (36). These three miles cover roughly half of the food desert but leaves half of the space without access to public transportation. While the population that this affects may be small, it further speaks to the importance of equitable food access for all people.

SNAP Benefits

Because the region is low-income, there are many characteristics that are present in this area that are common across peri-urban regions. Fast food restaurants are more likely to be present in higher numbers in low-income regions (37). The community map above proves this theory holds true for Warren County as well. With a total of 18 fast food restaurants in the area, this is the most prevalent form of food access in the county. Fast food has little proven benefits. The health quality of the food that is available at these establishments is poor and can lead to deleterious health outcomes for those who regularly consume these foods (37). These restaurants are often low-cost options for people who need to put a meal on the table quickly, making them highly utilized resources for low-income regions such as Warren County. SNAP is a U.S.

government program with the goal of combating malnutrition by providing monetary assistance to low-income residents to purchase healthy, nutritious food options. SNAP has the potential to deter people from fast food restaurants and towards grocery stores that are in their area. It also has the potential to provide nutritional assistance for those who cannot afford fast food or food of any type that is available to them. The diamond on the community map signifies the Warren County Social Services Department. This location is the only physical location in Warren County where low-income residents can sign up for SNAP benefits. The usage of this resource center is critical because 19% of the residents in Warren County do not have access to broadband internet, implying that they will need some form of in person assistance or access to apply for these benefits (38). Given that low income people in the U.S. are less likely to have internet access, the assumption can be made that a majority of the 19 percent of residents without broadband internet fall towards or under the poverty line in Warren County (39).

In the Warren County census tract being studied, 10.9% of households are receiving SNAP benefits. However, 15.9% of households are eligible for SNAP, leaving a 5% gap of households that are currently eligible but not signed up to receive the benefit. This gap accounts for roughly 420 low-income residents in the census tract that could be on nutrition assistance but are not either because they choose not to, they do not have the resources available to sign up, or they do not have the knowledge that they are eligible for the benefit.

Farm Fresh Produce

Another common method for communities to deliver food to local residents is through food pantries. Referring to the community map, there are a number of food pantries within the region and one food pantry resides within the boundaries of the food desert. It is important to note that the food desert identifier does not account for food pantries as part of its analysis. This is for a few reasons. First, food pantries are often informal. Two of the food pantries in Warren County are run by local food access organizations and the third is run by a local church. Funding, labor, and food can all be variable for these access points. Also, pantries can vary in size and availability, however, they are often seen as successful ways to prevent malnutrition in local residents who experience food insecurity (40). Contrary to these studies, food pantries have also been studied as sources of food access that do not provide many healthy options for their users (41). Many items stocked in food pantries are non-perishable, processed foods that can be high in calories, salts, sugars, and other preservatives that can be linked to chronic diseases. Another barrier to the availability of food pantries is they often have limited hours. Oftentimes it can be difficult for residents to get to the food pantries and if they can get to it, getting there during its hours of operation can be tricky.

To supplement some of these perishable, processed foods one would find at a food pantry, farm fresh options are a nutritious option. There is immense value in eating fresh, locally grown produce (42). Local farm fresh produce has many great health benefits for its consumers. The connection between local, small farmers and local residents aids in economic stimulation, especially in peri-urban regions such as Warren County. Additionally, local farmers are more likely than large farming operations to operate using sustainable agriculture techniques. This helps to create an all-around beneficial physical, mental, and economic environment for the community. Because of Warren County's geographical nature, it has a high level of farming operations currently active. In line with most of the state, the county primarily focuses its crop farming operations on the top agricultural exports for the state: corn, wheat, soy, and hay (38). The county additionally is a mainstay in livestock farming, with that being its second largest

source of agricultural revenue (38). These do not fit well into the category of farm fresh produce, however, the county ranks top ten in the state for production of fruits, tree nuts, and berries, and it ranks in the top 20 in the production of vegetables (38). This data tells a story that there is a substantial amount of fresh produce already being generated in the region, but there seems to be a lack of connection to the consumers that live locally.

Farms that have operations that provide direct-to-consumer methods are denoted with stars on the map above. The local food organization, Show Me Food, created a tool for identifying locations throughout the state for accessing food in different forms. Some examples of the direct-to-consumer options that could be displayed on this tool are farmer's markets, community supported agriculture (CSA), and you-pick farms. This tool shows no direct-to-consumer farming operations in or near the food desert in Warren County, Missouri (43). However, county profile data from the USDA shows that in 2017, ten percent of the 568 farms in the county sold products directly to consumers (38). While these farms can be important to food access in the area, they may not be farm fresh produce vendors and may not advertise sales to the widespread public. An example of direct-to-consumer relationships that could currently exist are hay being grown in the county and sold to a livestock farmer in or outside of the county. There is potential for undocumented sales of produce in the community such as a farmer selling fresh food to their neighbors who live very close by. The informality of many direct-to-consumer farm sales and the self-reporting nature of a farm operating in a direct-to-consumer business makes the amount and availability of fresh produce through these methods difficult to track.

Another method of bringing fresh produce to local residents is having them grow it themselves. A proven avenue for this is through community gardens (44). The food desert in Warren County has a community garden within its boundaries, named the Truesdale Community Garden. In 2023, the garden produced an estimated 200 pounds of vegetables, all grown by local residents (45). While this amount is impressive from the small plot of land the garden operates out of, it hardly makes a dent in the improvement of food access in the region. However, a newspaper article from the Warren County Record suggests the community garden has goals larger than simply growing food on site. The program aims to offer low cost options for purchasing soil, seeds, and equipment, and also has a large focus on agriculture education for the local residents (46). By educating local residents on gardening techniques, it is a goal that more people will be able to utilize these skills outside of the community garden and set up their own small farming operations at their homes. This places the community garden not only as the source of food, but the source of education that enables residents to become more self-sufficient with food access.

Factors Near and Far

The community map is a great avenue to assess the current state of the factors influencing food access within the food desert and within the surrounding area. Food access is not limited to factors that are present in a small community. To explore aspects that are impacting food access in Warren County, Missouri, Figure 2 displays a Levels of Analysis Diagram that was performed. This diagram captures many proximal factors that have already been discussed. These will fall under the local/community, work/school/home, and individual factors columns. Distal factors that were not captured in the community mapping exercise will be captured in the international/global, and national/regional columns of the diagram.

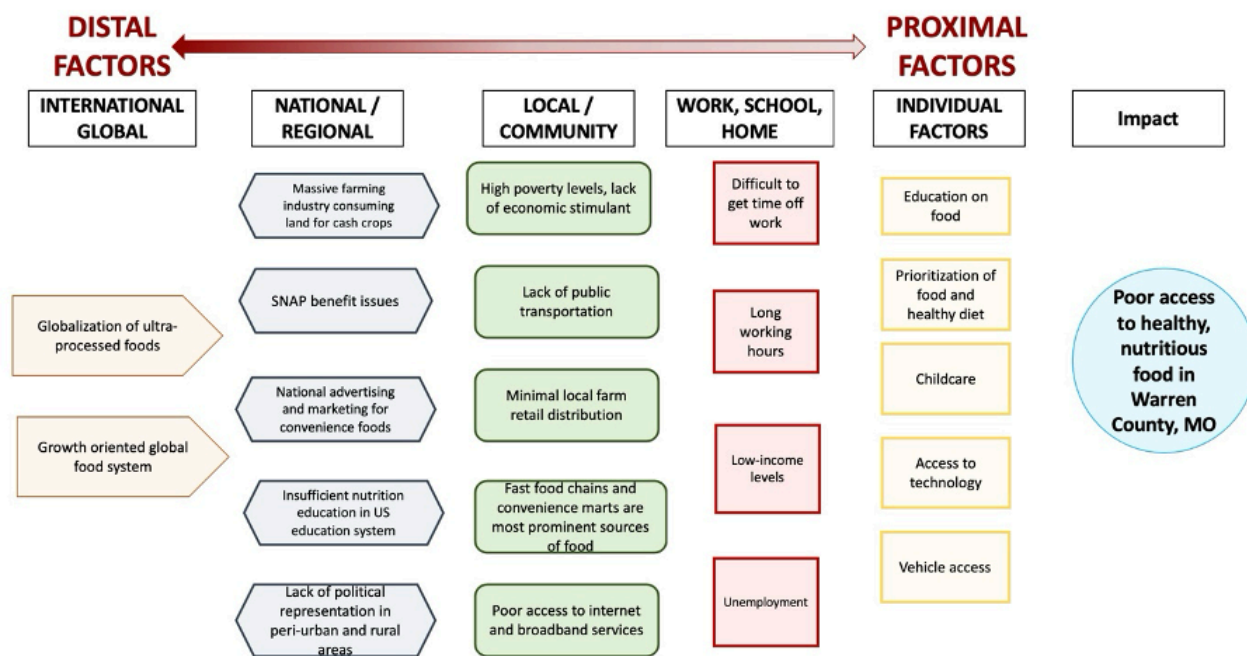


FIGURE 2 ([47](#), [48](#), [49](#), [50](#), [51](#), [52](#))

International & Global

The global food system can be, in many ways, vast and unnoticeable to the everyday food consumer. The origin of foods, ingredients, and their impacts often go widely unknown to the average person. It is clear that in the present state, the global food system has influence on nearly every part of the globe, including Warren County, Missouri. Ultra-processed foods are one of the fastest growing food sources in high and middle-income countries, and their rapid growth and ease of accessibility promote high levels of consumption across the food system ([47](#)). This is felt in the studied food desert through the high amounts of fast-food restaurants and convenience marts throughout the region. Additionally, global food corporations operate in a growth oriented and profit driven model ([48](#)). It has been argued that the capitalistic, growth oriented global economic system has heavy influence on the global food system's methods of operation ([48](#)). This comes with troubling effects at the community level of the food system. Prices can be driven higher for nutritious foods and foods that are cheaper to manufacture, such as processed foods, can be made cheaper to the consumer. This has a deep, systemic impact in communities such as the food desert being studied. While these are important to consider, global food access factors are largely out of reach for local communities to address. These problems are highly complex and require international, systemic change from all levels of government and society to truly be impactful to promote health and access to nutritious foods. Therefore, while these are an important piece to the Warren County food access puzzle, this study will not aim to solve global food access factors.

National/Regional

At the national and regional levels, this is where factors begin to feel a little closer to

home. The factor I would like to return to in this section is SNAP benefits. As previously discussed, there is a shortcoming of residents in the region who are eligible for the benefits but are not signed up to receive the benefits. Most research on this topic focuses on the economic viability of SNAP and the products it offers. It is proven that, when received and used, SNAP increases food security and promotes health (49). One issue with SNAP is that it does not account for the true cost of healthy foods or standards of living (49). This leaves consumers with a difficult decision on whether to buy cheaper, unhealthy options or fewer healthy options. In addition to economic issues with SNAP, there are deep social concerns with the program. One study found that most people receiving the benefits do not want to rely on the program for nutrition assistance (49). This study suggests there is a social stigma that comes along with signing up for and utilizing the program. The study of SNAP participants found that “feeling judged and devalued was one of the most often reported challenges among participants” (49). This data suggests that not only can physically signing up by accessing the internet or a resource center be a barrier to SNAP benefits, but faults in the design of the program and the social stigmas that are associated with the program further hinder access, effectiveness, and desire to participate among food insecure residents.

SUGGESTIONS FOR IMPROVED FOOD ACCESS

A scenario that has been created in Warren County where grocery store access is a small factor in food accessibility to people in the region. If the food desert classification for the region were not defined by a one-mile distance to the nearest grocery store, it can be assumed that supermarket access would not be an issue in the region because all corners of the food desert lay within 10 miles of the nearest supermarket. The findings of high supermarket access corroborate previously mentioned research about how supermarkets located in a food desert are not a simple path out of food insecurity and food desert status. The contrast of the abundance of grocery stores in the region compared with the heavy influence that grocery stores have on determining food desert status calls for investigation into how food deserts are classified through the USDA’s food desert atlas. However, as I have shown, regardless of grocery stores in the region, there are still many individuals in the census tract that experience food insecurity for a number of other reasons.

SNAP Benefit Improvements

As I have discussed, increasing the usage of SNAP benefits in Warren County, Missouri has the potential to remove food insecurity from many residents in the area. There are a number of subtasks within this solution, however, it starts with ensuring all who are eligible are signed up to receive the benefits. Suggested methods for increasing the usage of benefits for eligible residents can come through increased government funding for sign up efforts, standardizing and simplifying sign up forms, and increased support for community organizations and other non-profit groups working to reach those not signed up (53). Next, the need to adjust the benefits based on the cost of healthy, nutritious foods should be a focus of the program. The benefits should be altered to meet the true needs of the cost of living, and the benefit amount should constantly fluctuate with the price of food, ensuring people do not get priced out by inflation of food costs. One study showed that SNAP participants said they would need \$10-20 more per person to meet dietary needs each week (54). This further highlights the shortcomings of the amount of benefits being given to participants. Removing harmful, devaluing language from

public assistance programs such as SNAP is a systemic change that involves us all. Resource center employees, grocery store clerks, grocery store shoppers, media, and elected officials all play a role in ending stigmatization against those receiving assistance. Lastly, there needs to be continued efforts to work to bring residents out of and beyond SNAP benefits. In 2023, Missouri passed legislation that would create a separate public assistance bucket for transitional assistance to SNAP recipients who have breached the maximum threshold for income to be on the benefits (55). This bill, which has yet to be implemented, has the ability to ensure people transition out of SNAP in a healthy manner and it aims to decrease the amount of returning users to the public program.

Community Based Agriculture Systems

Improvements to the SNAP system can provide more immediate relief to those experiencing food insecurity. In order to address long term food access needs, community-based agriculture systems should be considered. Peri-urban regions have the ability to grow larger amounts of food due to the larger amount of land they sit on, and they can be critical pathways to feed both peri-urban and urban regions (56). Developing a community driven framework to improve the peri-urban agriculture landscape in Warren County not only has the ability to provide a pathway out of food insecurity, but also has the ability to stimulate economic growth in the region. Increased access to and usage of community gardens can be key to agriculture education and production for the Warren County community. This method does not require but can encourage residents to take action to grow their own fruits and vegetables on their home property, increasing the amount of small farming operations in the region. The more widespread growth of agriculture and small farming operations happening throughout the county would provide a foundation for more direct-to-consumer sales from farmers to residents. This increases overall fresh produce in the region and has the potential for small farmers to informally offer it to their neighbors for a cost that is much more achievable for low-income residents than the costs supermarkets offer. Other methods to improve at home horticulture are through ‘do-it-yourself’ or grow kits. Both India and Switzerland have government supported grow kits for their residents to promote widespread at home agriculture (57). Adopting practices such as these at the local, state, or federal government levels can stimulate at home farming production and education. Additionally, creating more direct-to-consumer avenues for small to mid-level farmers to distribute food to the local community should be considered. Establishing a network of farmer’s markets and CSAs throughout the region could allow for fresh produce to end up on many more plates in the county. When developing community-based agriculture systems, it is of the utmost importance to have these efforts be guided by residents and small farmers within the community. Their input into the systems that are created will lead to a higher level of success of the food systems.

APPLICATION BEYOND WARREN COUNTY

Performing a case study on a specific census tract in Missouri is an efficient way to analyze a singular group of people who are experiencing food insecurity. Part of the goal of this research is to understand how the information discovered in Warren County could be applicable to other food deserts throughout the state. To do this, census data was gathered and analyzed for all 240 census tracts categorized as food deserts in the state. These 240 were pared down based on similarities to the Warren County food desert. I utilized the following qualifying factors to

develop a list of census tracts that were similar to Warren County.

- Classified as an urban census tract
- Poverty rate less than or equal to 25%
- Food deserts in the counties of Boone, Greene, Jackson, St. Louis City, and St. Louis County were removed due to their more densely populated urban geography
- Recognized as low vehicle/transportation access

The result of this filtering exercise left 38 food deserts in the state which have similar geographies and characteristics to their food desert classification to the Warren County food desert that has been studied. These 38 food deserts can be viewed in appendix Table 1. To further analyze these food deserts in relation to Warren County, their SNAP benefit usage versus eligibility was charted. See Figure 3 for this comparison.

SNAP Recipients vs Eligibility

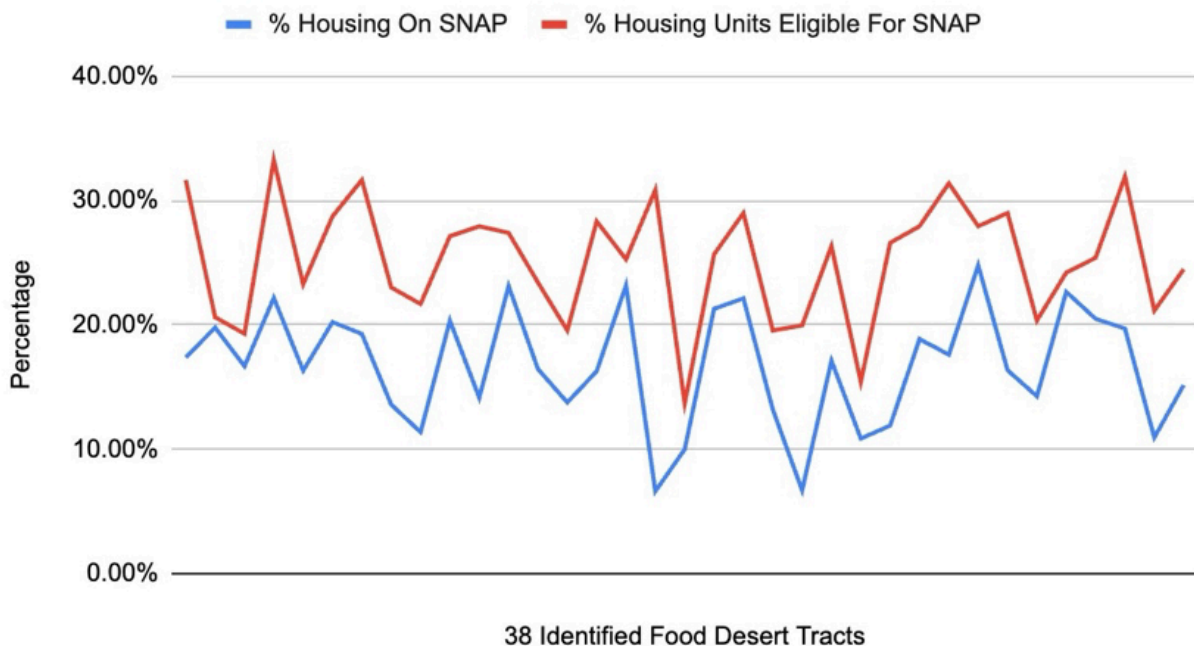


FIGURE 3 (3)

The issue of not having all eligible housing units signed up to receive SNAP benefits is a problem that is not unique to Warren County. The chart shows a clear gap in the similar food deserts by having higher eligibility than people receiving and using the benefits. This further highlights the issues stated previously with the effectiveness of SNAP and the social implications that prevent people from using SNAP benefits.

CONCLUSION

The analysis of a singular Warren County, Missouri census tract classified as a food desert has revealed opportunities to improve food access through the increased effectiveness and usage of SNAP benefits and the increase in community-based farming solutions and direct-to-consumer sales of farm fresh produce. With a focus on the peri-urban geography of the food desert, suggestions were made based on the unique situation that these understudied regions bring. The data gathered displayed a group of people living in Warren County who were eligible for the benefits but were not signed up to receive them. This highlighted many issues with the SNAP benefit program including outreach to eligible residents and social concerns with the program. In addition to government assistance programs, there was found to be a lack of farm fresh produce options in the area. While the region has a large presence in farming, community-based agriculture systems should be explored as avenues to encourage higher growth of fresh produce and to increase options for small farmer to consumer sales. These results and suggestions were compared to all 240 food deserts in the state of Missouri. An additional 38 peri-urban food deserts were found to have similar characteristics to the studied Warren County food desert, implying that while the case study was narrowly focused on a small subset of the Missourian population, the opportunity for improvements in food access across the state is vast. The assumption can also be made that peri-urban regions like these identified in Missouri exist across much of the United States, calling for similar reform and solutions to increase food access.

The work to increase food access to peri-urban regions is one that takes years to improve. It is important to note that this study has highlighted two large areas for improvement that have timelines that are potentially deep into the future. A combination of efforts is needed along this journey. This includes continued efforts that the community, government, and organizations are currently working tirelessly to implement to get food to residents on a daily basis. While the projects suggested consume time and resources, the necessity of addressing the immediate needs of those who are food insecure should not be overlooked. Systemic improvements should be worked alongside short term needs for food access.

This research focused on archival, quantitative data to form an argument and present opportunities to the food access issue in Missouri. This research project did not present the opportunity to include ethnographic components or the lived perspectives of those residing in the Warren County census tract being studied. Future studies should work to document challenges low access residents face firsthand to better understand solutions that the community wants and needs to lift itself from a low food access status. Additionally, there are a wide range of factors that influence food access. The scope of this study did not allow for the exploration of all potential reasons as to why residents in this region struggle to access food.

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Appendix

Table 1

Missouri Food Desert Census Tracts Similar to Warren County

County	Census Tract	Population, tract total	Tract poverty rate
Audrain County	29007950500	3582	23.8
Bates County	29013070300	4520	15.5
Butler County	29023950300	7046	14.5
Butler County	29023950800	3039	25
Camden County	29029950500	3726	17.5
Carroll County	29033960300	4120	21.6
Cass County	29037061400	5310	23.8
Cedar County	29039870200	5002	21.7
Clay County	29047021208	6134	17.3
Clay County	29047020201	5004	16.3
Clay County	29047020500	5911	20.4
Clay County	29047021702	6446	21
Cole County	29051010500	4824	20.6
Dallas County	29059480200	5198	17.6
Franklin County	29071800902	6727	14.7
Grundy County	29079960400	3540	21.3
Henry County	29083950500	3995	19
Jasper County	29097011700	6467	23.2
Jefferson County	29099700208	5818	10.6
Jefferson County	29099700900	5340	10.3
Jefferson County	29099701200	5856	19.3
Laclede County	29105960400	3853	21.8
Lafayette County	29107090601	6233	14.7
Lawrence County	29109470601	4945	15.2
Macon County	29121960500	2728	15
Madison County	29123960200	5243	19.8
Pettis County	29159481000	4480	11.6
Platte County	29165030001	7735	20
Ray County	29177080200	6433	21
Saline County	29195090300	3073	23.6
St Francois County	29187950902	7134	21
St Francois County	29187951100	7781	21.8
Taney County	29213480105	6529	15.3
Taney County	29213480201	9130	18.2
Taney County	29213480502	7506	19.1
Vernon County	29217950300	6049	8

Vernon County	29217950400	3197	24
Warren County	29219820102	8412	15.9
Webster County	29225470201	5113	18.4

Voices of the Coast: Women's Narratives on Microplastics in Coastal San Diego Communities



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MESH 540 Final Project

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Abstract

The present project investigated how small particles of plastic waste, otherwise known as microplastics, are perceived by female-identifying members of two different coastal communities in San Diego, California, whether these effects and interactions differ between cities, and how these conversations can help encourage plastic circularity environmental programs or community involvement. Two groups of female-identifying participants volunteered to take a preliminary independent survey to share their baseline knowledge of microplastics and then interviewed in a group panel with other female-identifying contributors from their same community to discuss how they interact with microplastics. Participants were also presented with images in the initial survey of different sources of microplastics and asked to identify which household items they believed emitted microplastics. The study showed that panel participants from the northern coastal community cohort were more independently educated on microplastics than the panel participants from the southern coastal community and did not report as many respiratory and reproductive health issues that they believe were related to microplastic exposure. The panel participants from the southern coastal community were more interested in learning about microplastics and felt disproportionately impacted by them due to their physical proximity to the polluted water and air from the Tijuana estuary. The findings ultimately show a discrepancy between the two cohorts and highlight the greater socioeconomic impacts of microplastics on coastal communities, as well as a demand for improved plastic circularity programs and education.

Introduction

Microplastics, defined as plastic particles less than 5 millimeters in diameter, have become ubiquitous contaminants in marine and terrestrial ecosystems. Originating from the breakdown of larger plastic debris and the release of microbeads from now-illegal manufacturing methods for consumer products, microplastics pose significant environmental and health risks to all living organisms. They result from the breakdown of everyday items from textiles and cosmetics, to single-use plastics and tires. These particles can be ingested by marine organisms, subsequently entering the food chain and potentially impacting human health. Recent studies have highlighted the presence of microplastics in various human tissues, raising concerns about their effects on human health, particularly reproductive health.

My MESH project focused on the issue of microplastics and their impact on the environment and, specifically, women's health. To narrow the scope, the research conducted was concentrated on the lived experiences of women in South San Diego, examining how microplastics affected their daily lives and identifying how women interact with microplastics on a known or unknown level. The central research question guiding this study was:

What can the voices of women in our Coastal San Diego community teach us about how we understand and relate to microplastics, their impact on human health, and how

discussing these topics can promote environmental programs focused on reducing plastic waste, advance women's health, and support circular economies?

This question captures the essential elements of my MESH project, including the demographic focus, geographic area, and the broader implications that microplastics pose for public health and environmental policy. It uncovers how specific groups like fenceline communities, or areas that border high-risk areas like waste disposal sites, are disproportionately affected by exposure to microplastics and how these communities feel that this specific waste impacts their health. The goal of this study was to uncover why microplastics have become pervasive in our ecosystem and to understand women's perspectives on the presence of plastic particles in their bodies, bloodstream, and overall health. Additionally, it investigated whether there is a perceived gender inequality in pollution impacts or an acceptance of the non-communicable diseases associated with two developed environments within San Diego County. The epistemological stance of this project was influenced by my personal experiences finding plastics on my local beach walks, and it aimed to gather insights from other women in coastal cities to assess the extent of concern regarding microplastics.

The methodology involved collecting qualitative data surrounding the general sentiment towards microplastics among women and their understanding of the perceived associated health effects on female health systems. This included exploring consumption patterns related to single-use plastics throughout their lifecycle. The research incorporated interviews with thirteen women from two geographically distant regions of San Diego at two separate libraries. This is also combined with personal observations of plastic litter in local ecosystems, particularly around Mission Bay and Pacific Beach. These observations aimed to provide a comprehensive understanding of community awareness regarding microplastics and their localized impact. The findings of this study show that there is a definitive and serious concern posed by microplastics and their growing threat to ecosystems within the female community of both areas. Additionally, the research proved that levels of education, access to information and geographic vicinity to the Tijuana estuary.

Literature Review

This literature review focuses on academic journals, technical reports, articles and books that support the aforementioned research question and ultimately aid in telling the full story of material origination, existing health research and solution-based plastic circularity programs relating to microplastics. With this developing research question in mind, the following literature will act as connecting pieces to define microplastics, underline how humans interact with them, explain their effect on human health and develop a comprehensive review of how circularity can fit into this microcosm of greater waste management discourse.

Theoretical framings that were used to understand the context and data collected included an environmental justice framework and integration of valuable perspectives like that of the

feminist theory and the circular economies. Based on the aforementioned research question, I shaped the following study to investigate whether marginalized communities bear a disproportionate burden of microplastic pollution and dare to connect this to additional principles based in feminist theory and intersectionality. Furthermore, I framed my research questions to capture how gender intersects with environmental issues, especially as I know that feminist theory emphasizes power dynamics, social justice, and women's lived experiences. This is where the interviews conducted and data were interpreted within these specific frameworks and created a value-add commentary on microplastics from a unique lens.

Methodology

When deciding how to search for literature, there was an added emphasis on finding variety in sources, timelines, and perspectives in order to understand the issue of microplastics from a holistic perspective. Keywords included, but were not limited to, the following: 'Microplastic AND Infertility', 'Plastic AND Circular Economy', 'Community based Environmental Research', and 'Bioaccumulation of plastic'.

In order to maximize the search results relevant to this two-pronged research topic, there was extensive work done to improve the search inclusion criteria to focus on the following:

- Women-Focused research
- Relevant Location
- Environmental Stewardship Programs
- Resources that are peer-reviewed

These were necessary for this research to focus on the female lived experience, especially those specific to their relationship with microplastics and relevant environmental programs as it relates to those living in coastal environments. Additional inclusions aligned with the academic search for peer-reviewed publications that were not outdated to ensure accurate and credible detail.

Once the sources were narrowed down, sources were selected based on the varying perspectives being offered and filling gaps where more factual details were needed. Some articles offered the baseline explanation of what microplastics are and how they are made, whereas others included their effects on human health or bioaccumulation. Technical reports were selected to establish a baseline understanding of microplastics and health-related data for the reader.

Thematic Literature Review

Understanding and Relating to Microplastics

Microplastics or 'microlitter' are classified as any plastics less than five micrometers. Andrady (2003, [2011](#)) provides the following definition of microplastics and outlines the main reasons why these fine plastic particles have become so critical to waste management discourse, the source of their spread and ecological impact that follows.

1. Microplastics are classified as ‘barely visible’ particles that are able to fit through a 500 μm sieve but too large to pass through a 67 μm sieve ($\sim 0.06\text{--}0.5$ mm in diameter). Small particles like resin pellets that are greater than 0.5 mm in diameter are classified as mesoplastics, but are still within scope of small plastic waste particles.
2. The majority of marine microplastics originate from the weathering of mesoplastics and larger plastic fragments, at which the weathering process of the litter is often catalyzed via hot temperatures and sand sifting.
3. Lower production costs of synthetic plastic materials versus traditional paper or glass packaging has resulted in nearly one-third of all plastic produced going towards consumer packaged products, including single-use plastic items.
4. Land-based sources, including beach litter, aquaculturing practices, and fishing contribute about 80% of the plastic debris in the ocean.

Distribution of Plastic Production Worldwide in 2018, by type

Plastic Class		Percentage production #	Products and typical origin
Low-density polyethylene	LDPE LLDPE	17%	Plastic bags, six-pack rings, bottles, netting, drinking straws
High-density polyethylene	HDPE	15%	Milk and juice jugs
Polypropylene	PP	23%	Rope, bottle caps, netting
Polystyrene	PS	7%	Plastic utensils, food containers
Foamed Polystyrene		6%	Floats, bait boxes, foam cups
Nylon	PA	<3%	Netting and traps
Thermoplastic Polyester	PET	7%	Plastic beverage bottles
Poly(vinyl chloride)	PVC	16%	Plastic film, bottles, cups
Cellulose Acetate	CA	N/A	Cigarette filters

fraction of global plastic production distributed worldwide in 2018 ([Jaganmohan via Statista, 2024](#))

Table 1: Plastic classifications for materials most commonly found in the ocean ([Andrady, 2011](#)). Percentage production (%) updated to reflect 2018 plastic data via Statista ([2024](#))

Public Perception

The first theme to be uncovered within the process of relating to microplastics is that of public perception. In 2022, [a European study](#) was published and titled, “*What does the public think*

about microplastics? Insights from an empirical analysis of mental models elicited through free associations”, which provides valuable insights on this exact question. Unlike my study that focused specifically on female-identifying subjects, this article uses a sample Norwegian population (N=2720) to understand the public perception of microplastics (Felipe-Rodriguez et al., 2022). The study participants had been asked to recall their thoughts when encountering the term “microplastics” and their responses were then categorized into clusters of thematic notes. Subjects were also briefed with the background knowledge that microplastics are defined as small plastic particles that exist as a whole or from broken down, larger pieces resulting in microparticles of five micrometers in size or less. The findings suggest that people generally perceive microplastics very negatively, associating them with pollution in the ocean and being harmful to the local wildlife. However, the general awareness of microplastics' sources was low, and the study mentions how few participants knew of any real solutions to the problem. Another interesting finding shows that socio-demographic factors influenced the participants' responses to these questions, thereby supporting my original MESH research question. Conclusive to the study, women and younger individuals (ages 18-24) were more likely to consider the functional spread and material sources of microplastics. Further, participants with higher education levels more often thought about creative solutions to attack the issue. Most of the solutions noted were looking at microplastics from a point-source starting with poor waste management practices in their local municipalities. Additionally, there was an additional component to the study that factored in personal values. Values such as self-transcendence and openness or willingness to change were linked to considerations of microplastics' solutions and consequences (Felipe-Rodriguez et al., 2022). These insights can help guide what will eventually be a community panel within the local San Diego coastal communities and help in understanding what a similar study was able to uncover in their community conversations. Lastly, the sentiments taken from this study assist in the way that academics tailor future communications surrounding microplastic discourse, primarily influencing the way that I conducted the following study, and proposed interventions to reduce plastic pollution effectively, especially when it is now known that certain education backgrounds, genders and social demographics have unique perspectives on this topic.

The second theme that is critical to understanding microplastics lies within the community perspective. The following study found in the University of San Diego's Digital USD library highlights coastal San Diego microplastic findings and showcases how sediment samples laced with microplastics reframed a University of San Diego study in 2019. Undergraduate student Rachel Sarner set off to understand if microplastics are present in offshore ocean sediment and, if so, what types of plastic are most commonly found. In their study, the student used a multi corer able to pull sediment samples from 100 to 960 meters below sea level, resulting in the finding of microplastic fibers all the way down to 960 meters which suggests that plastic pollution is able to accumulate within deep oceanic basins on Southern California's continental margin (Sarner et al., 2020). This was a direct report to localize the threat of microplastics directly within coastal San Diego waters and is intended to help tell the story of how these pollutants are not only

present in this coastal ecosystem but also engaging the local academic community to redirect their undergraduate research towards solving this continuously growing problem.

Impact on Human Health

Moving forward into the next theme, this review will cover the findings of health risks posed by microplastics. The following studies are primarily focused on reproductive health within the human body as it relates to microplastic exposure, however, there is also discourse surrounding non-communicable diseases that are claimed or made worse through coming in contact with plastics in air pollution. For example, fenceline communities, or communities that are in the vicinity of plastic production or waste disposal sites, have been found to experience increased risks of asthma, low birth weights, childhood leukemia, heart disease, COPD, lung cancer and premature births ([Landrigan, et al., 2023](#)). In 2023, Science of the Total Environment published an [article](#) on the adverse effects of micro and nanoplastics in the human reproductive system. To set a baseline, the paper discusses how microplastic particles are able to enter human bodies through primary sources of ingestion, breathing them in and by skin contact. Once they enter, these small plastics are able to direct towards the reproductive system depending on their size and disturb germ cell or somatic cell development. This study represents a systematic review of all adverse effects of plastic micro-particles on human reproductive function and offers insight into germ cells development stages with areas of potential disruption. There is a specific line added to specify the distinction between microplastics and nanoplastics: (MPs, 100 nm < diameter < 5 mm) and nanoplastics (NPs, diameter < 100 nm), which is critical to designate between the sizing as it relates to any technical journal references ([Hong et al., 2023](#)). Further in the study are findings of ovarian dysfunction, disturbed embryonic development, and ovarian inflammation within mice over the course of thirty-five days being exposed to microplastics ([Hong et al., 2023](#)). In another study titled *Plasticenta*, it was confirmed that microplastics can be found in nearly every human placenta, causing a need for concern in the greater conversation surrounding the grave threat that plastic pollution places on female bodies, along with their children ([Ragusa, 2021](#)).

Efficacy of Environmental Programs

The last theme to be reviewed in the area of environmental programs and circular economies, focusing on how they can tie into this overarching interest in microplastic discussion. There are two programmatic sides, social and governmental, that will be explored. On December 28, 2015, President Obama signed the Microbead-Free Waters Act of 2015 into law which banned all plastic microbeads typically found in personal care products. For reference, these beads were used for exfoliation and abrasion in face washes and toothpaste which were designed to flow down drain after use with no expectation to break down. This act called for an immediate halt on manufacturing products that contain them. This act stopped the introduction distribution of plastic microbeads into our ocean, sewage systems and coasts by July 2019. It was estimated that this act eliminated a daily release of around eight trillion microplastics into sewage systems and

ocean waters (NOAA, 2015). Moving into the review of literature on circular economies and their effectiveness in reducing plastic waste and supporting sustainable development, look no further than the [Ellen MacArthur Foundation](#). The three main principles shared by the foundation to achieve plastic circularity are to:

1. **Eliminate** any and all unnecessary plastic items from the production process.
2. **Innovate** to ensure new plastics are reusable, compostable or recyclable
3. **Circulate** the existing plastics in our supply to keep them within our economy and out of landfills or natural environment

Plastic circularity relates to production and product lifecycle of plastics and how this can be improved to create what is known as a circular economy for this stereotypically polluting material. The foundation has multiple posted case studies about success stories relating to businesses and cities that were able to implement circular methods to reduce the amount of trash that is sent into landfills and oceans that is eventually broken down into smaller pieces of plastic that are essentially impossible to recycle. Overall, this foundation emphasizes designing out waste, keeping plastics in use over multiple lifetimes, and prioritizing low-cost recycling. The initiative involves collaboration among businesses, governments, and NGOs.

Gaps in Literature

Some gaps that have been identified in this study include limitations in full long-term studies of health impacts as it relates to microplastics. Although there is the valuable study surrounding mice exposed to MP's and NP's, it is not clear how a long-term feasibility study would look with human subjects who are already exposed to microplastics in their daily lives. There was a lot of research that came out recently on the presence of microplastics in testes and specifically the male reproductive system, but not as much on females.

Methodology

Research Design

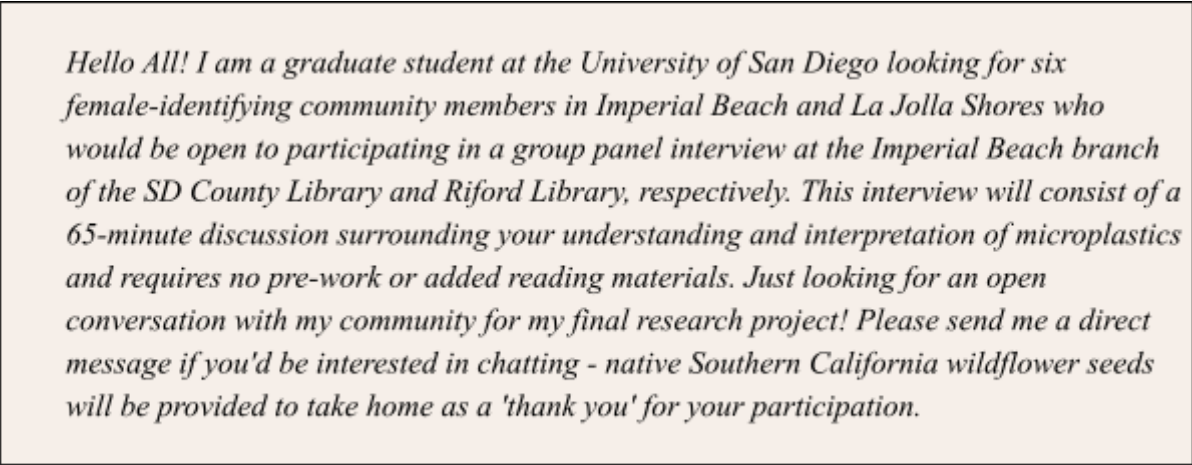
Following the literature review for this project, it was evident that community voices, specifically those of women in coastal communities, were underrepresented in the datasets. The majority of quantitative data gathered did not fully capture the experiences and perspectives of the particular groups that were central to my original research question. Therefore, it was critical to conduct further research on a local level to address this gap.

To properly address the environmental injustice related to the issue of microplastics in two different San Diego communities, this study was based on ethnographic research and subsequent qualitative interviews. Ethnographic research is an immersive approach to gathering qualitative data that emphasizes engaging with a group, conducting interviews, and observing the group to find meaningful interpretations of their behavior (Singh, [2023](#)). This approach was critical for

conducting the style of study that best suited my research question, as it allowed me to speak with key voices within the community and observe how members of the community interact with plastics on a typical day. Ethnography also allowed for a deeper dive into the lived experiences of these women and created space for me to capture the nuanced perspectives that my previously researched quantitative methods likely overlooked. Additionally, being physically present in my coastal community created space for me to accurately contextualize each participants' narrative and extrapolate richer qualitative data. I ensured that the panel interviews felt small and personal, being sure to include introductions, explain my passion for the topic and academic journey, and build a healthy and strong rapport with my volunteers to ensure that the environment felt nonjudgmental and encouraged candid, real responses.

Participant Selection Process

The study focused on two coastal communities in San Diego: La Jolla (Group A) and Imperial Beach (Group B) and specifically included female-identifying participants. In order to gather participants from each neighborhood, I submitted a post using the social media platform Facebook to a San Diego women's group page that I was already a member of. This Facebook group was created to foster a community of women who are interested in making new friends, participating in group activities and sharing community news. Also note that this group has an age range of 18 to around 35, creating a large age range of possible participants. I was approved by the group page administrators to share the following text post:



Hello All! I am a graduate student at the University of San Diego looking for six female-identifying community members in Imperial Beach and La Jolla Shores who would be open to participating in a group panel interview at the Imperial Beach branch of the SD County Library and Riford Library, respectively. This interview will consist of a 65-minute discussion surrounding your understanding and interpretation of microplastics and requires no pre-work or added reading materials. Just looking for an open conversation with my community for my final research project! Please send me a direct message if you'd be interested in chatting - native Southern California wildflower seeds will be provided to take home as a 'thank you' for your participation.

Figure 1: Outreach message shared on Facebook to gather participants for my study

I chose this participatory format of purposive sampling to ensure a diverse representation of women from various age groups, socioeconomic backgrounds, and levels of engagement with environmental issues in the San Diego community. Once the participants privately messaged me with the interest to participate, I sent them an invitation with details of time and location to meet

at their respective community library. Participants who reached out first received an invitation to ensure an element of random selection. In the end, I was able to interview six

Participants who were willing to meet for an hour and share their experiences and insights at the Imperial Beach public library and six from the La Jolla Riford Library. Note that the original date of interviewing had to be postponed due to the Fourth of July holiday, resulting in 10 of the original 13 participants still included, and an additional three were added by reaching out to auxiliary people of interest from the initial post in the original order that they messaged me.

Consent from Participants

I was very mindful that the volunteers that were interested in being part of the group panel interviews may come from vulnerable populations, suffer from chronic health conditions, or otherwise willingly share sensitive information. For this reason, it was critical to make sure that all volunteers felt that their participation was voluntary, and their conversations could be recorded and transcribed. At no point did I ask participants to reveal their identity, personal information, or image for the sake of my study. Additionally, I made it clear in the introduction that it was never required nor necessary to anonymously share any health history that they did not feel comfortable speaking about.

Data Collection

Data collection was carried out over a period of three weeks. The primary methods included:

Public Space Observation: I immersed myself in the daily routines of the community, attending local events, beach cleanups, and everyday beach goer visits to Pacific Beach. During this time, I would take photos and field notes of how women interacted with plastics and microplastic-emitting materials. This passive form of ethnographic study and data collection allowed me to observe firsthand how women perceive their impact on the environment and subsequently, how they consume plastic products.

Focus Groups: To gain a broader understanding of community perspectives, two focus groups were organized. These discussions provided a platform for participants to engage in dialogue, share collective experiences, and generate ideas for addressing microplastic pollution. The primary takeaway from these focus groups was to gather a deeper understanding of how women from two different communities feel that they have been impacted by microplastics, to what degree they feel that these plastic particles may be affecting their health, how familiar they are with them, and how involved they are in their community to reduce plastic waste.

The La Jolla cohort and Imperial Beach cohort focus group panel interviews were scheduled and conducted on different days one week apart. During both focus groups, I initially asked for permission to record the group session and conversation, provided that no names or identifying information would be collected beyond what was initially known in the participant selection process. Once permission was granted, I began recording the session. It began by asking each

participant to engage in an independent preliminary survey that they took via Google Forms. This survey was intended to capture a baseline understanding of how much the participants knew about microplastics before engaging in the discussion.

The image shows a screenshot of a Google Forms survey titled "General Survey". The survey is part of "Section 3 of 3". The instructions are: "Please answer the below questions openly and honestly. I appreciate your participation." The survey contains five questions:


- On a scale of 1-5, how concerned are you about plastic pollution?
 - 1: I never think about plastic pollution
 - 2:
 - 3:
 - 4:
 - 5: Concern for plastic pollution affects my daily actions
- Do you feel that you have a choice when deciding how much plastic you interact with throughout a given day?
 - Short answer text
- Do you feel that you've experienced any non-specific health conditions that may be related to long-term exposure of plastics?
 - Short answer text
- How likely would you say you are to find plastic trash on your local beach during a 20 yard stretch?
 - 1: I rarely find plastic trash on my local beach
 - 2:
 - 3:
 - 4:
 - 5: I see trash any time I visit the beach
- Which of the below items do you believe emit microplastics?
 - 

Figure 2: Preliminary Survey provided to participants used to gather a baseline knowledge understanding of microplastics for both group panels

Analysis of Interviews and Observations

The collected data for the focus group panel interviews was recorded with the permission of all group participants. Once the focus group interviews wrapped up, I transcribed the conversations verbatim and analyzed both focus group conversations using thematic analysis. Referencing Dr. Linda Bloomberg's *Techniques to Identify Themes in Qualitative Data*, I identified common sentiments, key terms in-context and repeating words that came up in discussions, known as coding, to identify recurring themes and patterns in my qualitative data ([Bloomberg, 2016](#)). This iterative process involved multiple rounds of coding to refine categories and ensure the reliability of the findings, which will be shared in the next session.

Data was analyzed based on geographical location, gender specification and intersectionality. Namely, I am curious to investigate how diverse identities intersect with microplastic pollution exposure. Additionally, I will pull from gender dynamics of feminist theory and my own lived experience to interpret the empirical data related to census collections, academic journals, existing studies and literature used to support this project. Lastly, the epistemological assumptions of my own knowledge gathering through walks on the beach will act as a final framework of how this data is interpreted and aid in generating the final conclusions of this study.

Ethics & Implications

Once I began the group panels, I was very meticulous in making sure the conversations were guided and directionally staying true to my original research question. It was decided that the material value of my work would not require International Review Board approvals due to the material data I was seeking was not requiring any specific health data be divulged from the female-identifying subjects that I was interviewing. Ethical guidelines and intended impacts that helped inform my work thus far included the overarching goal to have meaningful conversations with two nearby communities that are central to the plastic waste issue facing our coastal regions. This meant that there would be no need to gather personal health data beyond what my participants were willing to share. Additionally, it was critical to keep in mind as I communicated with potentially at-risk populations that could be considered fenceline communities that their data and feedback was respectfully recorded in a way that felt congruent with the overarching research question. It was a top priority to ensure that sensitive information was responsibly handled and recorded anonymously.

Results & Discussion

In my conversations, I discovered that eleven of the thirteen participants had a general understanding of what microplastics are, where they come from and that they pose a risk to human health.

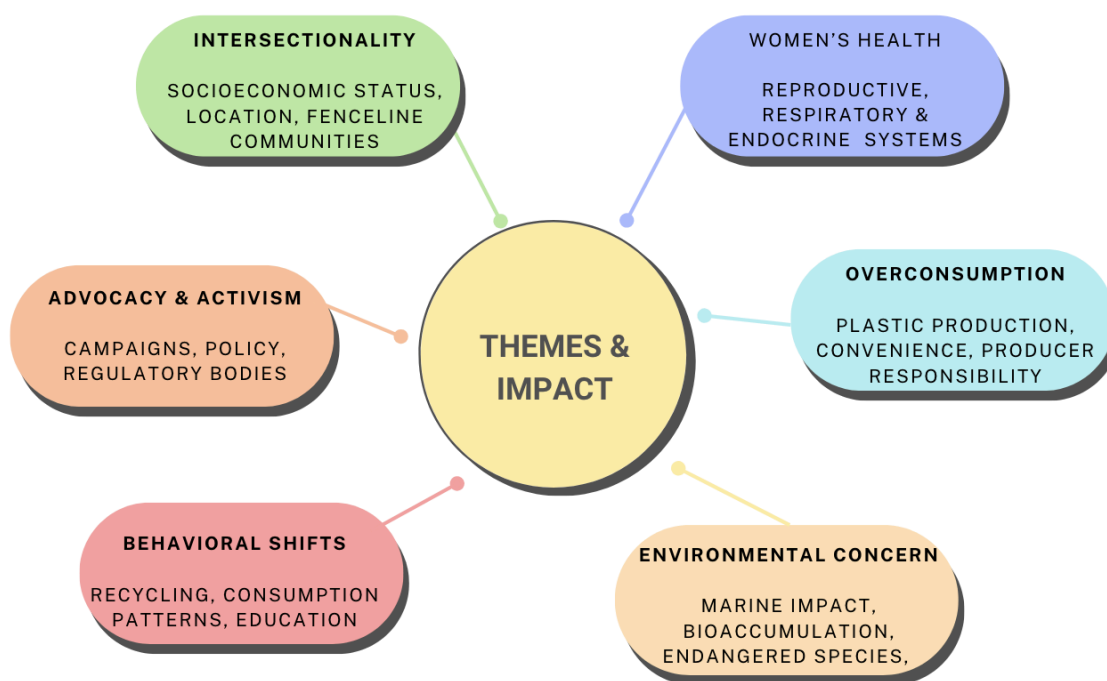


Figure 3: A map of key themes and insights from the conversations had between both groups.

Female Narratives

As seen in Figure 3, the conversations resulting from the group panels had six main themes:

1. **Intersectionality:** Participants felt that their vicinity to waste disposal sites or polluted water and socioeconomic status was related to their level of microplastic exposure
2. **Advocacy & Activism:** Space was created to ask how changes can be made through policy, increased plastic regulations and intervention from governing bodies
3. **Behavioral Changes:** Group A & B both ended their panel interviews with solution-oriented questions and conversations that they could implement in their everyday lives
4. **Environmental Concern:** Participants were concerned about the effects that microplastics have on marine ecosystems and how plastics can migrate through trophic levels via bioaccumulation, putting certain species at risk
5. **Overconsumption:** Both groups felt that plastic production is hard to address with the existing state of consumer mindsets, product packaging and lack of responsibility placed on corporations
6. **Women's Health:** Group A & B both felt that microplastics have a direct effect on their health, with some believing that their exposure has contributed to certain non-communicable diseases.

In particular, my dialogue with Group B surfaced themes of women's health and intersectionality very closely. Those located closer to waste disposal sites and runoff like the Tijuana Estuary felt

that their exposure to plastic waste had directly impacted the health of themselves or their families.

“At some point, how can we as a group not feel like our health is not a priority when we are constantly unable to take our children to the beach because the water is so dirty and trash is everywhere. I don’t see that happening in richer areas [of San Diego].”

- Participant from Group B

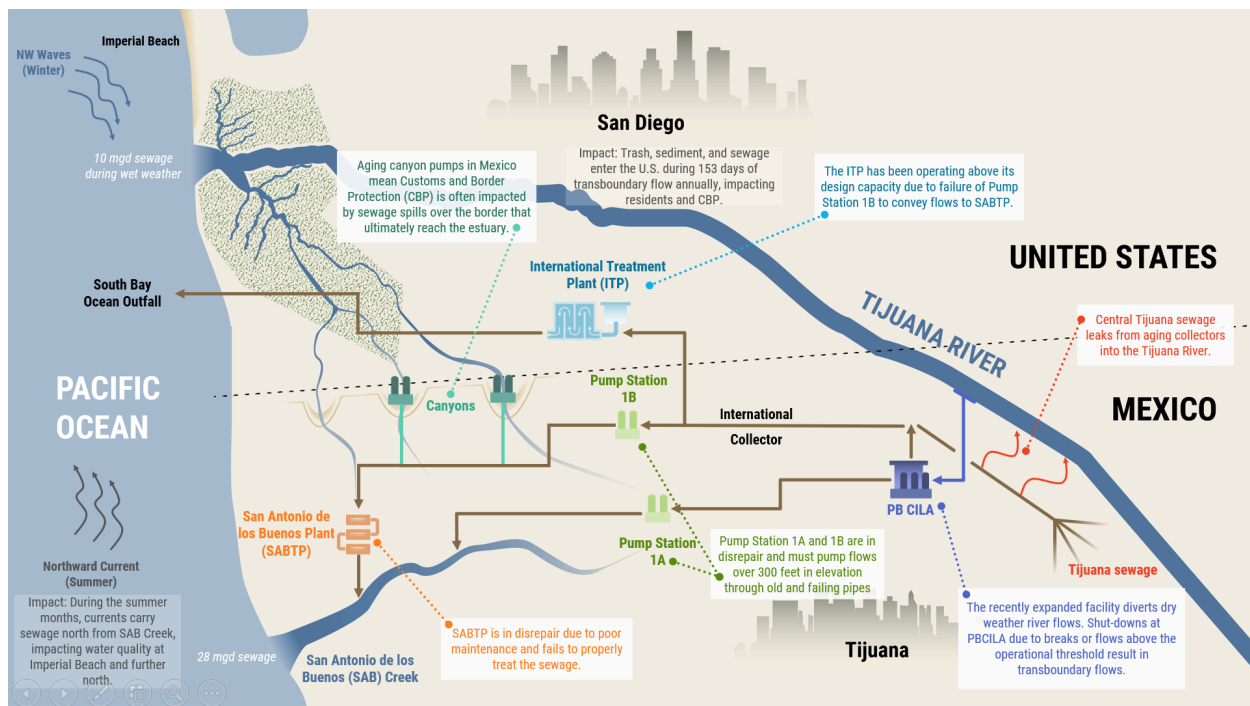


Figure 4: Tijuana Estuary and river flows directly into Imperial Beach via [EPA](#).

While Imperial beach borders Mexico and receives runoff and waste pollution from the Tijuana River, it is also adjacent to the US Naval Landing Field, which contributes additional pollution and creates what was previously referred to as a fenceline community ([Landrigan, et al., 2023](#)). The women of Group B felt that their health was disproportionately impacted by pollution, specifically that of plastic pollution in the air and water, due to their geographic location

Understandings & Relationship with Microplastics

In my panel with Group A, it was found that the women of La Jolla were objectively more aware of the existing research surrounding microplastics and their potential effect on human health.

According to the preliminary survey that I administered prior to the panel conversations, it was found that five of the six women had spent time independently educating themselves on the issue of microplastics, whereas only 3 of the six from Group B had done so. These female narratives reflect that the level of education surrounding microplastic waste and the actual group most impacted by the waste had an inverse relationship. This data and overarching sentiment will continue to be supported as the results of this study continue in the report.

“My knowledge of microplastics feels very limited to the information and events in mainstream media like the Great Pacific Garbage Patch. It is alarming to now learn that [microplastics] come from so many different places. It sounds like we have a much bigger issue in our supply chain and we should be holding these large businesses responsible more than we currently do.

- Participant from
Group B

Within the conversations, it was also clear that the groups also had misconceptions of microplastics and knowledge gaps were present. Common misconceptions that came up in conversations included one panel member believing that microplastic spread was only limited to water. They were not aware that microplastics can be spread through soil and as particulate matter in the air, contributing further to non-communicable diseases such as asthma and cardiovascular events ([Marfella, 2024](#)). There were also side conversations that alluded to concepts like extended producer responsibility and loosely-regulated sustainability goals that companies set, but often do not achieve or get deprioritized.

Connection to Human Health

Based on the data collected, the answers of the preliminary questions have been visualized below to represent the differences in perceived health impacts related to microplastics. Both groups were asked ‘Do you feel that you've experienced any non-specific health conditions that may be related to long-term exposure of plastics?’. It was found that less Group A members felt that they currently had a health condition that may be correlated to their exposure and five of the six in Group B felt that they had.

It was in this area of discussion that the most concern was evident in the group as they continued to discuss areas that I was expecting, such as their own health status, but the conversations quickly evolved to additional concerns for panel members that had children and elderly family

members in their home. This dialogue was shortened to remain in scope of the study, but acted as an important note as the participants shared valuable information regarding their concern for other members of their families who suffered from possibly related non-communicable diseases, although the participant themselves may not identify as being affected themselves.

"It feels impossible to know what caused my personal fertility struggles and asthma, or my mom's cancer when we are exposed to so many toxic materials everyday. It can all feel very overwhelming."

- Participant from Group A

This participant from Group A felt directly affected by microplastic exposure and was very interested in learning about additional health impacts that these finer particles have been found to have on human health. Another participant from Group B had a similar experience with acquiring adult-onset asthma, which falls in line with recent studies where experimental evidence strongly suggests that small plastic particles amplify human susceptibility to a spectrum of lung disorders, including [...] fibrosis, dyspnea (shortness of breath), asthma, and the formation of what are called frosted glass nodules (Saha, [2024](#)). Overall, the participants in the study collectively agreed that they believe there is a clear connection between micro and nanoplastic exposure as it relates to human health, especially as they provided personal anecdotes and some participants voluntarily shared their existing health conditions. This coincides with the overarching goal to answer previously unknown questions around the ways that two different communities of women perceive microplastics and specific ways that they feel these pollutants affect their health and personal lived experience.

Encouraging Plastic Circularity Environmental Programs

The narratives of this study included unilateral interest in plastic circularity initiatives and environmental programs, especially when the programs discussed were focused around education and community togetherness. As a researcher, I was surprised by how many ideas the group was able to come up with in conversation relating to community-based initiatives to improve circularity in their own neighborhoods. Ten of the twelve participants were familiar with plastic reduction programs (not the term 'plastic circularity' specifically) and, of that number, five agreed that they would be interested in participating in a future plastic circularity information session to learn more about the concept, if the opportunity arose. Following that, the group was asked to list ways that they've seen plastic circularity programs in action and named the following list:

- Product refill stations at grocery stores

- Improved recycling education in San Diego
- Closed trash can bins at the beach and organized beach cleanups
- Single-use plastic wrap ban in all grocery stores
- Biodegradable plastic alternatives for single-use plastic utensils

Finally, I wanted to share the overall list of guiding questions that were used in the research to help gather the information shared in this section. Research questions were used to guide conversations for this study include the following table:

Interview Questions
1. Thank you for your willingness and interest in participating in this group panel. What sparked your interest in participating in today’s conversation?
2. What do you think of when you hear the word microplastic?
3. How familiar is this group with microplastic pollution? How would you classify microplastic pollution as opposed to other types and do you feel that it is more or less dangerous than other types of pollution?
4. Does anyone here feel that their own health has been impacted by microplastic pollution?
5. What impact do you believe microplastics have on human health?
6. Are you a member of any community or work-related environmental programs? Do you feel that any programs currently exist to address microplastic pollution? If so, how effective are these existing programs in reducing plastic waste?
7. Are you interested in learning more about microplastics? In what capacity? a. Are you more interested in the effects they may have on the environment, human body, at-risk populations, young populations?
8. Have you heard of plastic circularity? Do you feel that this is achievable with the current state of legislation and local governance?
9. Would you be interested in learning more about plastic circularity or programs that help eliminate future plastic waste and encourage a closed-loop system?
10. Are you familiar with any environmental programs currently that exist to address women's health? If so, have you found these programs effective in educating women on pollution and its relationship with non-communicable diseases?

Thank you so much for your participation. Does the group have any additional topics that you wish to discuss? Any questions that I can help answer?

Table 1: Key questions asked in both panel interviews

Community Spotlight

Throughout this experience, I spent time interviewing and observing my community. As part of this project, I wanted to feature local solutions that are being implemented to improve plastic circularity and will take the next page to feature these critical changemakers in action.



Left Image: Beach cleanups being hosted by Purpose First Beach Cleanup in Pacific Beach

Right Image: Castile soap refill stations featured at a refill-focused store in San Diego's Kensington neighborhood.



Left: Earrings sold at a local farmers market crafted with microplastics hand-harvested from a beach in Hawaii.

Right: Clothing that was collected for a community clothing swap in Pacific Beach

Summary

In this study, I gathered different perspectives from two different San Diego coastal communities, learning about their varying levels of interactions with microplastics based on factors such as their proximity to contaminated water, waste zones and waste runoff from Mexico. I also encountered very compelling participant stories that I did not initially expect when I embarked on this study. One conclusion being that of education level surrounding plastics, waste and specifically microplastics. In the end, my conversations uncovered that the group that was more educated (conventionally taught or independently spent time researching to be generally familiar with the term) on the topic of microplastics was objectively less burdened by their geographic location, that being located further from areas like the Tijuana estuary and in higher cost of living (COL) areas. Furthermore, all the participants were not only excited to share their stories, but returned with additional questions for myself as a researcher. They wanted to know how they could continue the conversations, both learning about plastic circularity and ways forward to help reduce the amount of plastics produced in the future. Conversations ended with suggestions to independently research key areas like extended producer responsibility and feminist theory as it relates to environmental justice. There is no accurate way to calculate how the conversations and interviews that we have conducted will shape any changes in the future, but it is acknowledged that my engagement in the community started very important and critical conversations that empowered the group of twelve women to continue independently learning about microplastics and continue on as educated and present community members. Suggestions for future research can include a more in-depth study of microplastic particulate matter following

rain showers or extreme weather events in both La Jolla and Imperial Beach in order to gain a more granular understanding of exactly how different the conditions are between the two cities. Further, definitive research that directly attributes microplastic particulate matter exposure to increased rates of infertility and respiratory diseases is needed to create absolute and definitive resulting data correlating the two areas.

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The Tijuana River Waste in a Watershed Compromised by Capitalism



Cover Photo: Los Laureles Canyon, South Fork Tijuana River

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In partial fulfillment for the Master of Science in Engineering, Sustainability, and Health

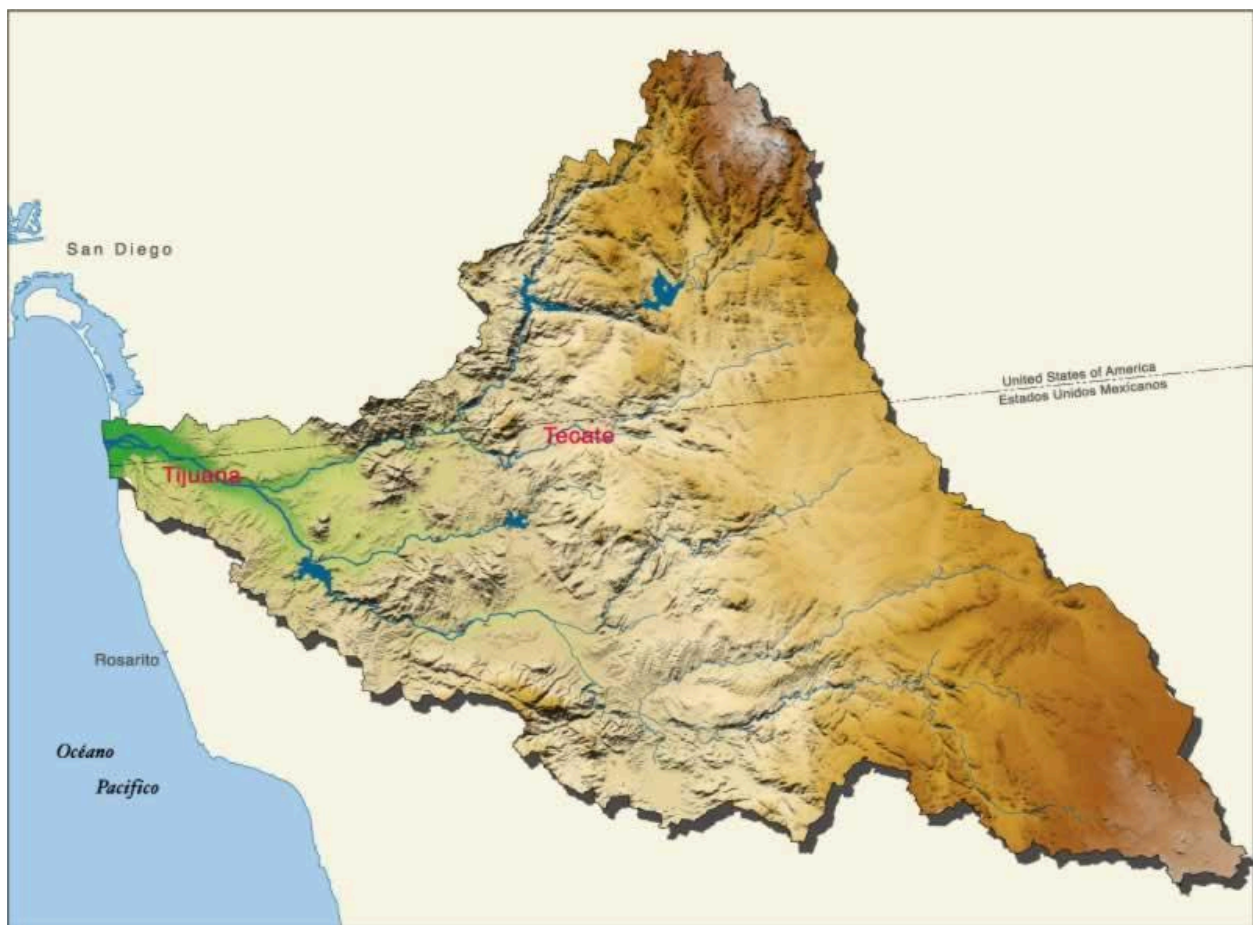
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Abstract

Over the last thirty years, the Mexican borderlands have experienced rapid population growth that have resulted in the conversion of historic wildlands to informal housing settlements. In Tijuana, informal housing developments are pollutant sources, impacting human and environmental health. Informal housing in the canyons of Tijuana have resulted in disturbance of natural hydrologic drainage patterns, often removing vegetation from slopes, rendering the hillsides unstable and prone to erosion. Many overburdened neighborhoods within Tijuana have no formalized sanitary trash collection, shifting waste processing efforts to informal collection. Homes within Los Laureles Canyon in Tijuana have limited access to sanitation services such as potable water or trash collection and have become a vector for trash and biohazardous waste. The lack of municipal trash collection services in overburdened underserved communities have resulted in high levels of pollution. Many vulnerable groups of people are impacted by the waste issue in the South Fork of the Tijuana River, most of these people work and live amongst waste. The water quality of the Tijuana River is heavily degraded, consisting of wastewater, stormwater runoff, and variable sources of groundwater. During storm events, increased storm flows mobilize pollutants down gradient, where trash and biohazardous waste are transported across the international border and into San Diego County California. Current ecological rehabilitation efforts focus solely on California; water quality improvement efforts occur at the international border and within the California reaches of the watershed. This restoration approach provides no community benefit to Tijuana and fails to manage pollutant control at pollutant sources. In April of 2023, I traveled to Tijuana Mexico to document impacts of aquatic and terrestrial degradation in Los Laureles Canyon Tijuana Mexico, that was later used as a visual when conducting qualitative interviews. The research of this case study aims to identify social, political and economic factors that have led to the degradation of the Tijuana River, with the intention of identifying strategies to overcome transnational barriers in pollution prevention and steer ecological rehabilitation.

Introduction

The Tijuana River watershed spans one thousand seven hundred and fifty square miles across the Mexican state of Baja California and into San Diego County in California. Most of the population, about ninety seven percent, live in the Mexican reaches of the watershed. Within the California reaches of the watershed there are ten census tracts in San Diego County as well as the Campo Indian Reservation. The higher elevation reaches of the watershed drain the Baja California landscape and form the Tijuana River Valley that flows through the city of Tijuana. The densely populated urban center of Tijuana has antiquated drinking and wastewater infrastructure and has uncontrolled discharges of sewage and waste to the river. Managing the large quantities of pollution from Tijuana via transboundary flow has been challenging for watershed managers; the Tijuana River Estuary is down gradient of the urban reaches and is heavily impaired.



Tijuana River Watershed Map (Source: San Diego State University)

Numerous overburdened neighborhoods within Tijuana have no formalized sanitary trash collection, shifting waste processing efforts to informal collection. This form of trash management typically processes and reclaims waste with monetary value. Informal housing settlements and their lack of civil infrastructure are sources of pollution; most have no sanitary services, with entire communities lacking paved roads,

trash collection, sewer connection, and potable water. Trash piles accumulate outside of homes in overburdened neighborhoods, where rainfall mobilizes pollutants down gradient, crossing the international border. With the threat of polluting waterways by transboundary flow, there is a need for environmental planning and policy reform.

The Tijuana River and estuary are listed as impaired for over fifty-five constituent water body combinations. The Secretariat of Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales or SEMARNAT) is the federal entity overseeing the laws, standards, programs, and initiatives that shape the environmental sector in Mexico. This organization is like the United States' Environmental Protection Agency (US EPA) as it is the primary federal regulatory agency of environmental protection. Mexico recycles between ten and five percent of its waste, the burden of recycling and resources recovery has been shifted onto an informal work sector. Local governments in developing countries, especially in high-density urban landscapes like Tijuana, struggle to provide adequate waste management services. An alternative to a formal system of waste management is supplemented by the informal labor sector. In Tijuana, the deficit in waste collection service stems from a lack of infrastructure, and thus causes the unmanaged disposal of significant solid wastes in illegal landfills, empty lots, and streambeds. Most formal waste collection services are non-municipal and require payment for collection, adversely impacting the majority of the city's inhabitants. This has resulted in unhealthy and high-risk conditions for the environment and the public, as trash is often left on the streets and not collected.

Literature Review

There are many environmental and social injustices that have resulted due to the industrialization of the Mexican border for the expansion of the North American economy. "Rapid urbanization has placed tremendous strain on Tijuana's sewage infrastructure, causing significant challenges for communities on both sides of the border." (San Diego Regional Water Quality Control Board, 2023). The data focus of research in the Tijuana River tends to surround the antiquated civil infrastructure such as failing wastewater and drinking water facilities in the urban centers of Tijuana. While this data is important for water quality within the watershed, it does not provide useful information for the amounts of trash and biohazardous waste coming from the informal community developments. Research into the role of informal waste management in Tijuana will be needed to determine if there are more viable pathways to legitimize work while also accomplishing pollution reduction. Focusing on both informal housing communities and informal waste management will contribute to the water quality data for the Tijuana area, as it targets priority areas that have no formalized resources assessments or pollution source identification methods.

The Tijuana River is the most crucial transnational watershed within the Mexican borderlands, as it has the highest population and greatest amounts of industry of any of the watersheds along the border corridor. The economic asymmetries between Baja California and California, the differences in infrastructure and public services, have forged an uneven relationship and have exacerbated environmental and social injustices. "The most critical environmental issues that have been identified include the rapid population growth on the Mexican part of the watershed, the unrestrained

urbanization, the increasing demand for water and basic services such as sewage and wastewater treatment, and the disappearance of important animal and plant species and habitats.” (Castro-Ruiz et al, 2006) Densely populated trans-national communities like Tijuana have a decreasing quality of life. The border is plagued with high levels of traffic, poor air quality, lacks recreational opportunities, diminished public safety, and has higher levels of crime and extreme poverty. Tijuana has extended beyond the landscape’s carrying capacity, where over population and unrestrained consumption has begun to degrade the ecosystem.

The application of contemporary socio-political-economic context is needed to better understand the environmental and social inequities in Tijuana. The literary work, Beautiful Flowers of the Maquiladora: Life Histories of Women Workers in Tijuana, by Norma Prieto, interviews female factory workers in Tijuana between nineteen seventy-two and nineteen eighty-two. “In the 1970s, foreign capital entrepreneurs attracted by duty-free incentives, low infrastructure costs, and cheap labor, installed a platform of assembly plants. The Programa Fronterizo [Border Program] developed by creating jobs and stimulating the economy of the borderlands. The maquiladora [factory] industry is a staple of the Mexican economy and contributes well over thirty-five percent of the total output of the export sector. Tijuana is the center of the maquila industry and houses around thirty percent of the assembly plants in the country.” (Prieto, 1997). The testimonials within the text are important, as factory expansion in Tijuana was increasing due to the Border Industrialization Program, which was designed to replace the farm and railroad focused Bracero Program (Manual Labor Program). The social, political and economic features of the borderlands have attracted transnational corporations and have forged the current relationship of exploitation in Tijuana.

Informal Waste Management

In Mexico, people that work in informal waste management, are often referred to by the term “pepenadores”. The term has some social stigma and even repugnance, it is used to describe people that make their living by picking out and selling reusable or recyclable material from garbage. In some places, informal waste collection is the only form of waste collection. In Tijuana, where the public lives hand to mouth, and cannot afford privatized sanitation services, informal waste collection is one of the predominant forms of waste management. Handling waste poses many health risks. Informal waste collectors are exposed to contaminants and hazardous materials such as: fecal matter, medical waste, toxic fumes, and chemicals. A lack of worker protection and poor access to health care sharply increases the risk of occupational hazards for people that work in this industry. Children can be involved in sorting materials to add to the family income.

Pepenadores contribute to the prevention and management of waste in marine, wetland, and terrestrial ecosystems. Recycling is one of the cheapest, fastest, and easiest ways to reduce greenhouse gas emissions. The reuse and recycling of the materials collected by pepenadores decreases the need for virgin materials in manufacturing. Pepenadores contribute to the local economy, public health and safety, and reinforce sustainable management practices, despite formal recognition from state or government sanitation organizations. The lack of formal legislation addressing the use of informal waste workers for materials recovery is a violation of human and

environmental rights. The waste management processes of Tijuana, or lack thereof, marginalize underserved groups that are coerced into informal waste collection out of necessity as well as lack of formal waste management infrastructure. The poverty and marginalization that pepenadores experience is linked to the value of their work, and while they do much of the hard work their socio-economic situation seems stagnant. The pepenadores' assimilation into the informal waste sector forms a dynamic function within the global economy in waste resources management. Their labor and the degradation of the environment are the undisclosed cost of the waste resources management industry, an area compromised by international business.

Contemporary Political, Economic, and Social Conditions in Tijuana

To improve the social and ecological conditions of Tijuana requires understanding the contemporary political-economic conditions that surround the border. In the early 1990s the North American Free Trade Agreement (NAFTA) established a free-trade zone for North America; Canada, the United States and Mexico, negotiated reduced trade tariffs to boost North American trade. In 2020, NAFTA was replaced with the United States-Mexico-Canada Agreement (USMCA). Trade agreements have proven to be successful at boosting trade for the region, but also exhibit neo-colonial attributes, as multinational corporations have strength in the region. Since the start of the 1990s, North American policies have initiated gross exploitation of humans and natural resources.

The World Bank has been involved with the economic development of Mexico, recognizing their population size and abundant natural resources, the World Bank has been supporting Mexico to expand their access to finance, for growth and poverty reduction. The World Bank has made the following statement regarding Mexico:

“With a population of almost 130 million, a rich cultural history and diversity, and abundant natural resources, Mexico is among the 15 largest economies in the world and the second-largest economy in Latin America. The country has solid macroeconomic institutions, is open to trade, and has a diversified manufacturing base connected to global value chains. Over the last three decades, Mexico has underperformed in terms of growth, inclusion, and poverty reduction compared to similar countries. Its economic growth averaged just above 2 percent a year, limiting progress in convergence relative to high-income economies. Mexico’s stable macroeconomic framework, the U.S. dynamism, and solid manufacturing base will support economic growth. To accelerate sustainable economic growth and poverty reduction over the medium term, Mexico needs to address structural constraints such as limited access to finance, insecurity, informality, regulatory burdens, and infrastructure bottlenecks. Tackling these challenges is essential to fully seize the opportunity that nearshoring represents in the current international environment.”
(World Bank)

The World Bank does not believe industrial manufacturing efforts are sufficient, given the natural resources and population size of Mexico. The last thirty years have resulted in immense industrial production growth along the border-corridor of the United States and Mexico, but it has also been a time of suffering for working people, and a time of widespread environmental degradation. The World Bank is known for pressuring the

expansion of manufacturing along the border corridor but does not provide community infrastructure to support the expansion of the industrial manufacturing economic sector.

The North American Development Bank is a binational financial institution established by the governments of the United States and Mexico to provide financing to support the development and implementation of infrastructure projects, as well as to provide technical and other forms of assistance to projects and actions that preserve, protect, and enhance the environment, and to advance the well-being of the people of the United States and Mexico. The organization is authorized to serve communities located within 100 km North of the international boundary and within 300 km South of the border. This applies to potential infrastructure improvements for Tijuana, as the city is within the required geographic parameters. The North American Development Bank's Community Assistance Program could greatly benefit the most underserved communities of Tijuana, where people employ informal waste resources management measures. The program provides grant financing for critical environmental infrastructure projects in low income-communities, for public entities with limited capacity to incur debt. Grants are available for projects in all sectors eligible for North American Development Bank financing, with priority given to drinking water, wastewater, water conservation and solid waste infrastructure. Grant assistance is available for studies to develop documentation needed to complete a comprehensive analysis of the development so that it supports long-term sustainability. These funding opportunities are exactly what the South Fork of the Tijuana River needs to begin waste resources management , as well as planning and assessment for other civil infrastructure projects within the South Fork of the Tijuana River.

Methodology and Research Methods

The original scope of my research was coordination for watershed planning in the Tijuana River. Additionally, I had hoped to apply the trash management framework in Tijuana modeled after the Los Angeles Region's Nonpoint Source Conditional Trash Waiver. (Los Angeles Regional Water Board) While traveling to Tijuana, I observed measurable differences in civil and social infrastructure, and concluded that these differences would make watershed-based planning using the conventional framework impracticable. In Tijuana, where sanitary trash collection services have been privatized, implementing trash management practices seems to be less pressing when compared to survival. Attending the Degrowth Conference in August of 2023, helped to re-shape the outlook of my research. The conference reinforced the connection between capitalism with the global environmental and social degradation.

The following research questions were used to shape research methodology:

- What social, political, and economic attributes have resulted in the degraded-present condition of the Tijuana River Watershed?
- Given the environmental and social issues related to pollution in Tijuana, what barriers prevent Tijuana from being able to manage trash and biohazardous waste?
- What strategies can be developed to overcome watershed degradation?
- How can the experiences of people living within informal housing settlements inform watershed practitioners to make more informed decisions for equitable and just watershed rehabilitation?

The stories of vulnerable people could be used to weaponize and further marginalize overburdened and underrepresented groups living in the borderlands. Instead of collecting data from members of these groups, two California Government Officials were interviewed. The interviews were semi-structured, allowing for free-flowing discussion. A photo essay was supplemental documenting environmental injustices found in Tijuana. The video interviews were conducted independently, both were recorded and transcribed used Microsoft Teams.



Video Interview with David Gibson conducted on July 9, 2024.

David is the Executive Officer of the San Diego Regional Water Board, the governing agency that regulates water quality within the San Diego Region, notably the California reaches of the Tijuana River watershed. David has been the Executive Officer of the San Diego Regional Water Board since 2009 and has elevated many of the environmental and social injustices of the Tijuana River to the State Water Board and California Environmental Protection Agency. David has been one of the Tijuana River's biggest supporters, advocating for water quality and public health issues.



Video Interview with Susana Arredondo conducted on July 17, 2024.

Susana Arredondo is the Executive Officer of the Los Angeles Regional Water Board, prior to her assignment to the Los Angeles Water Board, she worked in wastewater management in San Diego County. Susana is a local of the Tijuana River watershed and is committed to addressing inequity and environmental disparities in overlooked and overburdened communities. Susana provides unique insight as a watershed local, knowable about the social and environmental injustices of the border, but also as a water quality manager with experience in water treatment and recycling processes.

Interview Questions:

1. Please tell me a little about yourself, and how you began working in water quality.
2. Describe your connection to the Tijuana River Watershed. If you're comfortable doing so, please share any environmental and social injustices that have impacted the watershed over the last thirty years.
3. Based on your understanding of the complex environmental and social issues that surround pollution in the Tijuana River, can you describe any barriers that prevent Tijuana from being able to effectively manage trash and biohazardous waste?
4. Can you suggest any approaches to pollution control that could be transformative to the situation in the Tijuana River? Something resilient in climate change, while also prioritizing equity throughout watershed?
5. With your expertise in water quality, do you have any recommendations for managing antiquated infrastructure and biohazardous waste?
6. Are there any notable bi-national or international organizations making progress in managing transboundary pollutants?
7. In communities like Tijuana where people and the landscape are subsidizing the cost of industrial manufacturing, and people are living amongst waste, do you have any recommendations to make meaningful improvements to environmental protection?
8. Given the history of colonialism and the subsequent neo-colonial trade policies that have dominated the border region, do you feel that international policies could be doing more to help protect the environment in vulnerable places like Tijuana?
9. What do you feel is missing from effectively implementing pollution control programs in bi-national watersheds like the Tijuana River?

Photo Essay of the Tijuana River Watershed:

Sharing photos of the informal housing communities and informal waste workers provides a deeper and more nuanced understanding of the water quality as well as human and environmental justice issues in the watershed, while not endangering vulnerable groups of people. The people of Tijuana are not defined by the waste issue in the watershed. The historical socio-economic and political factors that have led to regional poverty and insufficient housing, highlighting the voices of underrepresented to have a full picture and less of the single-story narrative that the media portrays. The photos highlighted water quality concerns, specifically trash and biohazardous waste, as well as environmental degradation that originates in the South Fork of the Tijuana River before it flowed into California. All photos included in the photo essay were taken by myself from my mobile phone, on April 24, 2023.



Image One: Informal housing in Los Laureles Canyon.



Image Two: A female artisan operates a plastic press to make recycled materials.



Image Three: Delivery of sanitary water in Los Laureles Canyon.



Image Four: A dog carcass lies on top a pile of trash at the bottom of an unpaved street.



Image Five: A pedestrian bridge over a tributary of the South Fork Tijuana River.



Image Six: Locals incinerating trash in Tijuana Mexico.



Image Seven: A wastewater outfall on the South Fork of the Tijuana River.



Image Eight: A slumped bank and buried tire in South Fork of the Tijuana River.



Image Nine: A washed out road along South Fork Tijuana River.



Image Ten: A highly urbanized tributary to the Tijuana River.



Image Eleven: A catch basin filled with tires and sediment.



Image Twelve: The mainstem of the Tijuana River in Tijuana's urban center.



Image Thirteen: The United States-Mexico International Border and Pacific Ocean.



*Image Fourteen: "Tijuana Mexico aqui empieza la patria"
(Tijuana Mexico here starts the motherland)*

Findings from Interview with David Gibson

In the interview with David, he revealed that he is passionate about entomology and the use of aquatic bioassessment for auxiliary indicators of water quality. He began working in the industry, employed by San Diego County in mosquito control, working in vector surveillance, killing mosquitos and protecting public health. Having worked in the Tijuana River since 1991, he elaborated on the environmental and social justice impacts in the watershed. David States:

“San Ysidro is predominantly Latino, and it classifies as a disadvantaged community status by median income. The median income there a couple years ago was about forty-four thousand dollars per household. These are people who don't have the choice to get up and move to another neighborhood, Imperial Beach, although it's not officially a disadvantaged community, mirrors the same demographics. There's just enough less poor people living there to be in the official disadvantaged community category, but it doesn't matter whether you're rich or poor. There's a grave injustice when you're exposed to daily flows of wastewater, and the air quality and water quality impacts that come with those. Tijuana has outgrown the International Treatment Plant, and when one looks back into history, this is a repetitive cycle, where new infrastructure is built, but it was built to what they needed ten years ago to save money. The City of Tijuana continues to grow and outgrows its municipal infrastructure. Both nations are back into crisis mode. Looking at this from an engineering and water quality viewpoint, planned infrastructure ignores the impact to the community. I think it's really telling that Imperial Beach is the only coastal community on the West Coast of the United States where property values have decreased in the last five years.”

While discussing environmental injustices, David referenced research from the UC San Diego Scripps Institution of Oceanography, indicating that people do not have to go swimming in the sewage contaminated surf to get sick. Walking on the beach can get people sick from the sewage being stirred up and sprayed into the air. Exposure can be as simple as walking in the surf zone, and there are health effects cases that have been documented in Imperial Beach.

David stressed the solution to this public health concern is already known, a collection system that's properly operated, of adequate capacity, and designed to expand as Tijuana continues to grow. Until Tijuana has a central collection system that's operated properly and grows as Tijuana grows, and the central regional wastewater treatment plant that is maintained by the United States and Mexico, these problems will continue to reoccur. A key component of the strategy for environmental justice is the installation of a river diversion and treatment system. Data from the Tijuana Estuarine Research Reserve and University of California Santa Barbara shows there's been one hundred percent fish kill in the Tijuana River Estuary in the last two years. The estuary has been historical habitat for ten species before 2021, and now zero species reside in estuary. Within the estuary there are extended periods of anoxia every day, with very limited refugia for the fish to escape to, and likely a toxicity signature as well. There are also industrial contaminants, not just sewage. It's industrial waste, trash, and plastics, with documented human health effects and the risks to environmental health.

Mexico is a country that struggles with basic services; Tijuana is located near the United States and is subject to funding for by projects by the North American Development Bank. Mexico City doesn't have the same level of services that some parts of Tijuana have benefited from, given Tijuana's border location. Trash and biohazardous waste are national problems across Mexico. In Mexico, they have insufficient funding, with no capital improvements budget set. This is a basic barrier to infrastructure maintenance and operations, in any country when you simply don't have the funding, and you don't have the architecture and the management and the planning to foresee problems and deal with them before they become a serious problem and ultimately an environmental catastrophe. David expressed that both nations need to come together on how to manage the collection system in Mexico, and the treatment plant in the United States, for a comprehensive long-term solution. David stated:

“This is a solvable problem. It's an engineering problem and a financing issue. Nine hundred million dollars is needed for the new treatment plant, both countries have about four hundred million dollars allocated. An economy model can be produced for six hundred million dollars. Mexico is investing one hundred and forty-five million dollars and that's significant. They have much less money to work with than the United States. The types of infrastructure improvements implemented are yesterday's technology, undersized, and distant from the source. It is unlikely that there will be a long-term lasting solution that's credible and durable there with the investment that both countries are making, they need to double the investment, and until they do, impacts to San Ysidro and Imperial Beach will continue.”

Noting the amount of tires documented in the Photo Essay attached to the interview questions; David suggested that a tire recycling program be developed by the state of California. Currently, there is a tire resale program in California, where used tires are trucked south to Tijuana to be resold and reused. They use them as building materials and revetment materials on steep slopes. But when it rains, the tires often come down and end up in the estuary. It costs between twenty dollars to forty dollars per tire to be removed from the Tijuana River Valley. In storm events the tires get lodged in the forest. This is important because tires are not only trash, but habitat for yellow fever mosquitos (*Aedes aegypti*), that can also carry Zika, Dengue, and other diseases. Tire removal needs to be prioritized in the Tijuana River Valley. Unfortunately, the business model for tires doesn't lend itself towards effective recycling. There isn't a market for rubber with mercury, zinc, lead, and other metals that are found in tires. David expressed that California needs to find a way to stop tires from entering Mexico and to have less tires return to California by transboundary flow.

In the interview David elaborates on what he calls a “pie in the sky” idea, a solution to the collection system treatment plant dilemma, with an international water district. This water district would have a board of directors appointed by the state and federal governments in both countries, on staggered four-year or six-year terms, and funded by the North American Development Bank. If this bi-national water district is capitalized by both countries, there would be a capital improvements budget for long term ongoing operational maintenance and preventative maintenance for the treatment plant. Other projects funded by the North American Development Bank have been very successful. It

has Commissioners from both the United States and Mexico, and funds projects in Mexico. There's a funding formula which ensures that Mexico pays a portion of the costs and has resulted in improved collection systems and water systems and power systems all along the border between the United States and Mexico. The investments the North American Development Bank is making now in Tijuana will help for the next 10 to 20 years, but the solution cannot be solely episodic investments. Civil infrastructure must be an ongoing annual investment by both countries, increasing the capitalization every two or three years. The North American Development Bank and recapitalization has been important for financing civil infrastructure. There is reason for optimism in the long term, both countries and states of California and Baja California could come together on an array of projects. Acknowledging operational maintenance costs, and budgeting for these expenses to build in at the front end of the project and that there are logical and realistic performance expectations that are met with those projects.

When asked for recommendations for meaningful improvements to environmental protection David suggested that corporations that locate manufacturing in Tijuana, can invest in environmental and civil projects to make Tijuana a better place. Toyota has funded two wastewater treatment plants, and more corporate investment in environmental protection in Tijuana could make measurable differences. David stressed that the long-term solution in Mexico has been articulated with previous examples of the success with public private partnerships. If public private partnerships are the way that they like to get things done there, then there's an opportunity I think for companies like Toyota and Coca Cola and others to invest in the community.

In the interview David described the success of a trash boom project in Los Laureles Canyon. This project was funded by Wild Coast Conservation and provided funding for community members to finance operational maintenance for the equipment's useful life. The organization is employing residents to take care of trash booms, so it would not be vandalized and/or scavenged, in hopes that it can be effective at removing the trash from the channel for the foreseeable future. This type of private public partnership has proven effective in the watershed and serves as a good example for other trash-related best management practices.

While asking David about international policies, and if they could be doing more for the protection of the environment and vulnerable people, David took a diplomatic response. He stated: "this is a bi-national issue, and we are bi-nationally invested in both countries' economies and societies. There needs to be more opportunities for the United States to work to make this a much better place for Tijuana and for San Diego." Implying that both United States Federal and California State Governments could be doing more for the region. David stated the Gross Domestic Product (GDP) of Mexico is one sixteenth of the United States, and reinforced that Mexico struggles with basic services.

When asked what he feels is missing from effectively implementing pollution control programs, David reiterated the financial constraints of both nations. He explained that funding international infrastructure becomes more complicated when you have two congresses, two countries, two state legislatures, two governors; However, with both

nations there are opportunities. Both countries can invest in water recycling that benefits Tijuana and San Diego and gets sewage and trash out of the river. With forecasted changing climatic conditions, the reality is that watershed inhabitants are going to live in a much hotter and drier landscape with more climatic uncertainties. Southern California and Baja California will have long periods of drought, punctuated by atmospheric rivers, making design sizing of civil and social infrastructure more challenging.

David described innovative adaptations to water resilience within the region, and stated:

“Located within the Tijuana River Watershed, the city of Tecate has created two large sedimentation basins to capture the runoff during storm events and to infiltrate stormwater in-place. The city of Tecate is dependent upon groundwater as well as imported water for municipal water sources. Engineered features of the sedimentation basin also include trash controls that capture stormwater and infiltrate stormwater in place. Stormwater is a resource not a nuisance, and adapting stormwater flows in a water scarce environment like Tecate, helps to combat water insecurity for the region. Creating sustainable infrastructure like this in Los Laureles Canyon would so immeasurably improve the living conditions for its inhabitants. It would improve the community by providing much needed public space that also perpetuates groundwater infiltration and pollution removal. These types of projects are a mutual investment that would benefit both countries.”

David concluded that diffuse green infrastructure projects could have meaningful impact for Tijuana, as they are not too expensive projects, smaller in scale, easier to build, easier to maintain and provide long term benefits to the entire community. Private public partnerships could finance green infrastructure projects, perhaps incentivized by the North American Development Bank in locations where the community is within the geographic requirements and does not have the ability to provide project match.

Findings from Interview with Susana Arredondo

Susana has an educational background in anthropology and graduate studies in environmental management. She was raised in San Ysidro within the California reaches of the Tijuana River watershed. Growing up in a historically underserved community has shaped her perspective on water issues. Before her appointment as Executive Officer of the Los Angeles Regional Water Board, she worked in drinking water and water recycling in San Diego County.

Susana explained her family’s roots in the watershed. She stated “My parents not only live in the watershed, but my aunts and my one hundred- and one-year-old grandmother live in the watershed. My grandmother was the founding member of the San Ysidro Health Center. My family is deeply rooted in San Ysidro, and in the watershed.”

When discussing environmental and social injustices Susana drew on personal experiences of loss. She noted that most locals know that during the rainy season, the river would flood from monsoonal rains. The floods would create property damage, destroying people’s homes and cars. Trash and sewage flood the streets, eventually making its way to the river’s estuary and the Pacific Ocean, impacting marine life, public health, and locals’ ability to go to the nearest beach. Susana shared stories of her

adolescence, she reflected on a time when her older brother bought his first car, but sadly this car was swept away by the river during a flood. Raised by working class parents, she acknowledged that her parents did not have the means to buy another car for her brother. Susana described that it was a way of life down there and it had its impact on local communities, reducing the quality of life for many working people. She was raised in a home without air conditioning, and her family relied on the ocean breeze to cool down their house. In present times, noxious odors in San Ysidro are tainting the region, and Susana's parents no longer open the windows for fresh air.

Susana noted habitat destruction due to urbanization and industrial activities. She states the city of San Ysidro has allowed developers to build homes right where it used to flood and has constructed huge shopping malls. The Tijuana River estuary has been an amazing place to see local birds that also serves as a rest stop for hundreds of migratory birds traveling along the way to the Pacific Flyway. These unique habitats are being destroyed by trash and flooding.

Susana described familiar experiences dealing with health-related environmental contamination. Susana states

“Residents of the watershed have faced respiratory problems, skin infections, and an array of other health issues. I grew up with asthma. I've always had asthma and more recently in the last few years, my dad being one of the individuals that suffers from skin issues. My dad was very athletic, he would bike ride through the estuary, and a few years ago, he fell off his bike. Ever since then, he has had a cut that won't heal. And now he gets these rashes that doctors cannot find the cure for. They don't know what it is, antibiotics do not help. He is not the only community member that has suffered from these ailments either.”

Susana noted that one of the biggest barriers in managing trash and biohazardous waste is insufficient infrastructure. Tijuana has had a rapid population growth, and it has outpaced the necessary facilities to treat waste. This includes shortages in properly managed landfills, recycling centers, treatment plants and facilities that will treat biohazardous waste. Without sufficient infrastructure, stormwater runoff and mobilized pollutants that end up in the river. Tijuana has limited funding that cannot prioritize wastewater management, their municipal budget has competing priorities. Economic and social factors also play a role in adequately managing trash and biohazardous waste. Mexico has higher rates of poverty and economic instability, and residents resort to informal and unsafe waste disposal. Susana States:

“Other barriers such as regulatory differences and enforcement are challenging, waste regulation and enforcement must be consistent. Effective management coordination is difficult when natural resources management becomes bi-national. The United States and California have a certain regulatory framework, whereas Mexico and Baja California have a different regulatory framework. Another huge barrier is public awareness of proper waste disposal. Additional education and outreach programs can inform residents and businesses, and without public engagement this work faces significant obstacles in implementation. I think it's important to connect communities to the land, to the waterways, to the air, and to

start young. Start with the children. Some of my fondest memories were going on field trips, fishing boats off the San Diego harbor. It's so important to connect."

In the interview Susana reinforced that there is still a lot that Tijuana can do to improve the bi-national environmental crisis, and to be careful to not view Tijuana from a deficient perspective. She emphasized that the community still has agency and does organize. She noted the opportunities for green infrastructure and nature-based solutions to help manage stormwater, reduce pollution, and enhance climate resiliency. Upstream constructed wetlands can help filter pollution and increase hydraulic residence time of storm flows. Best management practices such as bioswales as well as planting trees and native plants along the riverbed to help stabilize soil, could be used instead of using recycled tires to help reduce erosion and stabilize hillsides. It's very important both on the Mexico side and the United States side to involve residents in the planning and decision-making process, to ensure their voices are heard, and to comprehend their level of understanding. Looking into climate resilient infrastructure and creating flood control systems that are state of the art is important, governments should produce incentives for businesses and communities to adopt climate resilience infrastructure. By integrating green infrastructure both nations can create a comprehensive and resilient pollution control strategy for the Tijuana River that addresses current challenges but also adapts to future climate impacts. Prioritizing equity ensures that all communities, particularly the ones that are most affected by the pollution, benefit from community-based improvements and have a stake in the river's health and sustainability.

When asked for recommendations managing antiquated infrastructure, Susana elaborated on past experiences in water treatment. She stated:

"Within the United States, managers must have comprehensive audits of infrastructure. From the viewpoint of risk-based prioritization, this requires evaluation of the most critical pieces of equipment. The critical components are pieces of equipment that if you don't have, would be detrimental to water treatment in the event of equipment failure. In the mindset of evaluating antiquated infrastructure, managers must create redundancy, redundancy costs money, but redundancy is needed if something fails. Preventative and predictive maintenance are useful in engineering management, and having equipment that notifies if it is time to be replaced. Finding funding for antiquated infrastructure requires looking at grants and public-private partnerships that can leverage private sector investments. Investments in modern equipment, not just something top of the line 10 years ago, but what is top of the line in present times. The ocean desalination in Carlsbad has been a successful public-private partnership, it's a great example to investigate to see how projects can get funding for something that the federal government cannot afford to fund."

Susana was not entirely comfortable speaking on bi-national and international organizations that have been making progress in managing transboundary pollutants. She mentioned the San Diego Coastkeeper, a non-governmental organization that has been involved in community outreach, keeping the public informed on environmental concerns in Imperial Beach, with a water quality focus.

Susana stated that this interview made her nostalgic of her graduate program, where she had been afforded the opportunity to travel to the South American Nation of Chile. She was impressed by the Chilean community engagement and environmental education. Chile invested in community learning and the importance of human capital. Chilean citizens have realized that human capital can lead to some great sustainable practices such as investing in green infrastructure and renewable energy. Chileans care deeply about their Andean Mountains, glaciers and coastline, but they also cared about their economy. Susana stated: “There are strategies that other developing countries have used to enhance environmental protection, and I think it's also important to look at other countries to see what they have done, what is working, what is not working. We're not the only two nations that share a watershed.”

International policies have a significant role in natural resource management when it comes to vulnerable regions like Tijuana. The Tijuana River is a prime example of how cross-border pollution can severely impact both the environment and human health. International policies can help influence trade agreements; agreements can address relaxed regulations and help to reduce profit at the expense of the environment and public health. In Tijuana, there are many maquiladoras (industrial manufacturing facilities), many of these factories discharge heavy metals into the Tijuana River. Both nations must collaborate on environmental preservation in Tijuana and in San Diego. This involves pollution control measures and infrastructure investments in both municipalities, where incentives are given to private companies that participate in environmental rehabilitation and sustainable development.

Susana's interview concluded with an overview of the layers of government between both nations; she identified the City of San Diego, County of San Diego, California State government, and United States' Federal government, as well as the Mexican Federal government and all the subdivisions. Susana explained that pressures in each country are felt differently; in Mexico there's more crime, more violence, as well as a degree of corruption. She stressed the importance of political will and diplomatic collaboration.

Analysis of Findings

The interviews with David and Susana identified strategies to overcome the environmental degradation found within the Tijuana River watershed. David noted private-public partnerships for restoration within the Mexican reaches of the watershed as an effective approach for financing in Tijuana. David highlighted that Toyota, the car manufacturing company, has funded two wastewater processing plants in Tijuana as a form of giving back to the community. Susana described the creation of an ocean water desalination plant in San Diego County that had utilized private-public partnerships to leverage capitalization funds. These are new ideas to me, concepts that I have not encountered prior to either interview. In bi-national watersheds like Tijuana, where the United States Federal government and California State Government are apprehensive about funding capital improvement projects outside of the jurisdiction, private-public partnerships could be a useful tool in leveraging project funds to benefit the environment, while enhancing living conditions for locals and regional public health. This could be done in coordination with the North American Development Bank and World Bank to expand the current capacity of Tijuana, while enhancing community benefits.

Perhaps community needs be integrated into this expansion to prevent the neighborhoods of Tijuana from gentrifying from the uncontrolled pressures of capitalism and money from private corporations. Susana noted that international policies could incentivize private corporations to invest in Tijuana. Like the incentives multinational corporations receive to stimulate North American trade, international policy could incentive environmental stewardship in sustainable development. This could be private corporations funding the rehabilitation of impaired landscapes and/or the expansion of civil infrastructure in communities where manufacturing is located.

David described the success of the trash boom installed in Los Laureles Canyon by WILDCOAST Conservation. In 2021, the organization installed a plastic retention system in the Los Laureles canyon, a tributary of the South Fork of the Tijuana River. The device is an Elastic Brute Boom, a double walled floating device that has a galvanized steel screen. The barrier is attached to concrete structures on the banks of the river through galvanized chains and shackles. (Kelpsley, 2021) WILDCOAST Conservation staff has been working with locals to sort captured debris, shred recyclable plastics, and provide materials to create recycled by-products. This is a successful management measure employed by WILDCOAST Conservation, as it creates community buy-in amongst locals and promotes a sense of pride for rehabilitation efforts. WILDCOAST Conservation is also facilitating community outreach to raise awareness of the plastic problem that surrounds the Tijuana River, specifically behavioral changes negating single use plastics. (Ben-Hamo, 2022)



The Trash Boom of Los Laureles Canyon Tijuana. (Source: WILDCOAST Conservation)

Both interviews stressed the importance of operational maintenance for civil infrastructure and noted this as an obstacle in the management of trash and

biohazardous waste. David noted that because of minimal operational maintenance undertaken at the international treatment plant, the water treatment facility has lost almost all treatment efficacy, and the situation with sewage in the river has regressed to the pre-treatment plant conditions of the early 1990s. David suggested that operational maintenance be budgeted for at the project's design phase, and with each year increase the budget for maintenance. Susana brought up some compelling points for maintenance too, she stressed preventative maintenance measures that facilitate redundancy for critical infrastructure, and even described risk-based prioritization as one of the tools to employ in preventative maintenance. Susana described state of the art technology that can alert wastewater treatment managers when equipment has been compromised. I think this is a noble idea and would likely prevent critical equipment failure, but tools like this will only add to the project costs. Advanced warning systems and redundancy of critical equipment are likely necessary for effective waste management, but in a location like Tijuana, where the government struggles to provide basic services, "redundancy" is likely beyond what is reasonable for this scenario. Despite the economic limitations, future coordination between both nations and private corporations could appropriate funds for operational and preventative maintenance measures, and could ensure redundancy of critical equipment, like the operations of civil infrastructure projects in California.

Both interviews expressed that the United States and Mexico need to come together on shared environmental and societal outcomes, as a unified mission for the watershed. David mentioned that improvements to the management of the collection system in Mexico and the treatment plant in the United States, will provide the comprehensive long-term solution needed, but these efforts will need to expand with the growth of Tijuana's population. Susana underscored Tijuana's ability to organize and accomplish community development projects. To address these concerns, increased bi-national coordination could foster planning for the expansion of engineered infrastructure, while also addressing needs for social infrastructure in overlooked areas of the watershed.

A tire recycling program was recommended to be developed for California, to prevent the movement of used tires from California into Mexico. The California Environmental Protection Agency's CalRecycle, could develop a state-wide tire recycling implementation plan, that could be then applied on a national and international scale once successful. Tires are difficult to recycle, and most used tires are brought to Mexico for extended use. Stormwater flows often transport the degraded tires used to stabilize hillsides back across the border and ultimately deposit in the Tijuana river's estuary and floodplain. There are significant environmental, economic and public health issues associated with the deposition of tires in the Tijuana River estuary and floodplain. Used tires add an unforeseen cost of about forty dollars per tire for removal and proper disposal. Tires deposited in the floodplain and estuary also provide breeding habitat for mosquitos and other insects, potential vectors for disease, in an area already impacted by environmental pollution. David's conviction to the tires situation really transformed the optics of waste in the watershed. I had been consumed by water quality, but really tires are also a public health issue and obstacle in regional and community development. While thinking deeper about the resources available to the watershed, I believe that the use of the Pепенadores for the Tire Recycling program could be

capacity expanding, while greatly improving ecology and public health, while legitimizing the work of informal waste management services. Aside from tire recycling, legitimizing the work of the *pepenadores* for municipal trash collection would also negate trash within the watershed, while providing basic human sanitation for marginalized groups of people residing in overlooked areas of Tijuana.

David suggests a grand solution to the collection system treatment plant dilemma; he believes an international water utility district, like a water district in California, can relieve some of the transnational financing issues that currently impacts the watershed. David suggested an organization with a board of directors appointed by the state and federal governments in both countries, on staggered four-year or six-year terms, and funded by the North American Development Bank. Here the bi-national water district is capitalized by both countries, and there would be a capital improvements budget for long term ongoing operational and preventative maintenance. A bi-national water district will help to establish ongoing annual investments for both countries. The investments by the North American Development Bank now in Tijuana will help for the short term, but these episodic investments are not sufficient to cover civil infrastructure expansion as well as operational and preventative maintenance in the foreseeable future. Furthermore, a bi-nationally funded water district would foster bi-national cooperation, giving Mexico a reasonable portion of responsibility in developing both San Diego and Tijuana.

Susana described personal experiences recreating in the Tijuana River estuary. She discussed how her family would recreate there and noted the importance of recreation and outdoor education. Teaching environmental stewardship and outdoor education can be an effective tool to minimize trash and biohazardous waste in the watershed without having to spend money on infrastructure or maintenance across the border in Tijuana. The Tijuana River Estuary is one of the state's Critical Coastal Areas watersheds and provides great recreational opportunities for underserved community members. If lands could be preserved in Tijuana as they can in California, or if cross border habitat mitigation projects could be implemented, the preservation of wildlands could help to preserve and enhance habitat in Tijuana, while preventing the expansion of additional informal housing settlements in the last of urban Tijuana's natural spaces.

Susana described the expansion of industry and homes within the California reaches of the watershed. She mentioned the construction of the new duty-free mall in San Ysidro and multi-dwelling housing communities in historically flood prone areas of the watershed. She shared personal stories of loss; her brother's first car had been swept away in the floodplain. While the development of a mall and apartment complexes are certainly different from the informal housing developments across the border, their construction parallels the insatiability of capitalism ingrained into the region. The loss of fish species in the river's estuary as well as the noxious odors in San Ysidro and Chula Vista are indicators of environmental and social degradation. Capitalism has once again compromised the people and landscape of the Tijuana River watershed.

Green infrastructure projects are not expensive, smaller, easier to build and to maintain and provide long term benefits to the entire community. Private public partnerships could finance green infrastructure projects, perhaps incentivized by the North American Development Bank in locations where the community is within the geographic

requirements and does not have the ability to provide project match. The application of green infrastructure within the urban areas of the watershed would help reduce expansion efforts of water resources infrastructure with demand increases as the population of Tijuana grows. Incorporation of green infrastructure also increases community benefits and landscape aesthetics in overburdened communities. In Tijuana, many of the tributaries to the Tijuana River have been converted to concrete channels. Green infrastructure can help to treat runoff by flow-through treatment, like bio-engineered treatment wetlands, but even planting trees and increasing green spaces will help minimize water quality impairments. These features are great for improving water quality conditions and managing flow, they provide increased aquatic habitat, as well as increased hydraulic residence time for runoff. Hydraulic residence time has decreased throughout the watershed in numerous tributaries with the introduction of concrete channels. The conversion of natural channels to concrete channels was done as an engineering feature to help faster convey runoff from the urban areas downgradient to less populated areas. This has also resulted in the increased conveyance of pollutants, increased temperature, and loss of critical riparian habitat. As climate change brings unpredictable precipitation patterns, naturalized stream channels and other green infrastructure help to combat watershed degradation. Infiltration basins in Tecate that David described, are another example of integration of green infrastructure, where water infiltration has been prioritized for municipal use and secondary benefits include enhancements to water quality and recreational areas.

Closing Statement

Capitalism encourages the development of industry in locations with cheap labor and relaxed environmental regulations like Tijuana, for the benefit of the United States and other global consumers. The population explosion that has occurred within Tijuana since the 1990s has become a consequence of such large-scale industrialization, where the people and environment of Tijuana are paying the hidden cost of large-scale industrial manufacturing. The Tijuana River watershed has been compromised by capitalism, where humans and the environment have been subsidized in the facilitation of increased North American Trade. Taking note of the people residing within the South Fork of the Tijuana River, these people are living amongst serious environmental adversity, everyday life complicated by environmental risk and pollution. Children are playing with trash in wastewater effluent and mothers use the water source to wash laundry. It is clear that there are tremendous human and environmental injustices being upheld, but the people living here mostly have a positive outlook, almost as if they are acutely aware of the environmental dangers their communities pose, but strong and resilient, compartmentalize struggle, and still maintaining a relatively happy disposition. Within California tire recycling needs to be prioritized, as tires are both watershed pollutant and public health nuisance. Legitimization of the informal waste sector within Tijuana could be an innovative approach to reducing tire waste as well as other forms of trash and biohazardous waste in the watershed.

The importance of political will and diplomatic collaboration cannot be stressed enough. Mexico has one sixteenth of the Gross Domestic Product of the United States, this could be a ratio used to proportionally assign project costs for a new international treatment plant, collection system and other civil and community development projects.

As both nations continue to develop environmental and resource protection programs, consideration of economic limitations must be made to ensure that critical infrastructure is not neglected and engineered features are maintained operational for the equipment's useful life. These are two different nations, priorities are going to change, but there must be a unified mission together to enhance the conditions of the watershed. Southern California and Baja California will have long periods of drought, punctuated by atmospheric rivers, making design sizing of civil and social infrastructure more challenging. This greater substantiates the need for increased funding for civil infrastructure as well as operation and preventative maintenance costs, as it is expected that greater climate volatility will create managing waste and water resources even more challenging. The integration of green infrastructure could be supplemental to some of the proposed projects, while also providing some other community benefits. The pressure for increased civil projects can be minimized with diffuse integration of green infrastructure in some of the most degraded habitats in Tijuana. The integration of green infrastructure will minimize pollution and impairment conveyance, while enhancing infrastructure, recreation and community ascetic.

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**Examining Composting Awareness, Perspectives, and Access to Composting Infrastructure
in California**

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ESH-540-SU24 – Capstone Project

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Abstract

Food waste decomposing in landfills releases methane into the atmosphere. In efforts to reduce state-wide methane emissions, California passed a state composting law in 2022. However, it remains to be seen how well-known this composting law is amongst residents and whether or not this law is encouraging people to compost or not. Through this research, I investigated California residents' awareness about composting, perspectives, and access to composting infrastructure based on residential unit type, so that I can get a better understanding of considerations when introducing a new composting program. An anonymous survey was distributed physically to 126 residents in my local neighborhood, as well as to a number of online spaces composed of California residents, to gain a better understanding of residents' living circumstances, experiences with composting, and their level of access to a residential composting program. I conducted one qualitative interview with a California resident who has lived in a single-family home to gain further insights into their experience with the composting program offered at their residence. The 49 survey results showed that almost $\frac{3}{4}$ of participants had not been aware of the California composting law, but about $\frac{3}{4}$ of participants who have access to a composting program do at least some amount of composting. Participants who hadn't known about the law but still compost seem to be motivated by factors other than obligations to the law, based on their qualitative responses. This suggests composting behavior is not solely motivated by awareness of the composting law alone. All participants who don't currently have access to a composting program expressed at least some positive interest in participating in a program if the appropriate resources and information were provided. There didn't seem to be a specific residential unit type that had particularly less access to composting programs: all residential unit types should be prioritized in getting access to composting infrastructure, since it's something that everyone should have access to in order to practice environmental stewardship and social responsibility. Taken together, these results suggest that, when considering the implementation of a composting program, the combination of awareness of the law, information about composting, composting infrastructure, and developing cultural norms around composting are beneficial in encouraging people to consider the food waste they generate and separate organic waste from municipal waste, thus decreasing methane emissions from landfills.

1. Introduction

In our world where overconsumption has grown rapidly, food waste makes up the largest portion of global waste composition ([Kaza et al., 2018](#)). In 2018, out of 146.1 million tons of municipal solid waste (MSW) entering landfills in the United States, 24% of the MSW was food ([US EPA, 2022](#)). When we throw away food, we don't waste just food: we waste the resources used to produce that food: "in the U.S., an estimated 25 percent of freshwater use is wasted producing food that is never eaten" ([John Hopkins Center for a Liveable Future, n.d.](#)). Food waste reveals an inefficient and unsustainable pattern that has risen with increasing consumerism, especially in the Global North ([Peluso, 2022](#)). The generation of food waste indirectly contributes to many environmental issues observed today: when organic matter is present in landfills and decomposes anaerobically, methane (CH₄) is released into the atmosphere ([Mønster et al., 2019](#)), which contributes to the greenhouse effect and accompanying rising global temperatures and natural disasters like heightened and intense wildfires in California, extreme drought, rising sea levels, and changes in storm and weather patterns ([CalRecycle, n.d.](#)). Twenty percent of California's greenhouse gas emissions come from methane produced in landfills, making landfills the third largest contributor of methane in the state ([CalRecycle, n.d.](#)).

In efforts to reduce state-wide methane emissions, California state issued a new law under the Senate Bill 1383 in September 2016 that mandates the separation of organic matter, such as food scraps, yard trimmings, paper, and cardboard, from MSW ([CalRecycle, n.d.](#)), with the hopes to reduce organic waste disposal into landfills by 75% by 2025 ([Nair, 2022](#)). Though this law has been in effect since January 1st, 2022, local jurisdictions are responsible for ensuring residents and businesses abide by the law, and the efforts in this area vary widely by location in California. While certain towns and certain people (ex: single-family households) seem to be provided composting bins/buckets and the means to divert organic waste out of landfill waste streams, not everyone in California has had the opportunity or access to composting infrastructure. Being withheld access to composting infrastructure that residents require to abide by the state composting law is a matter of injustice that should be investigated and addressed as soon as possible. For my capstone project, I set out to investigate composting awareness and perspectives of California residents to better understand the relationship residents have with composting: do they compost, what are their views on composting and why they do or don't compost, and if they have access to a composting program, or if not, if they could see themselves participating in one given the appropriate resources and information.

Secondly, though single residential units have been provided collection bins by some cities, multi-residential units have been less likely to be provided these from the get-go, depending on the property manager. This may leave those who are not single family home-owners, such as multi-residential apartment renters, without the means to compost. This issue of access to composting infrastructure reveals a distributive injustice, since residents shouldn't be withheld the ability to compost just because of their status as renter or homeowner or just because of their property manager. Through my project, I hope to better understand access to composting programs in my local community and see if certain residential unit types are less likely to have access to composting programs than others. I'd like to learn about the factors that could contribute to an effective composting program, should it be introduced to a given residential area. Additionally, I'd like to encourage mindfulness with regards to the resources we have access to through this project: thinking critically about food and our relationship with it to ensure we can value food in ways that help us reduce food waste as much as possible, and thinking of food not as a passing resource in our lives that ends with us throwing it in the trash,

but rather it cycling back through compost to bring us nutritious foods for ourselves and the generations to come.

To develop the central argument of my capstone project, this paper is structured in 7 sections: Section 1 serves as the Introduction, Section 2 serves as the Literature Review, Section 3 serves as the Methodology, Section 4 serves as the Results, Section 5 serves as the Discussion, Section 6 serves as the Summary, and Section 7 serves as the Bibliography. The Appendix follows Section 7.

2. Literature Review

In this literature review, I explore the issue of food waste and why there is food waste in the first place. I bring some context to the California composting law as a solution to reducing food waste in California, and I explore some of the challenges and questions in the context of composting in California. I briefly explore some case studies from around the world of composting programs that have been implemented, and I motivate this research by synthesizing the questions that remain regarding how composting programs might be implemented to encourage composting effectively throughout California state.

Food waste as a Global Issue

The issue of food waste has grown tremendously as many societies around the world have begun to overproduce and overconsume goods. Food waste makes up the largest portion of global waste composition ([Kaza et al. 2018](#)). However, the issue of food waste goes beyond just the food unconsumed: the amount of resources used to produce the food that goes wasted (energy, water, nutrients, human labor, etc.), as well as the greenhouse gas emissions released when organic waste decomposes anaerobically in landfills. The UN Food and Agriculture Organization (FAO) estimates that the amount of food loss and waste accounts for 4.4 gigatonnes of greenhouse gas emissions annually, such that, “if food loss and waste were its own country, it would be the world’s third-largest emitter, surpassed only by China and the United States” ([Hanson, 2019](#)). This demonstrates that food waste is directly contributing to climate change issues, including but not limited to natural disasters like intense wildfires in California, extreme drought, rising sea levels, and drastic changes in storm and weather patterns around the world ([CalRecycle, n.d.](#)). The World Bank estimates about 11% of global methane emissions come from landfill waste, and as global populations increase, this is anticipated to go up to 70% by 2050 ([Dickie, 2022](#)). With landfills rapidly running out of space in the US, an increased consciousness about the waste one produces is necessary so that we can categorize waste in ways that efficiently use, honor and protect the spaces and resources on this Earth ([Clough, 2023](#)). There are many complex factors contributing to food waste generation in today’s world, and further research is required to better begin to unpack the interconnected systems contributing to the generation of food waste.

Why do we waste food? Examining Factors Contributing to Food Waste Behavior

The first question that came to mind as I thought more about food waste was: *why* is there so much food waste in the first place? Many scholars have sought to better understand how and why food waste is generated. One of the theories that has been commonly used to study environmental behavior is the Theory of Planned Behavior (TPB). The TPB model suggests that

one's behavioral intention and actual behavior can be determined based on one's attitude toward behavior, subjective norms, and perceived behavior control ([Ajzen, 1991](#)). This theory has been used to study other environmental behavior, such as travel mode choice, water conservation, recycling, energy consumption reduction, and sustainable food choices ([Graham-Rowe et al., 2015](#)). However, though TPB has been used to study food waste behavior in some studies ([Stefan et al., 2013](#)), these studies found that the TPB alone wasn't sufficient to model food waste behavior ([Schanes et al., 2018](#)). Scholars have sought to study other factors that may contribute to food waste behavior, such as moral attitudes, knowledge of food conservation, shopping habits, and eating habits ([Aydin & Yildirim, 2021](#)); self-identity, anticipated regret, moral norm and descriptive norm ([Graham-Rowe et al., 2015](#)). As Andrew Shakman, President of LeanPath, put it, "Perfect menus and planning don't lead to zero food waste. Why? Food waste is ultimately about behavior. We need to change culture to change behavior" ([Shakman, 2012](#)). Behavior, emotions, convenience, economic incentives, and attitudes toward food waste have been studied as factors that contribute to food waste generation in various contexts ([Bartelings & Sterner, 1999](#); [Comber & Thieme, 2013](#); [Stancu et al., 2016](#); [Mallinson et al., 2016](#); [Zepeda & Balaine, 2017](#); [Ellison et al., 2019](#); [Russell et al., 2017](#); [Attiq et al., 2021](#); [Aydin & Yildirim, 2021](#); [Noto, 2024](#)). The complexity of food waste behavior reveals the need for further research to be conducted in this field, thus motivating my capstone project to expand our understanding of food waste behaviors, attitudes, perceptions, and awareness.

The issue of food waste behavior is complex because it is context-dependent, so factors such as location, culture, socio-demographics, etc. can influence behavior. Because of these variations, it appears that there are contrasting or even conflicting findings within the literature. For example, some researchers have suggested that moral norms do not play a significant role in reducing consumer food waste ([Stancu et al., 2016](#)); while others have found that moral norms are critical to food waste behavior ([Aydin & Yildirim, 2021](#)). Some studies have found contradictory results about the relationship between gender and income with food waste: some studies found that males waste more than females, and the opposite was also found; other studies have suggested that higher-income households waste more food than lower-income households, while the opposite was also found in other research ([Principato et al., 2021](#)). The variety of factors that play a role in food waste behavior reveals the need for further data collection to better understand trends and tendencies to model food waste behavior. A review of the literature on consumer food waste that examined 16 research papers that applied behavior change interventions in the household context found that there remains a need for interventions that can demonstrate long-term changes in food waste reduction behavior ([Jobson et al., 2024](#)). Through my capstone project, I hope to gain insights into how frequently California residents who have access to a residential composting program practice composting and for those who don't have access to such a program, what may encourage or discourage composting for them via a pre-program survey.

Awareness of the California Composting Law

California has been a trailblazer in climate legislation since the 2000s: previous legislation like the California Global Warming Solutions Act of 2006 which required the state to measure and report carbon emissions and set goals to reduce emissions by 2020 demonstrate the state's commitment to climate consciousness ([Basnyat, 2024](#)). In line with this focus on climate legislation, the California composting law was passed as a part of Senate Bill 1383 in efforts to

divert organic waste out of landfills ([League of California Cities, n.d.](#)). The goal of the regulations is to divert organic waste by 50% of the 2014 quantities by 2020 and by 75% by 2025 ([League of California Cities, n.d.](#)). The regulation was passed in response to the climate crisis that has been exacerbated by anthropogenic greenhouse gases: California has been experiencing the consequences of climate change, including devastating fires, droughts, rising sea levels, and record high temperatures ([CalRecycle, n.d.](#)).

A large factor in how I became interested in my project topic was because, despite having lived in California for about 1.5 years, I did not find out about the California composting law until January of 2023, one whole year after the state composting law had gone into effect in 2022. This made me wonder how many other of my neighbors were aware of the composting law, especially in my multi-family residential complex where we do not have a composting program offered to us. I became curious to see if awareness of the composting law would encourage behavioral change: specifically, if being aware of the composting law would encourage residents to be more likely to separate organic waste at home. Previous literature has suggested that, in the context of laws for the public good, introducing obligations in line with laws is effective, but they're especially effective when paired with incentives ([Galbiati & Vertova, 2014](#)). Additionally, education is thought to be a critical component in changing public behavior ([Nichols, 1994](#)). Taken together, I'd like to better understand California residents' current awareness of the state composting law, as well as encourage people to engage with or think about composting through my anonymous survey as a small yet sure step toward increasing education about composting. Specifically, I am curious to see if awareness of the state law can encourage behavioral change in people and motivate people to compost.

Access to Food Waste Collection Services

In my time living in California, I have noticed that most of the kitchen countertop composting bins I have seen have been in single-family residential units. In my literature review, I was surprised to find somewhat limited research on changes in food waste behavior upon the introduction of composting programs in multifamily dwellings. There are several studies that have examined the introduction of *home composting* (ie: composting collected and composted all at home) in various contexts: a case study in Gampaha Municipal Council Area in Sri Lanka ([Lekammudiyanse & Gunatilake, 2009](#)) and a research study in Spain ([Vázquez & Soto, 2017](#)). There are several studies that have examined local composting programs in multi-family houses in Sweden ([Fransen, 1999](#)); in multi-family dwellings and university residences in Canada ([DiGiacomo et al., 2018](#)); and a study fairly close to where my capstone project is going to be conducted, in Alameda County, which is in the San Francisco East Bay region ([Crummett, 2010](#)). Crummett remarked on the lack of services that multifamily dwellings (MFD) received compared to other single family dwellings and businesses: three cities were studied, and each had varying policies about whether or not MFDs were provided universal compost collection services or not ([Crummett, 2010](#)). Crummett makes an argument that aligns very closely with my own perspective: "Providing a means for Multifamily unit dwellers to contribute to waste reduction is not only environmentally responsible, but socially responsible as well" ([p. 9, Crummett, 2010](#)). Seeing how the universal compost collection services varied across just three cities in the same East Bay region, I am curious to better understand what the compost collection services and resources are like elsewhere in other cities in California.

Case Studies of Composting Programs Worldwide

In the case study of home composting for multi-family houses in Sweden, it was found that sufficient education of the tenants helped to ensure a successful composting program ([Fransen, 1999](#)). Residents were made aware of how the composting machine works, as well as why their behavioral change by composting will have many advantages and positives ([Fransen, 1999](#)). This suggests that proper education and motivation to change behavior can play a role in composting programs that can encourage participants to compost. This aligns with other examples of multi-residential composting programs I have heard about from a classmate in southern California: though there was an introduction of composting bins and infrastructure for people to be able to separate organic waste from municipal waste, there was very little to no explanation or education given on how to use the composting bins, and so very few of the composting bins have been used in the apartment complex. In San Diego, though composting bins had been distributed by the city, the city has been lax about contamination in compost bins since separating compost is a big change in behavior and can take some time to get used to ([Elmer, 2023](#)). However, reading this news made me wonder if this is the most effective way to get everyone to compost correctly, since it would require another shift in behavior: not treating the composting bin as another trash can, but as an actual composting bin that can only take organic waste. In other parts of California, like Hinkley, CA, the sudden increase in compost generation has caused existing composting facilities to become overloaded, resulting in foul odors permeating the local communities, dangerous fires, and multiple violations by the Hinkley biosolids composting facility since 2020 ([Staggs, 2022](#)). This has severely jeopardized the air quality of the surrounding counties, causing local residents to suffer from migraines and other health ailments ([Staggs, 2022](#)). Successful execution of the California composting law should ideally minimize health hazards to residents, so balancing increased composting quantities with sufficient facilities also must be considered in the introduction of new composting collection programs.

This review of the literature, as well as the example of my classmate's experience, current standards in San Diego city, and the concerning situation in Hinkley, CA have helped me better reflect on what might be the most effective approach to encouraging residents of a multifamily apartment complex to participate in a compost collection program, if given the opportunity. Through this capstone project, I'd like to do some preliminary work to better determine if California residents who don't currently have access to a composting program, especially those of multi-residential apartment complexes, would have interest in participating in a composting program if they were provided the appropriate equipment, information, and resources.

Investigating Composting Awareness, Perspectives, and Access to Composting Infrastructure

Food waste is a pressing issue that needs to be addressed wherever possible, as it is arguably one of the most direct ways consumers can reduce their contributions to climate change via food waste. The complexity of food waste behavior as seen in previous literature highlights the intricacies of the factors contributing to food waste behavior and reveals the need for further research to better elucidate how food waste is generated. Though the composting law has been passed in California as of January 2022, it remains unclear how aware California residents are of this law and whether this influences composting habits at home or not. It remains unclear how

access to composting programs may vary across different residential unit types: some previous literature has suggested that multifamily residential units may be less likely to have access to composting programs, which becomes an issue of both environmental and social responsibility, since people are being withheld the ability to compost simply because of their place of residence and status as non-homeowners. If this is the case, bringing awareness to the lack of services provided to multifamily dwellings by city governments through this capstone project can also help address distributive justice within California. Lastly, I hope my capstone project can open pathways to encourage participants to reflect on their relationship with food and open up possibilities of creative ways we can reduce food waste through a raised consciousness and awareness of how we interact with our environment and ways to appreciate the value of food to then holistically minimize food waste.

My study sets out to investigate the following three questions:

- 1) How does awareness of the California composting law relate to composting behavior?
- 2) How does access to composting programs vary across different residential units?
- 3) What considerations should be taken in the potential introduction of a new composting program?

3. Methodology

In order to investigate the three research questions, an anonymous survey was distributed to California residents and one qualitative interview was conducted with a California resident to gain further insight into residents' perspectives on composting. The eligibility criteria for survey participants was current residency in California state. Survey participants were invited to enter a raffle for three \$50 VISA gift cards as a token of appreciation for participating in the survey upon completion. It was determined that IRB approval was not required to conduct the data collection in this project, per the [USD Policy for Protection of Human Subjects guidelines](#).

The anonymous survey was developed, comprising six questions (five multiple-choice questions and one open-response question) and optional demographic questions (see Appendix for survey questions). Questions focused on the participant's awareness of the California composting law and how they found out about it if they were aware, their residential unit type, whether they had been offered a composting program (materials and services): if so, how often they compost and what informs their response, and if not, if they would participate in a composting program if composting infrastructure and information were provided and what informs their response. The survey was distributed in two ways: physical postings of QR codes door-to-door in a local neighborhood in Palo Alto, and online. In total, 126 physical copies of the survey with the QR code were posted at a variety of residential unit types (primarily multifamily complexes and single-family homes), and the survey was distributed online to four group chats on various social media platforms (Facebook Messenger, GroupMe, WhatsApp, Slack) comprised of residents who were known to meet the survey participant eligibility. All survey participants were informed about the nature of the anonymous composting awareness survey at the very beginning of the survey. The survey period was from June 28th through July 10th, 2024.

A qualitative interview was also conducted with a California resident, who will be referred to as Resident A for maintaining anonymity, in this study. Resident A was chosen for the interview because of a very organic conversation I had with them regarding my MESH capstone project as a whole: upon sharing that I was interested in looking at composting awareness in the local area (without going into any details), Resident A was happy to share about their experience

composting over the last few years. Further information about the study was only shared with Resident A only after they had shared about their experience with composting, so as to minimize any personal bias from conversing about the project outside of the interview session. The interview questions and environment were catered toward a more romantic conception of the interview, sharing my own experiences with composting and learning about it and extending information about composting that I thought might be new and interesting to Resident A based on what they tell me about their experiences (see Appendix for interview questions).

The survey responses were analyzed by first examining the quantitative questions yielding quantitative data, and then the qualitative questions were analyzed using a grounded theory approach (Strauss & Corbin, 1997). Responses to the qualitative questions of the survey were read one by one, and codes were identified based on the concepts and themes that appeared in each response. After all responses were examined, these codes were compiled to then be grouped in themes based on the similarities and differences between codes. Themes were summarized based on these codes, and theories were shaped and grounded in these themes.

4. Results

For my anonymous survey, I distributed the survey physically to 126 residents in my local neighborhood and sent out the survey link to various group chats I am in consisting of California residents. In total, 49 survey responses were received. The quantitative data was analyzed first, followed by the qualitative data via a grounded theory approach.

Composting Law Awareness and Composting Program Availability

Figure 1 shows the number of participants currently aware of the California composting law at the time of survey completion. The majority of survey participants were unaware of the California composting law, with 35 people responding “No” and 14 people responding “Yes.” It was interesting to see that almost $\frac{3}{4}$ of the participants weren’t aware of the state law, despite the law being passed more than 2.5 years ago.

Participant Awareness of Composting Law

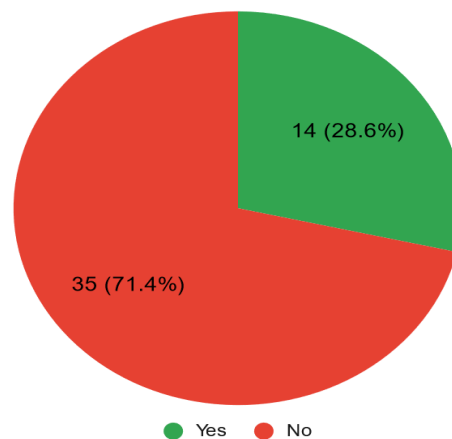


Figure 1. The number and percentage of participants who had and hadn’t been aware of the California composting law at the time of survey completion.

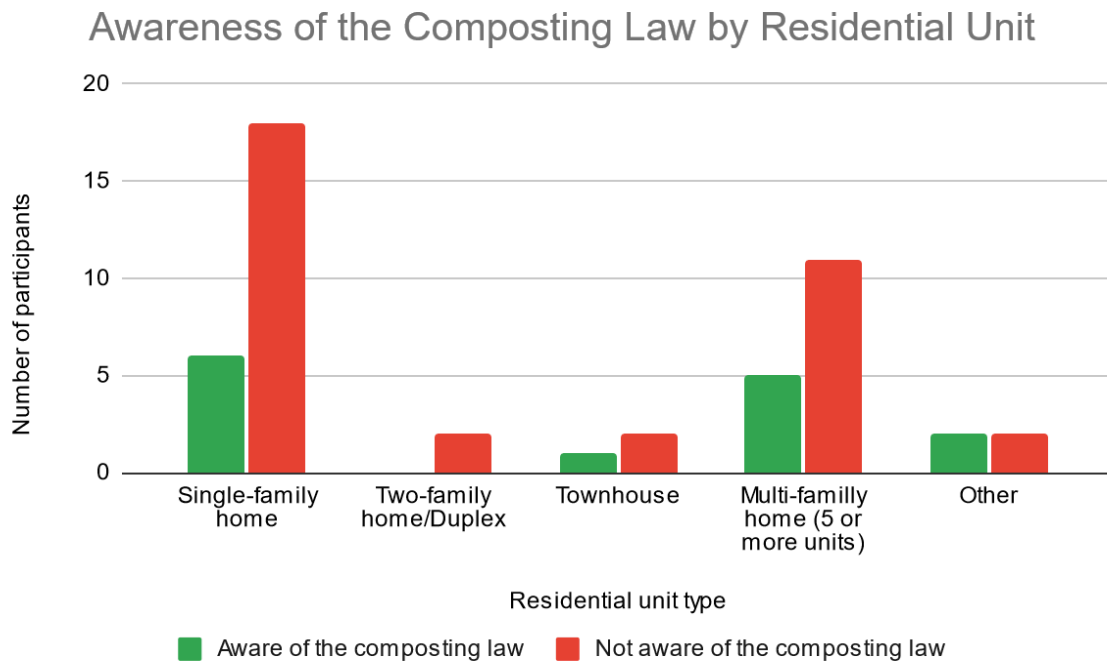


Figure 2. The number of participants' composting awareness by the residential unit they live in.

I was curious to see if awareness of the composting law varied at all by residential unit, so I took a look at the residential units participants lived in and their awareness of the composting law (Figure 2). There didn't seem to be a clear trend or indication that participants living in certain residential units were more aware of the law than others. The participants who had been aware of the law seem to have found out in a variety of ways, as seen in Figure 3, with the most number of participants finding out via utility bill flier and word of mouth.

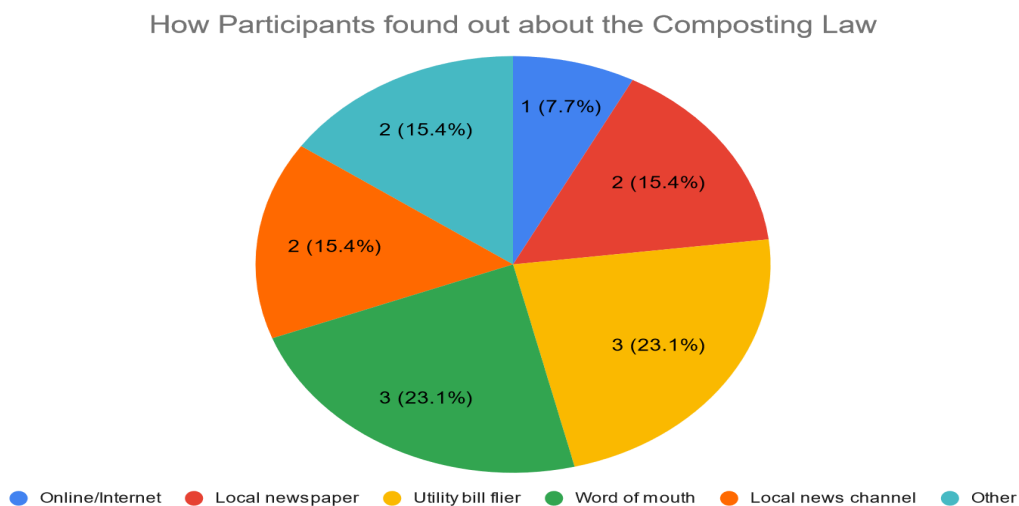


Figure 3. The various ways participants who had been aware of the composting law were informed about the law.

A major question I was curious about was if California residents were being offered a composting program at their places of residence. It was both a relief but still alarming to see that more than half of the participants had been offered a composting program (Figure 4). While it's a relief to see that more than half the participating residents have been offered a composting program, it's still a little concerning to see how many participants haven't been offered a program. I was also curious to see if certain residential units would be offered composting programs more than others (Figure 5), and there doesn't seem to be a clear relationship across residential units. It seems there aren't particular residential units where there are more participants who *haven't* been offered a program than those who have, which is somewhat relieving.

Participant Access to a Residential Composting Program

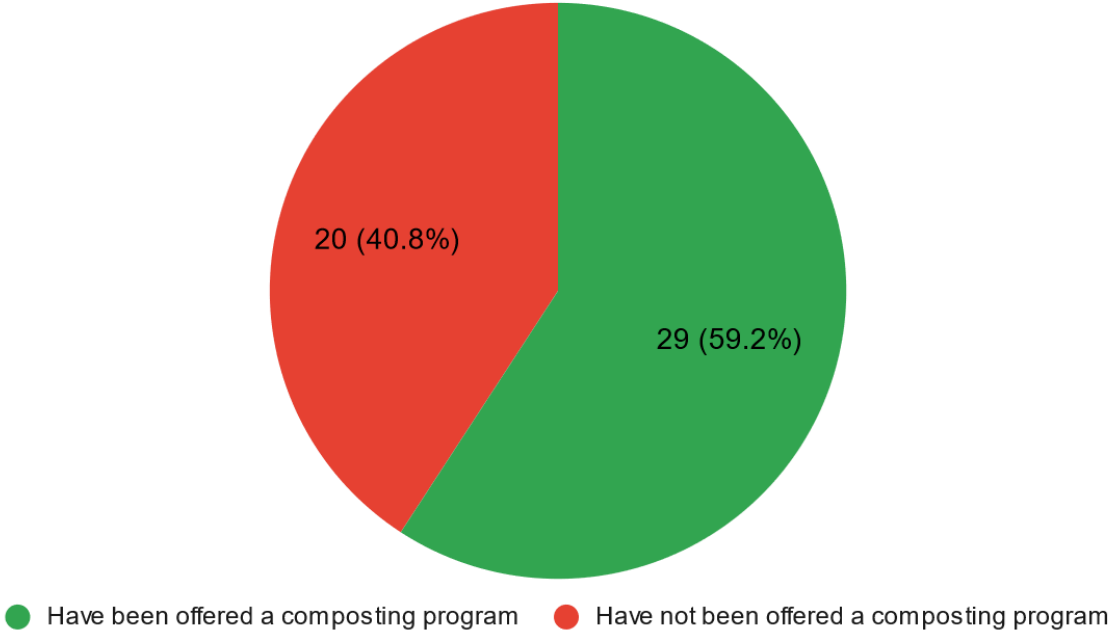


Figure 4. The number and percentage of participants who have and haven't been offered a composting program at their place of residence.

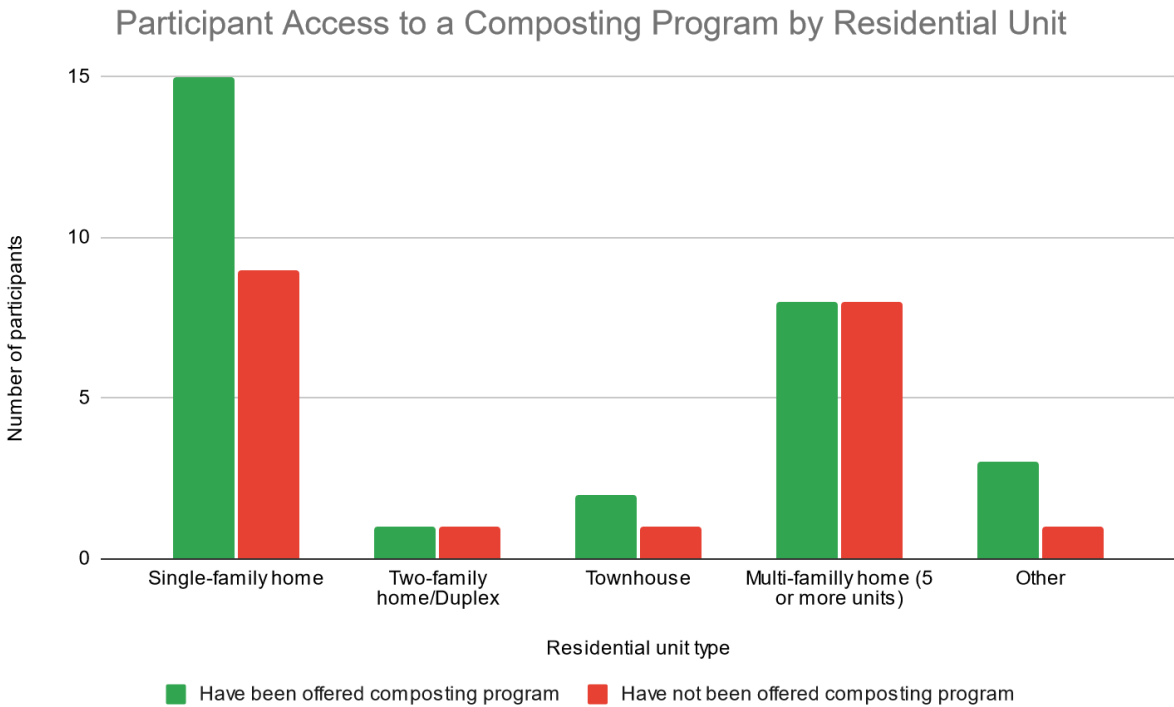


Figure 5. The number of participants who have and haven't been offered a composting program by the residential unit they live in.

Composting Frequency and Willingness to Compost

In total, there were 29 participants who had been offered a composting program at their place of residence. Participants indicated how often they compost (Figure 6). More than half of the participants (16 participants) almost always compost, while 5 participants compost moderately, and 8 participants don't compost often. It seems that a decent number of participants living in single-family home residents and multi-family home residents participate in their composting program (Figure 7).

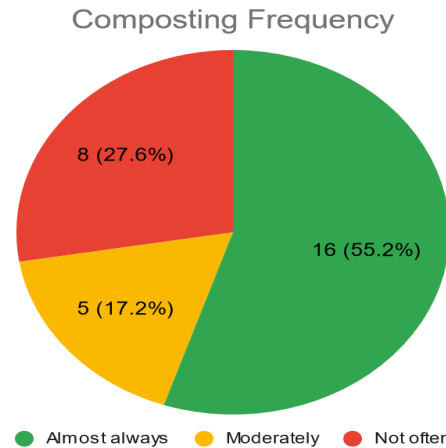


Figure 6. The number of participants who have been offered a composting program where they live and how often they compost.

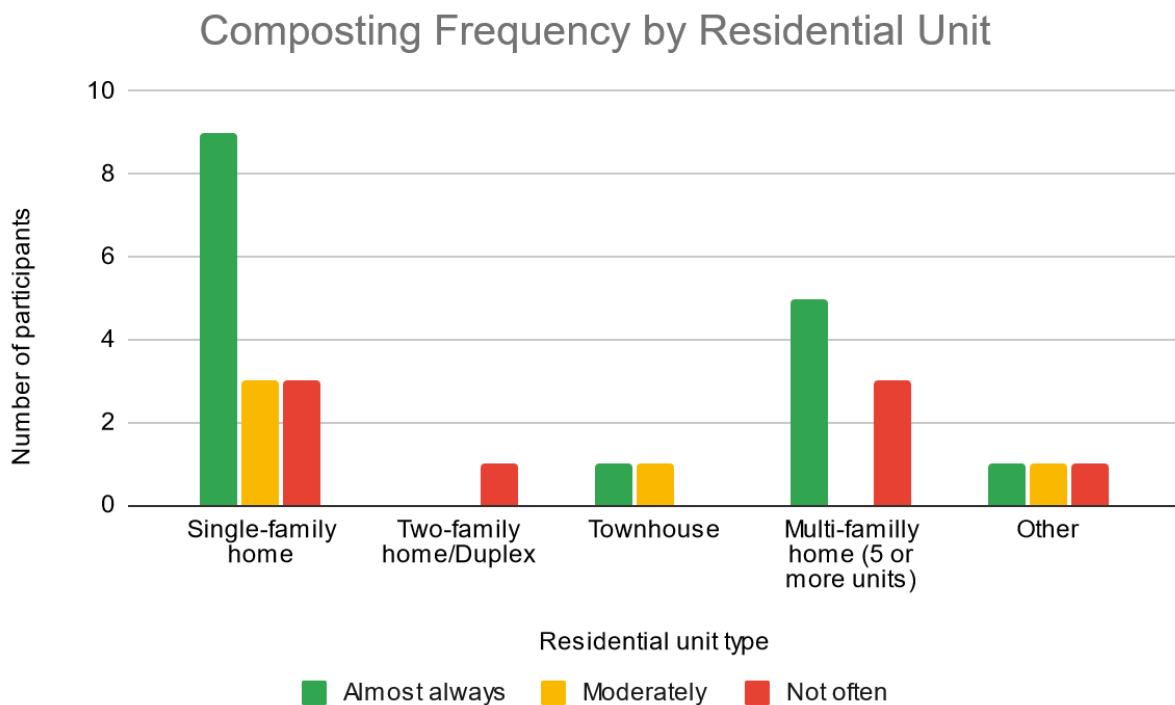


Figure 7. The composting frequency of participants categorized by their residential unit.

There were 20 participants who did not have a composting program offered at their place of residence. Of these participants, 19 responded that they would be willing to participate in a composting program given the adequate equipment and resources needed to be informed and prepared to separate compost, and one responded that they may potentially participate in such a program (Figure 8). There were no participants who seemed unwilling to participate in a composting program, which was quite encouraging.

Participant Willingness to Compost if given the Opportunity and Resources Required

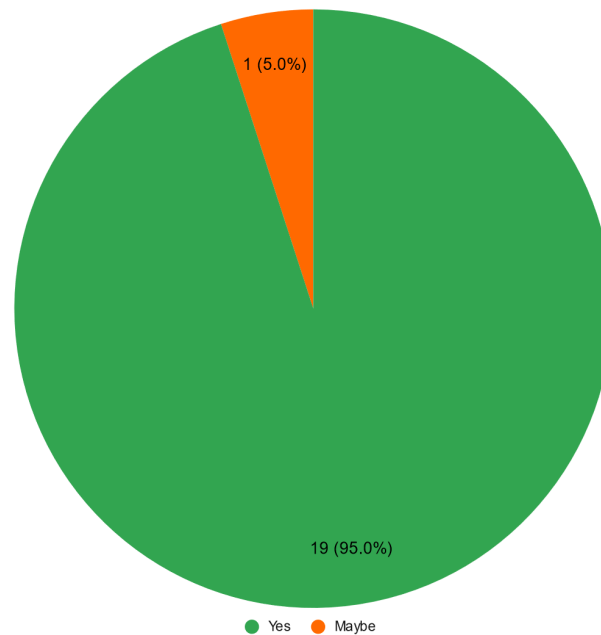


Figure 8. The number of participants who don't currently have access to a composting program at their place of residence and how willing they would be to participate if such a program were offered where they live.

Qualitative Questions

The qualitative questions of this survey were analyzed using a data-driven “grounded coding” process, where codes were identified from the responses collected). The qualitative question answered by the participant was dependent on if they had been offered a composting program where they live. In total, there were 29 participants who had access to a composting program and responded to questions asking how often they compost and what thoughts, feelings, reasons, etc. inform their response. There were 20 participants who didn't have access to a composting program and responded to questions asking if they would participate in a composting program given the appropriate infrastructure and information and what thoughts, feelings, reasons, etc. inform their response. The responses for these questions were examined carefully one-by-one and codes were identified based on the concepts touched on in the responses. In total, the codebook consisted of 18 codes (Table 1). As a note, some parts of the collected data could be grouped into multiple codes.

Two central themes that were drawn from the codes were **resources/information about composting and its benefits and drawbacks** and **behavioral familiarity with composting** and their relatedness composting, composting awareness, and composting willingness (Table 1). All 49 respondents either touched on one or both of these themes in their responses, and responses were either referred to in the affirmative or negative of the theme (ie: responses often demonstrated either having access to information about composting and its benefits, or demonstrated a lack of access to information about composting and its benefits; responses demonstrated a behavioral familiarity with composting or a lack of behavioral familiarity with

composting). Overall, the most common codes that were recurring throughout responses were: willingness to compost (15), awareness of waste one produces (14), access to composting infrastructure (14), familiarity with composting as a habit or previous experience with composting (13), knowledge of composting (11), awareness of environmental benefit of composting (11), and convenience of composting (11).

Table 1. Summary of codes and themes based on responses from the survey's qualitative question. The number of responses indicate how many responses referred to a given code in their response

Code	Responses from those who have access to a composting program	Responses from those who don't have access to a composting program	Total responses related to code
Resources and Information			
Knowledge of composting	6	5	11
Lack of knowledge of composting	1	0	1
Awareness of environmental benefit of composting	10	1	11
Awareness of waste one produces	11	3	14
Individual contribution to reducing greenhouse gases	2	0	2
Individual contribution as not solely responsible for climate change (big corporations, restaurants)	3	1	4
Consciousness about food/diet	1	1	2
Access to composting infrastructure	6	8	14
Behavioral			
Familiarity with composting as a habit/previous experience with composting	7	6	13
Association of composting to recycling (waste categorization)	3	1	4
Unfamiliarity with composting as a habit	2	0	2
Convenience of composting	6	5	11
Inconvenience of composting	3	1	4
Feelings associated with composting (positive, feel good)	2	2	4
Feelings associated with composting (negative, guilt, bad smell and attracting bugs)	5	1	6
People still composting despite inconvenience	2	0	2
Willingness to compost	5	10	15
Social cohesion for accountability (neighbors also composting)	0	2	2

Qualitative Interview

A qualitative interview was conducted for this capstone project. The interviewee, who will be referred to as Resident A, is a resident of Palo Alto who lives in a single-family home. The interview was transcribed and the codes generated from the survey qualitative responses were also highly relevant to the experiences and perspectives shared by Resident A. Some of the key codes that surfaced throughout the interview included: knowledge of composting, awareness of environmental benefit of composting, awareness of waste one produces, consciousness about food/diet, access to composting infrastructure, familiarity with composting as a habit/previous experience with composting, convenience of composting, positive feelings associated with composting, and willingness to compost.

5. Discussion

Majority of Participants Unaware of the California Composting Law

Through this research, I sought to investigate composting awareness, perspectives, and access to composting infrastructure in California. I first set out to investigate awareness about the California composting law. I was not too surprised to see that almost $\frac{3}{4}$ of the participants were also unaware of the law because I myself had not learned about the composting law until a year after it was passed. I was curious to see how participants learned about the law and found a variety of sources participants had learned about it: the largest number of participants had found out via their utility bill flier and word of mouth (Figure 3). I had personally found out through my utility bill flier, so I wasn't surprised to see that others had also learned about it that way. These results reflect the different and diverse ways participants have been informed about the composting law. Given the majority of participants had been unaware, this does make me wonder if an issue here is the communication of the law: how can new laws be conveyed to the public so that as many people can be informed as possible? How can the public be made more widely aware and educated on the composting law specifically, such that people are first aware of the law and from there, are given the tools and information needed to act with a raised consciousness about food waste? The results showing the various ways people learned about the law demonstrate the value of spreading the news about the composting law through multiple mediums: is the issue that *more* mediums need to be used to reach a wider audience?

The data on the number of participants aware of the composting law by residential unit in Figure 2 was also interesting to me because I'd personally thought that more participants who live in single-family homes would be aware of the law in general since I'd been under the impression that single-family homes would be more likely to have been offered composting programs than any other type of residential unit and thus would be informed about the law. However, it seems that awareness about the composting law wasn't necessarily associated with access to a composting program. In my interview with Resident A, Resident A had mentioned having a larger composting bin since moving to Palo Alto, but they had only learned about the composting law when their family received the kitchen countertop compost bin. This reveals a disconnect between awareness of the composting law and access to composting programs. Previous literature has suggested that laws can influence behavior through "what they ask of people, or signal" (p. 1, [Galbiati & Vertova, 2014](#)), indicating it may be beneficial and potentially even motivating for new composting programs to inform participants of the composting law as one form of motivation. In San Francisco, a city that has been vigilant in composting efforts, kids

in school are educated about composting and this increases composting at home ([Lotoux-Macias, 2024](#)), demonstrating that education and awareness about composting can serve as a helpful first introduction to composting.

Awareness of Composting Law and Composting Behavior

One of my research questions sought to examine how awareness of the composting law may impact composting behavior. Single-family home residential units were the most represented sample size in this study (24 participants), and 75% of these participants weren't aware of the composting law (18 participants). However, whether they were aware of the law or not, the majority of single-family home participants do some amount of composting (16 participants indicated they compost almost always, 5 participants indicated they compost moderately). This seems to suggest that whether someone chooses to compost or not may not depend *solely* on any law that's enforcing them to do so. This indicates that these participants who compost and didn't know about the law are motivated by other reasons, and we can get a glimpse into potential motivators by looking at the codes that came up in the qualitative responses: for example, composting as a daily habit/from previous experience, composting for environmental benefits, convenience of separating organic waste, etc. (Table 1). It's possible that awareness of the law may encourage composting, given that eight out of nine participants who were aware of the law and had access to a composting program indicated they compost, and all participants who were aware of the law but didn't have access to a composting program were willing to compost given the opportunity. However, there were also some participants who indicated they were aware of the composting law but were not in the habit of composting. Their response suggests that awareness of the composting law *alone* may not be enough to shift people's behavior and encourage them to compost. Other motivating factors that stem from a mixture of an awareness of composting's benefits and convenience of composting seem to be at play here. These other motivating factors may be key in encouraging composting as a behavioral habit, instead of just enforcing the law alone.

Taking a closer look at the qualitative responses, I was hoping to better understand why participants may choose to compost or not; specifically, what motivators and factors might be at play, since it seems that awareness of the composting law hasn't been a direct indicator of participant composting habits. As previous literature has shown, the myriad of factors described in participants' responses was reflective of the complexity of factors contributing to food waste behaviors that I observed in the literature. It was interesting to see the recurrence of **information** and **behavior** as common themes of the qualitative responses (Table 1). There seem to be a number of potential motivators, including: knowledge of composting, awareness of the environmental benefits of composting, awareness of the waste one produces, individual contribution to reducing greenhouse gases, consciousness about food/diet, access to composting infrastructure, familiarity with composting as a habit/previous experience with composting, association of composting to recycling (waste categorization), convenience of composting, positive feelings associated with composting, still choosing to compost despite the inconvenience, and willingness to compost. These factors are consistent with previous research that has found emotions, lifestyle, and convenience as factors contributing to food waste behavior ([Mallinson et al., 2016](#), [Russell et al., 2017](#); [Attiq et al., 2021](#); [Aydin & Yildirim, 2021](#); [Noto, 2024](#)). There are also a number of opinions and arguments against composting, such as: individual contributions as not solely responsible for climate change (big corporations,

restaurants, etc. are doing more and efforts should be focused there), lack of knowledge of composting, unfamiliarity with composting as a habit, inconvenience of composting, negative feelings associated with composting, and social cohesion for accountability. Seeing these responses was very informative in terms of honing in on conversations that need to be had in order to understand people's perspectives on composting, some of which will be discussed below.

It's critical to have conversations that acknowledge that methane emissions from organic waste in landfill only account for 20% of the state's emissions and a tremendous amount of attention should be paid to two industries that are contributing even larger quantities of greenhouse gases: agriculture and oil and gas ([CalRecycle, n.d.](#); [California Air Resources Board, n.d.](#)). At the same time, I think it'd be valuable to discuss the need for awareness of what we consume and dispose of in our individual lives. In a world where we're constantly being offered things to consume (not just food, but media, images, beauty standards, etc.), it may be worthwhile for us to have conversations where we take a step back to reflect on what we are actually consuming on the individual level. Are we consuming healthy, wholesome foods that can improve our overall health? Are we buying too much food and producing excess food waste from food not eaten? What factors are contributing to our food waste? Certainly, the individual contributions of food waste do not excuse the corporate responsibility of the agriculture and oil industries to continue polluting our shared air without restraint; however, that doesn't mean that we each don't have a responsibility to be stewards of the resources we do have access to in our daily lives. Having a balance of *both* corporate responsibility and individual responsibility in reducing greenhouse gas emissions however we can is something that can help raise our consciousness about how we spend our time on this Earth: how we treat the things we buy after we've finished using it for our own uses and how we can mindfully use the most of the resources we have access to?

In a similar vein, as I read through various papers in the field of consumer food waste, I noticed that many researchers have focused primarily on consumer behavior and the choices they make. For example, some researchers would mention portion control issues as something consumers were responsible for (ie: food waste was generated because the consumer took too large a portion than they could consume). However, reading these papers made me wonder: who are the players giving consumers these choices in the first place? Previous research has found that food waste was generated for some people because typical pre-packaged foods are too big for single person households but simultaneously, smaller portions of food are exorbitantly expensive ([Koivupuro et al., 2012](#); [Aschemann-Witzel et al., 2015](#); [Mallison et al., 2016](#)). If consumers are being forced to buy portions that are too large to be finished in one sitting and are inadequate for consumer needs, is this solely the fault of the consumer, or perhaps the food provider who has portioned food at such a scale and at such a price to make profits? Though there has been some literature on the relationship between big food corporations and the food system ([Clapp, 2022](#)), I haven't found as much literature on the contributions of big food corporations on food waste. Future research studying the relationship between how big food corporations are contributing to food waste behaviors may help add a valuable voice in this narrative: that consumers may not wish to intentionally waste food, but given the choices available to them at a given grocery store, they often are left with few choices that can help them minimize food waste.

There were some participant responses that stood out to me as distinct: two respondents indicated that, though they found composting to be inconvenient and sometimes smelly, they still

did their best to compost. This suggests to me that it's not *just* a matter of convenience or inconvenience, but if one is driven *despite* the inconveniences of composting to still choose to do so. Previous literature has found that, though most Americans don't compost, if it's made easy and accessible to them, they'd be willing to compost ([Noto, 2024](#)), and that personal attitudes may also influence composting behavior ([Ghani et al., 2013](#)). It's encouraging to see that some of the participants in this study were willing to compost despite the inconvenience. Of course, I think efforts should be made to make composting programs accessible and convenient, and if people could have grace and patience as new programs roll out and the inevitable trial and error that accompany them, then this may result in effective composting programs.

Access to Composting Programs Varies

Another major question I was interested in learning about was how many residents have been offered a composting program where they live. The results were both relieving and concerning: more than half the participants had been offered a program (Figure 4), but there were still about 40% of participants who hadn't been offered a program. This is actually a higher percentage compared to other parts of the US: an estimated 27% of the US has access to a form of composting service ([Okie, 2022](#)). It's a relief to learn that more people in California are being offered composting programs than not, especially compared to elsewhere in the US; however, the fact that this number isn't larger and that more California residents aren't being offered composting infrastructure in spite of a state law mandating composting is worrisome. I was also quite surprised by how many residents of single-family homes hadn't been offered a composting program just because of my previous impressions before collecting data (Figure 5). At the same time, it's difficult to definitively say that single-family homes are being prioritized or given easier access to composting programs since the sample size of participant residential units varied quite a bit, with single-family home unit participants being the largest. Previous research that examined food waste in Finnish households also didn't observe a clear correlation between food waste generation and residential unit type ([Koivupuro et al., 2012](#)). One response that stuck out to me was a participant who lives in a multi-family complex describing how their property manager "made it easy to compost by providing communal compost bins in a shared location." The participant describing the property manager's role in facilitating the composting program stood out amongst the responses from the multi-family complex participants because no one else had mentioned their property manager or landlord's involvement in the composting program. This particular response helped shed light on the unique role property managers have, especially on properties with more than one unit, in increasing access to composting programs. At the same time, it seems not all single-family homes have been offered composting programs, as well as townhouses, duplexes, and other residential units, so overall, access to composting programs should be prioritized for all residential types.

All participants who don't have access to a composting program indicated willingness to compost if a composting program providing sufficient infrastructure and information were offered to them. These results are consistent with the case study conducted in Sweden, where people were also more likely to compost and recycle if the proper infrastructure were provided ([Bartelings & Sterner, 1999](#)). Taken together, these results illustrate the overall interest in composting from most participants, highlighting the importance of ensuring California residents are able to have access to efficient, carefully designed composting programs that are able to facilitate the separation of organic waste from landfills.

Considerations for a Future Composting Program

The third question motivating this study was to better understand what considerations should be made for the implementation of a new composting program. Ensuring that all California residents of all residential units are provided with adequate infrastructure needed to separate organic waste from landfill waste should be of the highest priority, and several important takeaways have been gleaned from this project's results. Participants who indicated they did not compost often cited the smell and fear of bugs that may come with keeping organic waste separately. Providing durable and reliable composting infrastructure (kitchen countertop bins) that are able to contain food scrap containers hygienically, along with well-written guidelines for keeping these containers clean to minimize pests and lingering odors will be critical for new composting programs. Lastly, from this research, we've observed that the law alone is insufficient and that factors such as culture can impact behavior as well. Even if most participants hadn't been aware of the law, a large portion of participants were aware of composting and participated in some amount of composting. Two participants remarked on the role that seeing their neighbors also compost could have on the likelihood of composting themselves. Having more conversations about composting may thus be critical in normalizing the practice of composting. This brings to mind the impact of collective cultural norms: Norgaard's findings about the role that socially organized denial plays amidst an educated and aware public serves as a reminder that culture plays a strong role in behavior ([Norgaard, 2006](#)). Combatting socially organized denial about food waste by having conversations and normalizing composting as a regular practice that can be easily integrated into our daily lives should be taken into account when designing a new composting program. This could potentially look like hosting social gatherings in the local neighborhood where residents can learn about composting while also getting to know their neighbors over perhaps a shared meal or snacks. It could look like discussing what's compostable and what isn't after lunch amongst co-workers. By talking about composting as a natural part of our lives, this may encourage those around us to think about food waste more often and be conscious of the foods they're consuming.

Limitations & Future Research

This study set out to gain a better understanding of California residents' perspectives, experiences, and awareness of composting and the state composting law. I found myself wondering about other new questions as I synthesized my research findings. This study's participants were predominantly from single-family units: future research may consider conducting this research such that more populations from each of the residential unit types could be more fully represented in the data. Additionally, in order to maintain as much anonymity in this survey as possible, data on the city in which participants were living in California was not collected: in future studies, it could be interesting to be able to compare the composting awareness and access to composting across various cities in California to see how cities can collaborate to help one another in increasing awareness about composting and introducing composting programs. Furthermore, this research was based on results from a self-reported survey. Previous research has suggested that it possible food waste quantities are underreported in self-reported surveys ([Hebrok & Boks, 2017](#)); additionally, it's possible that each participant

may evaluate the provided responses for the quantitative questions differently, so there is possibility of participant's individual standards in their responses to be varied. Future research could benefit greatly from conducting optional follow-up interviews with willing participants where further questions can be asked about the qualitative response they provided to get a better understanding of the participant's context and background, and how these may inform the participant's responses. Lastly, demographic questions were listed in the survey as optional: because they were made optional, this decreased the sample size of comparable responses to only those who also answered the demographic questions, making it difficult to draw conclusive takeaways or further understanding from these responses. Future research may consider collecting demographic information as required questions on the survey to better understand if certain groups of people may be facing disadvantages or inequitable access to composting infrastructure and information.

Finally, these questions were investigated through this preliminary survey to better understand what it may take to introduce a composting program in a multi-residential complex context. In the near future, I'd like to start having conversations with my landlord/property manager to better understand the feasibility of introducing a composting program to the complex I live in. Conducting this study has given me more context and insight into what considerations may need to be taken, as well as what kinds of injustices may be addressed through providing residents the means to separate organic waste from landfill waste.

6. Summary

This research set out to investigate California residents' awareness of the state composting law, perspectives on composting, and access to composting infrastructure to better understand what should be considered when implementing a new composting program. An anonymous survey was conducted to learn about access to residential composting programs and the diverse experiences with composting amongst residents in various residential unit types. One qualitative interview was conducted with a resident living in a single-family home to gain further context into the resident's experience with composting. Of 49 participants, almost $\frac{3}{4}$ of all participants did not know about the California composting law; yet, there were many participants who compost despite not knowing about the law. This suggests that participants who hadn't known about the law are motivated to compost by reasons other than to follow the law, as seen in the participants' qualitative responses. About $\frac{3}{4}$ of participants who have access to a composting program participate in moderate to consistent composting. All participants who don't have access to a composting program at their residence indicated at least some amount of interest in participating in a composting program given the appropriate resources and information to participate. Though awareness of the law doesn't seem to be the only motivation for people to compost, all participants who are aware of the law but don't have access to a composting program showed interest in participating in a program given the opportunity. From our findings, there wasn't clearly a residential unit type that had more or less access to composting programs: it's recommended that all residential unit types be prioritized in getting access to composting programs. Future composting programs should consider a combination of raising awareness of the composting law, providing access to reliable composting infrastructure and guidance on separating organic waste, and increasing day-to-day conversations and social normalization of composting to better encourage composting and awareness about the foods people consume and food waste they generate.

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8. Appendix:

Anonymous survey:

Are you currently aware of the California composting law, which went into effect via Senate Bill 1383 on January 1st, 2022, that requires all Californians to separate organic material (food scraps, yard waste) from landfill waste?

Yes

No

If you answered “Yes” to the previous question, how did you find out about the composting law?

N/A (answered "No" to question 1)

Utility bill flier

Local news channel

Local newspaper

Online/Internet

Word of mouth

Other

Which best describes your current living space?

Single-family home

Two-family home/Duplex

Townhouse

Multi-family home (5 or more units)

School dormitory

Mobile home

Other

Have you been offered or do you currently have access to composting materials (composting bin, countertop buckets, compostable bags) and composting services (services where compost is picked up from your place of residence) where you live, as offered by the city/local jurisdiction or your property manager/landlord?

Yes

No

(If answered “Yes”)

How often do you compost using the provided materials and services?

Almost always

Moderately

Not often

What thoughts, feelings, reasons, etc. inform your answer to the previous question?

(Long response question)

(If answered “No”)

Suppose a composting program were to be introduced at your residence. You would receive a kitchen countertop compost bin to collect food scraps, and there would be a large outdoor collection receptacle where composting bins can be emptied out into. Information about what is and isn’t compostable and best practices to keep compost bins clean would be provided in an informational flyer. Could you see yourself participating in such a composting program if it were to be introduced to your place of residence?

Yes

No

What thoughts, feelings, reasons, etc. inform your answer in the previous question?

(Long response question)

Optional Demographic Questions

How many years have you lived in the state of California?

Less than 1 year

1-2 years

3-4 years

5-9 years

10+ years

Prefer not to say

How old are you?

18-24 years old

25-34 years old

35-44 years old

45-54 years old

55-64 years old

65+ years old

Prefer not to say

What is your gender?

Female

Male

Non-binary

Gender-fluid

Other

Prefer not to say

How many people are there in your household?

1

2

3

4

5+

Prefer not to say

What is your ethnic background?

White/Caucasian

Hispanic or Latino

African American

Asian

Native American

Native Hawaiian or Pacific Islander

Other

Unknown

Prefer not to say

What is your highest level of education?

Less than high school

High school/GED

Some college (no degree)

Technical certification

Associate degree (2-year)

Bachelor's degree (4-year)

Master's degree

Doctoral degree

Professional degree (JD, MD)

Prefer not to say

What is your annual household income?

\$0-\$29,999

\$30,000-\$59,999

\$60,000-\$89,999

\$90,000-\$119,999

\$120,000-\$149,999

\$150,000+

Prefer not to say

Qualitative interview:

Below are some of the questions I asked/tried to learn more about from Resident A:

1. Do you remember when you first learned about composting?
2. When did it become a part of your daily life? How did you find out/where did you learn from?
3. When you first started composting, did you feel you had ways of getting support in terms of learning what's compostable or not, how composting works, etc.? Was it more self-taught or did you feel you had a community or resource you could refer to?
4. How was the transition from going from not composting to composting? What was the biggest barrier if anything?
5. What might be some barriers to composting generally?
6. Since you started composting, do you feel more aware of the kinds of waste you produce from having to sort waste?
7. How did you find out about the composting law?

In Conclusion...

Throughout this magazine we have explored the intersectionality of sustainability, our shared humanity, and the natural world, but most importantly we have unearthed the inherent interconnectedness of all of these elements. Each of the case studies included in this magazine highlight a myriad of ways in which our choices as humans impact others, the natural world, and the overall health and wellbeing of the planet. Everything we do is connected to a thread that stretches across the earth, a thread that is interwoven with countless people, trees, oceans, animals, places and everything in between.

This interconnectedness led each of us to examine the different benefits and impacts of our innovation and development as humans. Through this lens of connectedness, we considered the direct and indirect consequences of various environmental and social justice challenges in this magazine. We explored the ways the bio-pharmaceutical industry creates waste and consumes energy while developing life changing cures. We examined the way plastic that is used for making products convenient and disposable is breaking down into microplastics that are harming female reproductive health while also polluting the environment. We learned about the different ways that our food waste and other organic materials contribute to global warming and environmental pollution, while looking at the social challenges of composting. We reviewed the role capitalism and pollution have impacted the Tijuana River Watershed. We reviewed rural food access in a small farming town in Missouri with high food production and low nutrient dense food consumption. And lastly, we looked at nutrient insecurity and San Diego and learned about the barriers and benefits of community gardens.

Despite having varying project subjects, each of our projects uncovered various impacts associated with human development and the built environment. As we each considered the implications of our chosen subject, the analysis of our data led to very different but also very similar results. While necessary for many of the things we have today, innovation has also led to the exploitation, pollution, environmental degradation, and inequitable distribution of resources. Some have benefited, while others face the consequences linked to increased consumption and waste production, pollution, and resource extraction. All of the actions taken in the name of innovation and development are accompanied by short and long term consequences that impact people and the planet at every stage of the process. Considering all of these consequences, both good and bad, is absolutely necessary to ensure that sustainability and equality are at the forefront of development and innovation. In order to develop solutions that are socially just and sustainable, engineers, developers, companies, governments, and individuals must consider the impacts of their choices at every level. We cannot continue to operate as if the thread that connects us all is invisible. We must create a future where our interwoven connection is celebrated, respected, and considered always.

We would like to end this magazine by encouraging you to explore your beginner's mind and consider the thoughts you have regarding your role in creating a more sustainable, equitable, and just world. How can you recognize and unlearn preconceived notions to better see what is in front of you and how can you move forward? Spreading awareness and raising

our collective consciousness about these very important issues is how we can build a better future, and we all have a part to play. For some it is a larger role than others, but our shared humanity and our collective reliance on the natural world for life, for food, health, air, shelter, and everything in between, makes this important for every single living being on this planet. In order for us to have an equitable, sustainable, and livable future for all, we must come together and address the social, economic, and environmental issues plaguing our planet. Collaborative and interdisciplinary solutions rooted in social and environmental justice

Thank you for taking the time to read this magazine! We hope you enjoyed reading the final culmination of our work and that you will continue to explore the ways you can impact sustainability, social justice, and community health in your local area.

- MESH Summer 2024 Cohort

