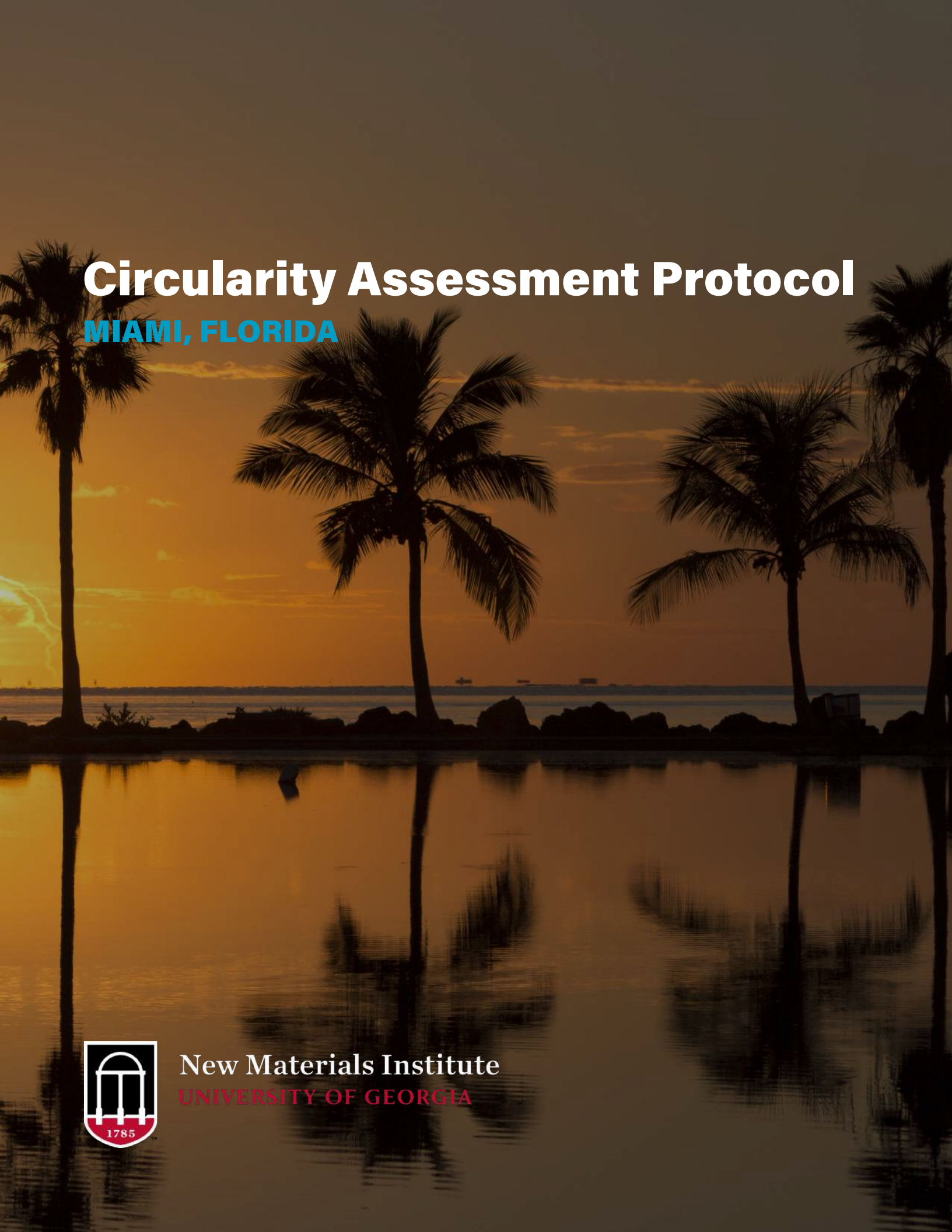

Circularity Assessment Protocol

MIAMI, FLORIDA

New Materials Institute
UNIVERSITY OF GEORGIA

The Circularity Informatics Lab at the University of Georgia is committed to information sharing, data analytics, empowering communities, and systems change related to circular materials management.

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On behalf of:
The City of Miami, with funding from Ocean Conservancy

www.circularityinformatics.org

Athens, GA, August 2021

New Materials Institute
UNIVERSITY OF GEORGIA

Ocean Conservancy

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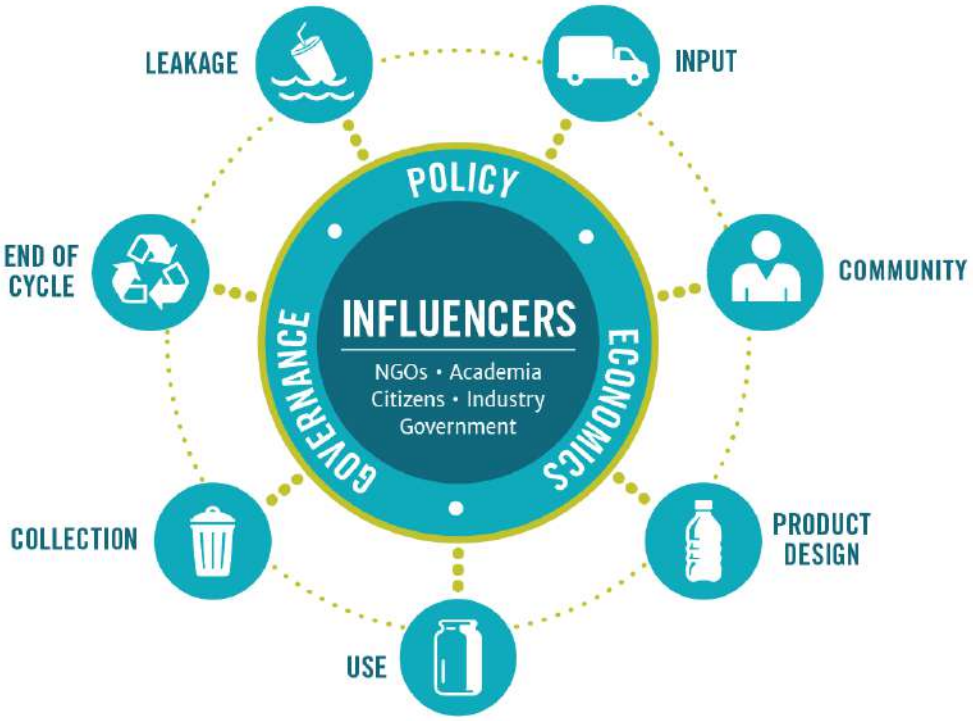
Executive Summary

Developed by the Circularity Informatics Lab at the University of Georgia, the Circularity Assessment Protocol (CAP) is a standardized assessment protocol to inform decision-makers through collecting community-level data on plastic usage. Grounded in materials flow and systems thinking concepts, the CAP uses a hub-and-spoke model to holistically characterize how consumer plastic flows into a community, is consumed, and flows out, either through waste management systems or leakage into the environment. The model, shown below, is comprised of seven spokes: input, community, material and product design, use, collection, end of cycle, and leakage. At the center, the system is driven by policy, economics and governance with key influencers including non-governmental organizations, industry and government.



In May 2021, a team from CIL conducted fieldwork in the City of Miami, FL, with support from graduate students at Florida International University (FIU). The CAP was conducted with support from the City of Miami's local government and the Ocean Conservancy (OC). Fieldwork included product and packaging assessments in stores across the city; key stakeholder interviews with government, industry, and non-profit organizations; material type characterizations for consumer plastic items; cost analysis of reusable products and alternatives to plastic available in the city; visual audits of recycling contamination; identification of public waste and recycling collection bins; and litter transects in three categories of population. Key findings from each spoke are summarized in the following table.

Key Findings and Opportunities

INPUT

Findings: The majority of top convenience items have manufacturing locations and parent company locations within the United States. Notably, various shops also import Latin American products, primarily made by Nestle Venezuela,

Opportunities

- Opportunities for extended producer responsibility (EPR) and alternative delivery systems, particularly for the most problematic plastic items such as plastic film and multilayer plastic items.
- Expansion of Plastic-Free MB (Miami Beach) to Plastic-Free 305 in the coming years and increased control over product input for the city.
- Ensure that actions related to plastic and waste reduction in the Miami Forever Carbon Neutral Plan for 2050 have funding and/or support as needed.

COMMUNITY

Findings: A recurring theme in the stakeholder interviews was the importance of building a sense of community and a sense of place in Miami. Many people do not know what happens to their waste, and there is a need to build more awareness and make more connections between individual behavior, environmental health, and resilience.

Opportunities

- Increased education in Miami, both formal education in classrooms via public school curriculum and informal to the general public, is critical to address awareness barriers.
- Make materials recovery facility (MRF) and other waste management infrastructure tours more available to schools, community groups, and volunteer groups.
- Support initiatives that support youth in each community in the City of Miami that want to spearhead cleanups in their own neighborhoods to build local pride and to help residents make connections between everyday items and litter.
- Invest in campaigns, messaging, outreach, in-situ education opportunities, and other initiatives — particularly for underserved communities — to enhance the sense of community and pride for the City of Miami among residents.
- The City could bring more recognized voices as spokespeople to the table for future initiatives and to build community around this issue.
- Increase Commissioner engagement in activities such as community cleanups to get more in front of this issue.
- Develop and increase messaging that the tap water in the City of Miami is safe to drink and actively combat misinformation on this issue.

PRODUCT DESIGN

Findings: Many compostable items were documented in food vendors and restaurants, though there is no industrial composting infrastructure for the city or the state. To-go food products in particular are made of a wide variety of material types which could contribute to confusion around best practices for recycling in the city. The prevalence of items such as expanded polystyrene (EPS) and other single-use plastic products that have had previously failed policy-initiatives point to a need for revisiting policy and enforcement structures within the framework of what is possible at the local level.

Opportunities

- The city needs to ensure that the product and material designs being used by local businesses match the infrastructure and capacity for waste management, and that businesses are aware of how the materials need to be managed [Note, there are periods after the sentences here, but not in other parts of this section where "opportunities" are written as bullets. If periods are needed here — each bullet should have one, so that they are consistent across all the spokes.
- Consistent labeling and messaging across the city, particularly for to-go items, would be useful for consumers and proper disposal.

USE

Findings: Alternatives such as biodegradable and reusable plastics, wood, and metal come at a cost premium for both consumers and businesses, in some cases costing over 700 times more than the standard single-use plastic equivalent. Some businesses have implemented eco-fees to share these higher costs with consumers, while others suggest tax incentives could help promote reusable products and other alternatives. Reuse and refill schemes are hampered by community perceptions around drinking water in Miami, low willingness to pay extra fees, and availability/level of adoption in the city.

Opportunities

- The city should ensure that local businesses have the support and/or resources that they need to understand the options available to them, coupled with incentives for businesses to explore reuse/refill and alternative options that may require upfront investment.
- Adjust the special event permit process for the city with regard to the use of single-use plastics vs. reusables at events. This has been initiated through the Sustainable Events Guidelines in-progress.
- The city of Miami may want to explore incorporating Woosh refill stations or similar option in the city as well as the option of allowing sponsorships for this program so that people don't have to pay for them.

COLLECTION

Findings: While on paper all residents of the City of Miami should have access to waste management and recycling, there are reported discrepancies in the availability of waste and recycling services for multi-family units. While these services are mandatory, they are not consistently enforced. Unclear, unequal, and confusing collection practices may contribute to illegal dumping in the city as well as high concentrations of litter on the spoil islands.

Opportunities

- The city should prioritize reducing the contamination levels for the local MRF via collection. This could be addressed in a variety of different ways and will likely require more than one intervention — including signage, enforcement, tailored outreach, infrastructure, and others — which are outlined in more detail in this report.
- Spoil island maintenance needs to be addressed urgently to reduce the amount of waste leakage coming from those point sources.
- The city may want to invest in regular inspection and education related to recycling bins in all communities in Miami, accompanied by tailored messaging around what 'contamination' means for the different communities.
- The level of collection and waste management may not be equitable across differing communities in Miami, so resources and engagement with underserved communities may be helpful.

END OF CYCLE

Findings: Recycling in Miami should be a cost-effective practice. Decreasing contamination and maximizing value of the resulting output is critical and interventions to support this must be prioritized. Depending on the continuing trend of compostable plastic in Miami, particularly among food vendors, the city may want to explore the possibility of installing or getting access to an industrial composter. The current landfills are rapidly running out of space and awareness on proper disposal and infrastructure is low.

Opportunities

- The city should prioritize the most feasible options to decrease contamination and maximize value of the resulting output of the MRF in Miami.
- The city needs to move away from its dependence on landfill and ensure that the waste management infrastructure matches the products and materials used and collected in the city.
- The city's Waste and Recycling Department should have more staff as well as community leaders that they can work with to get tailored messaging and engagement at the neighborhood level.
- Explore industrial composting for the Miami area to address the increasing quantity of compostable plastics being used in local businesses in Miami, if this trend continues.

LEAKAGE

Findings: Plastic fragments, food wrappers, and tobacco products are the top items contributing to urban litter in Miami. Highest litter densities were found in the lowest population count areas. Public awareness campaigns around the upcoming storm drain improvements should be implemented to maximize their effectiveness, and connections need to be made among the general public between the litter deposited on the street and the health of Biscayne Bay. The culture of cleanups should be normalized in inland and neighborhood areas, and not only around beaches and coastlines, to increase awareness and reach a broader audience. High levels of fragments and the prevalence of litter originating from other locations within the Miami area suggest that an integrated, cross-city, and cross-sector effort is needed to reduce litter at the source.

Opportunities

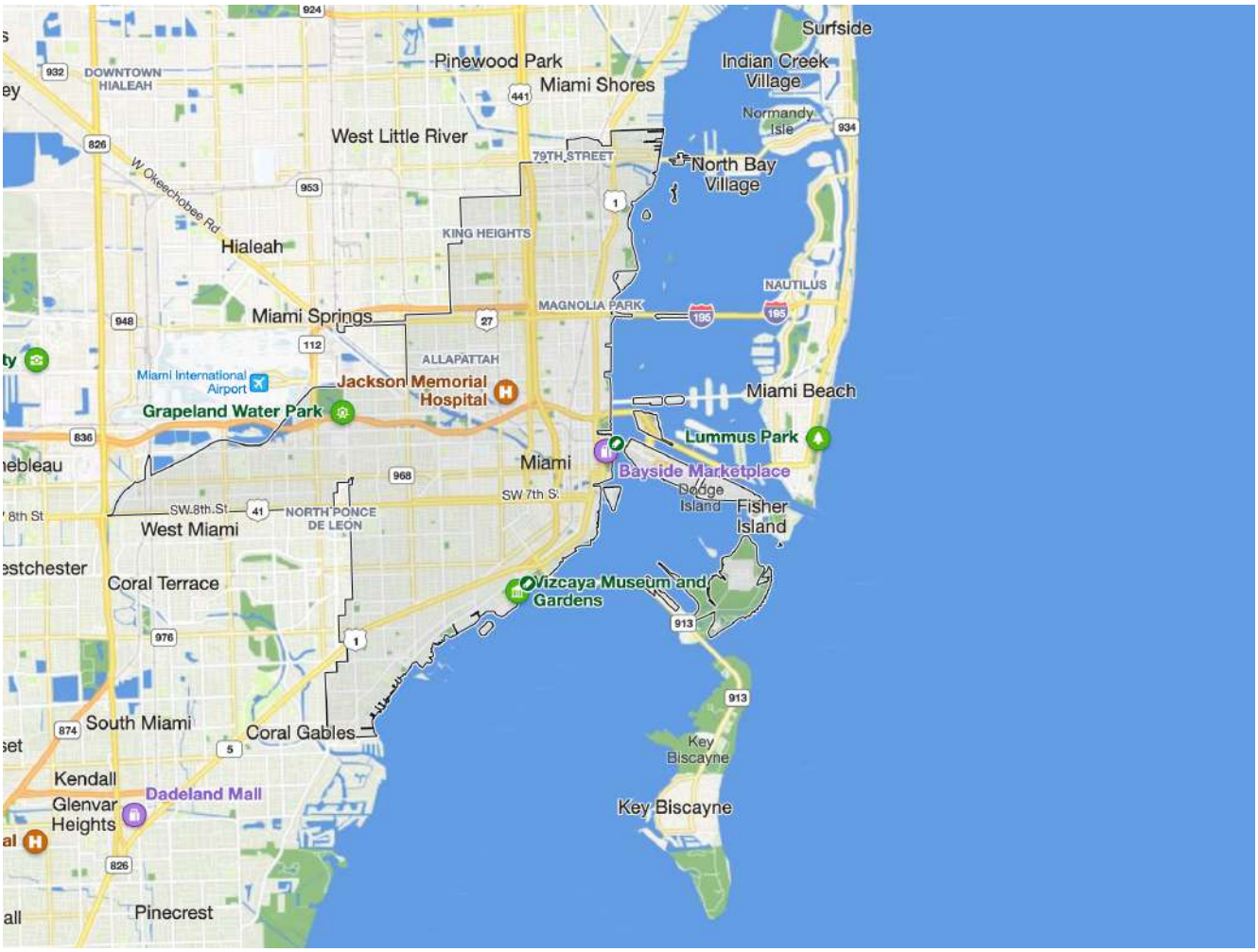
- The city should prioritize full implementation of the new storm drain filter system in Miami, as well as accompanied regular maintenance and community outreach.
- Public Education initiatives are needed around storm drains and the stormwater pump system.
- The city and relevant stakeholder groups could work to mitigate "inland" litter, beyond just the beaches and waterways in the city.
- Outreach and awareness should also target boaters and tourists, as these were mentioned by several interviewees as key contributors to litter (particularly that is washing up on the shore), and the most cost effective and efficient solution would be to stop the littering at the source as much as possible.

Glossary of Acronyms and Abbreviations

BBHC – Biscayne Bay Marine Health Coalition
CAP – Circularity Assessment Protocol
CE – Circular Economy
CIL – Circularity Informatics Lab
CTS – Central Transfer Station
C&D – Construction and Demolition Material
EPR – Extended Producer Responsibility
EPS – Expanded Polystyrene
FDEP – Florida Department of Environmental Protection
FIU – Florida International University
HDPE – High Density Polyethylene
HC2s – Home Chemical Collection Centers
GDP – Gross Domestic Product
MCQ – Multiple Choice Question
MPs – Microplastics
MRF – Material Recovery Facility
MSW – Municipal Solid Waste
MSWM – Municipal Solid Waste Management
NDLF – North Dade Landfill
NETS – Northeast Transfer Station
NMI – New Materials Institute
OC – Ocean Conservancy
PE – Polyethylene
PET – Polyethylene terephthalate
PP – Polypropylene
PPE – Personal Protective Equipment
PS – Polystyrene
PWWM – Public Works and Waste Management Department
rPET – Recycled Polyethylene terephthalate
RRF – Resources Recovery Facility
RRLF – Resources Recovery Landfill
SDLF – South Dade Landfill
SWM – Solid Waste Management
SWMMP – Solid Waste Management Master Plan
TRCs – Trash and Recycling Centers
UBC – Used Beverage Container
UGA – University of Georgia
WMIF – Waste Management Inc. of Florida
WTS – West Transfer Station

Introduction

The city of Miami, FL is the most populous metro region in the southern United States, with a population of over 470,000 that has grown by nearly 20% since 2010 and continues to grow 1.09% annually (US Census Bureau 2019). With that growing population, the waste generation rates for the county are also estimated to increase by 0.1% per year, reaching 1.44 tons/capita/year by 2060 (Miami-Dade SWMMP 2014). Miami and Miami Beach are two separate cities that are both located within Miami-Dade county, which is the most populous county in Florida (Miami-Dade Government 2021). The data collection from this report focuses on the area of the City of Miami, though some information or case studies from Miami Beach are referenced.



Miami, Florida

The City of Miami is home to one of the most diverse populations in the US, and in 2004 the UN Development Program ranked Miami as the city with the highest percentage of foreign born residents at 59% (World Population Review 2021). Given the demographic diversity, it has been found that 22% of Miami residents speak only English, while 77% speak other languages, the largest group being Spanish which is spoken by 70% of residents. The city has an employment rate of 58% and a poverty rate of 23%, while the cost of living is found to be 15% above the national average (World Population Review 2021; Forbes 2019).

The main industries of Miami center around tourism, finance, trade and media. The Port of Miami has been deemed the "Cruise Capital of the World" as it receives the highest numbers of cruise passengers among ports globally (Forbes 2019). In 2018, the tourism economy in the Greater Miami and Miami Beach areas saw record-breaking numbers, with 16.5 million overnight visitors, an increase of 3.5% from 2017, and 6.8 million day visitors. The estimated associated economic impact was $18 billion for the city (GMCVB 2019). Those numbers dropped substantially in 2020 due to COVID-19—the pandemic cut tourism to the state of Florida by 60% in the second quarter of 2020 and by 33% in the fourth quarter of 2020 (Turner 2021)—but will likely return to their previous levels in the coming months and years.

With a diverse and growing population, unique challenges related to climate change and flooding, and critical needs around infrastructure, the city of Miami has prioritized strengthening its resilience. Miami became part of the 100 Resilient Cities network in 2016 and has a dedicated Resilience office that focuses on all manners of climate, economic, and social resilience. The City of Miami, Miami-Dade County and the City of Miami-Beach jointly released the Resilient305 Strategy in 2019 as a living document to foster ongoing stakeholder input into the resilience building processes in the Greater Miami area. The Biscayne Bay Marine Health Coalition is another active group in Miami that is dedicated to supporting solutions for the health and resilience of the Biscayne Bay Watershed, and plastic debris is a key issue for their members as well as for the appointed Chief Bay Officer.

As part of the process to understand the current situation around waste management and the circular economy of Miami, the Ocean Conservancy (OC) and the City of Miami partnered with The Circularity Informatics Lab (CIL) at UGA to conduct a Circularity Assessment Protocol (CAP).

CIL at the University of Georgia developed the Circularity Assessment Protocol (CAP) in 2018, which is a standardized assessment protocol used to collect community-level data to inform decision-makers. The CAP characterizes seven community components:

1. **Inputs**—What products are sold in the community and where do they originate?
2. **Community**—What conversations are happening and what are the stakeholders' attitudes and perceptions?
3. **Product design**—What materials, formats, and innovations are found in products, particularly packaging?
4. **Use**—What are the community trends around use and reuse of product types?
5. **Collection**—How much and what types of waste are generated? How much is collected and what infrastructure exists?
6. **End-of-cycle**—How is waste disposed? What is the fate of waste once it is properly discarded? How is it treated?
7. **Leakage**—What waste ends up in the environment? How and why is it getting there?

This report documents work conducted by CIL with support from OC and the City of Miami. Background information

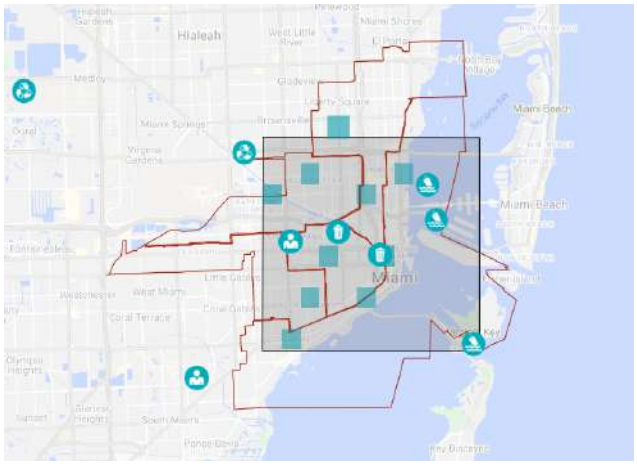
and a literature review were conducted in January - April 2021. Fieldwork was conducted in May 2021. The CAP report is split into the following sections, which include results and discussion of each: Input, Community, Product Design, Use, Collection, End of Cycle, and Leakage, followed by Opportunities to support the forthcoming stakeholder engagement with the City of Miami.

The intent is for the data in this report to inform ongoing stakeholder engagement around solutions to strengthen the circular economy and waste management in Miami. As a follow-up to this report, OC and the City of Miami are planning to partner with local organizations to run community-based engagement efforts, with local leaders driving the community focus in their area based on their priorities as informed by the CAP data. Outputs will include an action guide in three local languages developed in collaboration with community leaders and policy goals developed in collaboration with the city.

Sampling Strategy

In order to randomly sample various locations in a city, the CAP typically identifies a 10 x 10km area over the city (with the center of the city in the center of the area). In this area, the ambient population is sectioned into tertiles (three groups) (Figure 2). Ambient population count can be described as "where people go" and "societal activity" — it is not population density of where people live. These three areas typically form samples of different land uses, etc. However, while the ambient population across various areas of the city might be similar, there are distinct neighborhood differences in Miami that were desired to be captured. In addition, the shape of the city, as a coastal city, did not lend itself to a normal square area, and with a large and diverse population, areas representing the city along the coast and city areas off the coast, were added to the normal area (Figure 1).

Figure 1: Miami CAP Sampling Map



Teal square = litter transect, store survey, and food vendor survey

community group interviews (geographic area covered by group)

storm pump and scavenger boat tours

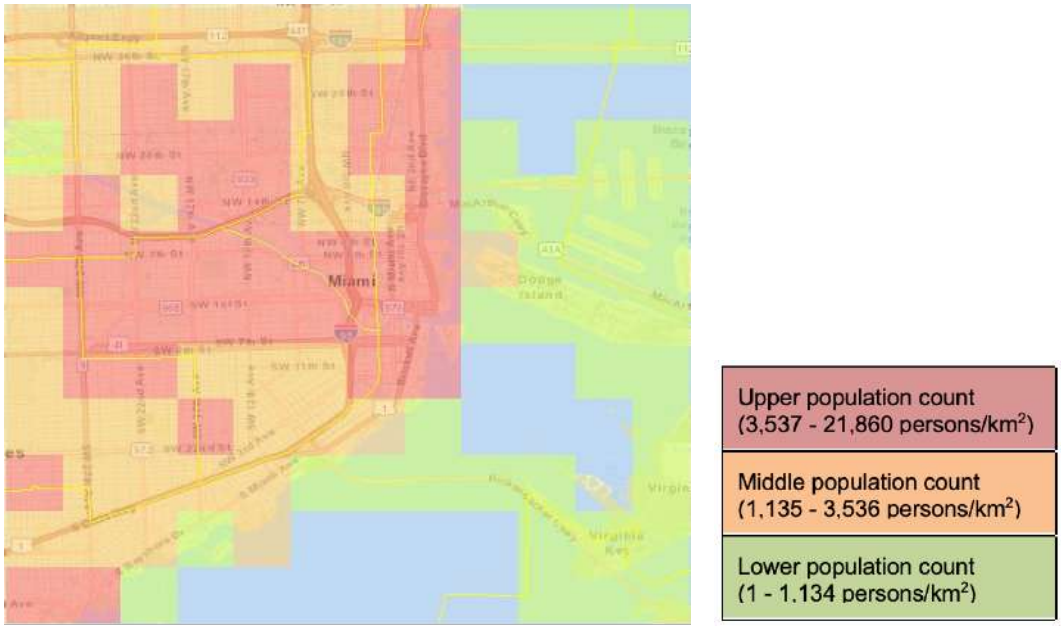
landfill, MRF, WtE tours

additional litter transects

use — conducted across whole city area

Red outlines — commission districts
Black outline — 10x10km sample area

Figure 2: Population count within 10x10km^2 area for CAP sampling in Miami



CAP Results

Input

To get a snapshot of the characterization, scope, and source of common plastic packaged items that are entering Miami, samples of common convenience items in four popular categories were taken within thirteen 1km^2 transects in Miami — four within each tertile of the population count as well as an additional transect for mid population count. The team selected three convenience or grocery shops to sample within each 1km^2 transect area. In total, 88 convenience products were collected and sampled, including 32 candies, 32 chips, 16 drinks, and 8 tobacco products. Samples of identical brands were not collected multiple times, even when present in multiple stores.

Figure 3: Typical convenience store packaging in Miami

(Photo Credit: CIL)

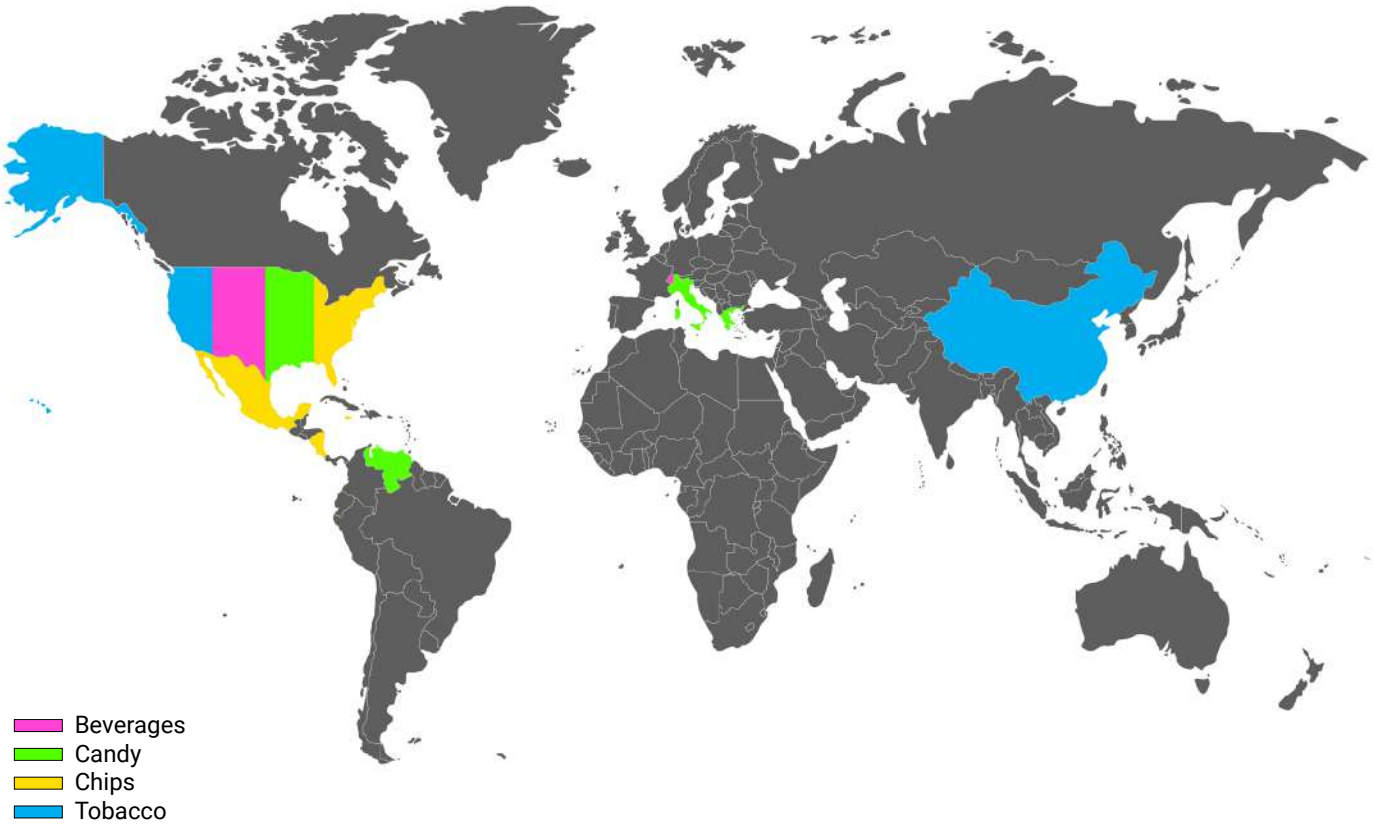
For each of the top products documented, the team noted the type of packaging (including polymer, if possible), the brand, and the parent company. From there, the team was able to determine the manufacturing location, which was determined from manufacturing locations listed on product packaging or desktop research, as well as the headquarters location for the parent company of the brand (largely determined by desktop research).

Table 1: Distances between Miami and manufacturer and parent company locations for top convenience items

	Distance Store to Parent Company (km)				Distance Store to Manufacturer (km)			
	Minimum	Maximum	Average	Median	Minimum	Maximum	Average	Median
Candy	0	10,676	2,713	4,321	0	10,677	2,457	2,556
Chips	0	4,141	1,838	1,424	17	4,174	2,020	1,516
Drinks	0	9,002	2,421	2,811	18	4,102	2,345	1,939
Tobacco Products	60	26,239	1,648	4,585	1,440	26,239	1,565	4,685

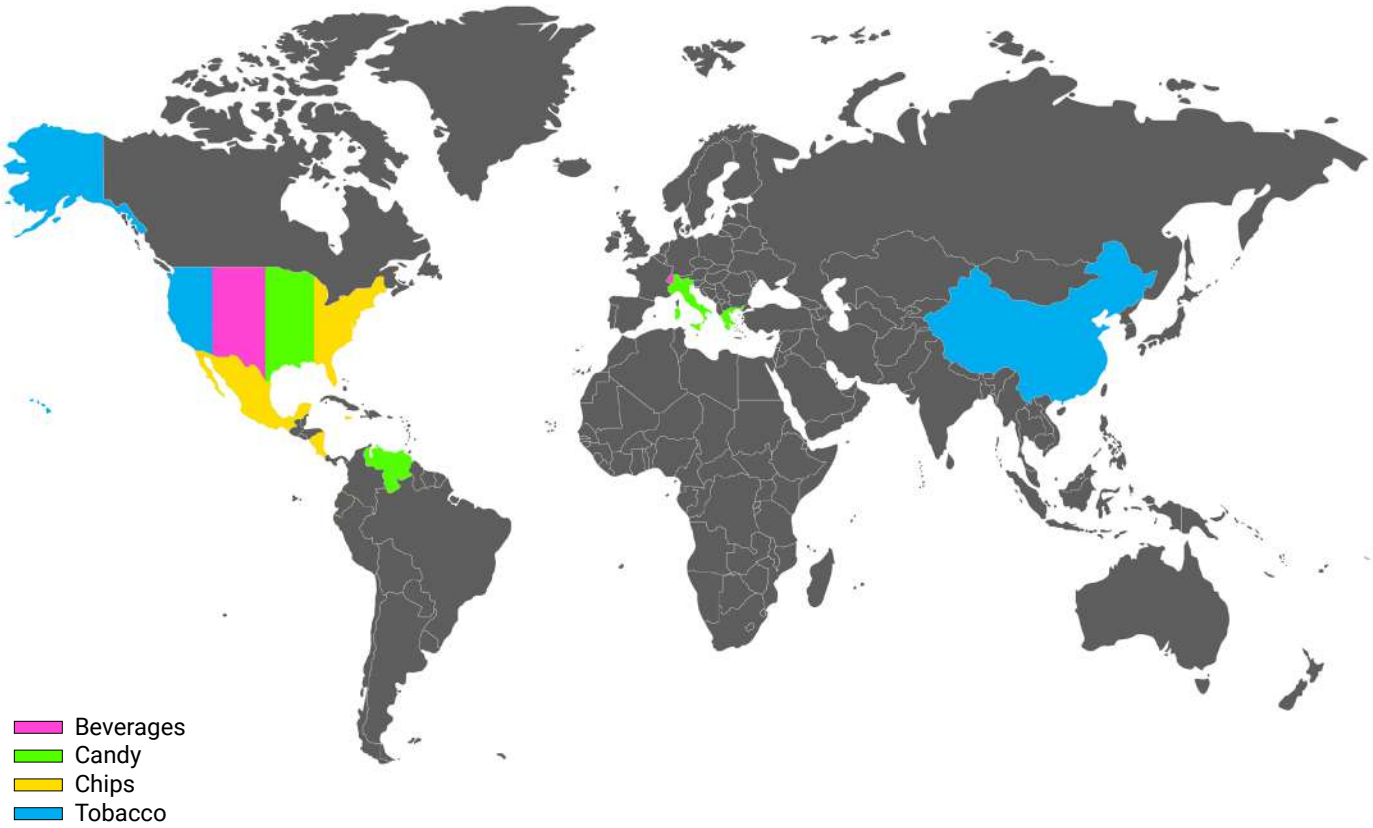
In observing the pattern of origins for top convenience items, it was found that both manufacturing and parent company locations were primarily regionally distributed in the United States and Latin America. Distances to parent companies and to manufacturers were, on average, roughly equivalent. This is likely driven by the large number of imported brands from Latin American countries that were found in stores in Miami. Among the four categories of convenience items sampled, the chip products on average had manufacturers and parent companies located closest to Miami. Considering that chip bags and similar plastic food packaging are often lightweight multi-layer plastic that is difficult to capture and recycle, the proximity of manufacturing and parent company locations for this category could present opportunities for engaging manufacturers in end-of-life packaging discussions, innovative product design, and alternative product delivery systems.

Figure 4: World Map displaying manufacturing locations for top convenience items in Miami



Across all products sampled, 63% were manufactured in the United States, which was the most represented manufacturing location, followed by Venezuela (11%), Mexico (6%), and the Dominican Republic (5%). On average, manufacturers for top drink and chip products were located within 2,000km of Miami. Tobacco products had the highest maximum and average distances to manufacturing locations.

Figure 5: World Map displaying parent company locations for top convenience items in Miami



Similar to the pattern of manufacturer locations, the majority (76%) of top convenience item brands were owned by a parent company headquartered in the United States. Notably, 11% of the top brands were headquartered in Switzerland. The large representation of Venezuela in manufacturing and Switzerland in parent company locations is driven by small shops importing Latin American products made by Nestle Venezuela, which is owned by Switzerland-based Nestle. There were many smaller companies and brands observed in the sampling process that had manufacturer and parent companies in the same location, which could further represent opportunities for end-of-life discussions and optimization of supply chains. These findings may also be relevant to the Greenhouse Gas Reduction Plan that is in development for the City of Miami.

Community

To understand current attitudes and perceptions of plastic waste, semi-structured interviews were conducted with 14 key stakeholders (Table 2). Among those interviewed, four were from NGOs, four were government officials, four were from local businesses, three were from private waste companies, and two were from academia (Table 2).

Table 2: Summary of stakeholder interview list

Stakeholder Group	Number of Interviews
NGOs	4
Government Officials	4
Local Businesses	4
Private Waste Company	3
Academia	2

In Miami, most interviewees agreed that plastic waste is a problem within the community. Interviewees frequently cited the disconnect between waste being on land and waste ending up in waterways as an example of why they felt awareness was low. These sentiments can be found below:

> **"People do not understand the relationships between trash on land and trash in the ocean."**
>
> **— NGO/Activist**

> **"You think it's a coastal problem but it's really not."**
>
> **— Government Official**

> **"Space is only where you might be at, and the relationship between how waste is connected to the land and ocean is not really considered. However, people thinking about the land, river, and ocean are considered among some people. It really just depends on who you are talking to."**
>
> **— NGO**

Several interviewees specifically mentioned how storm drains exemplify an area where awareness can be improved:

> **"Lots of pollutants get into the Bay through stormwater, and plastic and floatables are a huge part of the pollutants that enter."**
>
> **— Government Official**

> **"The floatables are largely litter. People think that if they can't find a bin, they can put litter in the storm drain then it isn't littering. Really [storm drains] are just a direct conduit to the Bay."**
>
> **— Government Official**

> **"This was a swamp, we literally dried it up to live here; the stormwater system and canal system means that everything gets carried into the bay."**
>
> **— Government Official**

Other interviewees brought up the misconception that waste management at the household level begins and ends with throwing waste in the trash or by recycling. "Wish-cycling", or the process of recycling contaminated or non-recyclable items in the hope they are recyclable, was also frequently cited as a factor that exemplifies a lack of awareness.

> **"What does disposing of waste 'properly' even mean? There is an attitude of 'my job is done when I put it in the trash.' The public perception is 'my job is to just get it in the bin.'"**
>
> **— NGO/Activist**

> **"What mostly drives wish-cycling is that people see the recycling arrows on everything and it all goes in [the recycling bin]. Anything that looks remotely like plastic [goes in.]"**
>
> **— Government Official**

> **"People roll out their blue carts but it's mostly wish-cycling and garbage."**
>
> **— Government Official**

Many stakeholders believe that some communities are already aware about plastic waste, while others are completely overlooked by awareness campaigns. Some interviewees felt that awareness campaigns do currently exist in a notable capacity, yet only in some communities. Other interviewees felt that awareness campaigns were either severely lacking, ineffective, or close to non-existent. These stark contrasts are shown below:

> **"People are aware in the sense that it directly affects their little bubble or community, but**

they are not aware about how it impacts the wider city or state. There is a 'if it doesn't directly impact me then I'm not concerned with it' attitude."

— Government Official

"The general level of awareness in the public is kind of split. The districts that are bay facing are very aware, but when you start to get westward (Allapattah, Liberty City, areas where there isn't a view of the bay) and even those on the river are not as aware."

— Government Official

"Public information campaigns work with the Miami River Commission to do public awareness events, but people are still not aware of the impact of their actions, or they just don't care. They don't realize that what they do has an impact on the waterways and the Bay."

— Government Official

"Cleanup groups do a lot of education, but it's pretty fragmented. There isn't one campaign that has reached everyone."

— Government Official

"Communication about waste and plastic is nonexistent."

— NGO/Activist

"In terms of education, no one knows where their trash goes after they put it in the bin."

— NGO/Activist

Our interviewees mentioned several barriers to improving waste management in Miami, including illegal dumping activities, a lack of capacity and funding, a lack of policy and initiatives, complications in waste management practices due to COVID-19, and slow government action. There were several complications that were mentioned by our interviewees when discussing recent efforts to mitigate plastic waste. These paradoxes are listed below:

1. **While beach clean ups serve as ways to get the public involved and interested in waste issues, some interviewees involved in beach cleanups shared their frustration with the fact that trash picked up from the beach will inevitably be brought to another area.**

"We are just moving the trash from one place to another when we pick it up and put it in the landfill. It's still in the environment."

— NGO/Activist

"We brought all our beach cleanup trash to the landfill, and we saw [the landfill] for the first time. It felt like I was just transporting trash from one place to another to get squished and burned and eaten by animals, but people don't see that side of the cleanup."

— NGO/Activist

2. While offering alternatives to plastic is a step in the right direction, interviewees noted that the success of these biodegradable alternatives might be hampered by education and local capacities for disposal.

"There is a lack of awareness among the public on how to dispose of compostable plastic alternatives. The city wants to get a composting facility, but the cost and staff are resource barriers… As a city we need to make composting more available or increase awareness among the public on those products."

— Government Official

"Fancier places switched to biodegradable plastics, but nobody ships them to an industrial composter."

— NGO/Activist

"There are no industrial composting facilities in the state of Florida."

— NGO/Activist

"We're just replacing one single-use item with another… We have to stop using plastic. There is no other option."

— NGO/Activist

"Promotion of biodegradable and compostable is null and void down here, there is no way to process it for hundreds of miles around."

— Government Official

3. Interviewees noted the importance of plastic bans, yet they also felt concern that previous local policies have been undone at the state level.

"Florida is tough, we have lots of policies banning bans."

— Government Official

> **"In Miami you have the headache of local, municipal, state etc. regulations that are all conflicting and unclear."**
>
> **— Academia**

> **"Three years ago there was [a] regulation [in Coral Gables] on plastic bags and as soon as people started to make changes based on that regulation to comply, the city lost its appeal in court in Tallahassee against the retail industry lobby. The ban was banned."**
>
> **— NGO**

> **"Even when the [plastic bag] ban was in place, you could go across the street and be in South Miami and be able to get plastic bags."**
>
> **— NGO**

Because of Miami's variety of communities, several barriers were mentioned that prohibited all communities from having equal access to awareness and waste management resources. These barriers included a lack of and over-extension of enforcement officers in low-income communities, signs and prohibitions against illegal dumping being posted in English in majority Spanish-speaking communities, and a fear of reporting to and interacting with enforcement apparatuses when some citizens in the community are undocumented. Some of these sentiments are shared below:

> **"The level of collection and waste management is different for certain communities. The more you are taxed the more access you have [to resources]. In lower income places, people are often working many jobs and don't have time to call the public works office or solid waste management if they miss a pickup."**
>
> **— Government Official**

> **"When you look at the litter on the road, you do see more trash in certain neighborhoods… There is unequal awareness in layers of society."**
>
> **— Local Business**

> **"In Little Havana, the penalty signs for illegal dumping are in English."**
>
> **— NGO**

While issues within the waste management system do exist in Miami, our interviewees have very comprehensive ideas for how to move forward, including:

1. More education and community awareness

- Ensuring that awareness events are family-oriented and intergenerational so that families can all learn together
- Awareness campaigns might not be as necessary as ensuring that people in communities have the adequate resources to dispose of their waste

2. Increased capacity and support for localized community groups

- Each community is different and therefore has different needs, so awareness campaigns, public involvement, and the distribution of resources will look different for each community
- Not putting the sole responsibility of awareness on under-resourced communities and making sure to provide an avenue for people to share their experiences and brainstorm solutions with stakeholders

3. Increased capacity and funding for the public works and solid waste departments

- Increase street cleaning frequency
- Expand prominence of storm filter technology
- Increase monitoring and inspecting

4. Find ways to help businesses implement alternatives and give them perks and incentives for doing so

- Large grocery stores can implement and/or expand collection hubs for the plastic bags that they provide for consumers (this will ensure that there are multiple drop off points to manage plastic bags in each community)
- Increase hubs where people could drop off their excess packaging trash
- Students could get community service hours by washing reusables in businesses

5. Implementing sustainable events guidelines and modifying events licenses and permits

- Making environmentalism "cool"
- More large-scale, low-waste events like the Ultra Music Festival where sustainability is built into the event's message
- DJ-led cleanups where attendees get a reusable cup signed by the artist
- Importantly, this process has already been started for the City of Miami through their Sustainable Event Guidelines in-progress

These clear ideas from the community on ways to improve going forward and the general trends of awareness and waste management indicate that waste management in Miami is moving in a positive direction.

In addition to interviews with stakeholders from the community, CIL collected data about community experiences through SenseMaker®. SenseMaker® is a qualitative data software that allows for respondents to share their own individual stories and code those stories within a signification framework. As a complement to the key influencer interview process, wherein the interviewee and researchers co-create a conversation on perceptions of plastic pollution in Miami, SenseMaker® solicits a personal narrative and allows participants to characterize and interpret their own story within a qualitative framework, allowing us to more directly compare individual experiences and explore patterns.

There were 47 respondents who consented to and answered the SenseMaker® survey. A majority of respondents were from the City of Miami, although there were also respondents from broader Miami-Dade county and elsewhere in the region. The survey was distributed in both Spanish and English to encourage engagement from a variety of communities within Miami.

Respondents began by sharing a story. This open-ended question asked:

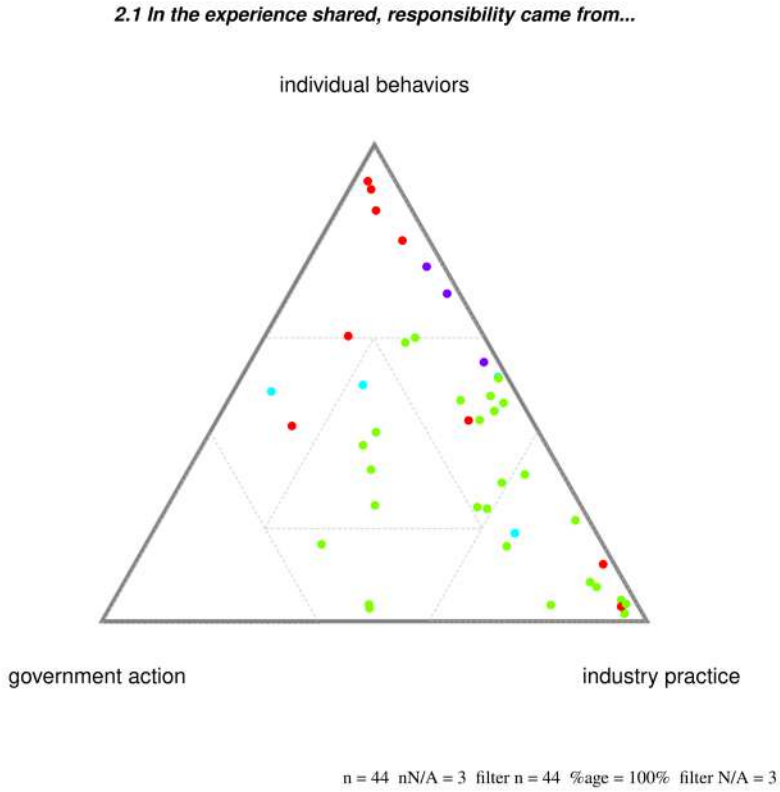
Think back to a time when you did not or could not buy an alternative to single-use plastic. Tell us about your experience. What happened?

An example of a story shared by one respondent:

> **I used to buy water bottles for my dad, and felt bad every time. Eventually, I got him to use a filter connected to the home faucet. But, between the time we decided on the filter and it was implemented, there were many more single use water bottles. If the faucet filters and pitchers were sold next to the water bottles, the decision and change would have likely come much sooner.**

Respondents then went on to characterize their story through a signification framework, which is a set of questions aimed at giving further nuance to the respondents' story. These signification questions sought to understand how respondents felt about their own story, what variables played into their feelings, and where they believe future engagement on this issue could come from. Respondents answer the signification framework questions by positioning a marker in relation to their own interpretation of the story they just shared (Figure 6). Here is an example of what a signification framework question looks like to the respondent.

Figure 6: Example picture of Triad 2.1



One main theme that stood out is change, transformation, and motivation were derived from a variety of factors. Triads asking participants about driving factors of change and transformation and about their motivations in the experience were very scattered, with little clear clustering (Figure 7 and Figure 8). This speaks to the diversity of motivating factors for change, and the need to appeal to each of these entities to reach different audiences.

Figure 7: Triad 2.2

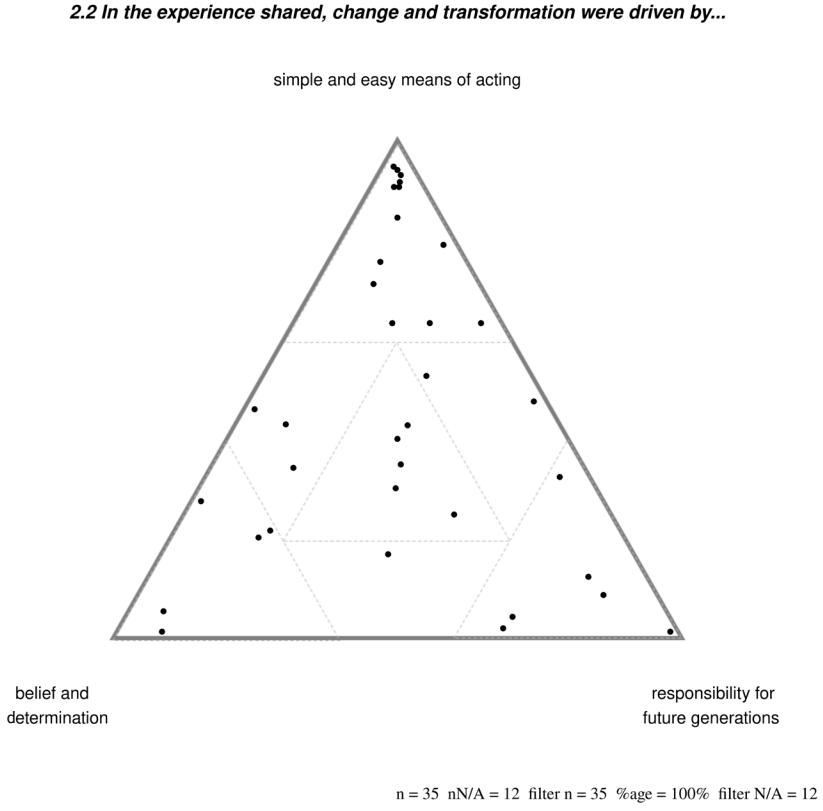
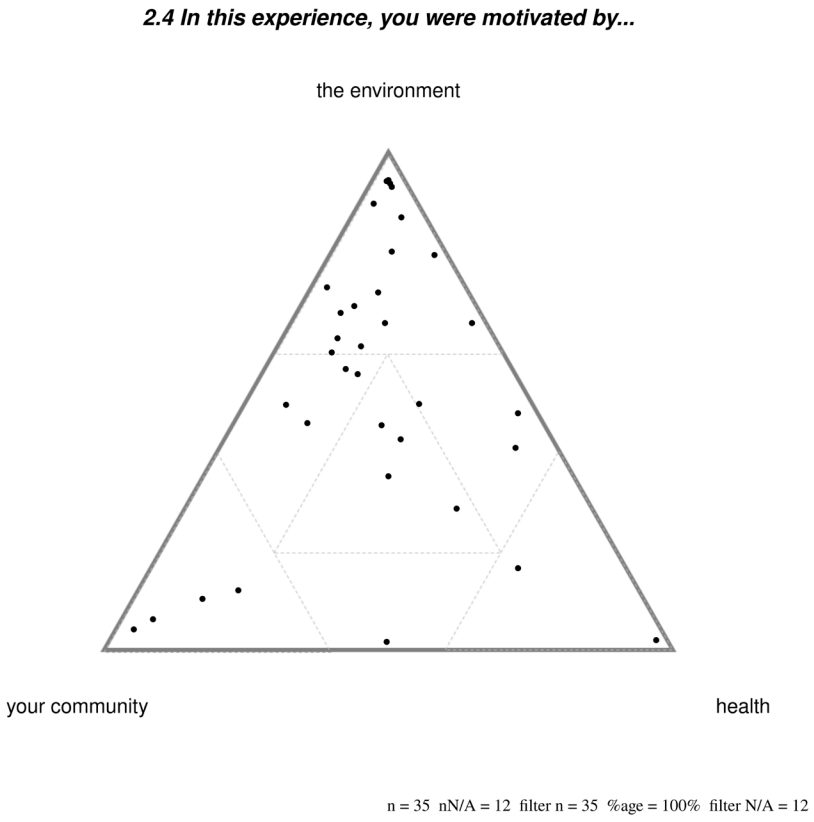
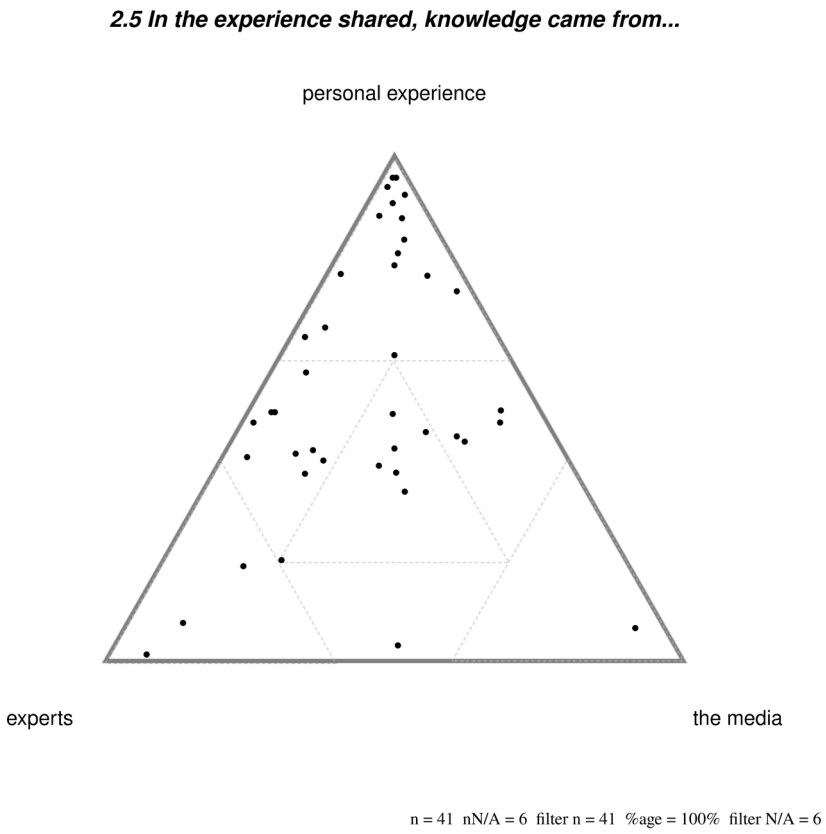


Figure 8: Triad 2.4



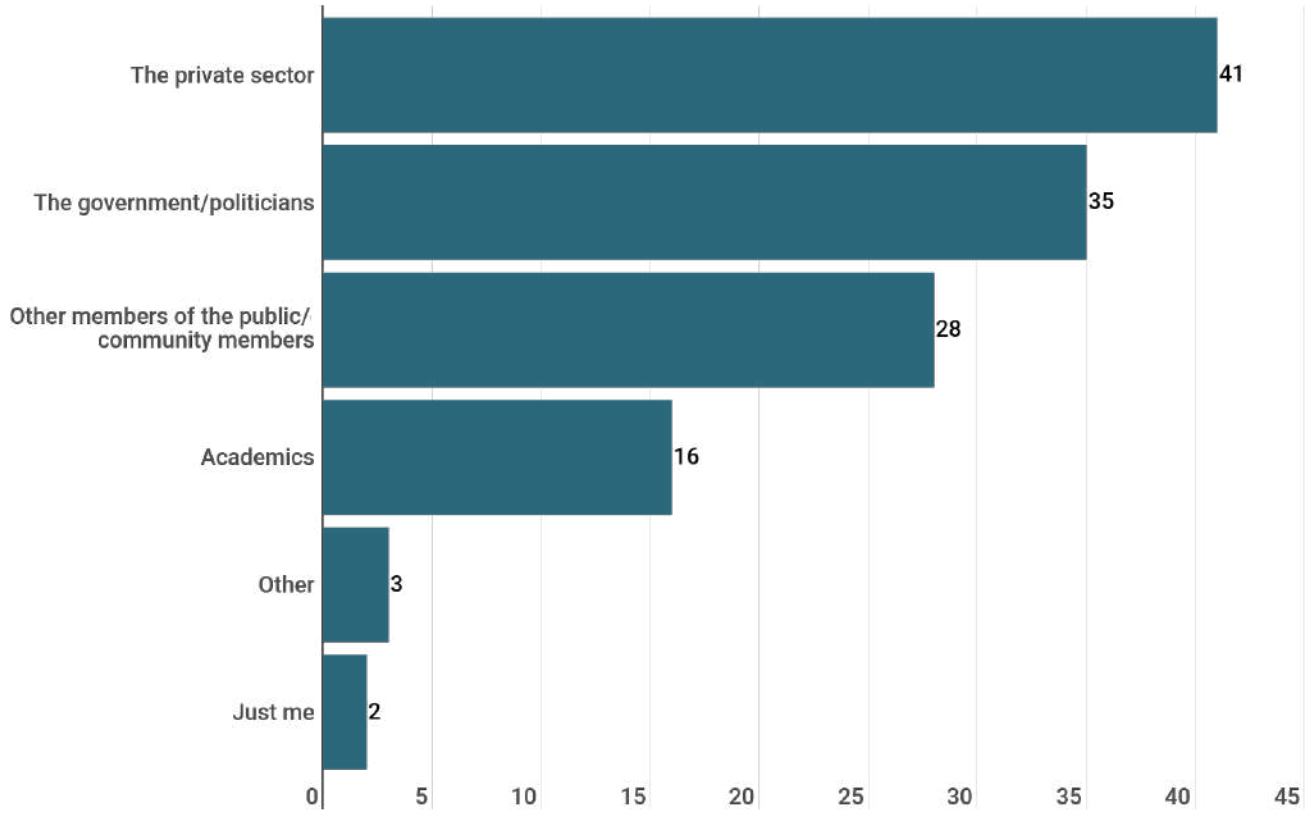
Additionally, many respondents are relying on personal experience for knowledge about waste management practices (Figure 9). This trend indicates that there are opportunities for knowledge-sharing and for leveraging experts and media to provide wider education.

Figure 9: Triad 2.5



Respondents felt that a variety of sectors should hear about their story, which indicates that our respondents feel this is a public issue, rather than a personal or private one (Figure 10). Interestingly, people want the government to hear about their stories, despite the fact that they did not feel responsibility came from government action (as shown in Figure 27 under “Use”). This might be an indicator that people do want government involvement, but it is currently lacking.

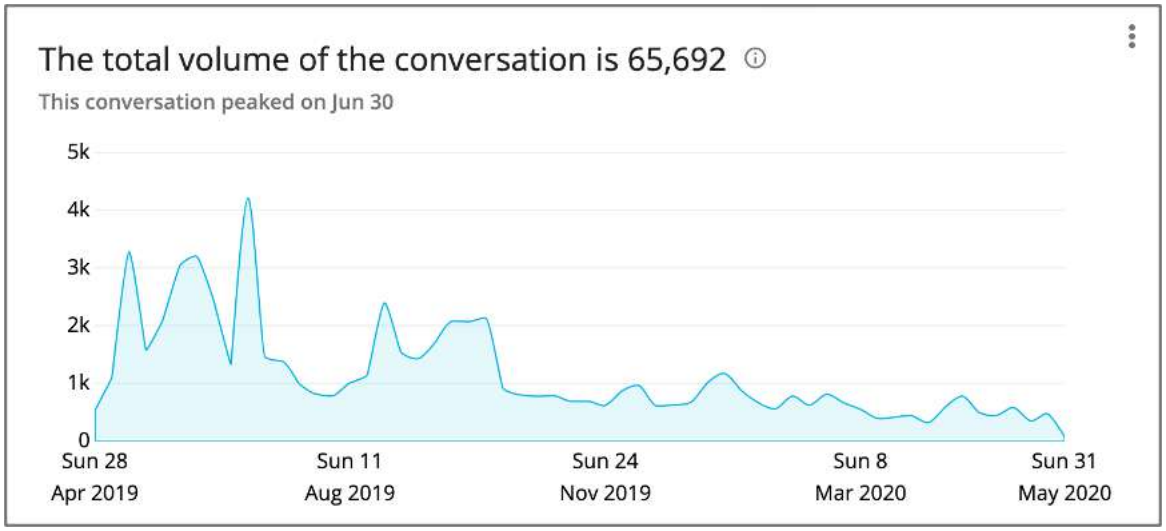
Figure 10: MCQ 5.2 — Who Should Hear About This Experience?



Across the signification framework questions, respondents consistently noted that they were motivated by the environment, yet their ability to make choices that align with this motivation varied. Respondents did want to protect the environment, but they were limited by what they could do in the moment (see "Use" section for additional details). Some stories respondents shared featured people making a decision in the moment and having to sacrifice what those actions meant in the long-term. If means of acting are simplified, then immediate action and the future potential do not have to be mutually exclusive.

In order to gain perspectives from a broader group, CIL also conducted an analysis of conversations about plastic pollution occurring on social media platforms in partnership with SEE Suite (Social media Engagement & Evaluation Suite) at the Department of Advertising and Public Relations at the University of Georgia. The data collection period was May 1, 2019 to May 31, 2020. SEE Suite analyzed 65,692 tweets about plastic pollution from Florida, including 11,392 tweets geographically from Miami and 1,560 tweets specifically about Miami. Additionally, SEE Suite looked at Facebook posts from the same time period, which included 4,866 posts on plastic from Florida and 3,019 posts from Miami. Finally, on Instagram, SEE Suite analyzed 2,220 posts about Florida and 746 posts about Miami.

Figure 11: Conversations on Twitter over time



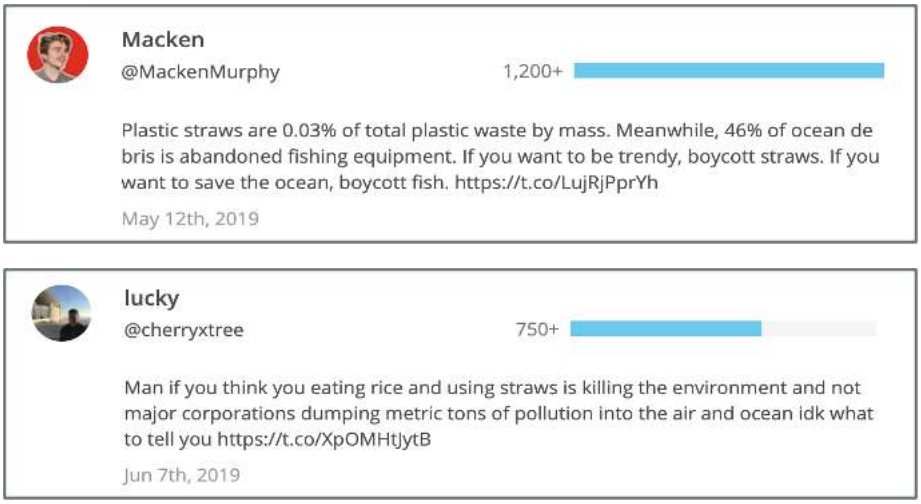
A sentiment analysis of the Twitter data set showed that only 9% of posts were positive, while 38% were negative. Positive sentiment posts focused on love for the ocean and protecting nature; there were calls to save our beautiful oceans, joy expressed for helping protect the sea, encouragement for others to take action, cute wildlife, and celebrations for Earth, Turtle, and World Oceans Days. Users praised those doing good and shared positive solutions to the plastic pollution issue. Negative sentiment posts focused on related problems, from abandoned fishing gear to even glitter. There was discussion on where plastic pollution comes from and who is the most to blame. Several accounts warned that the problem is even worse than we truly know.

Figure 12: Examples of positive (top) and negative (bottom) sentiment Tweets

Key themes in the conversation on plastic pollution in Florida were: single-use plastic, wildlife, beaches, ocean pollution, and government and legislation. The conversation around **single-use plastic** (n = 15,014) focused on individual use of plastic products. From bottles and takeout containers to grocery bags and straws, consumers speak to the

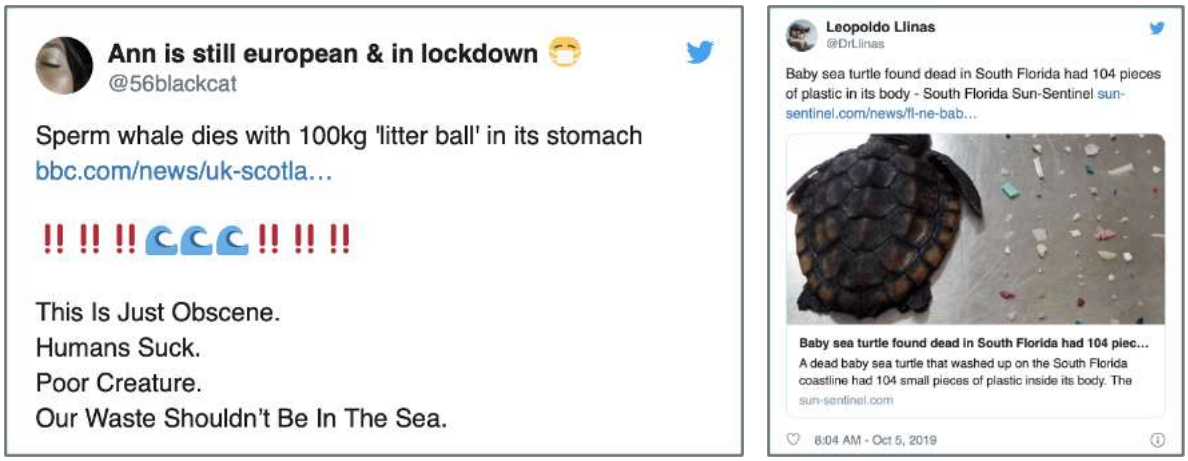
negative effects that these items have on Earth's oceans and marine life. Conversations often center around which of these products are most responsible for pollution. Straws in particular were widely discussed, comprising 63% of the tweets within this theme. Common threads involve the sentiment that straws are a "trendy ban," and that "real" environmental efforts should tackle problems like corporate pollutants and fishing gear. Many personal stories regarding the usage of plastic or metal straws received attention as well.

Figure 13: Top retweets about single-use plastic in Florida



Tweets discussing **wildlife** (n = 14,993) were also common in the dataset. This theme focuses on plastic pollution's negative effects on the animals that inhabit Earth's oceans and shores. From turtles choked by straws to whales with bellies full of plastic, conversations are often graphic and strongly worded.39% of the Tweets in this theme specifically referenced the effects of plastic pollution, particularly straws, on turtles.

Figure 14: Example Tweets about plastic pollution and wildlife



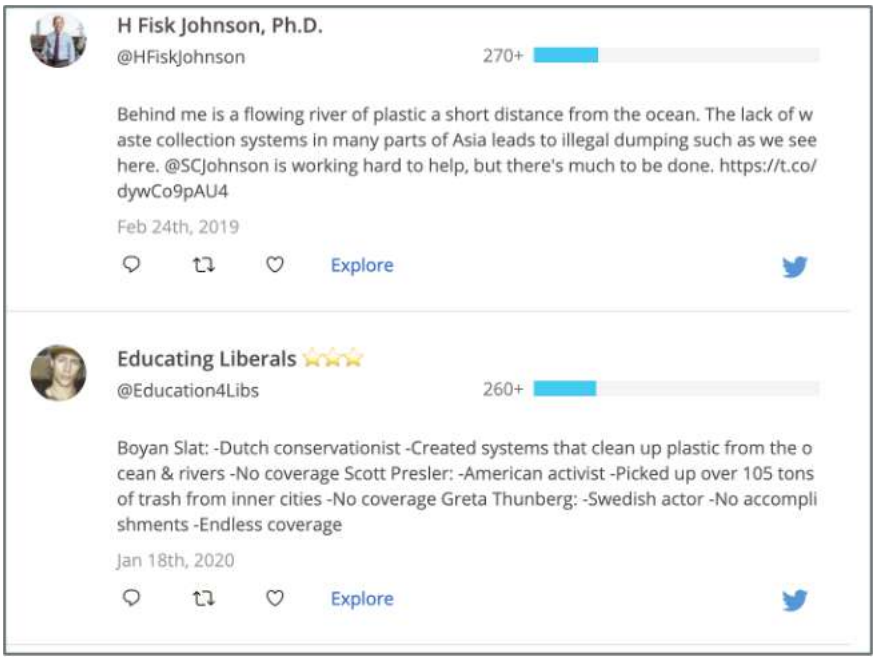
The theme of **beaches** (n = 14,740) explores plastic pollution in the context of its effect on coastline in Florida and

around the world. Posts include individual efforts to clean up coasts, company pledges to do the same, and negative criticism by outsiders. Conversations about cleanup events make up 21% of this theme, much of this user-generated from volunteers participating in these events.

Figure 15: Most popular retweet about plastic pollution and beaches

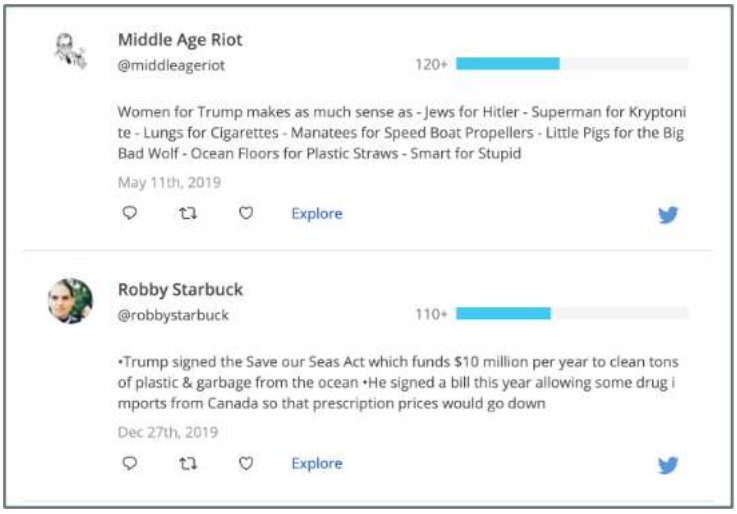
Whereas previous themes focused on individual effects of plastic pollution, the theme of **ocean pollution** (n= 10,066) explores the problem on a larger scale. Organizations seeking to create large-scale change are highlighted most often, and entire countries come under fire for their polluting actions. This conversation also included politically disparate approaches to remedying plastic pollution.

Figure 16: Top retweets about ocean pollution



Finally, the theme of governments and legislation (n= 4,021) shows users' varied opinions on federal government action in relation to ocean pollution. Several different pieces of legislation are also discussed, with users disagreeing on their effectiveness. Actions taken by Florida's government to help mitigate plastic pollution are also mentioned. Unsurprisingly, political tensions beyond those directly related to plastic pollution were showcased in this theme.

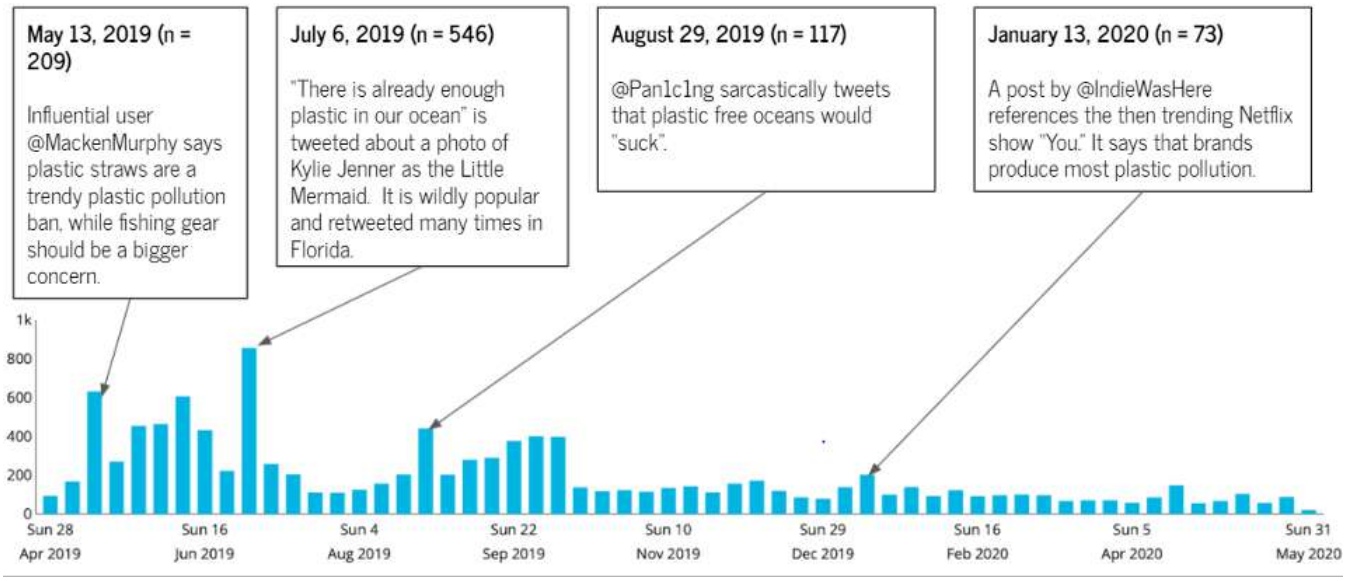
Figure 17: Top retweets related to plastic pollution and government



Additional conversations on plastic pollution were specific to Miami, including plastic straw bans, Biscayne Bay, and the Super Bowl. A Miami Beach city-wide ordinance went into effect on September 11th, 2019 that banned the use of plastic straws and stirrers. The majority of tweets praised this move; however, a handful of individuals thought that more effective laws could be passed. Biscayne Bay is a frequent target for showcasing plastic pollution effects. Many tweets discuss its polluted nature, while Florida International University (@FIUSeas) invites citizens to participate in their biannual cleanup event. The 54th Super Bowl football game was played in Miami in 2020. @OurOcean partnered with the NFL to accomplish the game's official community engagement goal: reducing marine plastic pollution.

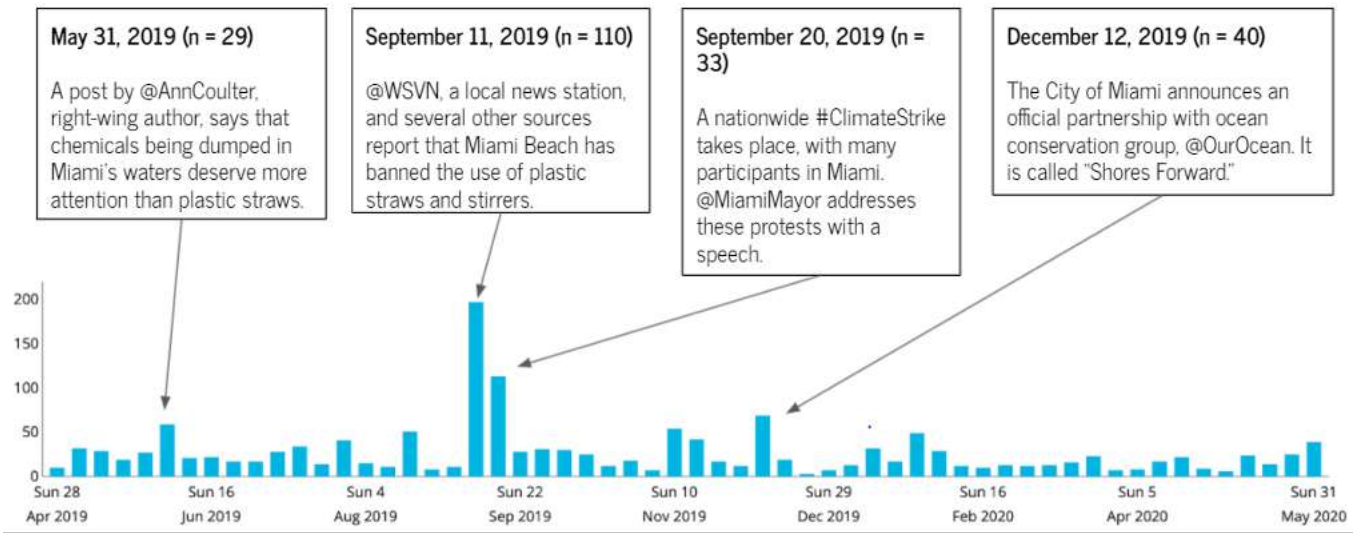
A spike analysis was also conducted to see when the volume of conversation around plastic pollution increased on Twitter. The following is the spike analysis of Tweets from the geographic area of Miami. These include Tweets that were not specifically about Miami but were widely shared by the Miami audience.

Figure 18: Spike analysis of Tweets from Miami



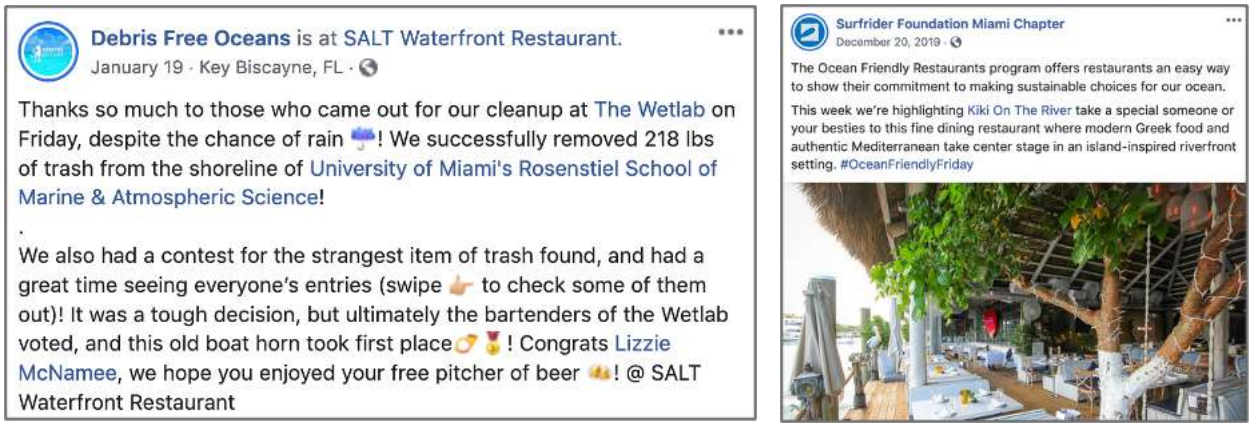
A spike analysis was also conducted for the Twitter conversations on plastic pollution that were specifically about Miami. Notably, the announcement of the Shores Forward Partnership with Ocean Conservancy was mentioned here.

Figure 19: Spike analysis of Tweets about Miami



On Facebook, much of the conversation on plastic pollution was content created by conservation organizations in the form of promoting legislative action, sharing scientific works, advertising events like beach clean-ups, and congratulating others for their good work. In Miami, local organizations like Surfrider, Miami Waterkeeper, and Debris Free Oceans pointed to resources local to the city for protecting the ocean, ocean-friendly businesses, events, and legislative action to be taken.

Figure 20: Example Facebook posts on plastic pollution



On Instagram, the most common hashtags in the conversation on plastic pollution in Miami were as follows. More so than Twitter, on Instagram hashtags — especially #ZeroWaste — were often used to describe a consumer product. Many of the Instagram posts involved paid sponsorships, influencer reviews of certain items, or the self-advertising of restaurants and events.

1. #ZeroWaste: 463 posts (62%)
1. #Miami: 383 posts (51%)
1. #PlasticFree: 249 posts (33%)
1. #Sustainability: 193 posts (26%)
1. #Recycle: 113 posts (15%)

Recommendations for engaging social media audiences with the topic of plastic pollution from the SEE Suite team are as follows.:

1. **Combine fact-based calls to action with content that appeals to emotion.** Turtles and plastic straws both received more engagement when talked about in tandem. The desire to keep cute turtles from suffering was convincing enough for many to say that they would change their actions and encourage others to do the same. This connection could be made for other ocean pollution issues to help them gain more traction as well.
2. **Utilize location-specific tags to better promote events.** Hashtags that are relevant within a certain area of Florida are often used by organizations to update followers about beach cleanups and promotional events. They allow for users to come across events they might not have otherwise known about. Posts about events, businesses, and legislative action are more powerful when tied to a specific location. Facebook users are more likely to get involved when they know how close to home an issue hits. The tags #Florida and #Miami both ranked high among the Instagram data set.
3. **Penetrate a plastic-conscious audience through positive posts.** Specifically in the context of single-use plastics and marine life, negative conversations are crowded. They make up the largest percentages of this Twitter data, and so taking the positive route might allow for an easier breakthrough of content. Common examples of positive posts include the impact of activists and the beauty of wildlife.
4. **Address the concerns of some citizens who are weary of legislation**. Throughout many themes, conversa-

tions arise around an uneasiness toward legislation. Although some organizations support acts like the Miami Straw Ban, some citizens feel that more should be done or that these efforts are going to have negative side effects. Some Floridians with active social media presence take the state of California as an example of policy gone wrong — giving rise to tags like #SaveCalifornia.

5. **Pitch plastic-focused stories to local colleges and news stations.** Local news stations familiar to Florida or Miami's audiences frequently share updates on environmental organizations and policies. These accounts, like @WSVN News and @FIU Florida International University offer a bridge toward specific audiences.
6. **Keep in mind the reach of national influencers and news entities**. Although local accounts might address Florida-specific marine plastic pollution efforts most effectively, many of our theme analyses show that accounts from outside of Florida are the most retweeted, mentioned, and talked about. Updates from accounts like @CNN and @Oceana, when appropriate, could be retweeted or mentioned to heighten audience interests.
7. **Connect to Florida-specific wildlife.** Organizations on Facebook all connected their messages to Florida's beautiful nature. Tying an environmental message to wildlife can make it relevant to several organizations and many Floridians, thus spanning multiple conversations.
8. **Get involved in organizations not entirely focused on plastic pollution.** Conservation organizations like Miami Waterkeeper, Ocean Conservancy, and Surfrider Foundation Miami are clearly interested in the topic of plastic pollution and could become strong avenues and partners for sharing pollution-related messages.
9. **Give clear actions to consumers.** When calling for action, some organizations gave specific instructions to consumers and advertised polling days. They shared facts like specific bills to support and oppose, why they were important, and even gave out representative's phone numbers. To bring actions regarding the plastic pollution issue onto these accounts' radar, they will need to be accompanied by clear guidelines on how consumers should address them. Action-based hashtags like #SaveThePlanet and #Recycle were not only very popular, but they were more frequently used by individuals. Many of the other hashtags in this data set become saturated with advertisements and product posts, but action-based tags remain focused on change.
10. **Utilize strings of environmental hashtags to break into several different conversations.** Most often, posts that included #EcoFriendly also included #PlasticFree or #ZeroWaste. In this way, those posts are able to penetrate multiple conversations

Product Design

To characterize material types used in common consumer products, samples of common convenience and to-go items were obtained as described in the Input section. The CIL team sampled stores and vendors in each of the thirteen 1km^2 transect areas. The average weight of both the packaging and the product itself was collected for all samples (Table 3).

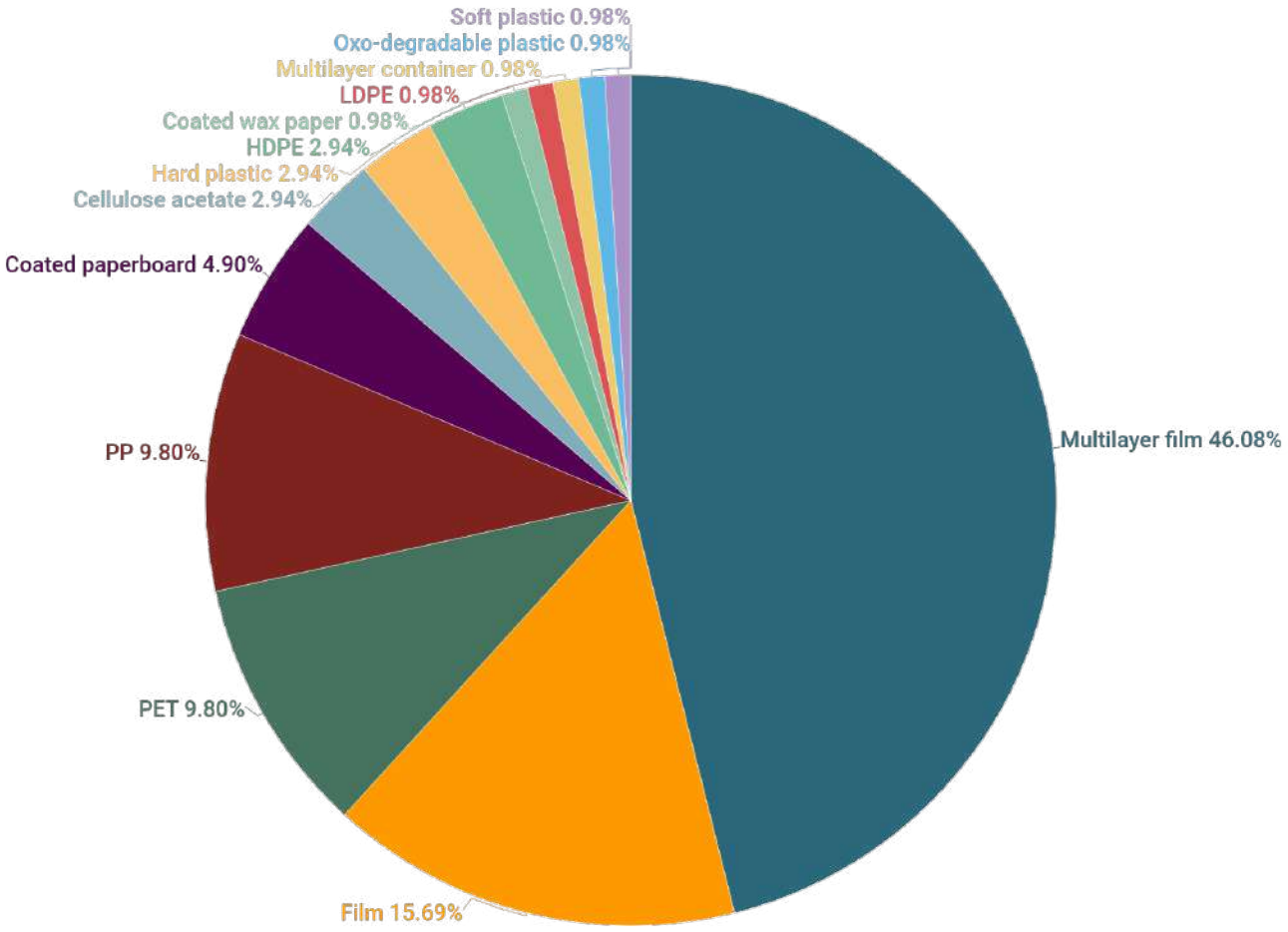
Table 3: Average weight of products and their plastic packaging for common convenience items.

Product Type	Number of Samples	Average Weight of Plastic Packaging (g)	Average Quantity of Product (g)
Candy	32	1.4	42.6
Chips	32	4.7	81.7
Drinks	16	27.5	458
Tobacco Products	8	10.4	14.8

Interestingly, candy has a higher quantity of product in Miami than CIL has typically seen in international contexts. While the ratio of product weight to packaging weight was similar, candy samples obtained were larger by weight than individually wrapped versions often seen elsewhere. For example, samples taken in several cities in India showed that the average product weight for candy items was around 3.8g and the average packaging weight was around 0.15g — those found in Miami were around 10 times larger for both product and packaging weight.

Cigarettes were found to have a very high plastic packaging to product ratio, meaning they are generating larger amounts of plastic waste per unit of product. This is likely driven by the cellulose acetate filters in cigarette butts, which typically weigh about a gram. Cigarillos do not have filters and less of them were observed littered on the ground when compared to cigarette butts. However, the plastic packaging associated with cigarillos was seen as litter in surveys across the city. E-cigarettes are also a new source of plastic waste that is appearing in the waste stream and was observed in Miami.

Figure 21: Material breakdown of top convenience items in Miami



Unsurprisingly, film and multilayer film were common materials used in convenience item packaging, primarily in chip and candy packaging. Film items in total comprised over 60% of the materials observed for top convenience items, which is significant as film is often difficult to capture in the waste stream, difficult to recycle, and is responsible for contamination and damage to sorting and recycling machinery. PET and PP were common in beverage products, with PET or rPET used for the bottle and PP (or occasionally HDPE) used for the cap. Coated paperboard, such as TetraPak packaging, was less common but also present.

Figure 22: Zephyrhills water bottles from recycled PET, often seen in convenience stores in Miami

(Photo Credit: CIL)

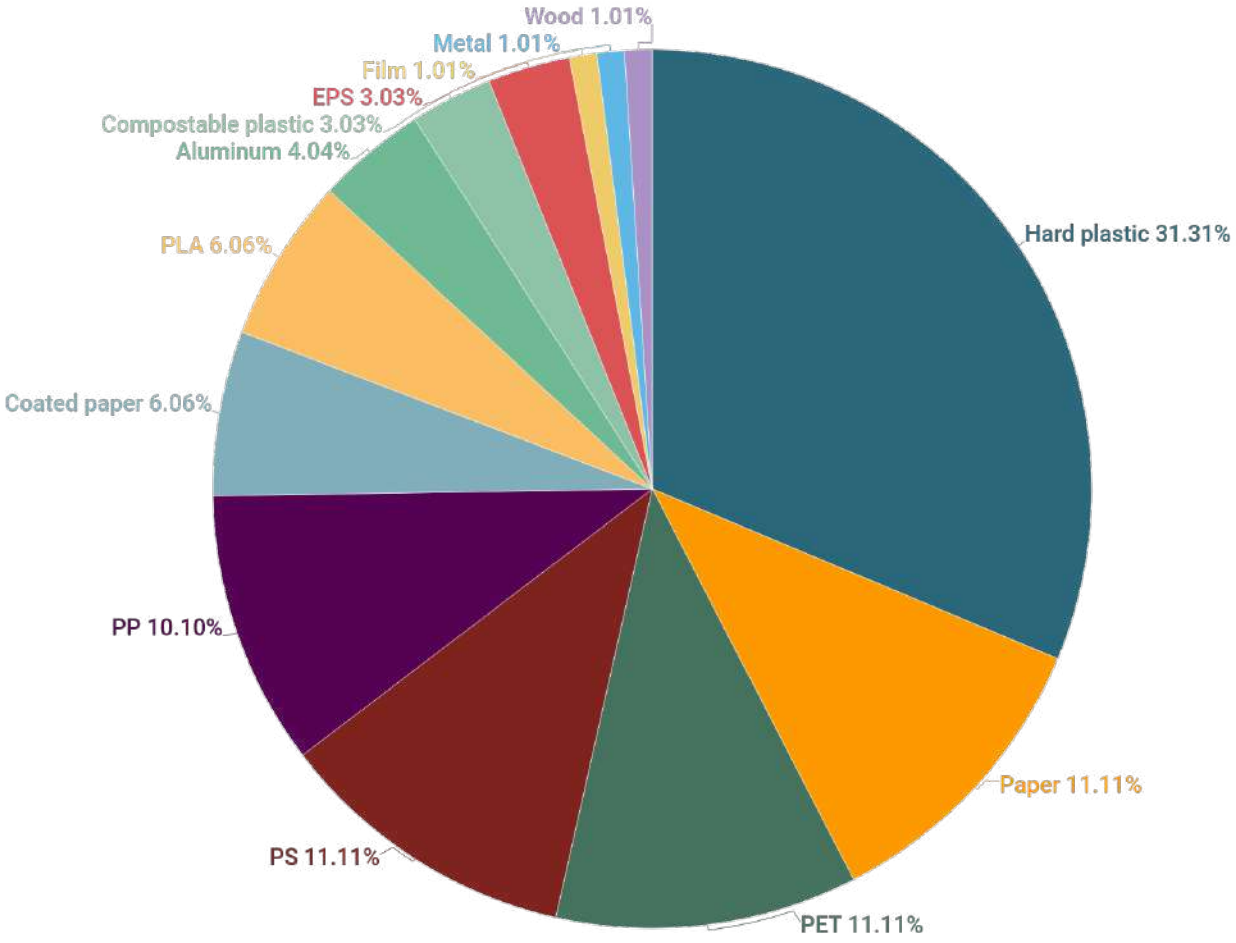
Within the thirteen 1km^2 transects in Miami, the CIL team also visited up to three randomly selected food vendors or to-go restaurants to sample the food packaging and utensil types that were being distributed. This totaled 20 vendors in Miami, as some sites did not have food vendors or restaurants.

Table 4: Average weight of common plastic packaging items from food vendors.

Product	Material Type	Number of Samples	Average Weight of Packaging (g)
Cup	Coated paper	1	10.2
	EPS	2	3.3
	PET	3	14.1
	PLA	2	10.1
	PP	3	7.6

Product	Material Type	Number of Samples	Average Weight of Packaging (g)
Cup Lid	Hard plastic	2	1.8
	PET	4	2.7
	PLA	2	2.5
	PP	1	3.3
To-go Container	Aluminum	3	12.5
	Coated paper	3	28.7
	Hard plastic	4	29.2
	Paper	3	42.3
	PET	1	10.8
	PP	2	40.8
	PS	8	14.3
Straw	Hard plastic	5	0.5
	Metal	1	25.5
	Paper	5	1.5
	PP	1	0.5
Utensils	Compostable plastic	2	4.4
	Film	1	0.4
	Hard plastic	11	4.1
	Wood	1	10.3

Figure 23: Material breakdown of to-go items sampled in Miami



Unlabeled hard plastic was the most common material type documented in food vendor products. These unlabeled plastic materials included two cups/lids, five straws, four to-go food containers, and 11 utensils. PET, PS, and PP all represented around 10-11% of the items sampled. Difficult to recycle materials such as EPS, film, and coated paper were also found among products available. Hard plastic, along with PET, PS, and PP, were fairly common in to-go items such as cups, lids, and utensils. To-go food containers were most often found in the form of hard plastic or EPS materials. Items categorized in the analysis as 'compostable plastic' were labeled as compostable but were not PLA. This is emblematic of a lack of transparency around the labeling of compostable plastics, and confusion around how they should be properly handled as waste, which was brought up during the stakeholder interviews from both the general public and businesses alike. Similar confusion around recyclability and proper waste management could arise from the unlabeled hard plastic materials.

Figure 24: Typical food vendor to-go items in Miami, including compostable plastic utensils available in a restaurant (left), EPS take out container littered on the sidewalk (top right), and cafe beverage and condiment containers largely comprised of PET (bottom)

(Photo Credit: CIL)

In terms of to-go items that were alternatives to plastic, around 10% were categorized as "compostable" plastic products, notably PLA, as well as alternatives such as paper (11%), aluminum (1%), and wood (1%). It is interesting to note that the percentage of products that were paper was similar to the percentage observed for common plastic materials such as PET, PS, and PP respectively. As was cited as a point of frustration several times in the stakeholder interview process, compostable plastic alternatives are increasing in popularity in Miami, but there is no industrial composting facility in the state of Florida that can properly manage that waste, and those products are often destined for landfill or contaminate recycling waste streams.

It is important to note that other cities within the County have attempted to ban certain single-use plastic materials in the past. Miami Beach prohibited EPS on its beaches starting in 2014 (Munzenrieder 2014). In 2016, Coral Gables passed a city law banning the use of EPS products. Fifteen businesses were fined in the first week of the ban going into effect for continuing to provide EPS (Shammas 2016). Coral Gables also passed a bill prohibiting the sale, use, and distribution of plastic bags in 2017. In response to these city-level bans, the Florida Retail Federation — which is a lobbying group that represents companies such as Publix, Walmart, Target, and CVS — sued Coral Gables to prevent the city from enforcing the ban. The Florida Retail Federation ultimately won the case in 2020 and the bans are no longer enforced. Other cities in the area, including Surfside, have had similar city-level laws against single-use plastic items repealed due to pressure from the Florida Retail Federation and the state (Cardona 2020). The fact that foam items are still readily distributed among restaurants and food vendors and also seen as litter across the city may present an opportunity to revisit some of those local policies for the most problematic single-use plastic items.

Use

To understand patterns of use and reuse for plastic products in Miami, alternatives to plastic and their respective prices were documented where available in Miami. Similar products in plastic packaging were recorded at the most approximate convenience store to the alternative product vendor.

Table 5: Cost of plastic items compared to reusable and refillable alternatives available in Miami

Product	Alternative and Reusable Packaging	Cost of Alternative	Cost of Plastic Packaging	Cost Difference for Alternative
Soap	Unwrapped	$6 each	$2.99 each	+101%
Shampoo	Sold in bulk; refill reusable glass containers	$1.09/oz	$5.99 / 13.5l oz	+146%
Conditioner	Sold in bulk; refill reusable glass containers	$1.12/oz	$11.99 / 12 oz	+12%
Utensils	Single-use or Washable Wood	$2.50 each	$1.99 / 24 spoons	+2,915%
Sandwich Bag	Durable reusable plastic	$11.99 each	$2.99 / 180 bags	+72,081%
Water Bottle	Reusable Stainless Steel	$28 each	$0.99 each	+2,728%

There was one store surveyed in Miami that sold nearly exclusively products that were alternatives to plastic. Other alternatives that were documented, such as reusable water bottles, were sold in more boutique settings as souvenirs or gifts. In general, while personal care products sold unwrapped or through refill schemes were more expensive, they were still within comparable ranges to these products sold in plastic packaging. Alternatively, utensils, sandwich bags, and water bottles were significantly more expensive on a per unit basis when compared with traditional plastic alternatives.

Figure 25: Metal straws (left) and bulk refill shampoo and conditioner (right) available at a store in Miami

(Photo Credit: CIL)

The cost increases associated with switching from single-use plastic apply to both businesses and consumers. CIL interviewed three businesses in Miami who have made efforts to switch away from single-use plastic products, primarily focusing on their to-go food packaging. Biodegradable plastics, such as those from EcoProducts (www.ecoproducts.com), and natural materials like bamboo and paper, such as those supplied by Lean Orb (www.leanorb.com) were used by businesses to reduce their plastic footprints, often at a cost-premium.

> **"We started charging customers an eco-fee during the pandemic because of the increase in takeout orders, which has persisted since then. It costs us about $3.00 to buy eco-friendly to-go products for an order, and we charge the customers $1.50 in an eco fee."**
>
> **— Local Business Owner**

> **"Price is the biggest barrier."**
>
> **— Local Business Owner**

> **"Lean Orb [compostable] products are probably twice the cost of Sysco [plastic products]."**
>
> **— Local Business Owner**

Businesses also spoke of their frustration with the lack of available information and how much research went into their product choices.

> **"We had to do a lot of research to find what works for our plating."**
>
> **— Local Business Owner**

> **"I spent a lot of time and energy trying to implement different practices and bring together businesses. The field is muddled and confusing and sometimes it's discouraging."**
>
> **— Local Business Owner**

Businesses also mentioned products that they were unable to replace with alternatives, either due to cost or lack of availability.

> **"In our convenience store, we've stopped selling single use plastics as much as possible, except for Gatorade. There would be a mutiny among staff if we stopped selling Gatorade, and there's no alternative. We also sell marine items that come in plastic packaging."**
>
> **— Local Business Owner**

> **"There's no reasonable alternative for coffee cups; there are "compostable" ones but that's kind of greenwashing because you need an industrial composting facility and it needs to be sorted and collected… consumers think that they can drop it in their backyard and it'll break down. Even if we did collect [compostable] cups there is nowhere to send them."**
>
> **— Local Business Owner**

This was likely additionally exacerbated by the COVID-19 pandemic; 79% of Plastic Free MB businesses surveyed in Miami Beach reported that they were concerned by the increased usage in disposal packaging associated with higher levels of take-out during the pandemic (#PlasticFreeMB Survey Report).

Among these businesses that were making efforts to move away from single-use plastic, there was a desire to — and also skepticism about — expanding this effort more comprehensively across the community. Businesses discussed the need for more support from the city, such as in the form of tax breaks or other incentives.

> **"We want the city to get on board so our efforts can actually make a difference."**
>
> **— Local Business Owner**

> **"We need to build a critical mass around the hospitality and food & beverage industries, and**

put those people in touch with vendors who are 'sustainable' or 'ethical' who sell products that are less wasteful or have alternatives."

— Local Business Owner

"I do this and I care, but many other businesses don't naturally care about this stuff so it's even harder to convince them. You need to make it easy for them and it can't be more expensive."

— Local Business Owners

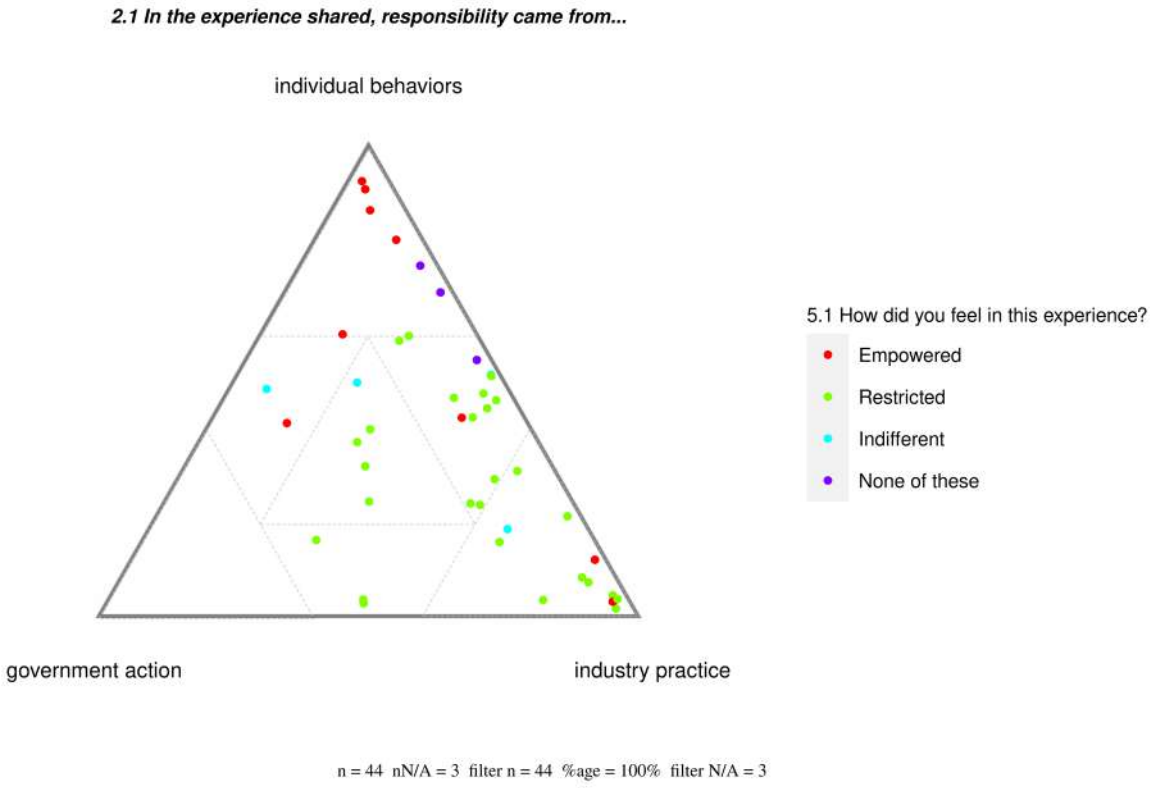
One example of a reuse and refill initiative that is only currently available in nearby Miami Beach are the recently installed Woosh water refill stations. It was noted in stakeholder interviews that the tap water in Miami is very safe, but people don't want to drink it, and most people prefer to purchase bottled water. With the average cost of a refillable water bottle in Miami being over 2,000% higher than a typical disposable PET plastic water bottle, the consumer perspective is understandable. It was also mentioned that initially the general public in Miami Beach were upset about having to pay for the water refills available at Woosh, and the general sentiment was that the refills should be free. The cost for the refill is due to the fact that the company was not permitted to have sponsors when the stations launched. There may be an opportunity to offset the cost to consumers if this is changed in the future. It may also be worth exploring the option of expanding into the City of Miami and other locations that would benefit from this model.

Figure 26: Woosh refill station in North Miami Beach

(Photo Credit: CIL)

Data collected from the SenseMaker survey intersected with use of plastics in interesting ways. One of the primary themes across the SenseMaker stories was a strong correlation between concepts of empowerment and individual action. There was also a strong correlation between restriction and industry practice (Figure 27). Respondents who felt empowered (red dots) in the experience they shared tended to believe that responsibility came from individual behaviors, while those who felt restricted (green dots) in their experience felt that responsibility came from industry practice.

Figure 27: MCQ 5.1 compared with Triad 2.1



Examples of those who felt empowerment and felt responsibility came from individual behavior are shown below:

> **I stopped buying liquid detergent about 1 year ago and at first used powdered detergent in a cardboard box but have since changed to using detergent sheets that come in paper wrapping. The detergent sheets are great but I can't buy them at the stores I go to. I have them shipped to my house… so easy to use and no plastic waste!**

> **I remember when I was a child and you could only buy glass soda bottles. You could return the glass bottles and get money for them. I think it was maybe one cent per bottle. When we wanted candy we would collect the glass bottles and turn them in for money. In those days, the early 60's, a candy bar was about five cents.**

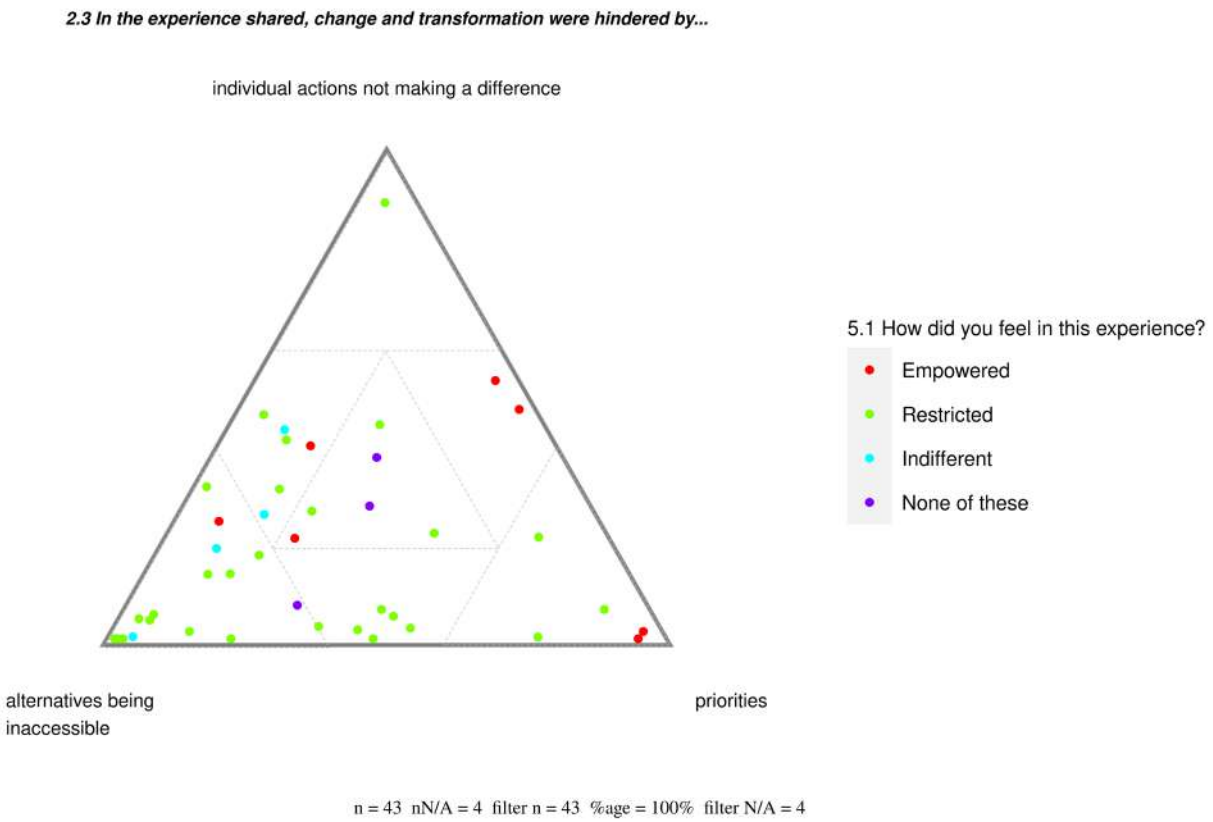
Examples of those who felt restricted and felt like responsibility came from industry practice:

> **I often shop at local grocery stores like Kroger/Trader Joes. I do my best to reduce my plastic waste by bringing my own reusable produce bags, but depending on the item, sometimes I am forced to buy something that is packaged with plastic. Other times, I will be trying to select between several different items, most of which contain plastic. In my experience I have found that the items without plastic tend to be the most expensive and are mostly out of my budget. Although I do my best to reduce plastic use, sometimes financial reasons prevent me from doing so.**

> **I went to the Dunkin Donuts on US 1 and 27th Ave and brought my reusable cup (this was before the pandemic). They kindly accepted my cup, but when I received the drink at the pick-up station, they had put my iced coffee in a plastic cup and put the plastic cup within my reusable cup. When I mentioned that I was using my reusable to avoid single-use plastic waste, they apologized and got back to work- they were quite busy.**

Most respondents who felt restricted also reported that change and transformation were hindered by alternatives being inaccessible (Figure 28). People who felt empowered in their stories may have had more access to alternatives, reflecting their perception that responsibility came from individual behaviors. Only one respondent indicated that change was hindered by individual actions not making a difference, meaning most respondents believed their individual actions matter in this regard.

Figure 28: MCQ 5.1 compared with Triad 2.3



These findings suggest that while there is a great deal of interest in plastic waste as well as a sentiment that individual actions can make a difference, good intentions tended to be limited by a lack of access to material resources, especially alternatives to single-use plastic items. Perceptions were generally split between responsibility coming from individual action and industry, and most commonly the experiences that were shared in the survey were associated with feelings of restriction rather than feelings of empowerment or indifference. This indicates that there are opportunities for behavior change, particularly at the individual and local business levels in Miami, that could drive meaningful change in the reduction of plastic waste if certain resources are made readily available and if the stakeholders are armed with knowledge. Efforts should therefore be concentrated on the availability and cost of alternatives as well as general awareness on what options are available, what tradeoffs may be associated with them, and how to properly dispose of them.

Collection

Household solid waste collection in the City of Miami is handled by the City of Miami's Solid Waste Department (SWD), which provides garbage, bulky trash, and recycling collection. In the surrounding municipalities that are included in Miami-Dade County, solid waste collection is handled by the Miami-Dade County Public Works and Waste Management Department (PWWM). The full collection program for Miami-Dade County at-large includes curbside garbage and trash collection by PWWM vehicles directly, thirteen Trash and Recycling Centers (TRCs), two Home Chemical Collection Centers (HC2s), as well as single-stream recycling household collection service provided through PWWM contracts with several different private companies (Miami-Dade SWMMP 2014). The facilities used by the City of Miami SWD represent a portion of that — this includes SWD vehicles and one Miami Dump Facility and does not include any of the TRCs. Where readily available, data on waste collection was recorded for the City of Miami itself, and information was otherwise supplemented at Miami-Dade County level where specified in this report.

According to the Florida Department of Environmental Protection (FDEP), roughly 4.3 million metric tons of MSW were collected in Miami-Dade County in 2020, which is the highest of any County in the state. Roughly 44% of the MSW generated in Florida at-large is generated by residential units, while the rest comes from commercial sources (FDEP 2020). Within the City of Miami, administrative buildings, police stations, fire stations, and parks are all provided services by private commercial haulers.

Figure 29: Garbage and recycling bins at a Public Park in Liberty City

(Photo Credit: CIL)

Some of the companies that are privately contracted for household recycling collection in Miami-Dade County at-large include World Waste Inc., Waste Services Inc., and Waste Management Inc. of Florida (WMIF) largely for processing. A team from HDR Engineering that supported development of the Miami-Dade Solid Waste Management Master Plan in 2014 at the county level found that, given the multiple contractual agreements for recycling, the capacity for collection for the county was adequate, though the challenge was found to be in enforcement of recycling requirements at over 100,000 multi-family and commercial establishments across the county (Miami-Dade SWMMP 2014).

Figure 30: Garbage and recycling bins available outside of a commercial building in Miami

(Photo Credit: CIL)

Local businesses that were interviewed also spoke to the lack of enforcement of recycling requirements among private businesses. Much like the residential waste stream, commercial entities also struggle with contamination in recycling streams.

> **"For corporate businesses, it's "the law to do recycling" but they don't really follow through. No one would know if I wasn't recycling. [The waste management company] charges me a contamination fee for my recycling container — I'm trying to do a good thing, but then if we don't do it properly I get charged, and I'm already paying more to have a recycling bin. And no one even cares that I do… when I get charged a fee its like why do I even bother doing this? It's a hassle — even if you're trying your best you're probably still getting it wrong."**
>
> **— Local Business Owner**

Figure 31: Residential Waste Bins outside of an apartment building (left) and free-standing home (right) in Miami

(Photo Credit: CIL)

According to the City of Miami Solid Waste Department, curbside services are provided to over 67,000 households through twice per week garbage collection of green carts, once per week bulky trash collection for items such as appliances and furniture, and biweekly (every other week) recycling collection of blue carts. The cost of this service is built into the annual tax bill for residents. The City of Miami Solid Waste Department does not provide collection services for residential properties that are larger than four units or for commercial properties, and those establishments must contract through an authorized, franchised local hauler. Recycling is also mandatory for those establishments. All waste collection for household and commercial properties in the City of Miami must comply with a sanitation code that is enforced by the City of Miami SWD.

Illegal dumping was mentioned by several interviewees as a problem in Miami and a contributor to plastic pollution in the city. It was noted that multi-unit apartment buildings, which contract waste management services through private services, are often located next to single-family units with access to city services. When single-family residents put out bulky waste, apartment residents follow suit. Other sources of illegal dumping noted by interviewees were businesses, particularly landscaping, and non-residents driving to Miami to dump waste on abandoned lots.

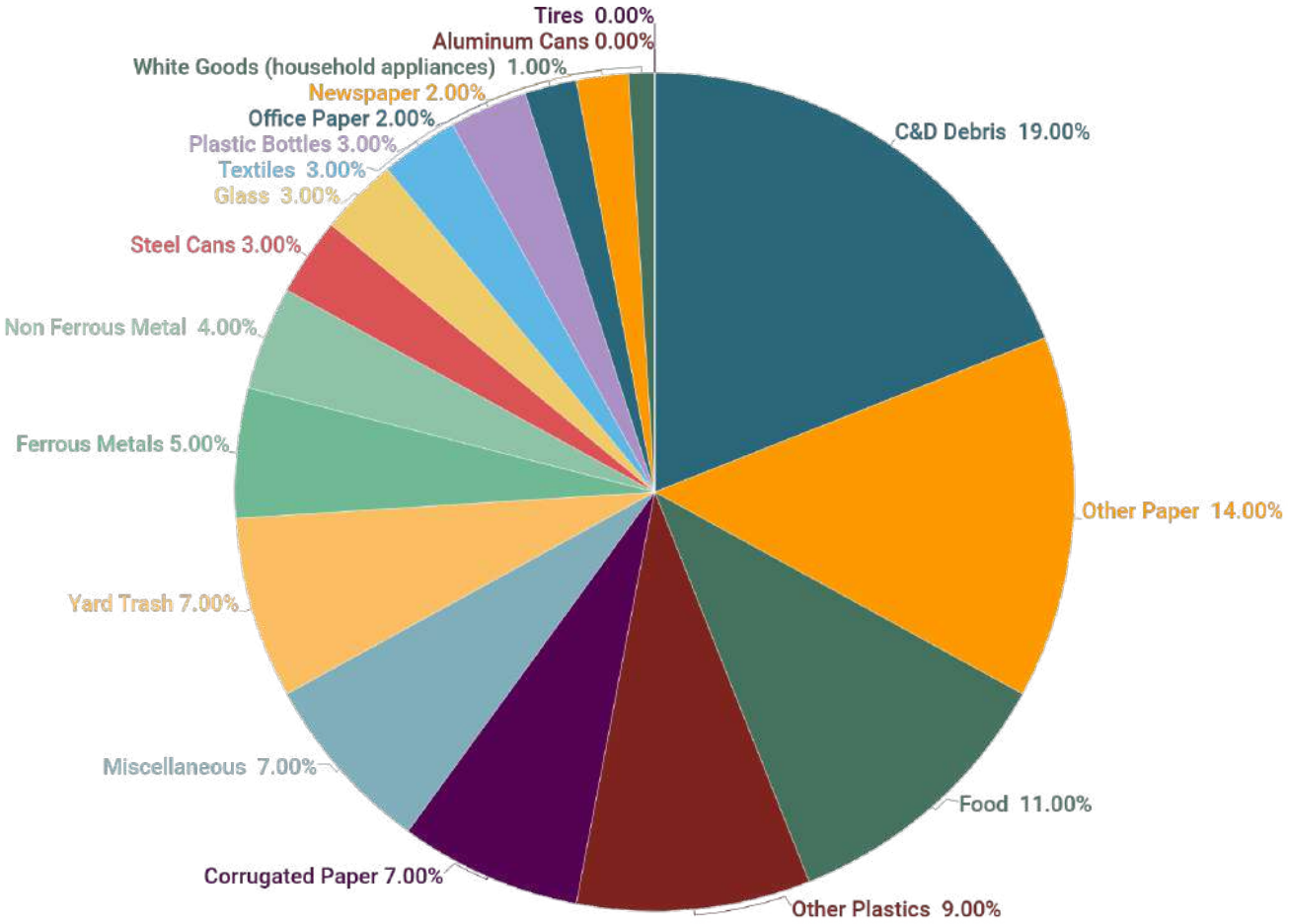
Interviewees reported that city-owned trucks for the neighboring municipalities of The City of Miami Beach and the City of North Miami Beach come by and regularly empty the bins that are on the beach, and that the bins that are on the beaches and tourist areas get emptied and cleaned much more frequently than those in residential areas. The CIL team was told this by several people in the interview process and observed the trucks emptying the beach trash cans. Although this waste collection is done by an entity separate from the City of Miami SWD, this represents an interesting example of comparison of collection and waste bin maintenance between heavily visited tourist areas and areas with lower ambient population in residential areas, which can also be seen in the litter data described in the Leakage section below.

Figure 32: Public waste bins and signage at North Miami Beach

(Photo Credit: CIL)

Based on FDEP data at the county level from 2020, of the over 4.3 million tons of MSW collected in Miami-Dade County in 2020, around 16% was identified specifically as plastic, though there are likely plastic polymers in other categories of MSW such as Textiles, Miscellaneous, and Other Paper. Over 50% of the MSW collected in 2020 was comprised of C&D Debris, Other Paper, Food, and Other Plastics. Waste and plastic waste generation rates are higher in Miami-Dade County at-large than US averages, as the county waste generation rate is 7.9 lb/person/day at 16% plastic and the US average is 4.9 lb/person/day at 12% plastic (FDEP 2020).

Figure 33: Composition of MSW that was collected in Miami-Dade County in 2020, from FDEP 2020



An issue of key importance to the health of Biscayne Bay that was raised several times during stakeholder interviews was the issue of waste collection on the islands within Biscayne Bay, also referred to as spoil islands. There are 12 islands total and they are popular locations for residents and tourists alike. The CAP litter transects conducted on one of these islands had the second highest litter density observed in the study area. While direct deposition of waste from visitors is certainly an issue on these islands, previously studies have also shown that litter and mismanaged waste from other areas around Biscayne Bay can also be transported to these islands, and some of the litter transects conducted by CIL were along the coastlines of the islands where this could have been the case (Carteh 2016).

Figure 34: Example of the location of a public waste bin on Pace Picnic Island

(Photo Credit: CIL)

From one study conducted at Pace Picnic Island by a local NGO, it was observed on a Sunday afternoon that 15 of the 21 waste bins on the island were overflowing. It is a good indication that people on the island are attempting to dispose of their waste properly, as well as the fact that there is a high density of bins on the island, however the capacity and maintenance of those bins appears to remain a challenge. Bins that were unsecured were sometimes used as tables or were moved by visitors. Some of those bins were found to be at or below the water line, when they are required to be at least 5 feet back from high tide, and 50% of the waste in the bins was recyclable (Doebler 2021).

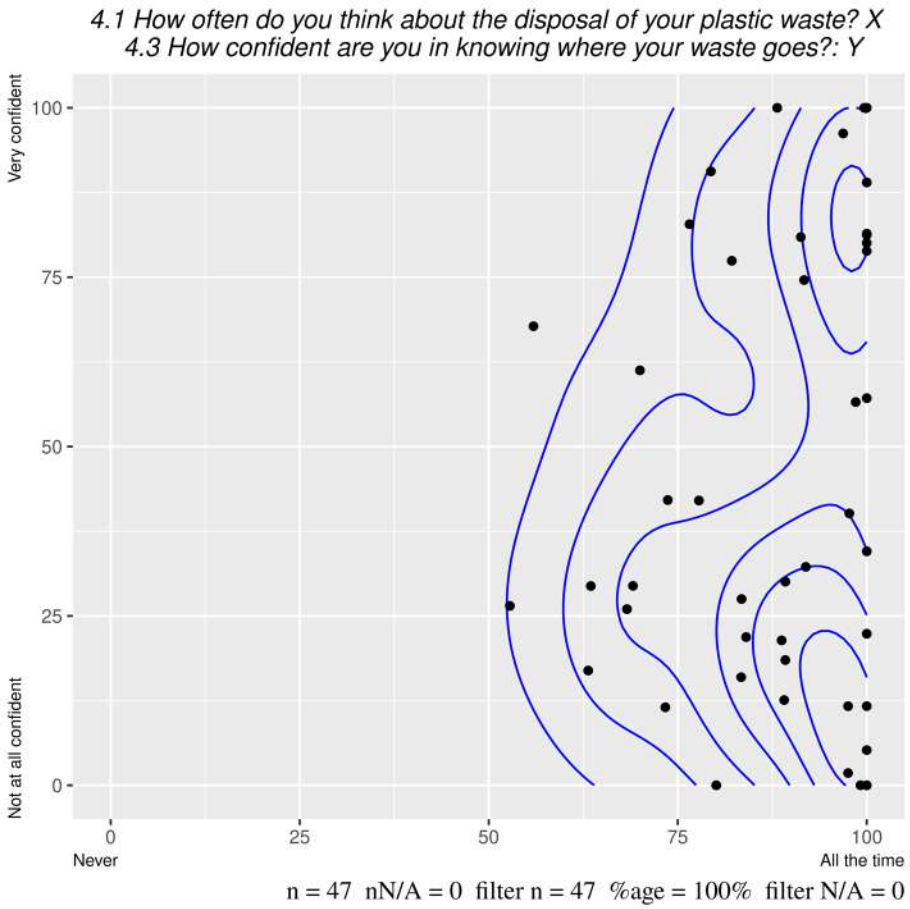
Figure 35: A portion of the waste collected from trash bins on Pace Picnic Island prepared for pickup on Monday, May 17, 2021

(Photo Credit: CIL)

It was mentioned during the stakeholder interviews that the County currently holds a contract with one private company to collect the waste from the bins on all 12 spoil islands. This is typically done once per week, but several interviewees mentioned that there can often be challenges with boat maintenance, capacity, and timing. It was also explained that the contract is carried out at a janitorial level as opposed to waste management, so the waste is often destined for landfill and there is not a management plan in place for the island waste. There are many opportunities to potentially improve the structure by which the spoil island waste is managed, either with more effective waste receptacles and collection, improved public outreach, or by rethinking the process and requirements for trash on the islands altogether.

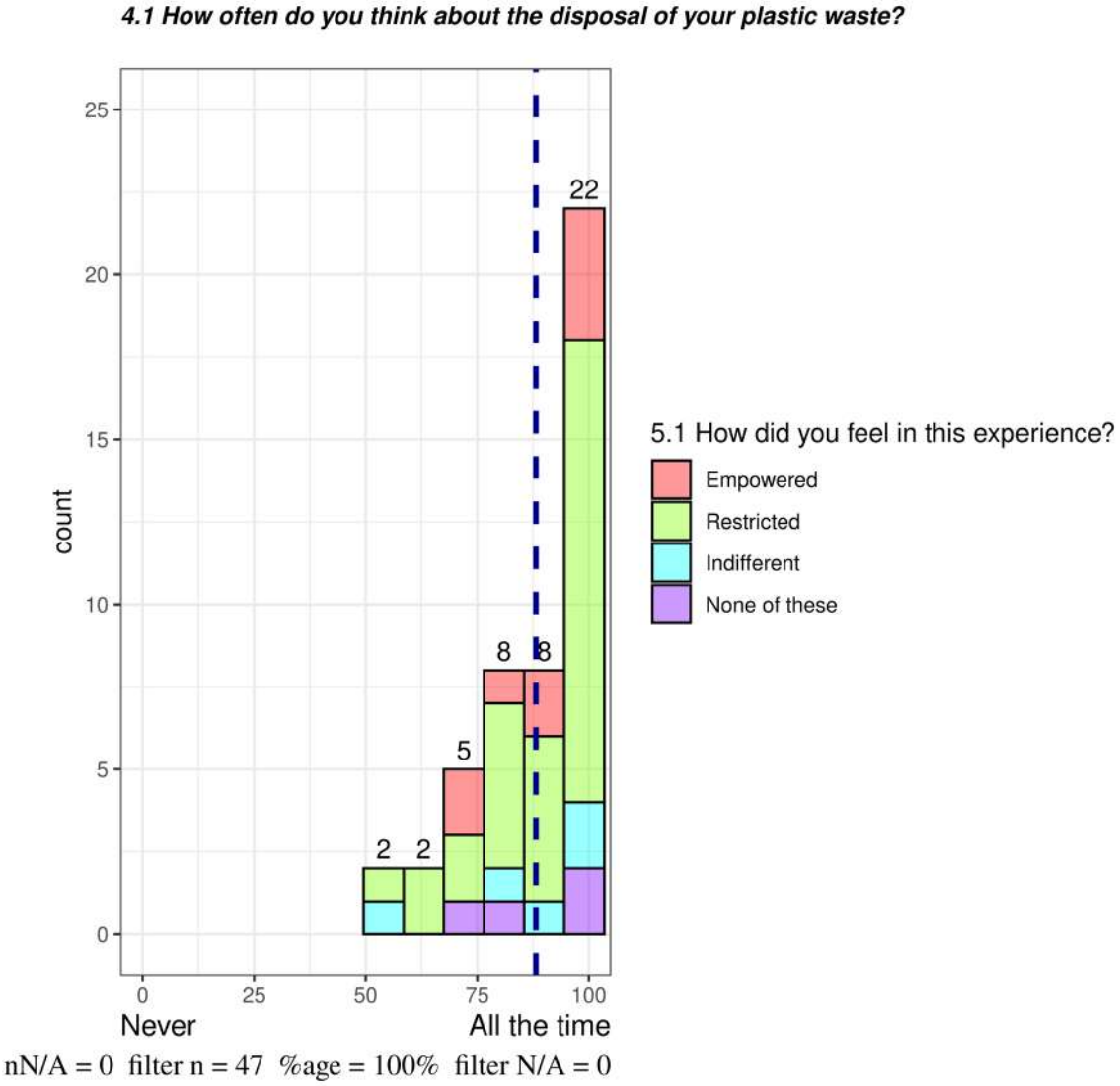
From the SenseMaker survey, it was found that respondents are regularly thinking about the disposal of their plastic waste yet there are disparate levels of confidence in knowing where the waste ultimately goes. This trend may be driven by lack of trust in recycling and waste management systems (Figure 36).

Figure 36: Dyad 4.1 compared with Dyad 4.3



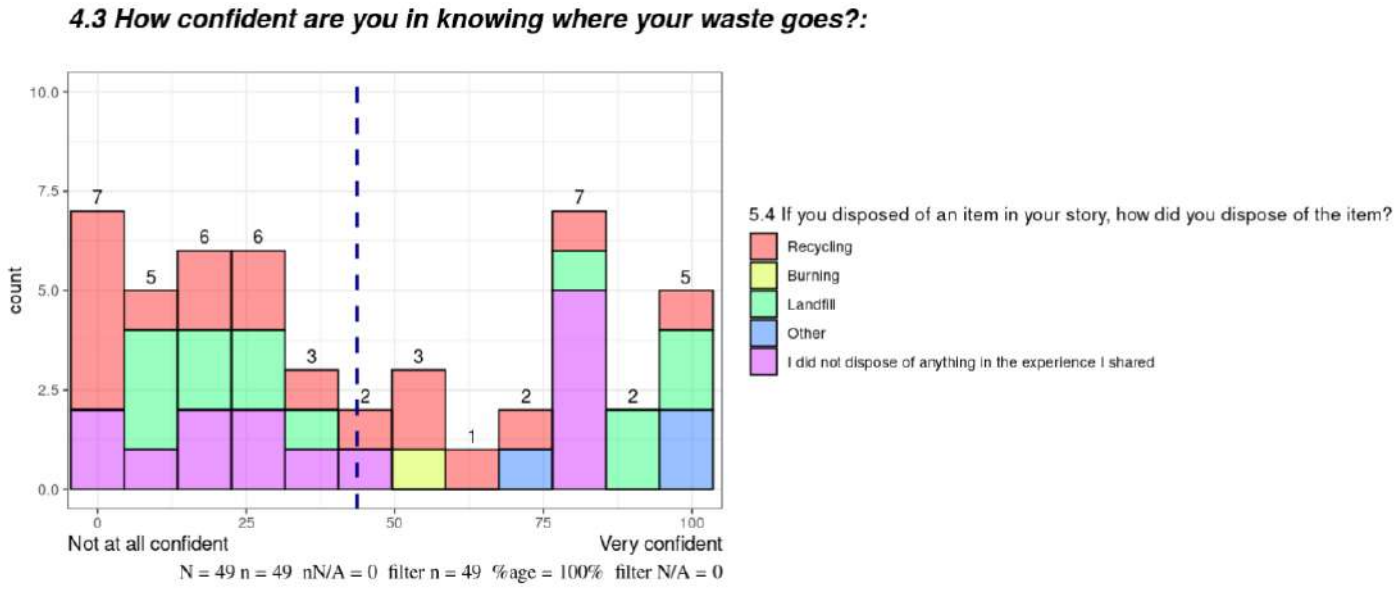
People who are regularly thinking about disposing of their plastic waste tend to feel restricted in their own stories (Figure 37). This indicates that there is a strong interest in plastic waste, yet the tangible resources needed to take action are lacking.

Figure 37: MCQ 5.1 compared with Dyad 4.1



In the MCQ where respondents were asked how they disposed of items in their stories, recycling was chosen as the most common choice. The wide spectrum of confidence in where waste goes indicates high levels of uncertainty, especially among respondents who actually recycled an item in their story (Figure 38).

Figure 38: MCQ 5.4 compared with Dyad 4.3



These findings suggest that even among groups where awareness is high, uncertainty about the fate of waste and correct disposal practices is significant.

End of Cycle

Solid waste management in Miami-Dade County is reaching a critical turning point. According to FDEP data from 2020, 50% of MSW in the state of Florida was landfilled that year, while 42% was recycled and 8% was combusted for energy (FDEP 2020). One of the three County-owned landfills — North Dade Landfill (NDLF) — is in the process of opening another cell to extend its operational capacity for another 10+ years. Two other County-owned facilities — the Resources Recovery Landfill (RRLF) and the Resources Recovery Facility (RRF) — are expected to exceed their permitted capacity this year, and South Dade Landfill (SDFL) is projected to reach its capacity in 2029. By 2060, the per capita waste generation rate in Miami-Dade County is expected to increase to 1.44 tons and the annual amount of waste to be managed through the system is projected to reach 3 million tons. The projected solid waste generation outweighs solid waste management system capacity by over 1m tons currently, and that gap is projected to continue to increase. The City and County must both address key infrastructure challenges to be able to accommodate these growing needs (Miami-Dade SWMMP 2014).

Figure 39: Trucks dumping household waste to be sorted at the MRF

(Photo Credit: CIL)

Two of the three landfills, NDLF and SDLF, are currently open for permitted private haulers, municipal waste haulers and permitted landscapers. NDLF started operating in 1951 and is considered a Class III (trash only) sanitary landfill. The landfill has two cells, one of which has already reached capacity and has been closed, and the other was expected to reach capacity in 2020. SDLF started receiving waste in 1979 and is a Class I (garbage — including off-road and automobile tires, animal carcasses, trash and yard trash, construction and demolition debris and asbestos) sanitary landfill. Three of the five cells at SDLF are already at capacity and closed, and the fourth cell is currently the only one that is open and available to accept waste. The fifth cell is currently under construction, which is what has extended the capacity timeline of the landfill to 2029 (SWM 2021).

As often happens in landfill settings, lightweight materials — particularly film plastics and expanded polystyrene — can blow off the landfill, in this case, onto a slope of one of the closed landfill cells. The team was informed that landfill employees pick up items that blow off the landfill; additionally, they have installed a barrier fence to try to catch these materials. How often this activity occurs depends on the weather; the edges of the wetlands on the property are also periodically cleared of debris. Landfill staff said that heavy rains may wash away landfill daily cover and that plastics can be exposed during these rain events because of its light weight. These observations emphasize that although a landfill may follow sanitary landfill requirements, plastic materials, especially film plastic, pose a challenge, as well as extra labor and expense, for the facility to contain, even if they don't travel off the property per their permit requirements.

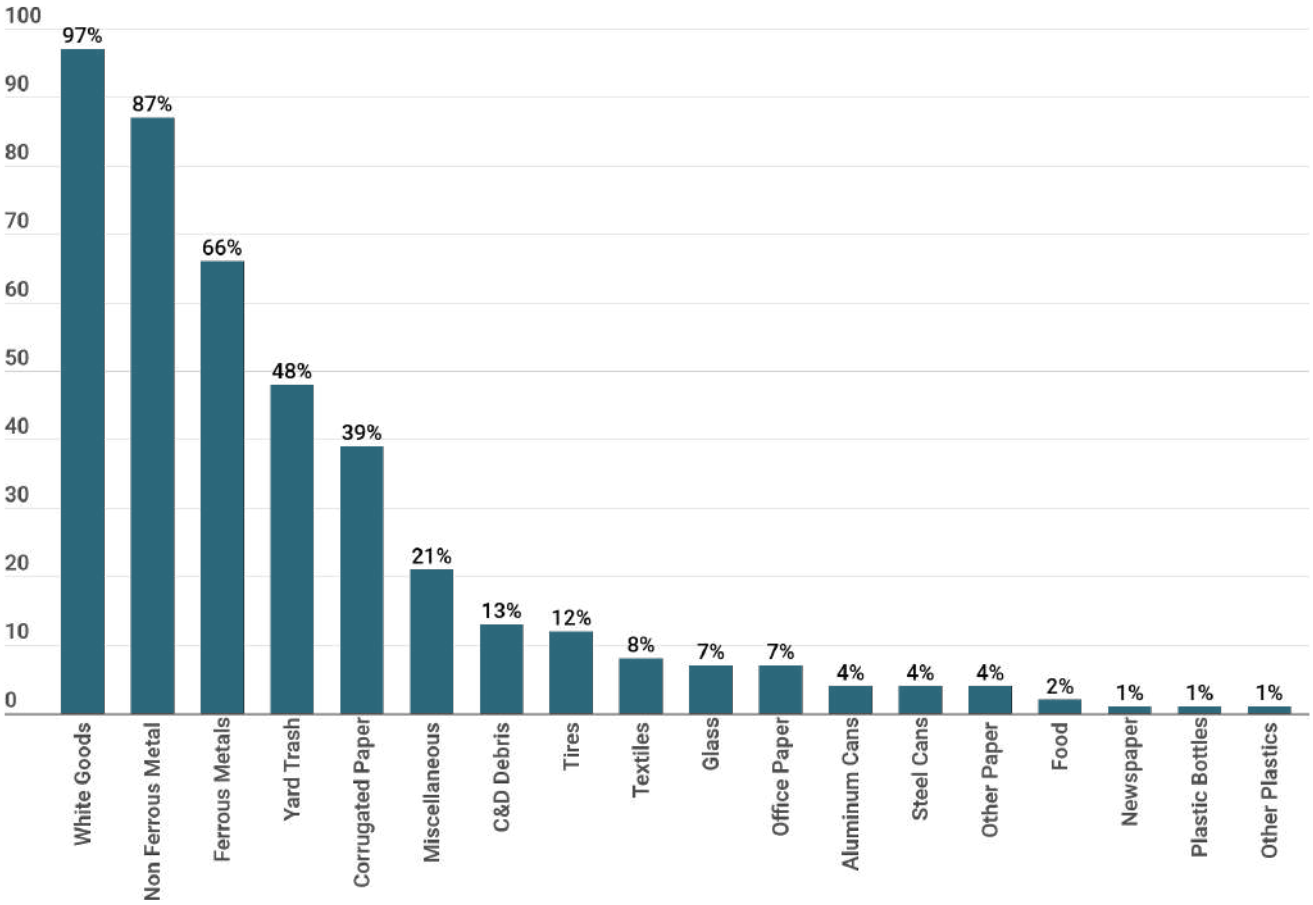
There are three transfer stations for solid waste that are owned by Miami-Dade County — the Northeast Transfer Station (NETS), the Central Transfer Station (CTS), and the West Transfer Station (WTS). However, residents of the City of Miami have access to a free Mini Dump for the city and are otherwise charged to use the other county-owned TRCs. According to the Miami-Dade County's Department of Solid Waste Management, the three transfer stations

combined receive and transfer around 35% of the total annual waste managed in the county. The remaining waste is handled directly by PWWM at NDLF, SDLF, and RRF (Miami-Dade SWMMP 2014).

In terms of recycling policy, the original Solid Waste Management Act (SWMA) of 1988 from the Florida Legislature set a goal of recycling 30% of waste in the state. In 2008, the Energy, Climate Change and Economic Security Act and House Bill 7135 led the Florida Legislature to increase that goal to recycling 75% of the waste stream by 2020. As part of that bill, interim goals for recycling rates were set in 2010 that required counties to reach 40% by 2012, 50% by 2014, 60% by 2016, and 70% by 2018. According to FDEP, Florida reached the interim goal for 2012 with a recycling rate of 46%, but did not meet the 2014, 2016, or 2018 goals. The latest available state-wide reported recycling rate is 49% from 2018 (FDEP 2019), though latest numbers from FDEP studies in 2020 suggest that it may be closer to 42%. The recycling rate for Miami-Dade County for 2020 was much lower than the statewide average from 2018 at just 27.34% (FDEP 2020). City of Miami-specific recycling data is ultimately reported to the county-level on a regular basis. FDEP cites that while widespread single-stream recycling in the state has increased the volume of collection, contamination is still a major issue that hinders effective processing of recyclable materials. High contamination rates also make it more difficult for Florida to engage in global recycling markets, with countries following China in closing their borders to recycling import or instituting stricter contamination requirements (FDEP 2019). Currently there is no monthly cost for recycling to single-family residences in the City of Miami. The cost is paid through the city's property taxes. Multi-family residences and commercial properties typically use private haulers to collect their recycling, as it is required according to city code for the City of Miami. Household recycling bins that are provided are typically 95 gallons.

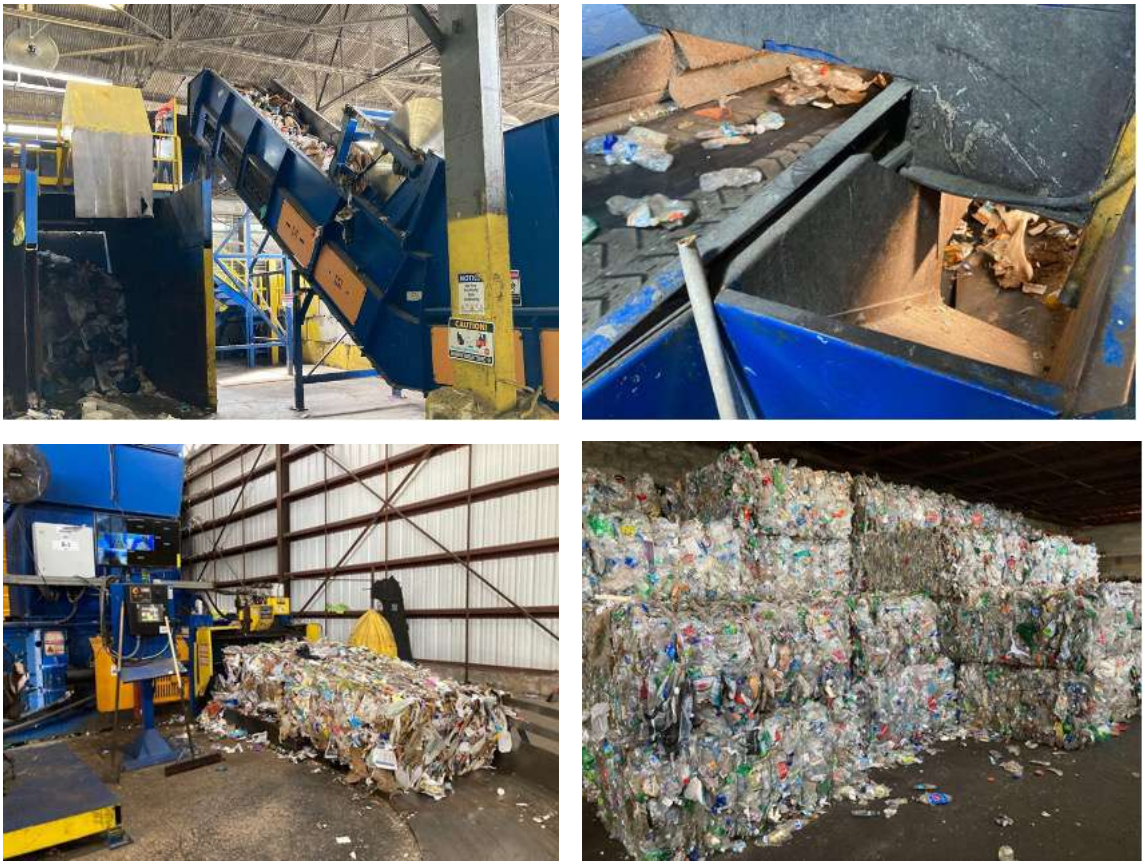
As part of the Miami-Dade Solid Waste Management Master Plan, a waste composition study was conducted for the county based on waste received at county-owned facilities from single-family households, multi-family households, and commercial units. The results found that half of the garbage at the waste management facilities consisted of recyclable materials, including paper (19%), containers (10%, majority plastic), and organic material (21%). Based on the composition study, plastic could be identified in around 16% of the waste stream — which is consistent with the 2020 County data on MSW collection — though plastic polymers and plastic liners could also be found in the categories that were labeled as Non-Recyclable Paper (13.4%), Other Garbage (9.3%), and Textiles (3.4%). Interestingly, the study did not find significant seasonal variation between waste composition in summer and winter, apart from a lower percentage of yard waste and higher percentage of food waste during the winter (Miami-Dade SWMMP 2014).

Figure 40: Percentage of MSW categories collected in Miami-Dade County that were recycled in 2020, from FDEP 2020.



As mentioned in the Collection portion of the report, while some materials such as Other Plastics, Food, and Other Paper may comprise a large portion of the MSW that is collected in Miami-Dade County (9%, 11%, and 14% respectively), 2020 County data show that less than 5% of each of those materials were recycled. Interestingly, for one of the most readily recyclable items—plastic bottles made largely of PET—only 1% of the amount that was collected was actually recycled. Plastic material categories each had a less than 10% recycling rate for the county in 2020, while metal materials such as white goods (household appliances) saw recycling rates of up to 97% based on amounts collected (FDEP 2020). Some of the lower rates of recycling for items such as plastic bottles or other plastic convenience items could be attributed to contamination or due to composition of materials such as PLA and other bioplastics, which was observed for several to-go and convenience items in the city.

Figure 41: Examples of the sorting and baling process for PET at the MRF in Miami



(Photo Credit: CIL)

The recyclables from the City of Miami go to a material recovery facility (MRF) privately contracted to and run by Waste Connections. The Waste Connections facility services 75,000 homes and 25,000 businesses across the county — which includes the City of Miami — and processes around 130 tons of waste per day, or 9,000 tons/month. The facility also receives an estimated 1,200 tons of garbage/day that goes to landfill. The MRF accepts single-stream recycling from the city, which includes #1 and #2 plastics (PET and HDPE), paper, cardboard, and used beverage container (UBC) aluminum. According to MRF staff, the contamination rate for the entire MRF currently averages around 70%. The staff reportedly remove around five 40-yard containers per day of non-recyclables from the waste stream before they are processed that would otherwise jam the sorting machinery. Of the waste that does go through the system, 20-25 bales of residual per day go directly to landfill due to contamination. The facility recently installed an optical sorting machine for hard plastics and a ballistic screen that helps to sort lighter weight items, but the facility has to replace 2-3 screens every month because they are often clogged by plastic bags and other non-recyclable contamination. The contamination rate was reportedly closer to 26% a few years ago and continues to increase over time, reaching its worst during the COVID-19 pandemic. The staff emphasized that contamination is the biggest challenge facing the MRF, which includes the waste that is being processed from the City of Miami.

> **"Recycling education is a never-ending story, but you have to start somewhere."**
>
> **— Private Waste Company**

> **"Recycling bins became alternate garbage bins during COVID. The contamination was insane."**
>
> **— Private Waste Company**

The majority of processed waste coming out of the Waste Connections MRF by weight is cardboard and paper items. The MRF bales around 600 tons/month of cardboard, and it was noted that most businesses in the City of Miami that do not do single-stream recycling instead only recycle "recoverable" material, which is largely cardboard. TetraPak items are also accepted as mixed paper in single-stream recycling for the MRF. The MRF processes around 5 bales/day of clean paper, but the staff note that this number used to be closer to 90-95 bales/day. This again is due to sorting and contamination challenges and requirements of recycling end-users. It was mentioned that most of the "paper" stream in the sorting machinery is now plastic bags, and the MRF no longer assigns people to sort them out by hand because the volume is too high, resulting in much of that waste stream going directly to landfill. One staff member recounted the MRF spending $10,000 to send a bail of paper for recycling to China for processing before the National Sword in 2018, but China would not accept the paper because it did not meet their standards, and it cost the MRF an additional $75,000 to have the bale shipped back to the US.

> **"We don't dare send our clean paper abroad anymore… because of the risk that it could get sent back."**
>
> **— Private Waste Company**

In terms of plastic, the Waste Connections MRF bales around 70 tons/month of combined plastic, which is mostly PET. Natural HDPE has a value of around 80 cents/lb, which is among the highest value the MRF has experienced due to current high prices of oil, though HDPE comprises a smaller percentage of the waste stream than PET. Colored HDPE is lower in value at around 30 cents/lb, due to the fact that the natural HDPE can be colored but the natural HDPE can never be returned to its natural state. PET has the lowest value of plastics accepted at the MRF at around 10 cents/lb. Both PET and HDPE plastics baled at the MRF are typically processed domestically, and the MRF works with recycling broker GP Harmon to match with an end-user. However, the staff expressed that the processing of plastic at the MRF is not cost-effective, and much of the plastic collected for recycling is taken to the WtE facility by the collection trucks. The city contracts the trucks for waste collection directly, so the MRF does not have control over what is delivered to them or taken elsewhere.

> **"The city could take it [the mixed plastic from single-stream recycling collection] to the burner [WtE facility] for less than it costs me to process at the MRF."**
>
> **— Private Waste Company**

In addition to paper and plastic, the MRF bales around 19-20 tons/month of UBC aluminum which is sold domestically. Any glass that is sorted at the facility is taken to a processor in Sarasota FL, but the MRF has to pay the processor to take it because there is no market for selling it. The MRF also exports "wet" waste, which has over 12% moisture, and most of that is shipped to India. It was also noted that the MRF does not accept metal and ferrous scrap beyond UBC aluminum, and residents have expressed desire for a way to recycle those materials in the city.

The Waste Connections MRF previously accepted waste from a dual-stream recycling system that was implemented by the city. MRF staff had mixed feelings about which system they preferred. The dual-stream system had much lower contamination rates and provided a cleaner output, but the system was also admittedly much slower. With the dual-stream system, the MRF was able to process around 1.5 tons/hour, and now they typically process around 12 tons/hour and can reach a maximum of 20 tons/hour. Some expressed a desire to return to the dual-stream system for the sake of product value and efficiency, but noted that market shifts and consumer behavior present a barrier. It was also noted that the city budgets typically rely on recycling to make money to fund their programs, but the budgets can often be $1-2 million short, and it is ultimately costing the MRF money to process materials. It reportedly costs the MRF around $75/ton to run the facility.

> **"The market shifted years ago from quality to quantity."**
>
> **— Private Waste Company**

> **"Currently we're not making money but the tables will turn."**
>
> **— Private Waste Company**

It is clear that contamination presents the biggest challenge for the MRF. Many in the stakeholder interview process attributed this to Miami's diverse and transient population. One interviewee described some neighborhoods as having a "turnstile of rental homes" that people regularly cycle in and out of. It was also mentioned that many communities in Miami originate from other countries with different solid waste practices and do not necessarily feel connected to or invested in the city itself. That variation in cultures and customs can be seen in the different items that cause contamination across different neighborhoods in the city. Many also cited the difficulty in educating a transient and changing population on topics like recycling practices.

> **"Miami has so much diversity and so many people coming and going, it's a cultural thing."**
>
> **— Private Waste Company**

> **"Contamination in Coconut Grove is [shipping envelopes and packaging]; in Little Haiti it's organic and construction materials."**
>
> **— Government Official**

Some MRF staff noted that the cleanest recyclables and lowest contamination rates often come from communities within Miami-Dade County that have fines for bin contamination and strong enforcement to accompany those fines. In particular, some areas have "oops" tags that are placed on bins that are regularly policed for contamination. The City of Miami does have fines for contamination, but they are not regularly enforced. Typically, the neighborhoods with the lowest contamination rates are often more affluent neighborhoods that also have lower population densities.

Figure 42: The tipping floor at the WtE facility

(Photo Credit: CIL)

The City of Miami sends over half of its collected solid waste to a combustion facility with energy recovery, called locally as the Waste to Energy (WtE) facility, which is owned by the County and operated by Covanta Dade Renewable Energy Ltd. The contractual agreement with the County expires in 2023 and includes four 5-year mutual options to renew. The plant opened in 1980 in response to the limited amount of space available for landfill in the area and currently processes around 4,200 tons of waste per day. The facility now services around 340,000 homes, including twice a week waste and once a week recycling pickup. Overall, Covanta reports that 1.6 million tons of waste are collected in the City of Miami annually, and 1.1 million tons — or roughly 68% — is sent to the WtE facility. This results in around 250,000 lbs/year diverted from landfill in Miami. The WtE facility accepts two streams of waste — trash, which includes bulky, lumber, and yard waste, and garbage, which includes household MSW and food waste. Any dirt, glass, or rocks that are collected are sent to the Okeechobee Landfill.

Figure 43: Processing and air pollution control systems at the WtE facility

(Photo Credit: CIL)

Through the processing at the WtE facility, they are able to reduce around 90% of the volume of the waste with the remaining 10% managed as ash and incorporated into cement through a partnership with Titan Cement Kiln as well as sent to landfill. They salvage around 20,000 tons/year of ferrous metals, 3,000 tons/year of which is aluminum. The plant also processes around 4,200 tons/year of tires, though they are shredded and used at the landfill as opposed to burned. The electricity that is generated is enough to power around 45,000 homes in Miami currently.

Pollution controls for the WtE facility include a lime in scrubber and a HEPA filter for particulate matter. The scrubbers also have continuous emission monitoring. The gas emitted from the smokestack at the plant is 90% water. The landfill that contains the ash is lined, and the leachate, which is largely potassium and water, goes into the sanitary sewer system. Ultimately the carbon savings for the plant are estimated to be about 1 ton CO2 of greenhouse gases per ton of MSW processed.

As part of the Miami-Dade County Solid Waste Management Master Plan (SWMMP) developed in 2014, the Solid Waste Advisory Committee went through a scenario planning process that took into consideration future waste generation rates and infrastructure needs in the County. The Committee decided on the Environmentally Preferred Scenario to best meet county SWM needs, which manages the waste generated by using the alternatives most favorably ranked by the Committee in regard to the following evaluation criteria:

- Environmental impact; and
- Contribution to source reduction, reuse, recycling and preservation of landfill space

The Committee now assists in developing a plan for implementation over the next 50 years, incorporating alternatives prioritized in the following scenario:

Figure 44: Alternatives outlined in the scenario selected by the Solid Waste Advisory Committee as part of the SWMMP, from SWMMP 2014

Source Reduction:
- Ban the use of plastic bags
- Support packaging for product stewardship - regulation of excessive and non-reusable/recyclable packaging
- Encourage home composting of organic waste materials
- Partner with local companies, community organizations, schools, etc. to create a lottery for used and surplus items
- Encourage development of food donation programs
- Support extended producer responsibility (EPR) - producer internalization of societal cost of its products downstream, including "take back" programs

Recycling and Reuse:
- Develop an information program to increase the public's awareness of recycling programs
- Encourage recycling programs for the County's Public School System
- Recycle RRF ash
- Expand recyclables accepted by the curbside recycling program
- Provide incentives to vendors for using recycled products

Collection and Transport - Curbside Waste and Recyclables Collections:
- Provide more residential enforcement of solid waste rules
- Institute a variable rates system to charge residents by weight or volume
- Change the frequencies of garbage, bulky waste and recyclables collection (e.g. once per week, twice per week, every other week, etc.)
- Charge a fee for bulky waste collection service
- Require County collection of waste from other County departments

Collection and Transport - Transfer Stations:
- Reduce operating hours at transfer stations
- Redesign transfer stations to allow for more efficient operations (e.g. material separation, eliminate compactors, expand tipping floors, etc.)

Collection and Transport - Trash and Recycling Centers:
- Site additional home chemical waste facilities
- Redesign the TRCs to allow for more efficient operations (e.g. use of transfer trailers, compactors, material separation, etc.)
- Reduce the operating hours/days at the TRCs

Landfill:
- Recover recyclable materials at active landfills
- Construct a wind or solar panel farm at existing/ closed landfills
- Mine active and closed County landfills to recover additional waste disposal capacity, soil, and recyclable materials
- Adopt policy against new landfill construction in Miami-Dade County
- Maximize the use of non-county owned disposal facilities to preserve existing county-owned landfill space (includes waste transfer)
- Close one or more existing landfills (North Dade)
- Construct a bio-reactor landfill (South Dade landfill)
- Expand existing and activate/expand closed landfills (South Dade, Old South Dade and 58th Street Main Landfills)

Energy Recovery
- Redesign the RRF to allow for more efficient operations (e.g. expand unders building, expand trash tipping floor, etc.)
- Construct a new mass burn WTE/EFW facility at an existing solid waste site or other site

While there have been promising strides made in recent years in waste management infrastructure in Miami, the city should ensure that any future infrastructure meets the needs of the city based on the waste characteristics, and also that residents of Miami are aware of best practices for handling different types of waste to maximize the efficacy of that infrastructure. Efforts can be made to reduce contamination in recycling streams, address waste processing for alternatives that are increasing in popularity such as industrially compostable plastic, and explore options for locally-based and domestic EPR schemes.

While there are no city-supported industrial composting operations in Miami, there are private and grassroots organizations that are working on compost collection within the city and the county. Such organizations include Back2Earth, which offers pick-up services, drop-off locations, and education programs around composting food scraps in Miami. Compost for Life offers curbside collection for both residential and commercial compost in Miami-Dade County, which is then processed at a farm in Homestead, FL. Verde Market, a zero-waste grocery store in the city of Miami, offers compost drop-off for a $1.50 fee. However, none of these operations currently accept any form of plastic, including biodegradable or compostable plastic, which still presents a problem for the disposal of such to-go items.

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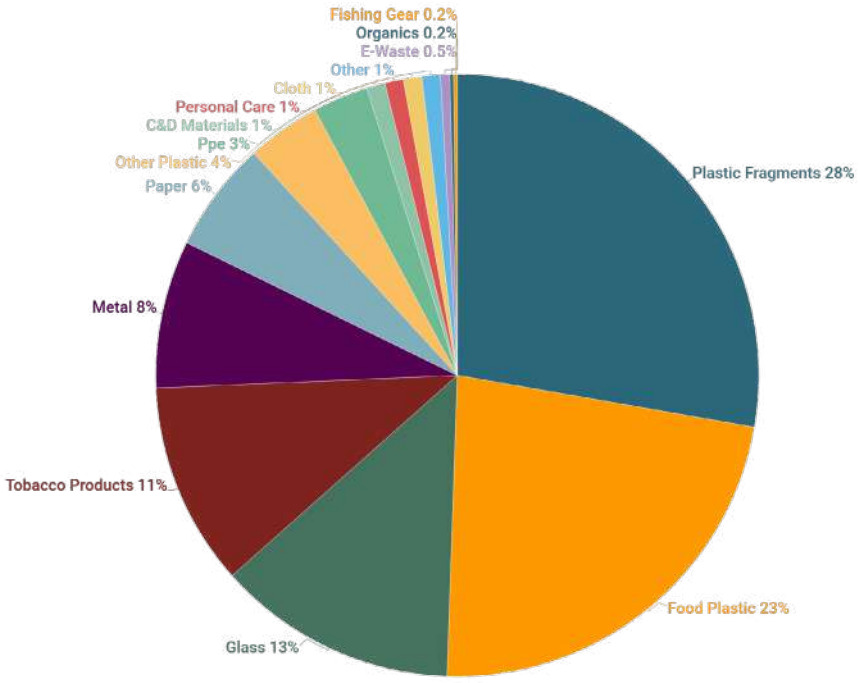
Regarding the development of waste management streams appropriate for biodegradable plastics, such as industrial composting, there are variables to consider. Miami's existing recycling stream has reportedly high levels of contamination, a problem that could be equally challenging for composting waste collection without simultaneously implementing education and awareness campaigns and/or financial incentives. Adding a composting waste stream would likely reduce the waste stream currently going to the existing combustion facility with energy recovery, which is processing 68% of Miami-Dade County's waste operating at capacity. According to the operator, the combustion facility is saving greenhouse gas emissions versus disposal in a landfill; there are, however, concerns from some environmental advocates about airborne pollutants such as dioxins and heavy metals (note that the Miami-Dade WtE facility has lime scrubbers and a baghouse with a HEPA filter and continuous emission monitoring to control outputs). In terms of cost, the existing combustion facility with energy recovery is profitable for the county to operate. Finally, these compostable plastic products do pose a significantly higher cost to businesses (see Use section). Working within the existing systems to use recyclable products or switching away from single-use products altogether might be more sustainable alternatives for both businesses and the city in terms of cost and waste management. These data should also be taken into consideration for the Greenhouse Gas Reduction Plan that is in development for the City of Miami.

Leakage

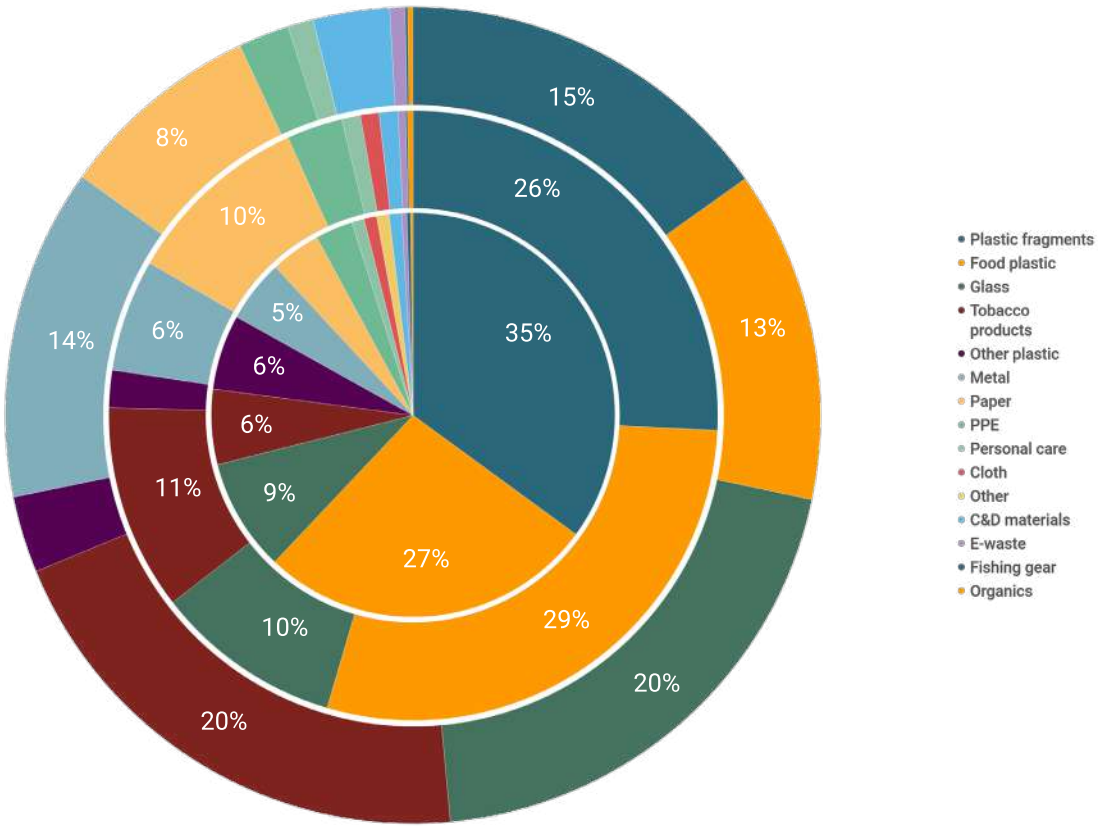
In total, 10,122 litter items were recorded across forty 100m^2 transects in thirteen different square kilometer areas sampled in May 2021. Transect locations were selected using a stratified random sampling method, in which transects were randomly selected in thirteen square kilometers which were distributed across three groups of population count (upper, middle, lower) based on LandScan ambient population data and across all five commission districts in Miami. Litter items were recorded using the open-source Marine Debris Tracker app. A full list of items available in the app and their associated material categories can be found in the Appendix.

Figure 45: Litter Material Breakdown for Miami



Across all transects, the largest percentage of litter by category was plastic fragments. This included hard plastic, film plastic, foam plastic, and other plastic fragments. This was followed closely by items in the category of food plastic, which included food wrappers and food related to-go items such as utensils and containers. Together these two categories constituted over half of the litter items documented in the city. Other categories such as glass, tobacco products, metal, and paper comprised between 6% and 13% of litter documented, while the remaining categories—including other plastic, PPE, C&D materials, personal care products, cloth, other, e-waste, organics, and fishing gear—each represented less than 5% of the litter items respectively. The total percentage of common plastic items (the sum of food plastic, other plastic, PPE, plastic fragments, and personal care items) was 55% of the total litter items documented.

Figure 46: Proportion of most common plastic items in low (inner), mid (middle), and high (outer) population count areas in Miami



When examining the litter densities based on the population count areas, there are distinctions for each. For example, glass and tobacco products both represented the highest percentage of litter items found in the high population count areas, but those items represented 11% or less of the litter items found in both middle and lower population count areas. Higher population count areas also had more metal litter items (14% of the total), over twice the percentages of either the lower or middle population count areas. Higher and middle population count areas both had nearly twice the proportion of paper litter items as compared to lower population count areas. The lower and middle population count areas had similar breakdowns of the litter material found, with plastic fragments and food plastic as the most abundant.

Litter densities were high when compared to other locations sampled in the United States and high compared to other CAP locations globally. For example, three cities sampled along the Mississippi River in the United States had average litter densities of 0.61 items/m^2, 0.69 items/m^2, and 0.28 items/m^2 respectively. The numbers for Miami are also slightly higher than litter densities found in other large metropolitan cities, such as Panama City, Panama, which had litter densities of 1.87 items/m^2 in high population count areas, 1.43 items/m^2 in middle population count areas, and 3.04 items/m^2 in lower population count areas as of 2021 (Urban Ocean). The densities are comparable to those found in Hanoi, Vietnam which ranged from 1.5 — 4.4 items/m^2 across the three population tertiles there.

Table 6: Litter Density and Top Litter Items for Each Area of Population Count

Population Tertile	Top 5 Litter Items	Litter Density (count/m^2)
Upper (3,537 - 21,860 persons/km^2)	1) Glass or Ceramic Fragments, 2) Cigarettes, 3) Hard Plastic Fragments, 4) Metal Bottle Caps or Tabs, 5) Paper	2.46
Middle (1,135 - 3,536 persons/km^2)	1) Hard Plastic Fragments, 2) Cigarettes, 3) Plastic Food Wrapper, 4) Glass or Ceramic Fragments, 5) Film Fragments	1.48
Lower (1 - 1,134 persons/km^2)	1) Hard Plastic Fragments, 2) Film Fragments, 3) Glass or Ceramic Fragments, 4) Foam Fragments, 5) Plastic Bottle Cap	3.79

Litter density was highest in low population count areas and lowest in middle population count areas. This could be due to the fact that, since sites were chosen based on ambient population many of the middle and upper population count areas appeared to be business and tourist areas with high visibility that are regularly cleaned by the city. Low population count areas may also have less infrastructure or more remote areas where illegal dumping or littering is more likely to occur. The two square kilometer areas with the highest average litter density were along the Miami River and on one of the spoil islands, Pace Picnic Island, which is important to note for environmental health. Hard plastic fragments and glass or ceramic fragments were among the top five items found in litter transects across all of the population count areas. It is notable that at least two and up to four of the top five litter items in each population count area were considered a fragment material. These items are particularly difficult to capture, manage, recycle, or even to collect via cleanup.

Table 7: Litter Density and Top Litter Items for Each District

Commission District	Top 5 Litter Items	Litter Density (count/m^2)
District 1	1) Glass or Ceramic Fragments, 2) Hard Plastic Fragments, 3) Cigarettes, 4) Metal Bottle Caps or Tabs, 5) Plastic Food Wrapper	3.81
District 2	1) Hard Plastic Fragments, 2) Film Fragments, 3) Foam Fragments, 4) Cigarettes, 5) Plastic Bottle Cap	2.39
District 3	1) Glass or Ceramic Fragments, 2) Cigarettes, 3) Hard Plastic Fragments, 4) Paper, 5) Plastic Food Wrapper	2.73

Commission District	Top 5 Litter Items	Litter Density (count/m²)
District 4	1) Glass or Ceramic Fragments, 2) Cigarettes, 3) Hard Plastic Fragments, 4) Paper, 5) Plastic Food Wrapper	1.07
District 5	1) Film Fragments, 2) Hard Plastic Fragments, 3) Plastic Food Wrapper, 4) Paper, 5) Cigarettes	1.97

Given the diverse and fragmented nature of Miami and its multiple districts, it is also critical to analyze data at the neighborhood level and understand the various hyper-local contexts, behaviors, and barriers that may be contributing to the situation. For example, District 2 largely comprises the low population count areas along the coastlines and spoil islands where there are high influxes of tourists, which corresponds to the high litter density and high amount of fragmented litter items that may have been in the environment for a longer time or transported from elsewhere in the aquatic system around Miami. District 1 had the highest litter densities but also largely comprised residential areas, demonstrated in the litter items related to food and household items, and was also directly along the Miami River, which is important to note for potential transportation of plastic litter items.

Figure 47: CIL Team conducting a litter transect on Pace Picnic Island (left) and at a chronic litter site in the City of Miami (right)

(Photo Credit: CIL)

As part of the CAP fieldwork, the team from CIL in Miami visited two of the thirteen Department of Public Works storm drain pump stations. These pump stations were built in the 1950s but have received some upgrades since then, including an Eco-Vault filter system downtown. There is a city street sweeper service that cleans the downtown area of Miami twice a week, typically cleaning out the metal grates that are on roughly 20 of the drains in the city.

Citations exist for illegal dumping in the storm drains, but several interviewees noted that they are difficult to hand out and enforce because of the direct evidence requirements. There is one contractor responsible for collecting the trash that is filtered out of the pump stations from the Department of Public Works twice per week, though the staff were unsure of how the waste is handled after collection. Reportedly over 5,000 tons of trash has been removed from the storm drain pump system to date. Most of the waste collected are "floatables," such as PET bottles and flip flops. Regarding the maintenance of the system, all French Drains, trenches, catch basins, inlets, and drainage piping are maintained on a 4 year cycle, and stormwater outfalls are maintained on a 1-2 year cycle (BBHC 2020).

Figure 48: Example of one of the Pump Stations in the City of Miami

(Photo Credit: CIL)

There are concerns from the BBHC and residents about the role of storm drains in pollution in Biscayne Bay. The drains in Miami are often clogged with waste and litter, which exacerbates flooding, and they also act as pathways for problematic items beyond plastic such as pesticides and leaf litter that cause chemical disturbances in the Bay. The major fish kill in Biscayne Bay in August 2020 was partially attributed to this type of pollution, which contribute to decreasing levels of oxygen in the system (City of Miami 2020). There are over 95,000 stormwater inlets, catch basins, and grates in Miami-Dade County, and it has been estimated that over 16 million pounds of debris — including leaf litter and trash — enter those inlets every year. There is a promising initiative that was approved in late 2020 to install storm drain screens throughout the city, though there has been some frustration in the community around how long the plan has taken to pass through government permissions and be implemented. As of September 1, 2021, the initiative had officially been launched with 20 filters installed as part of a pilot project in 2020 and another 1,000 filters — 200 for each of the five districts — scheduled to be installed in the City of Miami within the next five months (Aguirre 2021). With this initiative come exciting opportunities for public awareness and outreach to ensure that people know about the investment and the infrastructure and what they can do to support it.

Figure 49: Example of storm drains in Miami without a grate or filter (left) and litter being stopped by an older version of a storm drain grate (right)

(Photo Credit: CIL)

The Department of Resilience and Public Works in Miami developed a contract with Water Management Technologies in 2003 to run the Scavenger Boat, which travels along the Miami River on a daily basis removing litter. On average, the Department reports that the boat removes 128 tons/year from the river, collecting everything from cigarettes to tires. The boat oxygenates the water and decontaminates as it travels using UV and Ozone, and the hydraulics for the boat are run on vegetable oil to have a minimal negative impact on the aquatic system. The waste collected is handled by Waste Management. The boat operators noted that a large portion of the waste that is collected comes from recreational boating trash and construction waste in Biscayne Bay. There are requirements for offshore dumping, though they are not consistently followed or enforced. The operators also noted that the type and amount of trash changes throughout the year, with the highest amounts of trash collected during full moons and high tides.

Figure 50: Scavenger Boat in the Miami River

(Photo Credit: CIL)

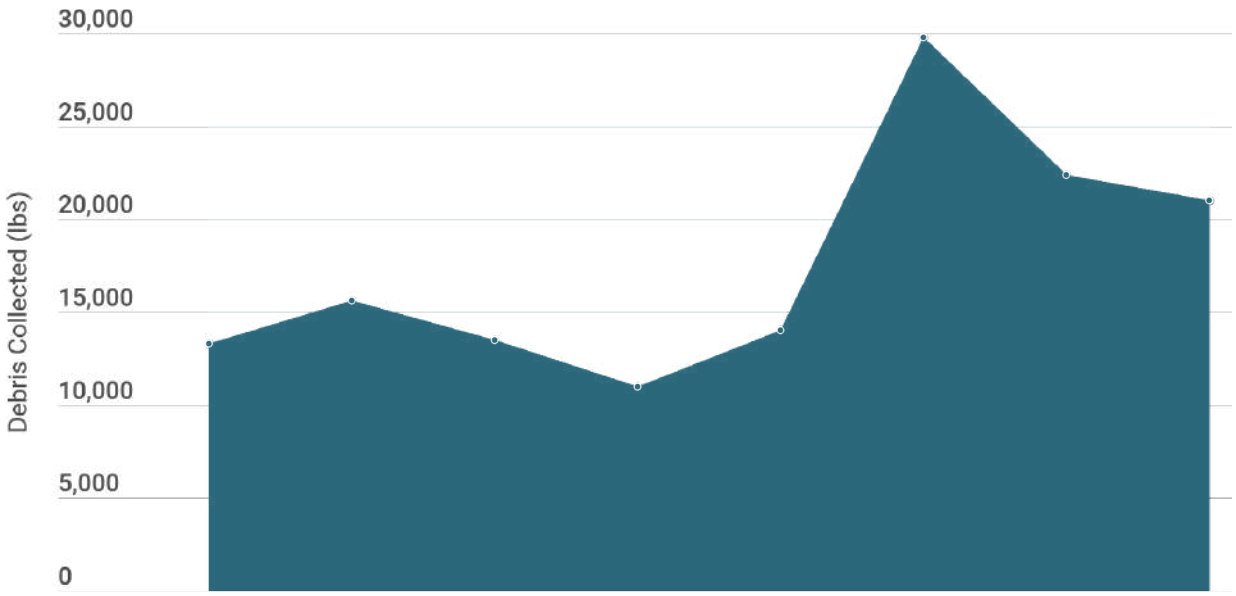
There is a very active community of beach cleanup organizations in Miami. Anecdotally, the CIL team was told that there are often between six and ten beach cleanups in the Miami area on any given weekend. Several of those organizing groups were interviewed as part of the stakeholder interview process.

Debris Free Oceans is one such group that regularly engages in cleanup and advocacy work in the Miami area. The organization has tracked the litter collected from their cleanups and was able to share their data from 50 beach cleanups at Virginia Key beach between 2020 and 2021. The litter characterization was similar to what was documented in the transects conducted by CIL, particularly the abundance of plastic fragments of various polymers. Among nearly 40,000 items collected, 97.2% were plastic items. The largest proportion at 27% was hard plastic fragments, followed by plastic bottle caps at 17% of items, soft plastic fragments at 16%, food plastic at 11%, and foam fragments at 8%. The majority of food plastic items were food wrappers and straws, and also included cutlery and candy items such as lollipop sticks. There was also a large number of plastic personal care items collected, particularly personal hygiene products, flossers, hair accessories, and toothbrushes. Notably, around 0.3% of items collected from the cleanups, representing over 100 individual items, were PPE.

The National Park Service also runs beach cleanups in Biscayne Bay National Park. Cleanups often take place between December and April on Elliott Key, which is comprised of 25 different beaches that are cumulatively less than 2 miles of coastline. Elliott Key separates Biscayne Bay from the open ocean, and it was noted by those that conducted the cleanups that much of the litter on the beaches there is fishing gear and plastic items that have floated to and accumulated at that location, and may not have necessarily been deposited directly there. In Spring 2021, the National Park Service conducted six days of cleanups in different areas along Elliott Key. They collected 2,260 lbs of litter from the beach and 782 lbs from mangrove areas, totaling 3,402 lbs of litter removed. In the beach areas, 81% of litter items were plastic, and 65% were plastic in mangrove areas, with a total percentage of 77% plastic litter items overall.

Beach cleanups at Elliott Key have been conducted in the same area since 2008 and the amounts of litter collected on the beaches has increased over the years. The amount peaked in 2019, following a season of record-breaking tourism numbers in the city, and appears to have decreased in 2020 and 2021, likely caused by lower levels of tourism and recreation due to the COVID-19 pandemic. If tourism numbers return or increase in the coming years, litter counts may continue to rise as well.

Figure 51: Beach litter collected at Elliott Key by the National Park Service beach cleanups over time



While upstream interventions are critical to reduce the amount of mismanaged waste in Miami, it is important to note the challenges associated with the characteristics and pathways of litter that is currently in the environment. The large proportion of fragments presents a problem for cleanup efforts and also increases the likelihood of those litter items escaping preventative interventions such as storm drain filters. Large floatable items are likely to be filtered out through the updated storm drain pump system or storm drain filter project, but this must be accompanied with regular maintenance and increased public awareness. Given the documentation from beach cleanups of litter items that were likely deposited elsewhere and transported to the coastline, integrated and collaborative interventions across the city are critical. There may also be value in investing in inland and community cleanups, as opposed to exclusively beach cleanups, so that local residents can more strongly make the connection between the litter in their own neighborhood and their own convenience items and the health of the environment and the city at-large. While upstream interventions to prevent mismanaged waste in the first place should be prioritized and are often most cost-effective, there is an opportunity to capitalize on the existing community of cleanups in Miami to increase awareness and reduce littering.

Opportunities

CIL recommends exploring the following opportunities to expand and enhance circularity in Miami based on the findings of this report. These opportunities are categorized based on the seven spokes of the CAP model and are roughly listed based on the level of potential impact to reduce plastic waste in Miami within each spoke. Stakeholder engagement with the partners of this project should take place to further prioritize these opportunities based on impact, feasibility, and cost. It is important to note that the opportunities listed below are individualized based on the findings, but solutions cannot happen in a vacuum and are most impactful when strategically combined within a holistic system framework.

INPUT

- It was reported in the stakeholder interview process that the Plastic-Free MB campaign is planning to expand to Plastic-Free 305 at the county level — this could be a very positive step for the city, and CIL recommends ensuring this is effectively implemented and has the support that it requires.
- The large percentage of domestic parent companies and manufacturers for top convenience items, in addition to the concentration of Nestle and Nestle Venezuela products, lend themselves to engaging companies on end-of-life management, product design, alternative materials and alternative product delivery systems.

COMMUNITY

- It was mentioned several times in interviews that “no one knows where their trash goes after it enters the bin,” and “everyone thinks that their responsibility ends when they put waste in the bin.” Many residents don’t make the connection with the products they use, litter in their neighborhood, and Biscayne Bay (for example, it was reported in interviews that there is no existing education in the state or county public school curriculum for things like recycling and waste management). Increased education in Miami, both formal education in classrooms and informal to the general public, is critical to address these barriers. Staff from the MRF mentioned that they would be happy for residents and students to visit and see the process — people need to see what happens after the bin, understand it, and be given information to make the best choices upstream. Such visits and education could be built into the local curriculum, or existing groups like cleanup organizations could also organize ‘upstream’ tours, etc.
- CIL was informed of a mentorship program that was originally proposed to the city by a local cleanup organization that identifies youth in each community in the City of Miami that want to spearhead cleanups in their own neighborhoods. These types of cleanups could be extremely useful to build local pride and to help residents make connections between everyday items and what ends up in the environment, and this initiative could be supported by the city.

- Invest in campaigns, messaging, outreach, and other initiatives — particularly in underserved communities — to enhance the sense of community and pride for the City of Miami among residents, something in the vein of 'protect what you love' campaigns and 'pride for the 305.'
- Louis Aguirre is an example that was brought up repeatedly as a voice for local pride and keeping Miami clean — the City of Miami could bring more celebrity and trusted voices (including DJs, musicians, actors, respected community members etc.) for the various communities and demographics in Miami as spokespeople for engaging and inspiring initiatives in this space.
- There seems to be a great deal of support at the Commissioner level in Miami for circular economy and waste management practices, and it would be extremely beneficial to increase their engagement in activities such as community cleanups to get more in front of this issue.
- Develop and increase messaging that the tap water in the City of Miami is safe to drink and actively combat misinformation regarding this — this may increase the likelihood of adoption for reuse and refill schemes.
- In future engagement with local communities and demographics, it may be worth exploring whether there are options for culture-based practices such as Santeria to involve less single-use plastic, such as making changes at the store level, but these solutions need to come from the community conducting the practices and must have their support.
- Increase the availability of in-situ and hands-on education programs such as Classroom in the Sand, particularly for students in in underserved communities, to continue connecting what people see in cleanups to the items they use in everyday life.

PRODUCT DESIGN

- There is a need for increased awareness around what types of materials are available, how to procure and dispose of different types of materials, and an understanding that there is not specialized infrastructure to handle particular items (e.g., compostable plastic alternatives), especially among local businesses in Miami — in general, the city needs to ensure that the products and material designs available and being used by local businesses match the infrastructure and capacity for waste management, and that the businesses know how to dispose of them properly, and that the process of disposal is not confusing.
- To-go food products in particular are made with a wide variety of material types, many of which are not labeled or have ambiguous labeling, which could contribute to confusion around best practices for recycling in the city. Consistent labeling and messaging across the city could help to combat this.

USE

- Similar to the recommendations in Product Design, local businesses do not appear to have the support or resources needed to understand the options available to them, nor do they have incentives to explore reuse/refill and alternative options that may require more initial investment upfront. Exploring ways that the city can support local businesses in this endeavor would be beneficial.
- Adjust the special event permit process for the city with regard to the use of single-use plastics vs. reusables at events — this would be a straightforward way for the City to ensure that certain items are not used during large events, particularly in places that often don't have sufficient waste bins or disposal options, without the

need to implement a large-scale ban. This process has also already been initiated at the city level through the Sustainable Events Guidelines in-progress.

- The City of Miami may want to explore incorporating the Woosh Refill Station initiative in the city as well as the option of allowing sponsorships for this program so that people don't have to pay for them, and there may be options to scale the program and make the stations more convenient.

COLLECTION

- In terms of collection, a priority for the city should be reducing the contamination levels for the local MRF. A lot of outreach is needed in Miami to reach the very diverse and transient population. This could be addressed in a variety of different ways and will likely require more than one intervention, including the recommendations from the Community section, increased staff for outreach, tailored campaigns, and fostering local champions from communities across Miami to assist in messaging and action.
- Spoil island maintenance is an urgent issue to reduce the amount of waste leakage. Besides increasing maintenance at the islands, there may be creative solutions available that are more efficient and cost-effective — one interviewee recommended that perhaps instead of having bins on the islands (which require regular cleaning, maintenance, and boats/staff to do this) those bins could be relocated to the 5-6 more accessible locations along the coast where people launch their boats, and this could be coupled with "pack in and pack out" messaging in multiple languages. Although more cost-effective in the short term, not everyone will know about or follow the "pack in and pack out" guidelines, so transition time would be needed, as well as continued cleanup for those that don't follow it. For a middle ground, there could still be signs about limited waste management on the islands and minimizing waste disposal while there, so that people are more aware, but still leave some cans on the islands to manage waste as needed.
- The city may want to invest in having regular inspection and education related to recycling bins (like the "oops" label) in all communities in Miami — this could be accompanied with tailored messaging around what 'contamination' means for the different communities.
- The level of collection and waste management may not be equitable across differing communities in Miami, so resources and engagement with underserved communities may be helpful.

END OF CYCLE

- Recycling in Miami should be a cost-effective practice — decreasing contamination and maximizing value of the resulting output is critical and interventions to support this must be prioritized.
- Per the strategic planning process, the city is trying to move away from its dependence on landfill and ensure that the waste management infrastructure matches the products and materials used and collected in the city.
- The city's Waste and Recycling Department should have more staff as well as community leaders that they can work with to get tailored messaging and engagement at the neighborhood level.
- Explore an industrial composting facility for the Miami area to address the increasing quantity of compostable plastics being used in local businesses in Miami, if this trend continues.
- Examine if single stream recycling continues to make sense given the contamination rates, reconsider dual stream, or further limit the complexity of what is allowed for recycling in Miami to simplify the system and reduce contamination.

LEAKAGE

- Storm drain grating and maintenance should continue to be a priority for the City of Miami — the storm drain filter initiative could be implemented as soon as possible with full support from stakeholders, as well as scaled if successful. The City of Miami also has the option to declare a state of emergency with regards to flooding exacerbated by clogged storm drains, which would allow them to unlock funding for storm drain upgrades and maintenance that are needed to reduce the amount of debris and litter entering the aquatic system.
- Public Education initiatives are needed around storm drains and the stormwater pump system — one interviewee stated, “There should also be public campaigns, awareness, art etc. around the filters that are going in — people aren’t aware of this huge investment and the whole system of pipes just underneath the city” — increasing awareness and making this connection for residents is critical for the continued success of the storm pump system and storm drain filter initiative.
- The city and relevant stakeholder groups could work to mitigate "inland" litter, beyond just the beaches in the city.
- Outreach and awareness should also target boaters and tourists, as these were mentioned by several interviewees as key contributors to litter (particularly that is washing up on the shore) — the mainland, islands, and Bay are all connected, and studies have shown that litter is readily transported from one area to another and turns into fragments, which are most difficult to clean up — the most cost effective and efficient solution would be to stop the littering at the source as much as possible.

Acknowledgements

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Appendix

Figure 52: Litter Densities for the City of Miami

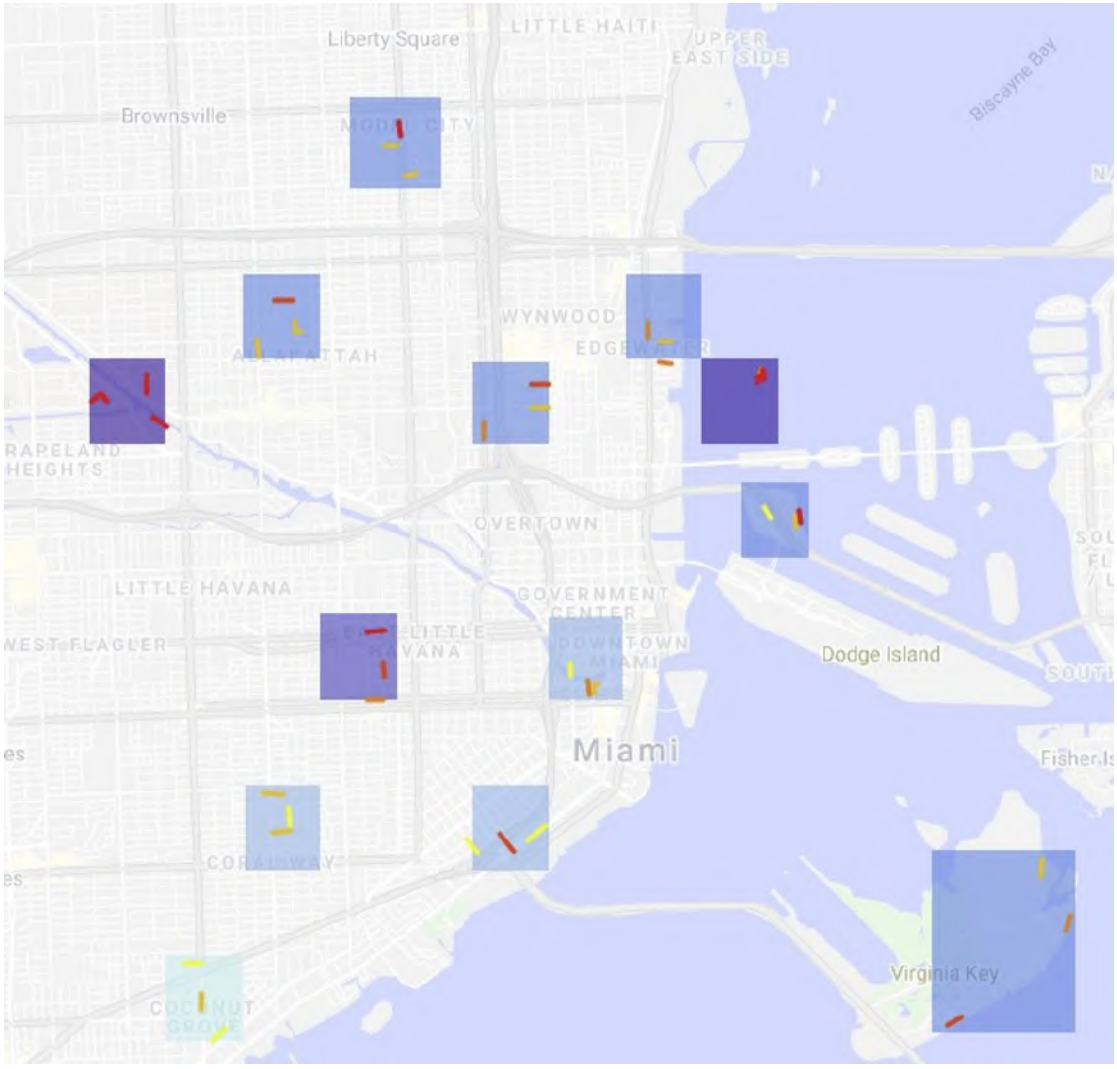

Table 8: All parent companies and locations for top convenience items in Miami

Country	Parent Company	Product	Product Count
China	Shenzhen Hanqingda Technology Co Ltd	Tobacco	1
Costa Rica	BGL Bermudez Group Ltd.	Chips	1
Greece	Tottis-Bingo	Candy	1
Italy	Perfetti Van Melle	Candy	1
Jamaica	GraceKennedy Limited	Chips	1
Mexico	Grupo Bimbo	Chips	3
Nicaragua	Kola Shaler Industrial	Beverage	1
	Vilchez Trinco	Chips	1
Switzerland	Nestle	Candy	8
USA	Nestle	Beverage	2
	PepsiCo	Chips	4
	PepsiCo	Beverage	3
	Mars Inc	Candy	6
	Mondelez	Candy	6
	Barberi International	Chips	5
	Coca Cola Company	Beverage	3
	Hershey Company	Candy	3

Country	Parent Company	Product	Product Count
USA	ITG Brands	Tobacco	3
	Altria Group, Inc.	Tobacco	2
	Bemar Snacks Inc.	Chips	2
	Harvest Hill Beverage Company	Beverage	2
	La Bayamesa Corp.	Candy	2
	Lam's Foods Inc	Chips	2
	Mexilink Incorporated	Chips	2
	Amazon.com	Beverage	1
	Beyu Foods	Chips	1
	Brooklyn Bottling Co	Chips	1
	Churritos Camagueyanos Corp.	Chips	1
	Conagra Brands	Chips	1
	EDT USA Corporation	Beverage	1
	El Faro Bakery	Candy	1
	FC Snacks Inc	Chips	1
	Grabba Leaf LLC	Tobacco	1
	Grupo Bimbo	Chips	1

Country	Parent Company	Product	Product Count
USA	Hato Potrero Inc	Beverage	1
	Kellogg's	Chips	1
	Keurig Dr Pepper	Beverage	1
	Mesa Meat Processors Corp.	Chips	1
	Miky's Marketing Inc	Candy	1
	National Beverage Corp.	Beverage	1
	Polaris Trading Corp	Chips	1
	Reynolds American	Tobacco	1
	Snak-King Corp	Chips	1
	Tootsie Roll Industries	Candy	1
Venezuela	Galletas Puig	Candy	1

Table 9: All manufacturers and locations for top convenience items in Miami

Country	Manufacturer	Product	Product Count
China	Shenzhen Hanqingda Technology Co Ltd	Tobacco	1
Costa Rica	Alimentos Bermúdez	Chips	1
Dominican Republic	Imperial Brands	Tobacco	3
	Grabba Leaf	Tobacco	1
Ecuador	The Exotic Blends Co	Chips	1
El Salvador	Productos Alimenticios	Candy	1
	Productos Alimenticios	Chips	1
Greece	Tottis-Bingo	Candy	1
Guatemala	Alimentos Maravia	Beverage	1
Honduras	Corporacion Dinant	Chips	1
Jamaica	GraceKennedy Limited	Chips	1
Mexico	Mondelez Mexico	Candy	5
Nicaragua	Kola Shaler Industrial	Beverage	1
	Vilchez Trinco	Chips	1
USA	Mars Wrigley Confectionery	Candy	6
	Barberi International	Chips	5
	Barcel USA	Chips	4

Country	Manufacturer	Product	Product Count
USA	Frito-Lay Inc	Chips	4
	Hershey Company	Candy	3
	American Beverage Corp	Beverage	2
	Bemar Snacks Inc.	Chips	2
	Glaceau	Beverage	2
	La Bayamesa Corp.	Candy	2
	Lam's Foods Inc	Chips	2
	Philip Morris USA	Tobacco	2
	Tootsie Roll Industries	Candy	2
	Beyu Foods	Chips	1
	Churritos Camagueyanos Corp.	Chips	1
	Coca Cola Florida	Beverage	1
	Conagra Brands	Chips	1
	El Faro Bakery	Candy	1
	Hato Potrero Inc	Beverage	1
	Iberia Foods Corp	Chips	1
	Mesa Meat Processors Corp.	Chips	1

Country	Manufacturer	Product	Product Count
USA	Miky's Marketing Inc	Candy	1
	Naked Juice Co	Beverage	1
	Nestle USA	Beverage	1
	PepsiCo	Beverage	1
	Perfetti Van Melle USA	Candy	1
	Polaris Trading Corp	Chips	1
	Pringles Manufacturing Co	Chips	1
	Santa Fe Natural Tobacco Company	Tobacco	1
	Snak-King Corp	Chips	1
	Snapple Beverage Corp	Beverage	1
	Sundance Beverage Co	Beverage	1
	The Gatorade Co	Beverage	1
	Whole Foods Market	Beverage	1
	Zephyrhills	Beverage	1
Venezuela	Nestle Venezuela	Candy	8
	Galletas Puig	Candy	1

Table 10: Full List of MDT Litter Items and Associated Material Categories

Material	Items
C&D Materials	Aggregate & Brick Bolts, Nails, and Screws Building Materials Lumber Other C&D
Cloth	Clothing Fabric Pieces Other Cloth
E-Waste	Batteries E-Waste Fragments Other E-Waste
Fishing Gear	Buoys and Floats Fishing Line Other Fishing Gear Plastic Net or Net Pieces Plastic Rope
Glass	Glass Bottle Glass or Ceramic Fragments Other Glass
Metal	Aluminum Foil Aluminum or Tin Cans Metal Bottle Caps or Tabs Metal Fragments Other Metal
Organic Waste	Food Waste Other Organic Waste
Other	Other Popsicle Stick
Other Plastic Products	Bulk Bags Flip Flops Other Plastic Plastic String, Tape, or Packing Straps Rubber Bands Tires

Material	Items
Paper	Coated Paperboard Corrugated Cardboard Multi-material Paper Box Noncoated Paper Food Wrapper Other Paper Paper Receipts
Personal Care Products	Blister Pack Cotton Buds Other Personal Care Product Personal Care Product Sachet Shampoo or Other HDPE Container Toothbrushes Toothpaste or Other Product Tube
Plastic Food Products	Foam or Plastic Cups or Lids Other Food-Related Plastic Other Plastic Bag Plastic Bottle Plastic Bottle Cap Plastic Food Wrapper Plastic Grocery Bag Plastic Utensils Straws Street Food Bowl Styrofoam Container
Plastic Fragments	Film Fragments Foam Fragments Hard Plastic Fragments Other Fragments
PPE	Associated PPE packaging Disinfectant Wipes Disposable Gloves Face mask packaging Face Masks Face Shield Hair nets Hospital shoe covers Other PPE

Material	Items
Tobacco Products	Cigarette Packaging Cigarettes Other Tobacco Product Tobacco Sachets

END OF DOCUMENT