Circularity Assessment

Florida Keys, Florida

CIRCULARITY INFORMATICS LAB, UNIVERSITY OF GEORGIA

JAMBECK RESEARCH GROUP

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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 Ocean Conservancy

www.circularityinformatics.org

Athens, GA, December 2022

Executive Summary

Developed by the Circularity Informatics Lab (CIL) 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 September 2022, a team from CIL conducted CAP fieldwork in the Florida Keys, with support from the Ocean Conservancy (OC) as well as local government and other stakeholders. 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	Among 196 convenience items sampled, 94% had manufacturing locations within the US, and 5% had manufacturing locations within the state of Florida. On average, beverage and chip products sampled had manufacturers and parent companies that were closer to the Keys than did common candy products, some within 115km. ● It would be worth the FL Keys exploring a bottle deposit scheme ● Engage local parent companies and manufacturers on redesign of delivery systems and product packaging ● Promote local brands (“shop local”) as much as possible, providing incentives where possible for consumers and businesses
COMMUNITY	Interviews with 17 local stakeholder groups demonstrated key challenges around recycling, tourism, and political will in the Keys. Many interviewees saw these main issues as interconnected and mutually reinforcing. ● There is a need for more open communication from government and waste haulers to residents on end points of recycling could restore trust in the system and encourage better recycling practices ● CAP data could be useful to local groups advocating for legislation, interventions, and systemic changes to plastic use and management in the Keys ● There is a need for local government and businesses to move forward/get clarity on next steps for Bag Ban in FL ● Build upon programs like Net Your Problem and other local enterprises that are using marine debris opportunities to inform product redesign options ● Work with Blue Star operators to enforce the prohibition of SUP on their boats and vehicles, and ensure they are connected with available grants and resources ● Consider engaging with the school districts on reduction of SUP used in schools (e.g., lunch trays and utensils, etc.). ● More education and outreach could prove to be beneficial (starting with schools and clubs that are energized about this topic, particularly the Ocean Guardian School Program) ● Engage short term vacation rentals as to provide educational materials and recycling directly to tourists
PRODUCT DESIGN	97% of all 190 convenience items samples were packaged in some form of single-use plastic, predominantly PET and multilayer plastic. Among 64 to-go products sampled from 17 food vendors and restaurants, PP was the most common material, followed by PET at 18%, followed by EPS at 10%. Around 12% of to-go items sampled were made from organic or compostable/biodegradable material.

	● Multilayer plastic should be targeted for reuse and alternative materials in the convenience item sector ● PP and EPS should be targeted for reuse or alternative materials in the food sector ● Local government and businesses should focus on reduction or matching infrastructure with compostable or biodegradable materials that many are transitioning towards ● Refill options and/or messaging should be available at grocery stores (particularly those often used by short-term renters)
USE	Reusable, compostable, and plastic-alternative products were on more expensive than single-use plastic items available at common convenience and grocery stores, particularly reusable cups. While some incentives exist for reuse and refill options, interviewees noted that there was a disparity in use between residents and visitors. ● Financial benefits of alternatives need to be effectively communicated to local businesses ● Explore implementing a system for refillable glass bottles, potentially piloted with local breweries, liquor stores, grocery stores etc. ● Build upon success with the straw ban in the City of Key West and replicate for other problematic items ● Develop clear incentives for reusable/refillable items and/or disincentives for using single-use plastic items ● Engage short term vacation rentals to provide educational materials on reuse directly to tourists
COLLECTION	While 100% of the Keys has access to curbside garbage and recycling collection, not all residents participate. The transient nature of the population in the Keys makes waste quantities inconsistent and puts stress on the collection system. Hauling is franchised between four private companies under Monroe County. Per capita waste generation for the county is ~3x more than the national average for the US. ● Recycling messages need to be more effectively targeted towards and communicated to visitors/tourists in the region ● Explore capacity needs that could support required recycling for businesses in particular ● Stricter and better communicated guidelines are needed for waste and recycling disposal for short-term rentals ● Clearer and more widespread messaging/marketing for residents around call-in waste collection ● Explore city or county support for a recycling co-op system ● "Oops" tags on waste and recycling bins that are improperly filled or contaminated could help reduce recycling contamination
END OF CYCLE	All trash and recycling must be hauled up to 150 miles out of the Keys and to landfills, recycling centers, or Waste to Energy plants on the mainland. Contamination and volatile markets hamper recycling

	efficiencies in the Keys. According to FDEP data, 45% of MSW managed in Monroe County was landfilled, 42% was recycled (which includes C&D waste), and 13% was combusted in 2021. Challenges exist with staff retention, space, and infrastructure (e.g. sourcing trucks and carts). ● Waste reduction should be prioritized for interventions and funding ● Innovation is needed for glass recycling and fishing gear disposal ● Explore the *Key West Forward* recommendation on anaerobic digester for food waste, starting in Key West ● Recommendations from Key West Forward that are still relevant: ● *Key West Forward* recommendation to develop trainings and resources for landscapers, electricians, contractors and plumbers on proper waste disposal and recycling practices ● *Key West Forward* recommendation to include in all business leases from the cities a requirement to manage waste and recycling properly ● *Key West Forward* recommendation to improve coordination and communication between the city of Key West and Waste Management
LEAKAGE	Of the 2,252 litter items documented in the Keys, the most common material type was plastic fragments (32% of litter), followed by tobacco products (22%), and glass (10%). Differences existed in the litter characterizations between regions of the Keys and between ambient population densities or levels of society activity. ● Expand enforcement of the cigarette ban on beaches in Monroe County ● Implement education and policy around tying down loose items on recreational boats ● Litter prevention and capture on land represents an opportunity for reduction ● *Key West Forward* recommendation for Keep Key West Beautiful/Adopt a Spot volunteer leader ● *Key West Forward* recommendation for “Love Your Island” Targeted PR Campaign

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Glossary of Acronyms & Abbreviations

CAP	Circularity Assessment Protocol
CE	Circular Economy
CIL	Circularity Informatics Lab
C&D	Construction and Demolition Material
EPS	Expanded Polystyrene
FDEP	Florida Department of Environmental Protection
FL Keys or Keys	The Florida Keys
HDPE	High Density Polyethylene
GDP	Gross Domestic Product
MPs	Microplastics
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NMI	New Materials Institute
OC	Ocean Conservancy
PE	Polyethylene
PET	Polyethylene terephthalate
PP	Polypropylene
PPE	Personal Protective Equipment
PS	Polystyrene
rPET	Recycled Polyethylene terephthalate
RRF	Resources Recovery Facility
RRLF	Resources Recovery Landfill
SWM	Solid Waste Management
UGA	University of Georgia

Introduction

With its iconic marine environment and unique confluence of stakeholder groups, including tourism, the fishing industry, shipping, cruises, as well as a wide range of environmental research groups and community activists, the Florida Keys presents an opportunity to better understand both land-based and ocean-based sources of plastic pollution, to investigate impacts on critical environments, and to work with the local community to craft the most impactful interventions.

The chain of islands that comprise the Keys includes a 220 mile stretch from Virginia Key to the Dry Tortugas that separates the Atlantic Ocean and the Gulf of Mexico (Britannica, 2023). The resident population was estimated at around 83,000 in 2021 and the area welcomes millions of tourists every year (FDEP, 2023). Key West alone received over 2 million visitors in 2018, and in 2022 tourism numbers started returning to or exceeding previous monthly records since the COVID-19 pandemic (Rockport Analytics, 2019; Key West Travel Guide, 2022).

There is a strong foundation for waste management services in the Keys, including door-to-door collection for waste and widespread recycling. Haulers in the area range from large corporations to small, family-owned businesses, but all have been operating locally for years and are well integrated into the community. Although recycling services are widely available, they are not mandatory in all areas, and recycling rates are lower than the 75% goal set for the state. In 2008, Florida was the first US state to pre-empt plastic bans, passing a bill mandating that no city, municipality, or county shall restrict or ban the use of plastic shopping bags, although current policies are hotly contested. The Keys face waste management challenges common to other island contexts, including lack of land for collecting, sorting, and processing, requirements to haul waste long distances for management, and a need to move towards waste diversion and reduction to support long-term sustainability.

The 2020 Florida Marine Debris Reduction Plan as well as current initiatives of Monroe County Solid Waste Management and the City of Key West Utilities Department set precedents for addressing the issue of solid waste in the Florida Keys. The Marine Debris Working Group, developed by the Florida Keys National Sanctuary Advisory Council, and other active local groups such as the Blue Star dive operators and Project AWARE are also heavily engaged on the issue of plastic pollution and marine debris. Along with the Caribbean, Florida is recognized as its own region within the NOAA Marine Debris Program. The momentum that has been generated among the communities in the Keys through the Goal: Clean Seas Florida Keys (GCS) Program and their cleanup efforts also provides a strong basis to take this work a step further and inform upstream solutions.

The Circularity Informatics Lab at the University of Georgia has developed a Circularity Assessment Protocol (CAP), 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 stakeholders in the FL Keys. Background information and a literature review were conducted in May - August, 2022. Fieldwork was conducted in September 2022. 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 for each section.

CAP has already been conducted in Miami, FL as part of a partnership between CIL, Ocean Conservancy, and the City of Miami, and this work serves as a continuation of understanding the inputs and outputs of plastic waste in southern Florida. The Keys represent the unique intersection of a thriving tourism industry and the iconic marine environments of Florida, and plastic pollution is augmented by and threatens both. This work helps to set a baseline for plastic waste and marine debris in the Florida Keys, from which the impact of upcoming interventions can be measured.

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 the FL Keys. As a follow-up to this report…[can we say anything here about OC and Oceans First Initiative taking this work forward?]

Sampling Strategy

In order to randomly sample various locations in a geographic jurisdiction (e.g., a city), the CAP typically identifies a 10 x 10 km area over the city (with the center of the city in the center of the area). In this area, the ambient population over a 24 hour period is sectioned into tertiles (three groups). Ambient population count can be described as "where people go" and "societal activity", in contrast to residential population density typical of census data. These three areas typically form samples of different land uses, income stratifications, etc. In the case of the FL Keys, due to the size and shape of the region and the distinct communities across, the decision was made to sample a 100 km^2 representative area in the Upper, Middle, and Lower Keys respectively (Figure 1). These areas included Key Largo, Marathon, and Key West (Figure 2).

Within each of those survey areas, three 1x1 km^2 squares were randomly selected - one in each of the three population tertiles - where fieldwork would take place (Figure 1). All areas with zero ambient population within the Keys were removed from consideration for random sample selection before the population tertiles were developed, due to concerns about accessing those areas from land.

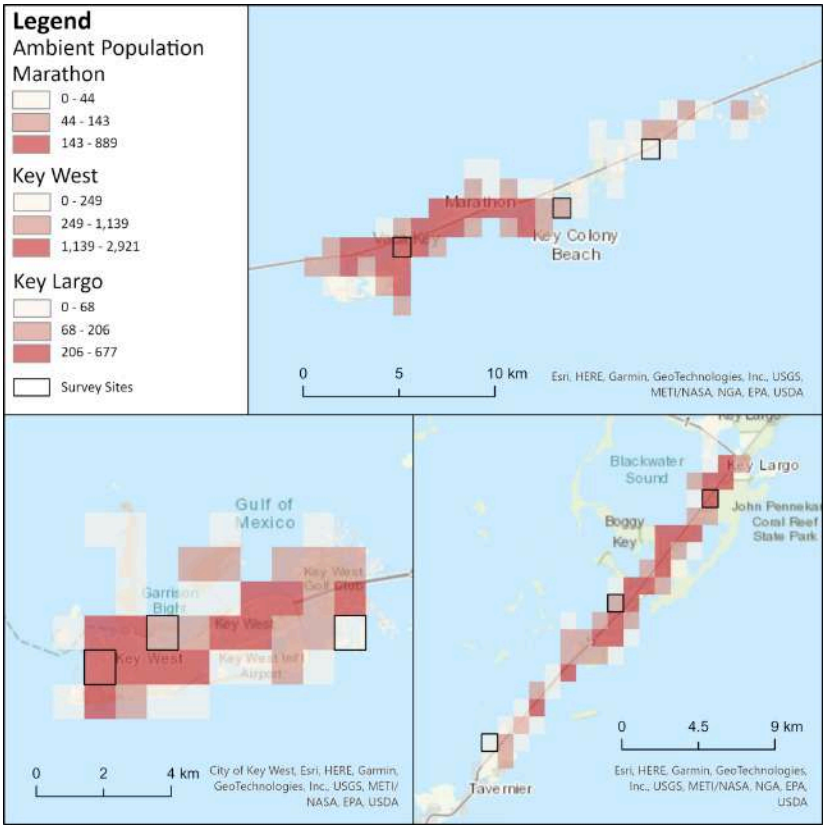

Figure 1: Sampling Sites and Landscan data for the Florida Keys

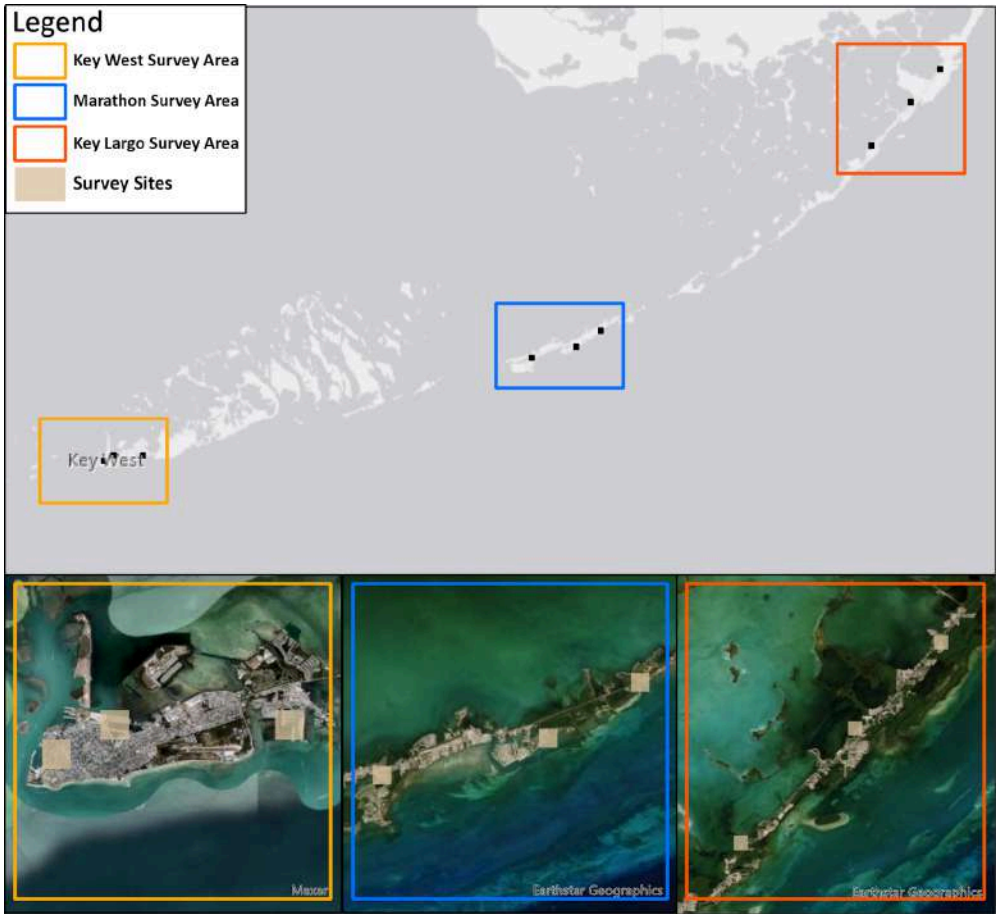

Figure 2: Satellite imagery of Florida Keys sampling sites

CAP Findings

Input

To get a snapshot of the characterization, scope, and source of common plastic packaged items that are entering the FL Keys, samples of common convenience items in four popular categories were taken within nine 1km^2 transects, three each in Key Largo, Marathon, and Key West across various ambient population counts. The team selected three convenience or grocery shops to sample within each 1km^2 transect area, where possible. In total, 196 convenience products were collected and sampled. Samples of identical brands were not collected multiple times, even when present in multiple stores.

For each of the top products documented, the team noted the type of packaging (including polymer, if possible), the brand, and the parent company or distributor. 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).

Among common consumer products sampled, 94% had manufacturing locations within the US, and 5% had manufacturing locations within the state of Florida (Figures 3 and 4). A smaller proportion (80%) of products sampled had parent companies located within the US, and an even smaller amount (3%) had parent companies in Florida. On average, beverage and chip products sampled had manufacturers and parent companies that were closer to the Keys than did common candy products (Table 1). The closest beverage and chip parent company and manufacturing locations were within 115km of their points of sale within the Keys.

Table 1: Distances to manufacturers and parent companies for common convenience items

	Length Store to Parent Company (km)			Length Store to Manufacturer (km)		
	Minimum	Maximum	Average	Minimum	Maximum	Average
Candy	611	11,359	5,020	611	25,366	3,368
Chips	113	3,903	2,419	113	5,842	2,302
Beverage	114	9,848	2,972	114	8,894	2,784

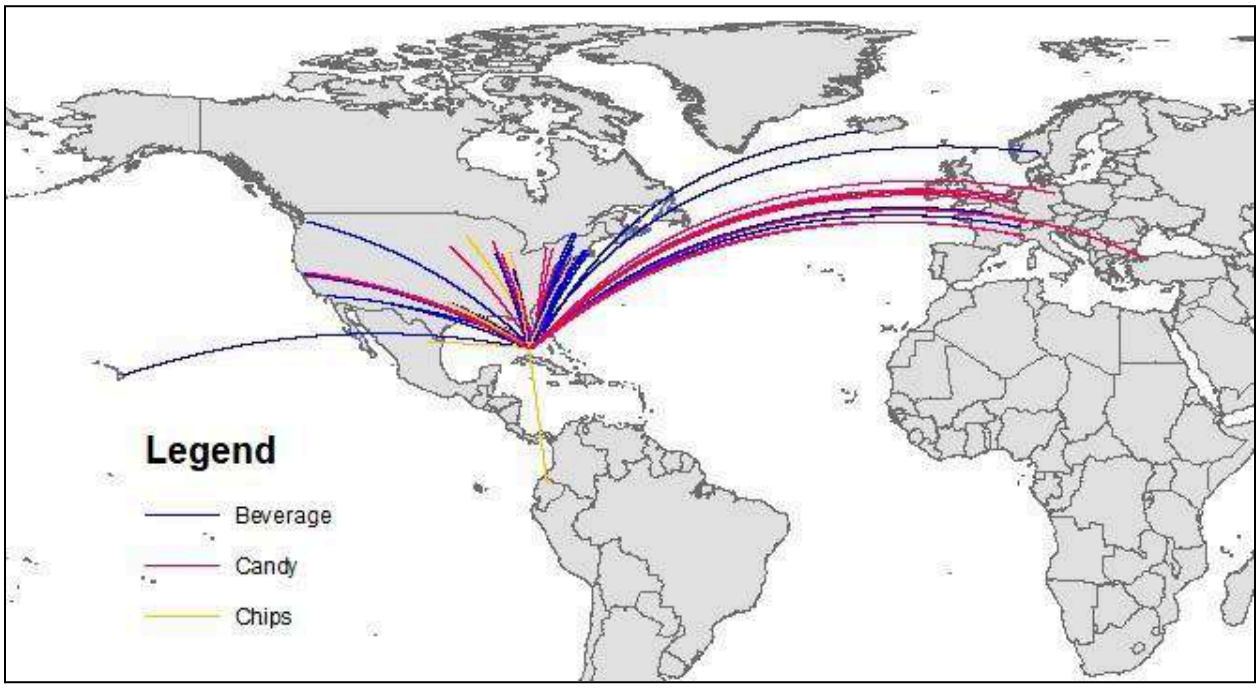

Figure 3: World map of parent company locations for convenience products

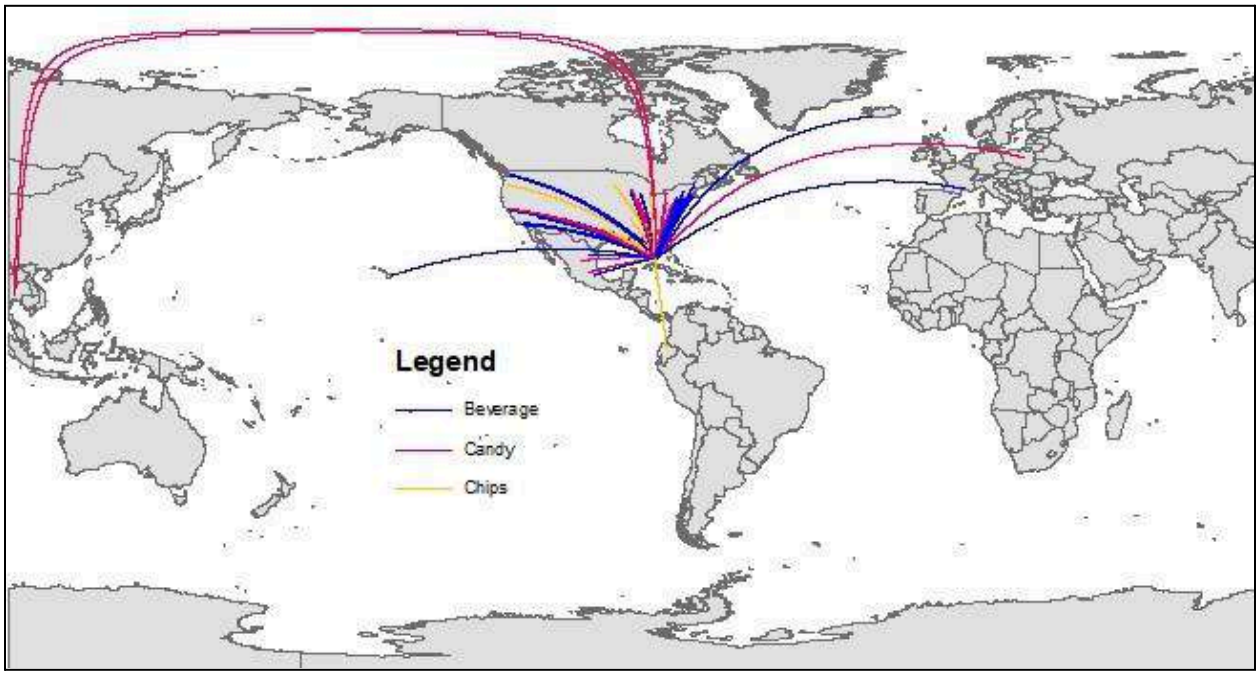

Figure 4: World map of manufacturer locations for convenience products

Parent companies representing the largest fraction of beverage brands surveyed included Coca-Cola (21% of samples), Pepsico (17% of samples), and Keurig Dr. Pepper (14% of samples). Among candy products sampled, the top three most common parent companies were The Hershey Company (25%), The Ferrero Group (19%), and Mars Inc (13%). The most common parent company found among chip products sampled was Pepsico (35%), and all other chip brands were found in less than 8% of samples. Top brands of each category, based on a visual assessment of shelf space in a store, conversations with shopkeepers, and repeated occurrence across stores, included the following:

- Beverages: Pepsi, Coca Cola, Mountain Dew, Fanta, Arizona, Nesquick, Gatorade, Zephyrhills, Monster
- Candy: Hersheys, Reeses, Snickers, M&Ms, Trolli, Push Pop, Kinder
- Chips:Doritos, Cheetos, Lays, Fritos, Uncle Rays, Pringles, Combos
- Tobacco: Marlboro, 305, American Spirit, Newport, Winston, Pall Mall, Seneca, Backwoods, Swisher Sweets

The highest diversity of parent companies were found in beverage products available in the area (34 brands), followed by candy products (24 brands), and lastly chip products (16 brands). Similar patterns were observed among manufacturers for convenience items sampled. A full list of parent companies and manufacturers from sampled convenience products can be found in the Appendix.

Community

To understand current attitudes and perceptions of plastic waste, semi-structured interviews were conducted with 17 key stakeholders (Table 2). Among those interviewed, 7 were from NGOs, 3 were from the local government, 2 were from local businesses, 2 were from private waste companies, and 3 were from sustainability specialists (e.g. sustainability strategy consultants).

Table 2: Stakeholder Groups and Number of Interviews

Stakeholder Group	Interview Count
NGO	7
Government	3
Local Business	2
Private Waste Company	2
Sustainability Specialists	3

The most common problems mentioned by interviewees included challenges surrounding recycling, impacts of tourism, and lack of political will at the state level. Many interviewees saw these main issues as interconnected and mutually reinforcing. Additional challenges that were mentioned include the geographic limitations of being part of an island community (e.g. needing to transport waste and recycling long distances for processing), perceptions about the cleanliness of drinking water, high tipping fees for waste, and infrastructure and manpower.

When asked about the effectiveness of local recycling, almost every interviewee felt that recycling had room for improvement. Some interviewees attributed the “recycling problem” to the awareness and participation levels of individuals, while one local business interviewee felt that recycling was a priority for some of their customers.

Examples of interviewees who attributed the “recycling problem” to individuals’ awareness and participation:

“There’s a perception that all collected recycling gets trashed anyway. Everyone has bins and separates recycling, but there is a ‘why bother’ mentality.” (Local Business)

“Everyone does know there is a ‘trash problem’ but they don’t do anything about it.” (Local Business)

Example of an interviewee who felt that awareness and participation were mixed:

"I would say recycling is a priority for some of the guests, but not all of them. You can tell who is more caring about recycling and environmental stuff by the ones that double check where the recycling is, etc." (Local Business)

Other interviewees felt that the "recycling problem" had to do with other factors, including cost, time, contamination, and a lack of participation from businesses:

"Lots of people feel reluctant to make recycling mandatory for businesses - because it's costly -- the perception is that it's more expensive to recycle, there isn't enough space, and there is no time. We have more bars per capita than any city in Florida. They don't have time to take the lemon out of the cup and recycle it." (Sustainability Specialist)

"If you're going to recycle, recycle right, or don't recycle at all…I wish more residents knew that." (Private Waste Company)

"The recycling is always contaminated -- there's a perception that 'only 30% actually gets recycled' - some of this is due to ignorance and some is because people just don't care." (Local Business)

Interviewees noted tourism as a stress point that exacerbated existing challenges with waste collection and management infrastructure. Examples of this sentiment are shown below:

"When people come down here for vacation the last thing they're thinking of is 'how do I recycle' - they don't want structure and rules." (Government Official)

"If you look at tourists' shopping carts, one whole cart will be bottled water. They are going to the beach and on boats and won't bring their own refillable bottle." (Government Official)

"Vacationers don't recycle, plus they are super transient." (Private Waste Company)

Politics were a common theme brought up by interviewees, with some of them attributing difficulty with enacting local policies and bans to being overridden by state-level political interests and concern with profit. For example, the state of Florida pre-empted any bans that may be proposed in the future on plastic bags.

"[Waste management?] is an issue of political will, not practicality." (Sustainability Specialist)

"The mayor had a huge desire to look at glass crushing. People were behind it and looked into technology for it, but there just wasn't enough political will and it fell through." (Sustainability Specialist)

"The will isn't there and there is so much resistance to change." (Local Business)

"Bans get preempted in Tallahassee -- it's all about capitalism." (NGO)

"Lots of places here have no concept of 'waste.' Especially grocery stores. It's all about profit, less about environmental consciousness" (NGO)

Interviewees tended to view education as an area for growth. Some interviewees viewed education and awareness as difficult, specifically citing tourism as a factor that has complicated existing education efforts:

"We had a flier campaign, but it was short-lived. We would have to do outreach like this every 2-3 months because it's such a transient population." (Government Official)

"5,000 of the 14,000 residents in the Keys are vacation homes. With a huge amount of short-term rentals in the Keys, it's a hard group to educate" (Private Waste Company)

Regardless of the obstacles with education mentioned by some interviewees, many remain optimistic and hopeful about community education and engagement. Ideas for education initiatives included suggestions that education must start early, be community specific, reject "blame" narratives, and be visual and creative.

"We need to start education early. We have the Recycle Right program in preschools. We have had teachers reach out to the SWM department to talk to students, but we want to incorporate that at the county level." (Government Official)

"Even though it's very transient and visitor-oriented, really the Keys are a series of small towns, and the people that live there are small town people in a very good way - they care about their communities and they aren't always huge fans of outsiders. Educating and bringing awareness needs to happen in a way that resonates and makes sense to a community, especially one that is low income or high diversity. You can't just say 'this needs to change' when they have limited means and limited options." (NGO)

"Communities need knowledge that is not pointing fingers and passing blame." (Government Official)

"How do you reach people with messages of connectivity with human impacts on the environment? Needs to be visual - needs to be connected to what people care about, needs to connect to something that they can actually do." (NGO)

"In terms of circularity in the Keys, it's very important to 1) make sure everyone understands and has trust in the recycling system and 2) get businesses on the sustainability train. Many people in south Florida have lost faith in our ability to recycle for different reasons, but educating the public through creative ways would go a long way." (Sustainability Specialist)

Aside from education, interviewees emphasized that changes would be most effective if centered around reuse and around affordability, profit, and financial incentives. Several local

enterprises also exist, such as Net Your Problem, which are attempting to collect and repurpose discarded fishing gear and other common types of waste, and couple those efforts with community outreach and engagement around solutions.

"Convenient and affordable solutions need to exist for this to be feasible." (Government Official)

"Small businesses can still be reached. There's an opportunity to change the mindset there, they can be more flexible. Even if it's small changes (e.g. straw bans) it's important for people to see that it's possible and profitable." (NGO)

"The community is open to change, but it needs to be easy and accessible. Someone needs to figure out money and availability - people will pay more but not much." (Government Official)

"We need financial incentives for businesses - tax breaks, willingness to pay surveys, etc., and a certification/list of environmentally friendly companies…Economic incentives would work really well in the Keys." (NGO)

"Pre-COVID, businesses were transitioning to more reusables and eco-friendly materials. But, like many businesses, during the pandemic, they switched back to using plastics. So, getting them to switch back and realize the cost savings is very important." (Sustainability Specialist)

While recycling, tourism, and political will were factors that interviewees mentioned complicated waste management efforts in the Florida Keys, interviewees had no shortage of ideas on what type of change they believe would be beneficial. Interviewees noted that education and outreach initiatives are necessary to the type of change they would like to see. They also shared that focusing on reuse while also promoting financial benefits and incentives would help bolster efforts to improve materials management.

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 nine 1km^2 transect areas, as well as within 1km of the surrounding area if none were present inside the sample site. 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 or ml)
Beverage	29	37.12	557.86
Candy	75	3.29	57.56

Chips	86	4.99	80.95

For convenience items, beverage products had the highest average packaging weight, average product weight, and ratio of product to packaging by weight. Candy products had the lowest average packaging weight and product weight (Figure 5).

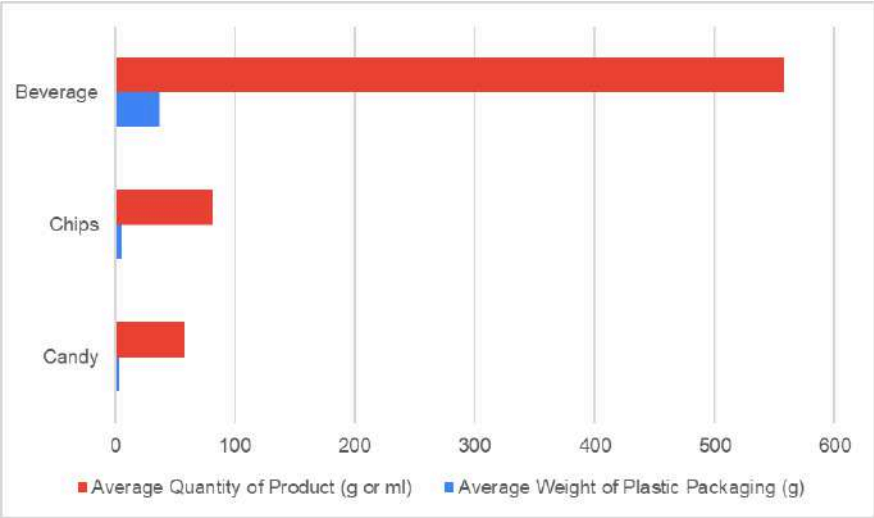

Figure 5: Average packaging and product weight for each convenience category

Among all 190 convenience products sampled, 45% were packaged in PET and 44% were packaged in multilayer plastic film. Each of the remaining material types - such as single-layer film, HDPE, PP, and multi material packaging - were seen in less than 4% of samples respectively. 97% of all convenience items sampled were packaged in some form of single-use plastic (Figure 6).

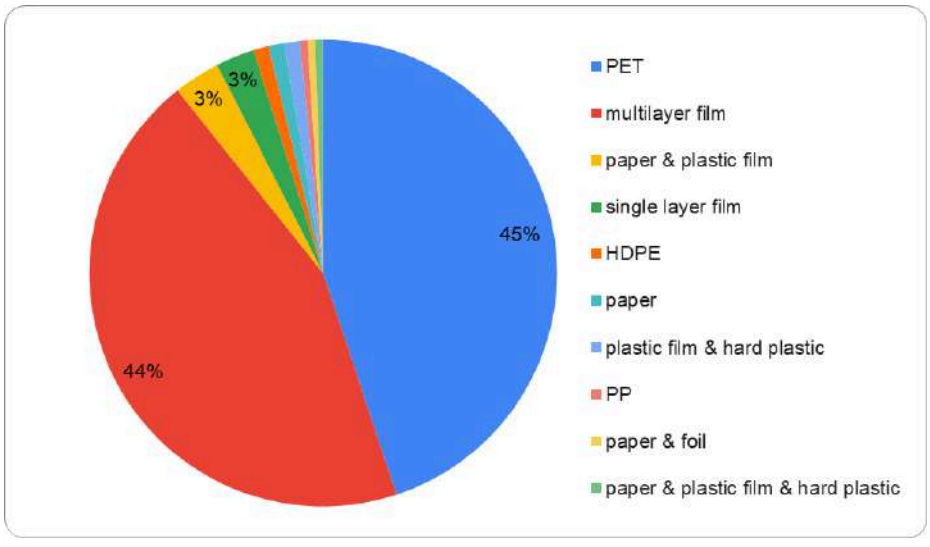

Figure 6: Material characterization of convenience items in the FL Keys

When observed by product, 96% of chip products and 67% of candy products were packaged in multilayer plastic film. Candy products had the highest diversity of packaging material types with 15 combinations surveyed, but 95% of all candy product packaging that was sampled contained some form of plastic. The majority (97%) of beverages sampled were packaged in PET, and 1% of beverages were packaged in rPET, PET, and HDPE respectively. 85% of all beverages sampled contained multiple polymers in their packaging - for example, a PET bottle, a PP cap, and a single-layer plastic film label (Figure 7).

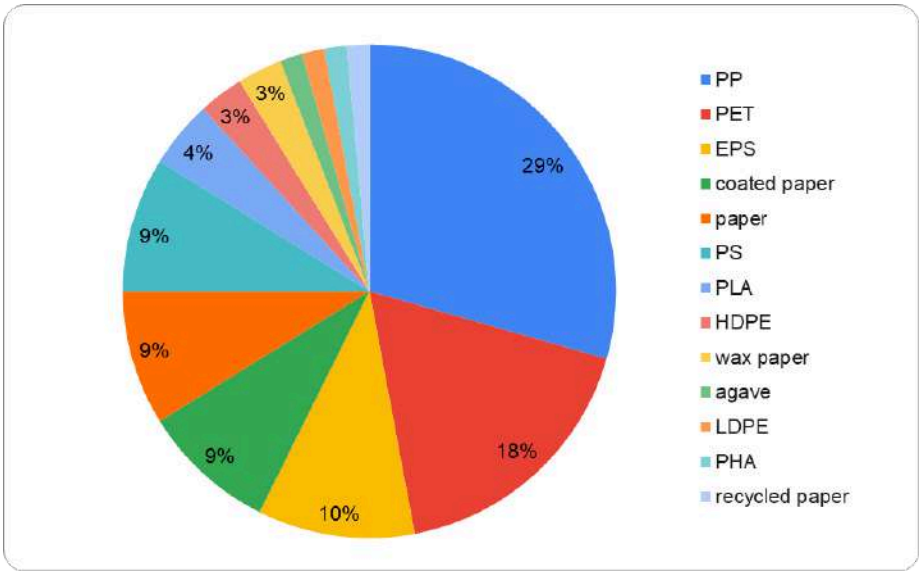

Figure 7: Material characterization of to-go items in FL Keys

The largest proportion of material observed among the 64 to-go products sampled from 17 food vendors and restaurants was PP (29% of samples). The second most common was PET at 18%, followed by EPS at 10%. Around 12% of to-go items sampled were made from organic or compostable/biodegradable material, such as paper or agave. Fairly similar results were found from the CAP conducted in Miami, FL, where around 10% of to-go items were categorized as “compostable” plastic products, 11% were paper, and 1% were wood. PET was the most common material type found among cup lids, sauce containers, and cups (though cups had an equally high percentage of coated paper). PP was the most common material among utensils and straws, and EPS was the most common material among food containers (Table 4). It was also reported that many schools in the Keys serve school lunches with EPS food containers and/or trays and plastic utensils wrapped in plastic.

Table 4: Characterization of to-go items sampled

Item Type	# Samples	Material Characterization
Cups	17	29% PET, 29% coated paper, 12% PP, 12% PS, 6% EPS, 6% paper, 6% PLA

Cup Lids	12	33% PET, 30% PS, 17% PP, 8% LDPE, 8% PLA
Food Containers	14	43% EPS, 29% PP, 14% wax paper, 7% plastic-coated paper, 7% regular paper
Sauce Containers	2	100% PET
Straws	13	46% PP, 30% paper, 8% agave, 8% PHA, 8% PLA
Utensils	6	100% PP

Similar results were found from a survey done of the Key West shopping area in 2021 that was shared with CIL. Among the 6 food vendors sampled, all offered paper straws, but the vast majority also offered plastic cups and plastic bags. Around half of the vendors had biodegradable to-go containers available and the remainder used EPS containers. All vendors used single-use plastic utensils and plastic condiment containers. While all but one recycled the cardboard used for packaging in the back of the store, only one vendor had a recycling bin for patrons and only one recycled plastic bottles. Many cited difficulties around manpower and space for recycling and the high cost of single-use plastic alternatives.

Use

To understand patterns of use and reuse for plastic products in the FL Keys, alternatives to plastic and their respective prices were documented where available in the area. Similar products in plastic packaging were recorded at the most approximate convenience store or grocery store to the alternative product vendor (Table 5).

Table 5: Cost Comparison for Single-Use Plastic Alternatives

Category of Alternative	Packaging Designation	Cost Compared to Single-use Plastic Option (by unit cost)
Cup	Reusable	38x cost
Straw	Paper	4x cost
Cutlery	Compostable	1.1x cost
Cleaning wipes	Compostable	1.3x cost
Sponge	Reusable & Compostable	1.4x cost
Soap	Refillable	0.4x cost
Soap	Bulk	0.6x cost
Floss	Paper	1.5x cost
Handsoap	Refillable	0.9x cost

Bar Soap	Paper	3x cost
Laundry detergent	Paper	1.3x cost
Trash Bag	Biodegradable in Landfill	0.7x cost
Sandwich bags	Recyclable Paper	0.7x cost

Overall, reusable, compostable, and plastic-alternative products were several times more expensive than single-use plastic items available at common convenience and grocery stores. Reusable cups and products in paper packaging were among the highest in cost comparison. Some personal care and home products, such as hand soap and dish soap, were offered in concentrate or refill options at local grocery stores (Figure 8). Interestingly, some of the refillable and bulk soap products were less expensive than their single-use plastic alternatives (Table 5).

Figure 8: Examples of refillable and concentrated household products sold in grocery stores in the FL Keys (photo credit: CIL)

Surveys of bag usage and type were also conducted in stores and restaurants where data was collected for Product Design. 100% of to-go bags sampled were HDPE. This could be a reflection of the 2008 law passed in Florida that prevents local municipalities and cities from passing laws that ban or seek to limit the use of plastic bags and other single-use plastic or foam items. There was a grassroots effort in Monroe County that proposed a pilot temporary (2.5 year) bag ban for coastal communities with 100,000 residents or less, however it was never passed. The City of Key West has been able to circumvent the 2008 law to some extent with its Ordinance 26-312 that bans the distribution or sale of single-use plastic beverage straws or stirrers. This was observed to be well enforced within the city of Key West, where 25% of straws sampled from to-go vendors were single-use plastic compared to 50% of straws sampled in Key

Largo and 67% of straws sampled in Marathon. Straws were also not among the top five litter items found in any of the three locations or among the stratified population areas within each. The efforts are also supported by multiple community and local government campaigns such as #NoStrawChallenge and Skip The Straw (Figure 9 & Figure 10), however the alternative straws were almost always served with single-use plastic cups and lids.

Figure 9: #NoStrawChallenge messaging at food vendors in the FL Keys (photo credit: CIL)

Figure 10: Skip the Straw messaging from FDEP to support Key West City Code Ordinance 26-312

While it was observed that several restaurants and food vendors did offer reusable or refillable options, particularly for beverages, interviewees shared frustrations over the divide between the use of these resources by residents and tourists. There are few incentives for bringing your own food containers or bags, and visitors don't often travel to the Keys with their own reusable items. This coupled with the higher costs of reusable containers available at convenience and grocery stores seems to lead to less use of those items by tourists.

"Locals reuse cups and bags, but tourists don't. They buy everything and don't bring their own cups or totes on vacation." (Government Official)

"There need to be incentives for bringing your own bags, containers, takeout, etc." (NGO)

Interestingly, bringing your own reusable beverage container - also the most comparatively expensive alternative observed in grocery stores - was one example where incentives were fairly readily observed, typically in the form of a free or discounted drink (Figure 11).

Figure 11: Example of incentives for reusables from food vendors in the FL Keys (photo credit: CIL)

Several interviewees felt strongly that the importance of reuse and reduction were messages that were needed and may also be effective in a place like the Keys.

"We need to get people to understand the importance of reuse, not just substitution." (NGO)

"We have to get people to reduce - it's not all about recycling - instead of using paper plates because we're a society of convenience. Use a regular plate and wash it." (Government Official)

This notion is also outlined in several policies, strategic plans, and reports that exist for Florida, Monroe County, and specific cities in the Keys. The '*Key West Forward*' Strategic Plan for 2021-2024 (Elisa Levy Consulting, 2021) mentions goals to reduce waste including renegotiating a new solid waste management contract, mandatory commercial recycling of aluminum and cardboard for businesses, and a pilot 'Pay as You Throw Program' to make recycling easier and more accessible for multi-family residences. While the 2020 Florida Marine Debris Reduction Plan has sections on derelict vessels, fishing gear, and natural disasters, it also includes a section on community actions including mechanisms to inform decision-making and improve environmental management related to reduction (NOAA, 2020). City-specific bans and outreach campaigns that have primarily focused on particular items, such as #SkipTheStraw and associated regulations (e.g. Ordinance 26-312), have reportedly been effective in reducing the use of single-use plastic items in some settings in the Keys. However, these tend to lead to substitutions for other material types (such as paper or PLA straws) instead of elimination or reduction of the item overall, and do not expand more broadly to associated problematic plastic items (such as plastic cups). As the '*Key West Forward*' plan outlines, enforcement of existing resolutions 19-22 and 19-174 to ban plastic straws and polystyrene products from City events and property is also a critical piece needed for success (Elisa Levy Consulting, 2021). That said, it may be a beneficial strategy to focus on specific

items or areas of use that have traction among user groups in the Keys - residents, fishermen, visitors, etc. - and use those successes as a platform to build upon for future policies.

Collection

Waste management in the Florida Keys is done through a franchised system and there are four haulers responsible for collection in distinct areas (Figure 12). Waste Management is responsible for curbside collection between Stock Island and 7 Mile Bridge, Marathon Garbage Services from 7 Mile Bridge to Mile Marker 72.5, Advanced Disposal in Islamorada, and Keys Sanitary Services from Mile Marker 91 to the County Line (Monroe County, 2023). Beyond collection, Waste Management also holds the haul-out contract for all of the Florida Keys. These franchise contracts are held between the haulers and the county through the Monroe County Solid Waste Management Department and include household collection as well as call-ahead bulk pickup (though there is an additional fee for pickup of bulky or extra large items).

Figure 12: Waste Management Operators in the Florida Keys (from Monroe County 2023)

There are three transfer stations in the Keys that are owned by the county (Figure 12) and one on Rockland Key that is owned by the City of Key West. Cudjoe Key Transfer Station accepts C&D, garbage, metal, recycling, yard waste and has a capacity of 350 tons per day. Long Key Transfer Station accepts construction and demolition (C&D) debris, municipal solid waste, waste oil, biosolids, sludge, tires, white goods and bulky waste, and yard waste. Key Largo Transfer

Station accepts C&D, municipal solid waste, sludge, tires, wood, white goods and bulky waste, and yard waste. A waste characterization conducted in 2012 at the transfer station that services Key West found 40.5% compostables, 17% paper products, 13.5% containers, and an overall total of 71% items that were considered recyclable fiber/containers and compostables (Figure 13).

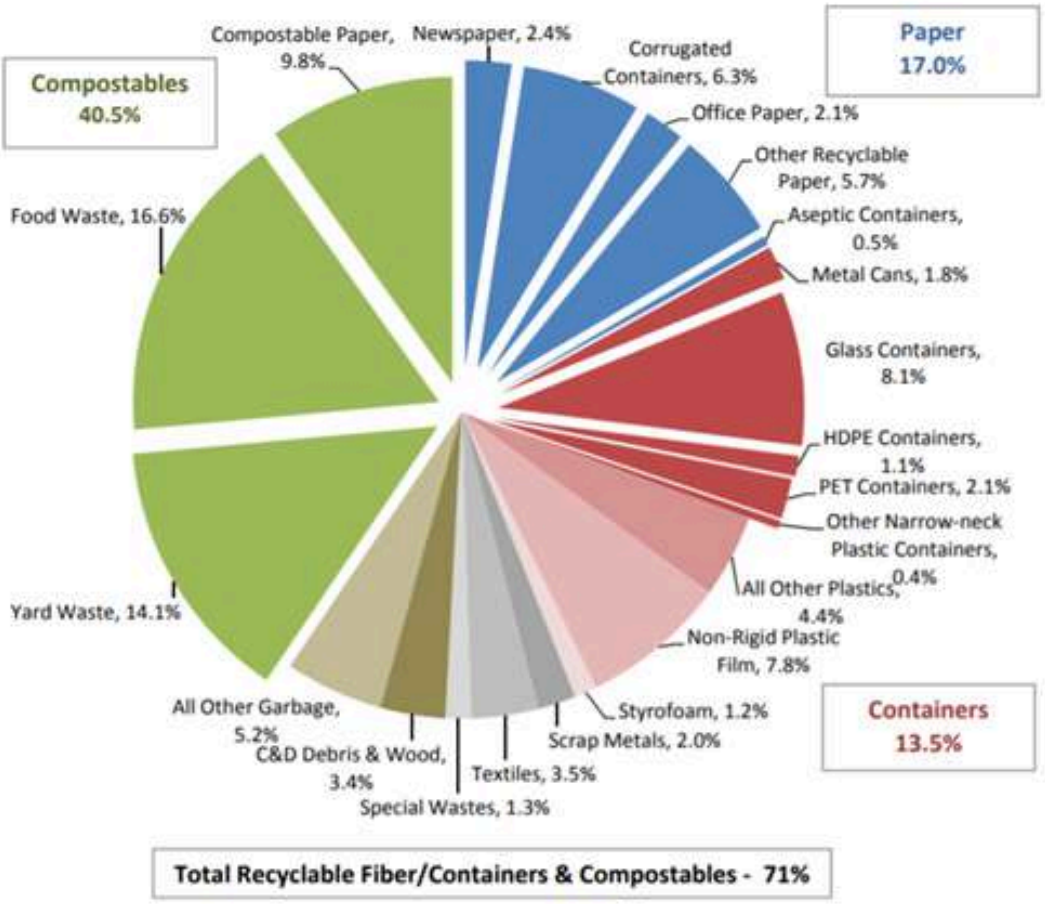

Figure 13: Characterization of waste for the City of Key West (from Kessler Consulting, Inc., 2012)

According to data from the Florida Department of Environmental protection (FDEP), 287,738 tons of MSW was collected in Monroe County in 2021 (2022 data was not available at the time of this report writing), ranking it as the 31st highest county (out of 67) in the state for waste collection. FDEP also estimated waste generation rates for Monroe County of 3.45 tons/year/capita, or 18.9 lbs/day/capita. This average is much higher than the US average of 4.9-6 lb/day/capita of MSW, which may be a result of increased waste generation from visitors to the area. At the time of CAP fieldwork (September 2022), Monroe County reported that year-to-date collection was 69,559 tons of garbage, 7,412 tons of recycling (9.6% of total MSW (garbage+recycling)), 25,465 tons of yard waste, and 10 tons of hazardous waste. One waste hauler interviewed estimated that they collect on average 120-140 tons/day of garbage, 18 tons/day of recycling (13%), and 18 tons/day of yard waste.

Resident fees for waste collection are set by the county and included in county annual taxes. These were reportedly $413 in 2022 and were raised to $446 in 2023. These taxes are paid by single-family homes as well as multi-family homes and are based on the property ordinance (e.g. if there are two kitchens in the home, the tax is charged for two units). Apartments and condos are also assessed and each unit is charged separately. Many residential buildings also include a clause whereby they can obtain a collective dumpster that the hauler maintains for a set fee.

The county sets the CPI rates on what haulers are allowed to charge commercial businesses, but it is reportedly often cheaper for commercial businesses to recycle than to put things in the garbage. For example, a one-yard dumpster with 1x/week pickup for garbage at the time of this report was around $100, compared to $50-60 for recycling. However the lack of ease and convenience seems to outweigh any financial benefits. For businesses in Key West, it is mandatory to have a Waste Management account for trash hauling, but it is not mandatory to include recycling unless the building is on city property. Particularly in Key West, there is limited space for dumpsters, and dumpsters are often kept in alleys that are difficult to access. Hotels in the Keys are also not required to recycle, though some still chose to do so. Labor shortages also contribute to lack of commercial recycling as staff time is needed to separate out recyclables (e.g., several key interviewees mentioned that bar and restaurant staff have difficulty removing limes from plastic cups and beer bottles, especially at peak hours, and it's therefore easier to put those items in the trash).

The shortage of labor and staff are felt among the hauling companies as well. One interviewee cited that there are around 300 people working at the recycling plant that services the Keys, and the plant operates 24 hours a day 7 days a week. As has been felt across the county, supply chain backups are also putting a strain on already stressed waste collection operations in terms of updating equipment. Waste collection in the Keys faces further challenges characteristic of island chains, where there is limited space and waste must be transported long distances to be processed.

“We are still waiting on the garbage truck that we ordered in June 2021. We’re now looking at getting it next year. We usually order a new truck every year, now we are 2 years behind. All trucks are about 10 years old, and we change out for a new one every year.” (Private Waste Company)

“The [company’s] manager and treasurer and her fiancé had to drive and operate the garbage collection truck one day. It is hard to get and retain staff.” (Private Waste Company)

“The Keys have the typical challenges of island communities - not a lot of space for aggregation, and transportation is super difficult.” (NGO)

All of the Keys has 2x/week garbage pickup, 1x/week recycling pickup, and 1x/week yard waste pickup. Resident participation is reportedly around 80% overall for MSW collection, though

much lower among the over 5,000 residences (over one third of the total) in the Keys that are vacation homes. It's not unusual in the Keys to have many people living in one house, as vacation homes can be over capacity and seasonal workers will often room together, which puts additional stress on the waste collection system as the limits for push cart and bin capacity per household are often exceeded and rules for disposal are not always followed. In the City of Key West, Waste Management services garbage and recycling containers in public areas, servicing those in high-traffic areas during peak tourism twice a day.

Recycling in the FL Keys is single-stream and includes glass (3 colors), cardboard, aluminum, and all numbers of plastics with guidance provided to participants in the program (Figure 14). According to FDEP, in 2021 100% of single-family homes, multil-family homes, and commercial units in Monroe County had access to recycling services, but only 65% of single-family homes, 58% of multi-family homes, and 43% of commercial units participated in those services.

Figure 14: Recycling guidance from the Monroe County website

All of the collected recycling is transported up to 150 miles from the transfer stations to Reuters Recycling MRF in Broward County. The city and county set the waste management rates, it was noted that more of the recycling market change cost burden is felt on the collection companies than the residents. There is reportedly a strong market for plastics #1 and #2 (resin codes) currently, but not for numbers 4 through 7 resin codes. Plastic bags are not accepted, and as an alternative recycling option there are collection bins at some local grocery stores such as Publix (Figure 15). It was reported in interviews that the MRF that services the FL Keys has to stop its machines every four hours to remove plastic bags that are getting caught in the machinery. Waste Management also recycles scrap metal, e-waste, and hazardous waste drop-off at transfer stations once a month. Recycling contamination is reportedly around 24%, and one company noted that they predominantly use rear-load trucks which are manually loaded, so the haulers can see if bins are contaminated. If contamination is observed, they will leave an “oops”

sticker and not pick up the bin. The sentiment is that the contamination rate is much lower than if they used an automated system because of this auditing.

Figure 15: Public waste bins outside of a grocery store in the FL Keys (photo credit: CIL)

Requirements around recycling across the Keys also vary, to some extent. For the City of Key West, for example, residential properties and any buildings on city property are required to recycle, but this is reportedly not actively enforced. For businesses in other areas of the Keys, recycling is not required or enforced. Poster and flier campaigns have been run by the county to build awareness among residents on what can and cannot be recycled, but they have been difficult to maintain because of the transient nature of the population. The '*Key West Forward*' strategic plan recommends requiring recycling of aluminum and cardboard for all businesses in Key West through a "Green Business" certification process (Elisa Levy Consulting, 2021), which could potentially be expanded to plastic if implemented and successful.

"On an island that pays a lot to transport recycling, it's not mandatory for businesses to recycle, and we don't monitor what is recycled." (Sustainability Specialist)

Illegal dumping was cited as a challenge across the Keys for a wide range of waste, including but not limited to household, C&D, yard waste, and furniture (particularly during rental changeovers). It was noted that the tipping fee for residents and businesses ($123.50/ton) to drop off waste or recycling at the transfer station may disincentivize proper management because of the cost. While bulk waste pickup is included in waste collection and available to all residents (although pickup must be scheduled), one hauler noted that they had 350 pickups in one month and they may try to set a limit. However, this service does not always get used (potentially people are not aware of the service or it is inconvenient to schedule), and so open dumping of bulk waste is still an issue. The local code office will also send photos to hauling companies or place "call WM" stickers on trash piles or bulk items that they come across.

"We have a tremendous problem with illegal dumping. There is a $123.50/ton tipping fee for residents/businesses that dump right to the transfer station - it is cheaper to dump in the mangroves or dead end streets." (Government Official)

The transient nature and residences for many areas of the Keys pose unique challenges to waste collection and management. It was mentioned repeatedly in stakeholder interviews that visitors to the Keys tend to load up on groceries and single-use items when they arrive and then reportedly overload trash bins and push carts and do not recycle. The stresses are also felt differently across the Keys in areas where there are longer-term rentals, such as Marathon, versus areas that are easily accessible from the mainland and where visitors typically have shorter stays, such as Key Largo. One interviewee called Marathon a “ticking time bomb,” referring to the fact that there is typically a 4-hour window in which the whole town turns over every week with renters, and in that time vacationers will often dump everything that they have in their fridge and cabinets directly in the trash or recycling. The main outreach for tourists around recycling protocol is through labeling on recycling bins, but many interviewees did not feel that this method was getting the information across effectively, especially considering that what may be deemed recyclable in the places where the visitors are from may not be the same for the Keys.

“Vacationers will fill their fridge when they arrive, then dump it all in the trash or all in the recycling when they leave.” (Private Waste Company)

“There’s a lack of motivation to recycle - everyone is on vacation, they follow rules from wherever they are from, or not at all.” (Private Waste Company)

There was a general sentiment of frustration from many stakeholders that were interviewed on lack of progress when it comes to sustainability, largely due to lack of staff, resources, and capacity - the government knows what needs to be done, but it's not happening:

“Everything in the [Key West Forward] strategic plan that should have been done by now is not done. For example, there is still a huge amount of trash that gets dumped into the ocean from liveaboards. We don’t have the manpower to follow recommendations like putting in new bins.” (Sustainability Specialist)

End of Cycle

Most of the processing of MSW collected in the Keys is done outside of the Keys area itself after leaving transfer stations (Figure 16). Each of the transfer stations in the Keys used to have a landfill facility, but all landfills in the Keys were closed by FDEP in the 1990s. The remnants of one landfill on Stock Island, officially closed in 1992 and maintained by the City of Key West Solid Waste Management department (City of Key West, 2023), is often referred to as “Mount Trashmore” by local media and community groups. A waste-to-energy facility was attempted to process the remaining landfill waste several years ago, but it did not generate much energy and only reduced the load by 40% over around 15 years of operation. It was noted that the waste

there had too much moisture and did not contain enough cardboard, which is the most combustible trash item.

Figure 16: City of Key West Transfer Station on Rockland Key (photo credit: CIL)

Municipal solid waste collected in the Keys gets hauled to either the Medley landfill in Miami-Dade County, owned by Waste Management, or to the Wheelabrator combustion with energy recovery facility in Broward County. Interviewees also mentioned that some waste from Key West goes to the Solid Waste Authority of West Palm Beach Renewable Energy Facility. Tipping fees are significantly lower at the landfill, but the hauler is required by contract to deliver a quantity of waste to the combustion with energy recovery facilities annually. All recycling from the Keys goes to the Reuters Recycling MRF in Broward County and WM is required to recycle according to their contract with the county. Recycling is also more expensive than landfilling for haulers, with tipping fees around $100/ton for recycling compared to around $40/ton to landfill, plus transportation costs. Additionally, recycling costs are market-driven so they may fluctuate and be unpredictable for budgeting. The MRF is scheduled for a reported $300 million renovation in the coming months which should overhaul equipment and increase efficiency. Yard waste in the Keys is reportedly sent to Barry Recycling for industrial composting and also to Brownie Interstate Recycling on mainland Florida. A composting program is being explored at the Navy Base in Key West, but the lack of land space presents a challenge. Waste Management is also considering a gas and motor oil dump station in the Keys in the coming years.

According to FDEP data, 45% of MSW managed in Monroe County was landfilled, 42% was recycled (which includes C&D waste), and 13% was combusted in 2021 (2022 data was not yet available at the time of report writing) (Figure 17). This represented a 12% increase in the average proportion of managed MSW landfilled and a 6% decrease in the average proportion of managed MSW recycled over the previous six years for the county. Per capita MSW disposal and recycling rates reached a peak in the Keys in 2017 and then steadily decreased through 2020. Disposal rates have increased since the low in 2020, but recycling rates have not rebounded (though it should be noted that recycling rates are still higher than the US national average of around 30%). It was emphasized in stakeholder interviews that China's National Sword policy from 2018 was felt very strongly among waste management and recycling

stakeholders in the Keys, likely because recycling was ultimately being exported out of port in Miami rather than locally or regionally processed, and it's clear that the industry is still recovering.

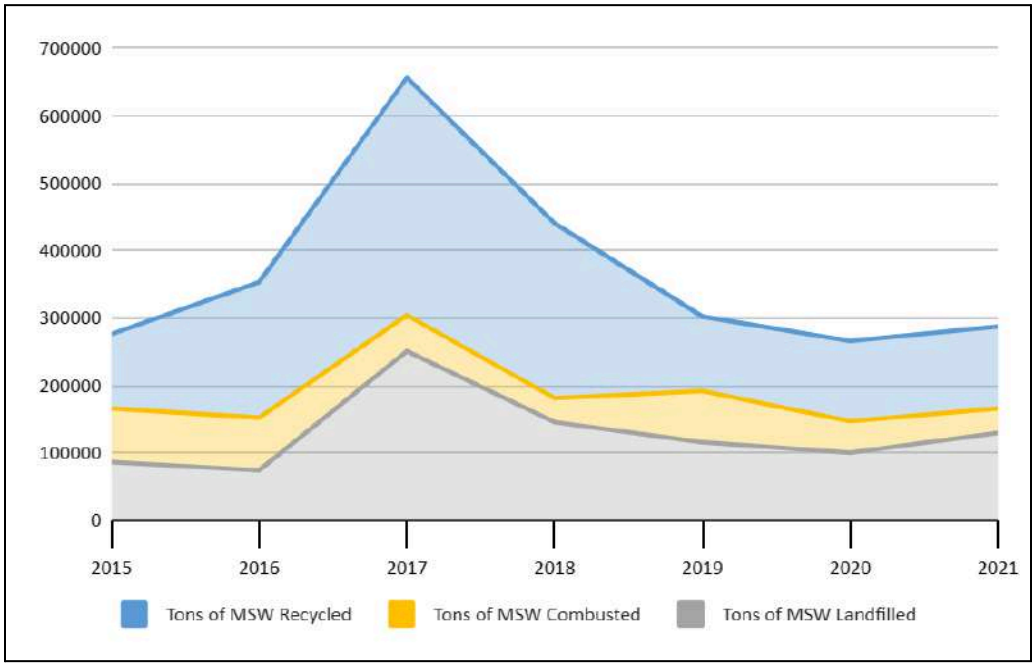

Figure 17: Fate of MSW in Monroe County 2015-2021 (FDEP)

Among the categories of waste that are collected for recycling in the Keys, the most readily recycled include aluminum cans, other paper, corrugated paper, yard waste, C&D debris, and ferrous metals. For all other categories, 30% or less are recycled. Plastic items are among the lowest, with plastic bottles at 4% recycled and other plastic at 23% recycled (Figure 18). C&D material is by far the most commonly collected recyclable material by weight - likely due to the heavy nature of those materials - around half of which ends up being recycled. This also accounts for the high reported MSW recycling rates for the county. Excluding C&D waste, the MSW recycling rate is closer to 7% for the county, based upon collection.

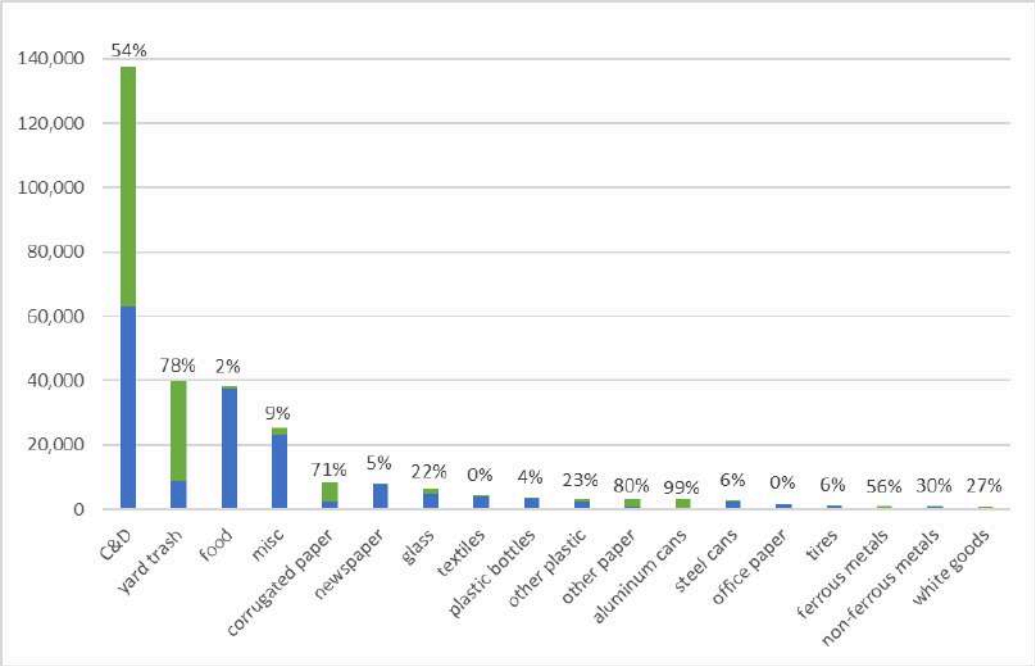

Figure 18: Categories of waste collected and proportion recycled (shown in green & in data labels) in Monroe County in 2021 (FL DEP)

Some interviewees expressed that they would like to see Florida taking more action upstream and giving value to commonly used products to ensure higher rates of recycling, particularly for readily recyclable items such as plastic bottles. This was largely in reaction to the Energy, Climate Change and Economic Security Act of 2008, whereby the Florida state legislature established a statewide weight-based recycling goal of 75% by 2020 (though the FDEP 2021 Solid Waste Management Analysis estimates that the recycling rate for MSW in Florida in 2021 was 41%).

"Florida has the 3 biggest bottling plants - Coke, Pepsi, and Anheuser Busch. We should have a deposit scheme, but instead the Governor set the 75% recycling goal." (Private Waste Company)

It was noted repeatedly in stakeholder interviews that the lack of space, the need for long-distance hauling of waste, and volatile end markets pose serious challenges to effective recycling in the Keys. In 2021, Monroe County reportedly spent over $700,000 on recycling haul-out for around 8,900 tons of waste. Particularly for heavier items like glass, which is abundant in the Keys, recycling is difficult and not cost-effective. One interviewee also mentioned lawsuits from tire companies where recycled glass had been incorporated into roads because the companies argued the glass in roads was decreasing the life of their products. The '*Key West Forward*' plan recommends exploring innovations that would incorporate recycled glass into city infrastructure (Elisa Levy Consulting, 2021), but this would also require long-term investment, space, and demand.

"Glass is a huge problem here. You have to haul it a long distance and it is very heavy. They can't get rid of it because Florida isn't industrialized -- it doesn't go into things like fiberglass -- we can use it for sand and asphalt, but we need land for processing, feedstock, and ultimately the end market." (Government Official)

In February 2022, Waste Management conducted a Waste Composition Study for 25 loads intended for recycling that were accepted at their transfer station in Rockland Key. The aggregated samples showed an average of 23.9% contamination, while the subset of samples from residential areas showed an average of 21.5% contamination (Figure 19). Among all samples, only two loads had contamination of more than 30%, but none had less than 18%. All sample composition was similar (within a couple percentage points) to the residential subset of samples. One private waste company interviewed cited that contamination in recycling ranges from items like garden hoses, to computer monitors, to plastic bags. Amazon envelopes were mentioned several times as a major source of contamination.

"For recycling, contamination is an issue. People are coming to visit from lots of different states and they all accept different items for recycling -- especially plastic bags." (Government Official)

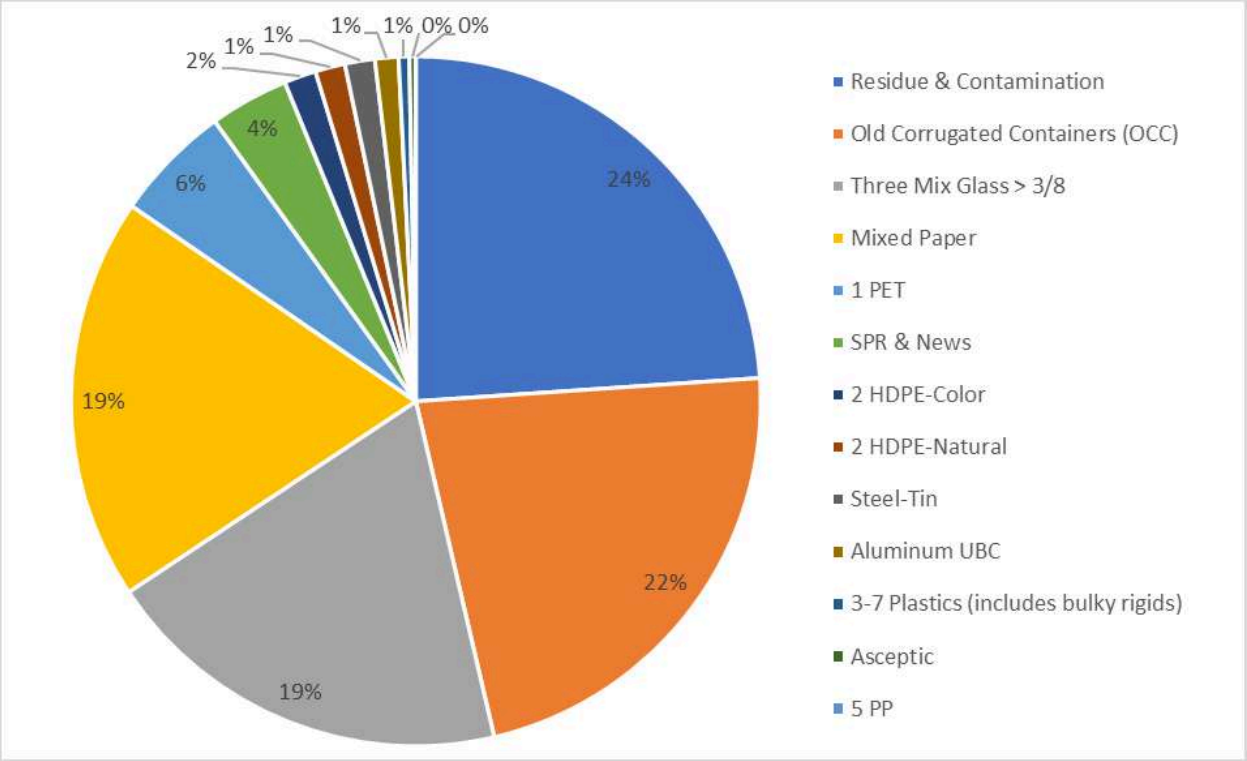

Figure 19: Data from 2022 Key West Waste Composition Study - Quarterly Comparison in Recyclable Commodity Percentages by Category from Samples

Solid Waste Management planning in the Keys is largely overseen by the Monroe County Solid Waste Department and the city-based offices for separate jurisdictions such as Key West. The City of Key West has a Solid Waste Master Plan that was developed in 2012 and includes a

series of recommendations for the Commission of Key West in the categories of policy, program, facility, and funding (Kessler Consulting, Inc., 2012). While many of the goals included are still relevant today, it might be worth revisiting the Master Plan and re-evaluating priorities and targets based on progress since 2012. The '*Key West Forward*' strategic plan also recommends exploring an anaerobic digester to transform food waste to energy in Key West (Elisa Levy Consulting, 2021).

Leakage

In total, 2,252 litter items were recorded across twenty seven 100m^2 transects in nine different square kilometer areas of the Keys sampled in September 2022, three square kilometers each in Key West, Marathon, and Key Largo. Transect locations were selected using a stratified random sampling method, in which transects were randomly selected across three groups (tertiles) of Landscan ambient population data (upper, middle, lower), after removing any areas with zero ambient population density due to concerns over access. 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.

The most common material type of litter found across the entire area sampled in the Keys was plastic fragments (32% of litter), followed by tobacco products (22%), and glass (10%). Other categories of litter material types represented less than 10% of the total litter composition sampled (Figure 20). The high amount of fragments could suggest that those plastic items had been in the environment and weathered to produce fragments over time.

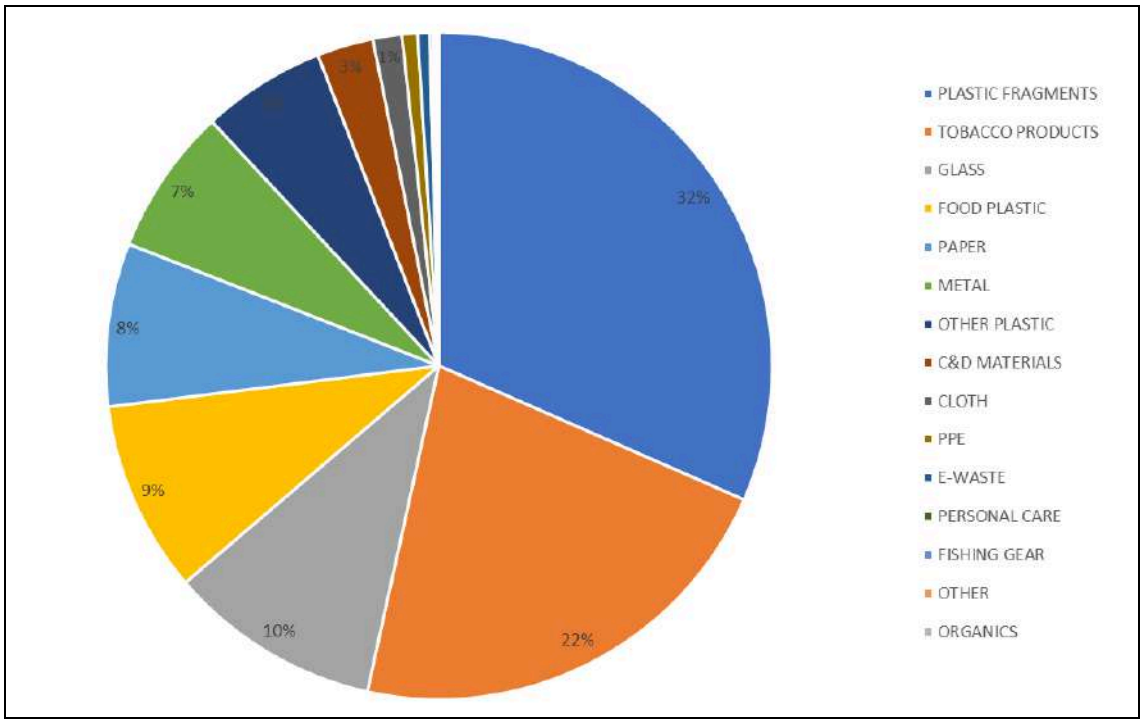

Figure 20: Material Characterization of All Litter Items for the FL Keys

When based on ambient population tertile (also representative of societal activity), plastic fragments were still the most common category for high and middle population areas, but glass was the most common in low population areas (Figure 21). Tobacco-associated litter is still relatively high across all population areas. Food plastic materials are notably higher proportionally in high and middle population areas when compared to averages across the entire Keys.

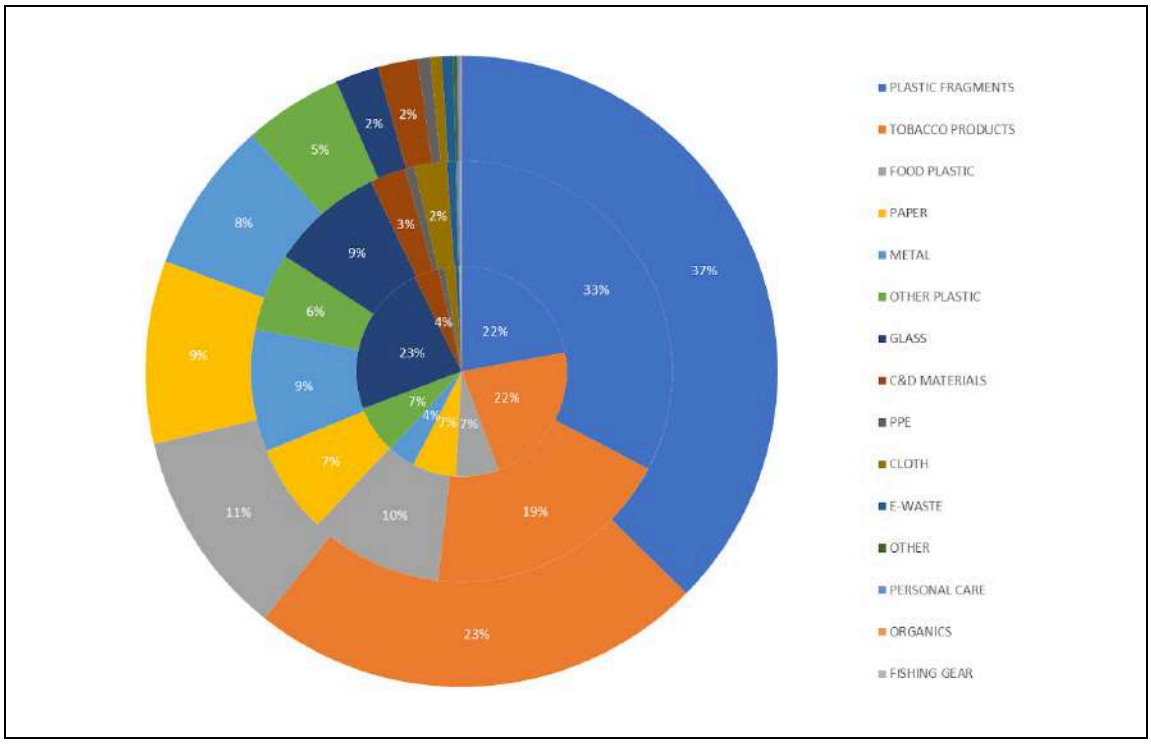

Figure 21: Proportion of most common plastic items in low (inner), mid (middle), and high (outer) population count areas (All 3 Islands)

Common litter items differed between population tertiles and between the three regions of the Keys sampled. Cigarettes, hard plastic fragments, film fragments, and paper were among the top five litter items in each tertile area and each region of the Keys. Cigarettes were the most common litter item when averaged for each of the three regions and were also the top item in five out of the nine individual litter transects. Monroe County banned cigarettes on beaches in 2022, citing human and environmental health concerns, and recently installed 70 cigarette disposal canisters as part of a beautification project. Glass and ceramic fragments were among the top items overall in both Key West and Marathon. Plastic string/tape/packing straps were among the top items overall only in Key Largo. Metal litter items such as bottle caps, tabs, bolts, and screws were only among the top items in the higher population area of Key West. The ubiquitous high abundance of fragments could suggest that those pieces of plastic have been in the environment for a time.

Table 6: Top Litter Items and Litter Density Across Population Areas of the Keys

Population Tertile (All FL Keys)	***Top 5 Litter Items***	***Litter Density (count/m^2)***
Upper	*1) Cigarettes, 2) Film Fragments, 3) Hard Plastic Fragments, 4) Paper, 5) Plastic Food Wrappers*	*1.54*

Middle	*1) Hard Plastic Fragments, 2) Cigarettes, 3) Glass or Ceramic Fragments, 4) Film Fragments, 5) Paper*	*0.89*
Lower	*1) Glass or Ceramic Fragments, 2) Cigarettes, 3) Hard Plastic Fragments, 4) Film Fragments, 5) Paper*	*1.06*

Litter density also varied slightly across the population tertiles and regions. When averaged across the Keys, the highest average litter density was observed in the higher ambient population areas, followed by the lower population areas, and the lowest litter density was observed in the middle population areas. In Key Largo and Marathon, the higher ambient population areas also had the highest litter densities (by a factor of 3 in Marathon, compared to the medium and low areas), but in Key West the highest litter densities were seen in the lower ambient population areas. The highest average litter density recorded was in the high population area of Marathon, at 3.11 items/m^2. Key Largo had the lowest average litter density across the three regions as well as the lowest litter density recorded at a transect, found at the middle population area at 0.52 items/m^2. The average litter density for Key West and Marathon were relatively close at 1.38 items/m^2 and 1.48 items/m^2, respectively (Table 7 and Figure 22).

Table 7: Top Litter Items and Litter Density Across Regions of the Keys

Area	***Population Tertile***	***Top 5 Items***	***Litter Density (count/m^2)***
Key Largo	*Overall*	*1) Cigarettes, 2) Hard Plastic Fragments, 3) Plastic String/ Tape/ or Packing Straps, 4) Film Fragments, 5) Paper*	*0.63*
	Upper (206-277)	*1) Cigarettes, 2) Plastic String/ Tape/ or Packing Straps, 3) Film Fragments, 4) Hard Plastic Fragments, 5) Paper*	*0.80*
	Middle (68-206)	*1) Hard Plastic Fragments, 2) Cigarettes, 3) Glass or Ceramic Fragments, 4) Plastic String/ Tape/ or Packing Straps, 5) Film Fragments*	*0.52*
	Lower (0-68)	*1) Cigarettes, 2) Hard Plastic Fragments, 3) Paper, 4) Film Fragments, 5) Other C&D*	*0.57*
Marathon	*Overall*	*1) Cigarettes, 2) Film Fragments 3) Hard Plastic Fragments, 4) Glass or Ceramic Fragments, 5) Paper*	*1.48*
	Upper (143-889)	*1) Film Fragments, 2) Cigarettes, 3) Hard Plastic Fragments, 4) Paper, 5) Plastic Food Wrapper*	*3.11*
	Middle (44-143)	*1) Cigarettes, 2) Hard Plastic Fragments, 3) Paper, 4) Film Fragments, 5) Plastic String/ Tape/ or Packing Straps*	*0.62*

	Lower (0-44)	*1) Glass or Ceramic Fragments, 2) Hard Plastic Fragments, 3) Film Fragments, 4) Cigarettes, 5) Plastic String/ Tape/ or Packing Straps*	*0.71*
Key West	*Overall*	*1) Cigarettes, 2) Hard Plastic Fragments, 3) Glass or Ceramic Fragments, 4) Film Fragments, 5) Paper*	*1.38*
	Upper (1139-2921)	*1) Cigarettes, 2) Metal Bottle Caps or Tabs, 3) Hard Plastic Fragments, 4) Bolts/ Nails/ & Screws, 5) Paper*	*0.71*
	Middle (249-1139)	*1) Hard Plastic Fragments, 2) Glass or Ceramic Fragments, 3) Cigarettes, 4) Film Fragments, 5) Paper*	*1.54*
	Lower (0-249)	*1) Cigarettes, 2) Glass or Ceramic Fragments, 3) Hard Plastic Fragments, 4) Film Fragments, 5) Plastic String/ Tape/ or Packing Straps*	*1.89*

Similar data has been found from NOAA Marine Debris Cleanups in the Florida Keys in recent years. A cleanup in Tavernier in 2018 removed 340 lbs of marine debris, 88% of which was plastic. In the land-based CAP litter transects, around 72% of all of the litter was plastic. The top five litter items found by the NOAA cleanups were hard plastic fragments, plastic rope/net pieces, plastic bottle or container caps, film plastic fragments, and plastic beverage bottles. A cleanup in Key West in late 2019 removed 100 lbs of marine debris, 53% of which was plastic, predominantly bottles and cans (glass, aluminum, and plastic) and plastic bottle caps. A cleanup at John Pennekamp State Park in Key Largo in 2018 removed 880 lbs of marine debris, 89% of which was plastic, and nearly 30% of which was hard plastic fragments. Top items from that cleanup also included plastic bottle or container caps, other plastic jugs/containers (including many oil containers), plastic beverage bottles, and film plastic fragments. A cleanup conducted at that same location in Key Largo three months later in 2019 removed 340 lbs of marine debris, 96% of which was plastic, and comprised the same top five most abundant litter items.

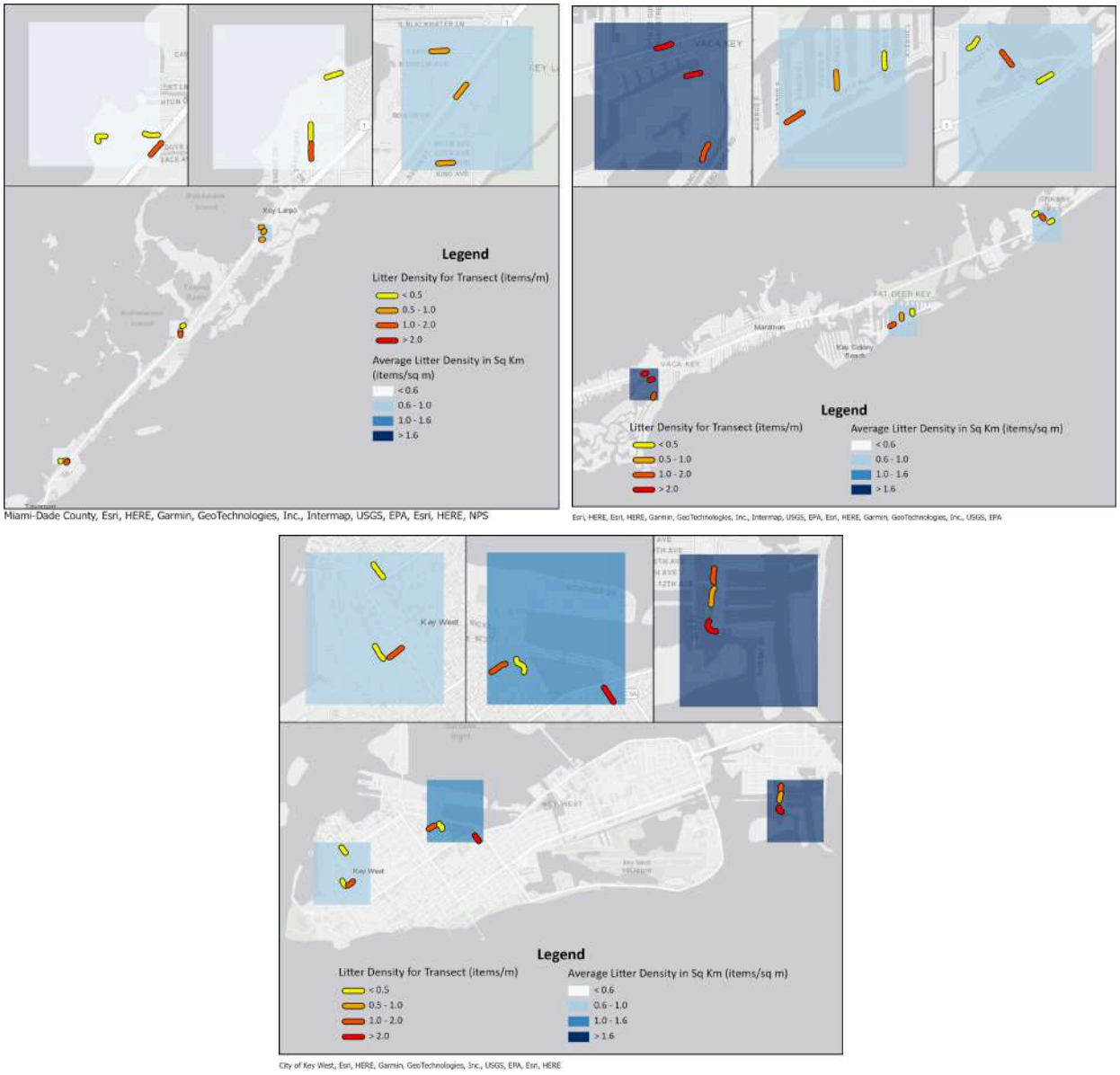

Figure 22: Litter densities for sampling areas and individual transects in the Keys

In addition to land-based surveys of litter, the CIL team conducted boat-based visual surveys in mangrove channels with support from the International SeaKeepers Society. All observable items were recorded. In total, 239 floating or suspended debris items were recorded during seven transects. Four surveys were conducted on the bay side; two surveys were conducted on the ocean side; and one survey was conducted in a residential canal connecting the bay and ocean (Figure 23).

Figure 23: Floating debris items observed in the Keys, including fishing buoy (top left), fishing line (top right), foam cooler (bottom left), plastic bag (bottom right)

On average, the ocean side had more floating debris than the bay side. Surveys conducted on the bay side typically observed 12.7 items/km, while surveys on the ocean side observed 107.9 items/km. Major categories of items found included plastic food packaging (35%), plastic fragments (23%), fishing gear like nets, and buoys (23%), and other plastic (16%), which primarily included debris from recreational activities, such as pool noodles and life jackets (Figure 24). Plastic fragments and food plastic were also significant categories of litter found in land-based surveys (Figure 19). Unsurprisingly, the fraction of fishing gear and recreational-related plastic was higher in the floating debris than on land, as much of these types of debris are generated on or near the water. However, the high fraction of plastic food packaging and plastic fragments in both land-based and floating debris surveys suggests that some litter items may be migrating from inland areas in the Keys to the bay and ocean. Several

stakeholders however felt strongly that the coastal and marine debris in the Keys was being transported there from other places, and not coming directly from the Keys themselves.

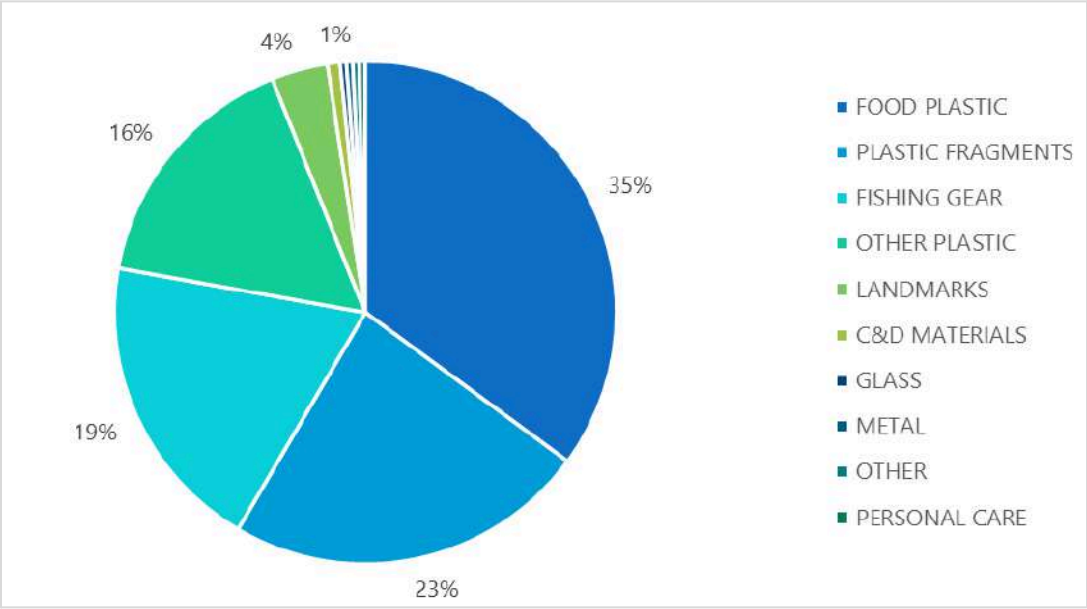

Figure 24: Material characterization of floating debris items logged during boat-based surveys

Both the bay side and ocean-side had high proportions of fishing gear, notably buoys (Figure 25). Interestingly, the ocean-side had a similar item characterization to those typically seen in land-based litter, with high proportions of plastic bottles, bottle caps, and plastic fragments. The largest proportion on the bay side was non-food packaging-related plastic (other plastic); these were typically recreation-related items like pool floats, life jackets, lawn chairs, and pieces of Styrofoam coolers. EPS, often used in such items, is especially problematic in the coastal environment of the Keys due to its rapid fragmentation.

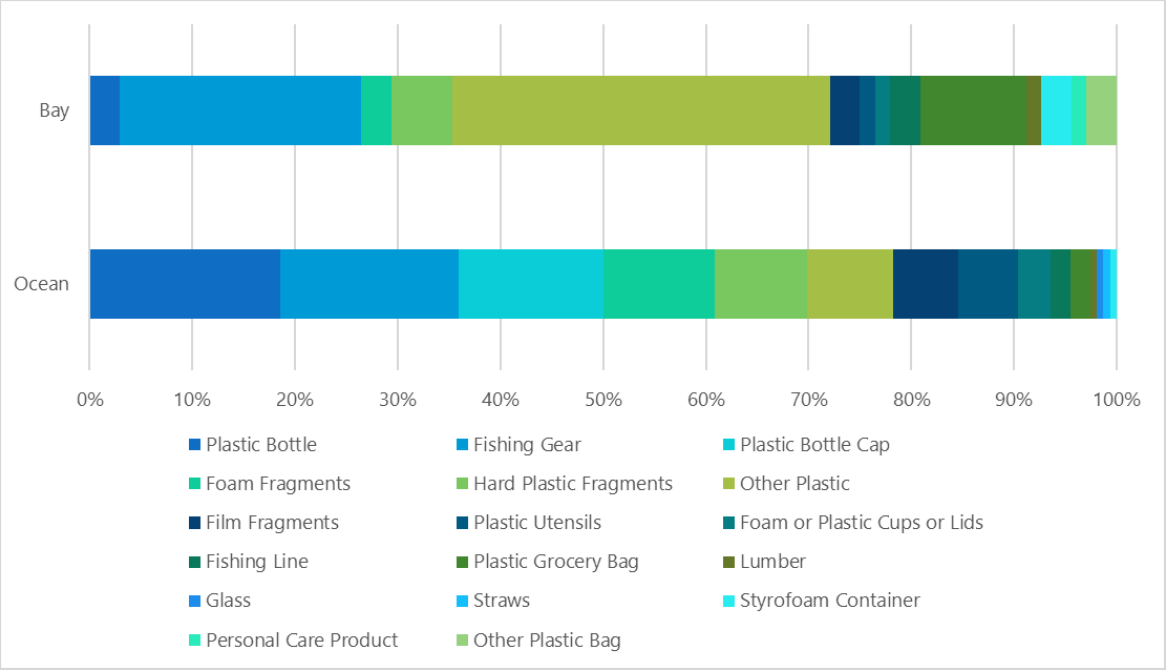

Figure 25: Proportion of litter items found on bay and ocean sides during boat-based surveys of floating debris

Material characterization varied transect to transect on both sides of Key Largo (Figure 26). Areas with high fractions of fishing gear, like Jewfish and Tavernier Creek, the northernmost and southernmost transects, might be appropriate targets for direct interventions like education efforts and/or cleanups. High fractions of plastic food packaging and plastic fragments throughout might be mitigated in-part by land-based efforts like reduction or last-chance capture.

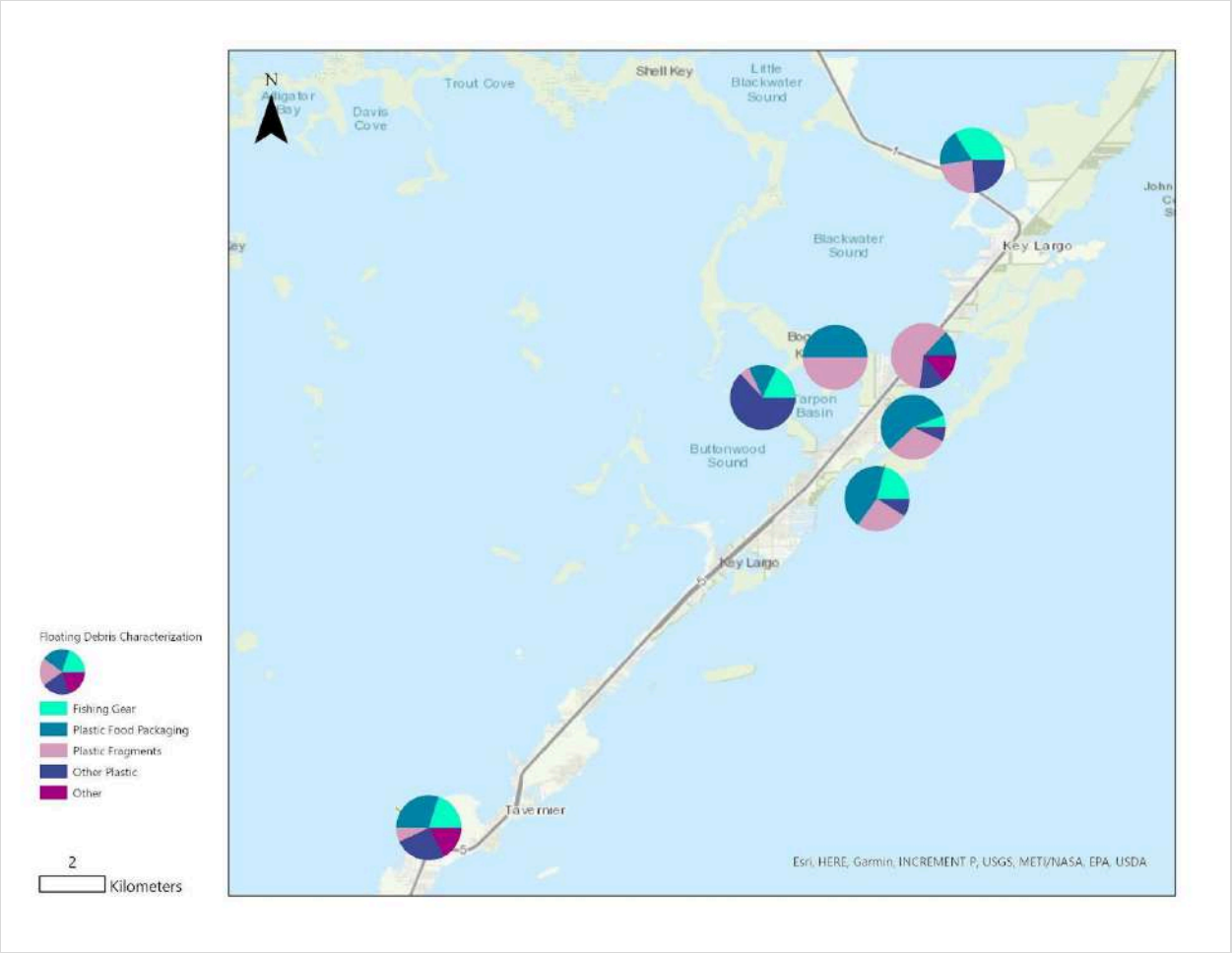

Figure 26: Material characterization of floating debris around Key Largo

Impacts on marine debris to the natural environment of the Florida Keys has been well-documented, particularly the impact of derelict fishing gear (Watson, 2012; (Miller et al., 2011; Chiappone et al., 2005; Chiaponne et al., 2002). Many residents interviewed noted that, during the COVID-19 lockdown in 2020 when the Keys were closed to visitors, they observed less litter and a healthier environment overall.

"The Keys shut out non-Monroe residents for 3 months during COVID, everything was re-sorted - we saw better water quality, less pollution, more wildlife." (Private Waste Company)

The Goal: Clean Seas Florida Keys program is a community-led initiative that aims to address the threat of marine debris to ecosystems in the Florida Keys National Marine Sanctuary. There are also many NGOs and grassroots organizations that conduct beach and coastal cleanups throughout the Keys, as well as several dive and tourism operators. It is clear from stakeholder interviews that marine debris in particular is a key concern for local businesses and residents, as the marine environment is critical to the local economy and is a part of everyday life. In 2019 alone, visitors to the Florida Keys National Marine Sanctuary for ocean recreation and tourism

spent a total of $1.7 billion, which translates to a contribution of 19,688 total jobs and $752 million in total labor income (Gazal et al., 2022). The efforts from Goal: Clean Seas Florida Keys and other groups in the area have energized local stakeholders and set a strong precedent to take this work a step further and inform upstream solutions.

Opportunities

Input

- Based on the litter and product data from CAP and other cleanups in the area, it would be worth the FL Keys exploring a bottle deposit scheme.
- Engage local parent companies and manufacturers on redesign of delivery systems and product packaging, particularly for the most problematic items (e.g. single-use plastic snack bags, food containers, cups, etc.).
- Promote local brands (“shop local”) as much as possible, providing incentives where possible for consumers and businesses.

Community

- Recycling was a common theme in stakeholder interviews - there is a need for more open communication from government and waste haulers to residents on end points of recycling could restore trust in the system and encourage better recycling practices.
- There is an opportunity for the CAP report to be used by local groups that advocate for interventions, and it could reinvigorate the efforts of groups like the FL Keys Environment Coalition and Plastic Free Keys . CAP data could also be helpful to community groups who are advocating for legislation, interventions, and systemic changes to plastic use and management in the Keys.
- There is a need for local government and businesses to move forward/get clarity on next steps for Bag ban in FL - the Governor requested a report before the bag ban is considered, that report was submitted, but still nothing happened and it hasn’t been signed.
- Build upon programs like Net Your Problem and other local enterprises that are using marine debris opportunities to inform product redesign options.
- Work with Blue Star operators to enforce the prohibition of SUP on their boats and vehicles, and ensure they are connected with available grants (e.g. through Blue the Dive) and resources to help transition back after COVID.
- School lunches in many schools in the Keys are reportedly served on EPS with plastic utensils wrapped in plastic - Consider engaging with the school districts on reduction of SUP used in schools (e.g., lunch trays and utensils, etc.).
- More education and outreach could prove to be beneficial (could start with schools and clubs that are energized about this topic, particularly the Ocean Guardian School Program); community members noted that education should start early, be community specific, reject “blame” narratives, and be visual and creative.

- Engage short term vacation rentals as an opportunity to provide educational materials and recycling directly to tourists (e.g. fridge magnet with what you can recycle, page in welcome book).

Product Design

- Multilayer plastic should be targeted for reuse and alternative materials in the convenience item sector - items already largely made of recyclable material such as plastic bottles should be targeted for recycling.
- PP and EPS should be targeted for reuse or alternative materials in the food sector (esp. EPS due to its rapid fragmentation in coastal environments).
- There has been a transition to compostable straws but no industrial composting infrastructure available to the community - local government and businesses should focus on reduction instead or matching infrastructure with compostable or biodegradable materials.
- Refill options and/or messaging should be available at grocery stores (particularly where visitors load up on items like single-use plastic bottles).

Use

- There is interest in alternatives, but emphasizing the financial benefits of participating in a more circular system, such as cost savings, financial incentives, etc. could be helpful in garnering interest among businesses.
- Explore implementing a system for refillable glass bottles (especially given regional challenges with recycling and weight/transportation) - this could be piloted with local breweries, liquor stores, grocery stores etc.
- Build upon success with the straw ban in the City of Key West - replicate for other problematic items and/or move towards reduction and elimination where possible.
- Need clear incentives for reusable/refillable items and/or disincentives for using single-use plastic items (and not necessarily a monetary discount, the business could receive marketing support as a more sustainable choice, could provide an education opportunity for customers instead, etc.).
- Engaging short term vacation rentals as an opportunity to provide educational materials on reuse directly to tourists (e.g. list of places that offer discount for bring reusable cup).

Collection

- It is clear that recycling messages are not getting through to visitors/tourists in the region and messaging needs to be more robust and accessible to that user group.
- Explore capacity needs that could support required recycling for businesses (starting with the Key West Restaurant Survey from the city) - move forward with *Key West Forward* proposal to start with aluminum and cardboard, and explore potential financial incentives for businesses to participate in recycling (may not require policy and therefore more quickly actionable).
- There is a need to address the issue of visitors using short-term rentals putting out more waste than allowed - better guidelines for visitors, harsher punishments, buy-in from

renters and homeowners, or other solutions that can be identified among local stakeholders.
- Citizens may be unaware that they can call private companies like Waste Management for a pickup. Clearer and more widespread messaging/marketing might make WM services more available and helpful to people.
- City or county support for a recycling co-op system where all businesses on a alleyway shared a recycling dumpster to alleviate space constraints - the city/county could also handle billing through existing contracts with haulers (could use the example from Jekyll Island, where each business pays a certain percentage of the monthly cost of the dumpster and the city handles all the billing so that individual businesses don't have to take on that kind of liability).
- "Oops" tags on waste and recycling bins that are improperly filled or contaminated have been successful in some parts of the Keys and could be replicated elsewhere to reduce recycling contamination (Oops tags in Atlanta reduced contamination by 57%, which could be used as a model - https://recyclingpartnership.org/recycling-atlanta-curbside/).

End of Cycle
- Waste reduction is critical - there is not enough capacity, space, etc. for existing waste, and reduction and diversion should be priotitized for action and funding.
- Innovation is needed in particular for glass recycling and fishing gear (and there are opportunities to build on existing initiatives, such as Net Your Problem)
- Explore the *Key West Forward* recommendation on anaerobic digester for food waste, starting in Key West
- Recommendations from *Key West Forward* that are still relevant*:*
    - Training and Resources for Landscapers, Electricians, Contractors and Plumbers: Train professionals and request agreements to adhere to proper waste disposal and recycling practices. Ensure that the Building and Licensing Departments share resources with relevant information.
    - Lease Agreements: If possible, introduce into all business leases from the City the requirement to manage waste, including recycling, and proper waste removal.
    - Coordination and Communication with Waste Management: Improve efforts between the City and Waste Management, including more public garbage and recycling cans to prevent littering.

Leakage
- Expand enforcement of the cigarette ban on beaches in Monroe County. These have co-benefits for human health and the environment.
- From boat surveys, we can see that recreational items like life jackets, pool noodles often blown away by the wind - education and policy around requiring tying down those items on boats would be valuable and could be communicated at marinas, at the point of rental, etc.
- Floating debris surveyed in mangroves was similar to litter observed on land, suggesting that litter prevention and capture on land represents an opportunity for reduction.

- Recommendations from *Key West Forward* that are still relevant*:*
    - Keep Key West Beautiful/Adopt a Spot: Identify a Volunteer Leader to work with the Solid Waste Technician to organize individuals, civic groups, and businesses to adopt spots on the island to clean and maintain. The Volunteer Leader will create a master schedule and coordinate with participants.
    - “Love Your Island” Targeted PR Campaign: Create a short but powerful campaign several times per year to message the importance of recycling and keeping the island clean. Utilize banners in designated areas, social media, traditional press, and business organizations to spread the message.

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Appendix

Figure 27: List of Parent Companies from Common Convenience Items

Beverage Products	**Location**

Alimentation Couche-Tard	Laval, Canada
All Market Inc	New York, NY, USA
BJ's WHolesale Club	Westborough, MA, USA
BlueTrition Brands	Samford, CT, USA
Campbell Soup Company	Camden, NJ, USA
CG Roxane, LLC	Novato, CA, USA
CVS Pharmacy Inc	Woonsocket, RI, USA
Danone	Paris, France
Eternal Beverage Inc.	Walnut Creek, CA, USA
Golden Fleece Bevarages Inc.	Chicago, IL, USA
good2grow, LLC	Atlanta, GA, USA
Harvest Hil BeverageCompany	Stamford, CT, USA
Hensley BeverageCompany	Phoenix, AZ, USA
Hint, Inc	San Francisco, CA, USA
Hornell Brewing Co., Inc.	Cincinnati, OH, USA
Icelandic Water Holding	Olfus, Iceland
JJ Martin Group	Newark, N, USAJ
Just Goods Inc.	Glens Falls, NY, USA
Keurig Dr Pepper	Plano, TX, USA
Lassonde Industries Inc	Rougemont, Quebec, Canada
Lemon Perfect Company	Atlanta, GA, USA
McArthur’s	Miami, FL, USA
Nestle	Vevey, Switzerland
Ocean Spray Cranberries Inc	Lakeville-Middleborough, MA, USA
PepsiCo	Purchase, NY, USA
Polar	Worcester, MA, USA
Publix Super Markets Inc	Lakeland, FL, USA
Real Brands Inc	Pompano Beach, FL, USA

SPI Westport Incorporated	San Francisco, CA, USA
Talking Rain BeverageCompany	Preston, WA, USA
The Coca-Cola Company	Atlanta, GA, USA
The Wonderful Company	Los Angeles, CA, USA
US Foods	Rosemont, IL, USA
Vital Pharmaceuticals	Pembroke Pines, FL, USA
Voss Production Americas	Oslo, Norway
Waiakea Inc	Hilo, HI, USA
Welch Foods	Concord, MA, USA
Candy Products	Location
American Licorice Co	Laporte, IN, USA
August Storck KG	Berlin, Germany
Consolidated Brands Inc	Victor, NY, USA
Ferrara Candy Company	Chicago, IL, USA
Ferraro SpA	Alba, Italy
Ferrero Group	Alba, Italy
Ford Gum and Machine Company	Akron, NY, USA
Frankford CandyLLC	Philadelphia, PA, USA
Galerie	Hebron, KY, USA
Ghiardelli Cocolate Company	San Leandro, CA
Haribo	Bonn, Germany
Jelly Belly Candy Company	Fairfield, CA, USA
L Frances Caramels	Appleton, WI, USA
Las Olas	Orlando, FL, USA
Lindt & Sprungli	Kilchberg, Switzerland
Mars Inc	McLean, VA, USA
Mondelez International Group	Chicago, IL, USA
Perfetti Van Melle	Breda, Netherlands

Smarties CandyCompany	Union, NJ, USA
The Foreign CandyCompany, Inc.	Hull, IA, USA
The Hershey Company	Hershey, PA, USA
The Topps Company Inc	New York, NY, USA
Tootsie Roll Industries LLC	Chicago, IL, USA
Viacom International Inc	New York City, NY, USA
Yildiz Holding	Istanbul, Turkey
Chip Products	Location
Amplify Snack Brands	Austin, TX, USA
Arca Continental	Monterrey, Mexico
Bemar Snacks	Medley, FL, USA
Campbell Soup Company	Camden, NJ, USA
Conagra Brands, Inc.	Chicago, IL, USA
Frito-Lay	Plano, TX, USA
General Mills	Minneapolis, MN, USA
H.T. Hackney Company	Knoxville, TN, USA
Hawk Products	Hatfield, PA, USA
Kellogg's	Battle Creek, MI, USA
Mars Inc	McLean, VA, USA
PepsiCo	Purchase, NY, USA
Plantation Products Company	Miami, FL, USA
The Exotic Blends	Quito, Ecuador
The Hershey Company	Hershey, PA, USA
Utz Quality Foods	Minneapolis, MN, USA

Figure 28: List of Manufacturers from Common Convenience Items

Beverage	**Location**
Apple & Eve	Carney's Point, NJ, USA

Argo Teat	Chicago, IL, USA
Arizona Beverage Company	Woodbury, NY, USA
BA Sports Nutriton LLC	New York, NY
Bai Brands, LLC	Plano, TX
BJ's Wholesale Club	Westborough, MA, USA
BlueTrition Brands	Zephryhills, FL, USA
Bottling Group LLC	Witchita, KS, USA
Campbell Soup Company	Camden, NJ, USA
CG Roxane, LLC	Novato, CA, USA
Circle K Stores Inc	Tempe, AZ, USA
Core Nutrition	Frisco, TX, USA
CytoSport	Beicia, CA, USA
Danone Waters of America Inc.	Pasadena, CA, USA
Dole Food Company	Thousand Oaks, CA, USA
Dr Pepper/Seven Up Inc	Plano, TX, USA
Dunkin Donuts	Canton, MA, USA
Essentia Water LLC	Bothell, WA, USA
Eternal Beverage	Walnut Creek, CA, USA
Fa!rlife	Coopersville, MI, USA
Fox Ledge Inc	Honesdale, PA, USA
Glacéau	Atlanta, GA, USA
Global BeverageCorp	Oradell, NJ, USA
good2grow, LLC	Atlanta, GA, USA
Harvest Hill BeverageCompany	Stamford, CT, USA
Hill Billy BeverageLLC	Plantation, FL, USA
Hint, Inc	San Francisco, CA, USA
Icelandic Water Holdings	Olfus, Iceland
JJ Martin Group	Newark, NJ, USA

Just Goods Inc.	Glens Falls, NY, USA
Lemon Perfect Company	Atlanta, GA, USA
Lipton	New York, NY, USA
McArthur's	Miami, FL, USA
Minute Maid	FL, USA
Naked Juice	Irvine, CA, USA
Nestle USA, Inc.	Arlington, VA, USA
Ocean Spray Cranberries Inc	Lakeville-Middleborough, MA, USA
PepsiCo	Purchase, NY, USA
Perrier	Vergèze, France
Polar	Worcester, MA, USA
Publix Super Markets Inc	Lakeland, FL, USA
Snapple Beverage Co	Frisco, TX, USA
SPI Westport Incorporated	San Francisco, CA, USA
Squirt	Tecámac, Mexico
Sunkist Growers Inc	Valencia, CA, USA
Talking Rain BeverageCompany	Preston, WA, USA
The Coca-Cola Company	Atlanta, GA, USA
The Gatorade Co	Chicago, IL, USA
The Wonderful Company	Los Angeles, CA, USA
Topo Chico	Monterrey, MX, USA
Tropicana Manufacturing Company	Bradenton, FL, USA
US Foods	Rosemont, IL, USA
Vita Coco	New York, NY, USA
Vita Nourish	Henderson, NV, USA
Vital Pharmaceuticals	Pembroke Pines, FL, USA
Voss Production Americas	New York, NY, USA
Waiakea Inc	Hilo, HI, USA

WIS-PAK inc	Watertown, WI, USA
Candy	Location
American Licorice Co	Laporte, IN, USA
Anastasia Confections	Orlando, FL, USA
August Storck USA	Chicago, IL, USA
Bazooka Companies, Inc.	Thailand
Boyer Candy Company	Altoona, PA, USA
Ferrara	Franklin Park, IL, USA
Ferrero U.S.A., Inc.	Chicago, IL, USA
Ford Gum and Machine Company	Akron, NY, USA
Frankford CandyLLC	Philadelphia, PA, USA
Galerie	Mexico
Ghiardelli Cocolate Company	San Leandro, CA, USA
Haribo of America, Inc	Rosemont, IL, USA
Jelly Belly Candy Company	Fairfield, CA, USA
L Frances Caramels	Appleton, WI, USA
Lindt & Sprungli USA	Stratham, NH, USA
Mars Wriggley Confectionary US	Hackettstown, NJ, USA
Mondelez Global LLC	East Hanover, NJ, USA
Perfetti Van Melle USA	Erlanger, KY, USA
Smarties Candy Company	Union, NJ, USA
Star Brands North America	White Plains, NY, USA
TFCC, Inc.	Thailand
The Hershey Company	Hershey, PA, USA
The Willy Wonka Candy Company	Queretaro, Mexico
Tootsie Roll Industries LLC	Chicago, IL, USA
Topps	Scranton, PA, USA
Chips	Location

Amplify Snack Brands	Austin, TX, USA
Bemar Snacks	Medley, FL, USA
Deep River Snacks	Atlanta, GA, USA
Frito-Lay	Plano, TX, USA
General Mills	Minneapolis, MN, USA
GoodMark Foods, Inc.	Raleigh, NC, USA
Hawk Products	Hatfield, PA, USA
Kettle Brand	Salem, OR, USA
Mars Wriggley Confectionary US	Hackettstown, NJ, USA
NatuChips	Plano, TX, USA
Paqui	Austin, TX, USA
Plantation Products Company	Miami, FL, USA
Pringles Manufacturing Co	Jackson, TN, USA
Sunchips	Plano, TX, USA
The Exotic Blends	Minneapolis, MN, USA
Uncle Ray's LLC	Raleigh, NC, USA
Utz Qualtiy Foods	Hatfield, PA, USA
Zapps	Salem, OR, USA

Table 8: 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
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
Tobacco Products	Cigarette Packaging Cigarettes Other Tobacco Product Tobacco Sachets

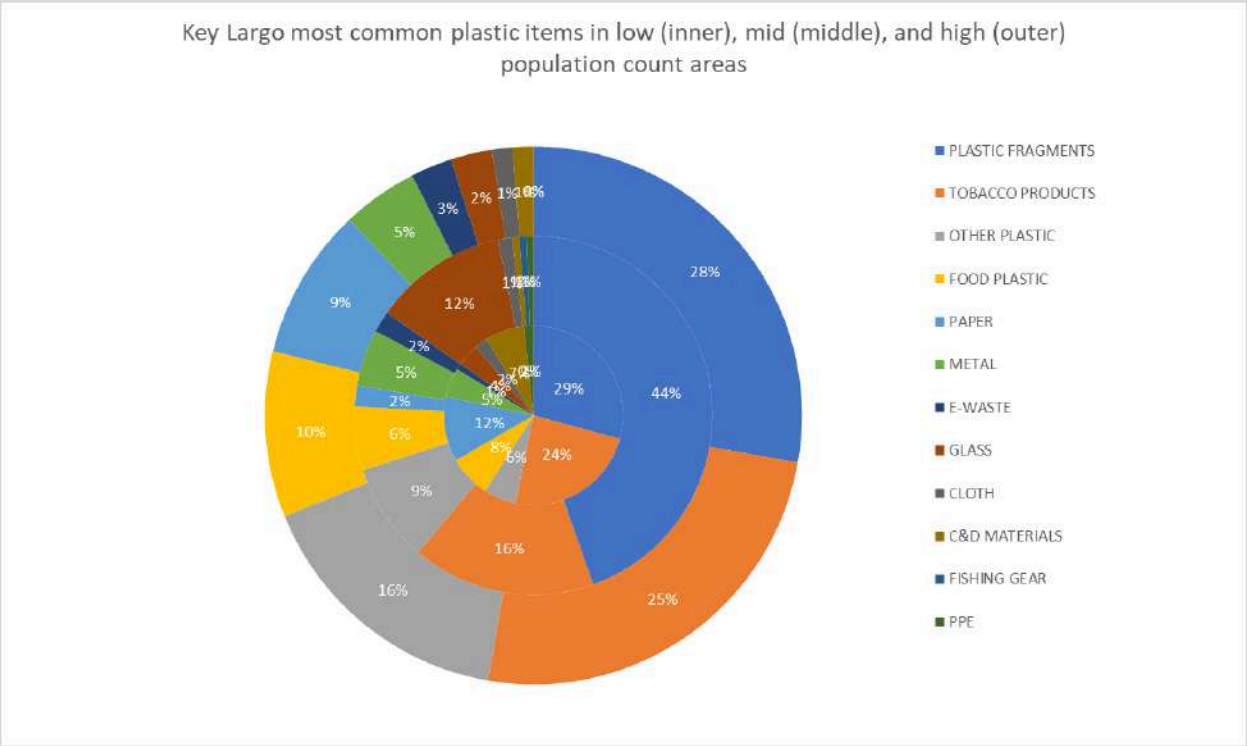

Figure 29: Characterization of litter in Key Largo

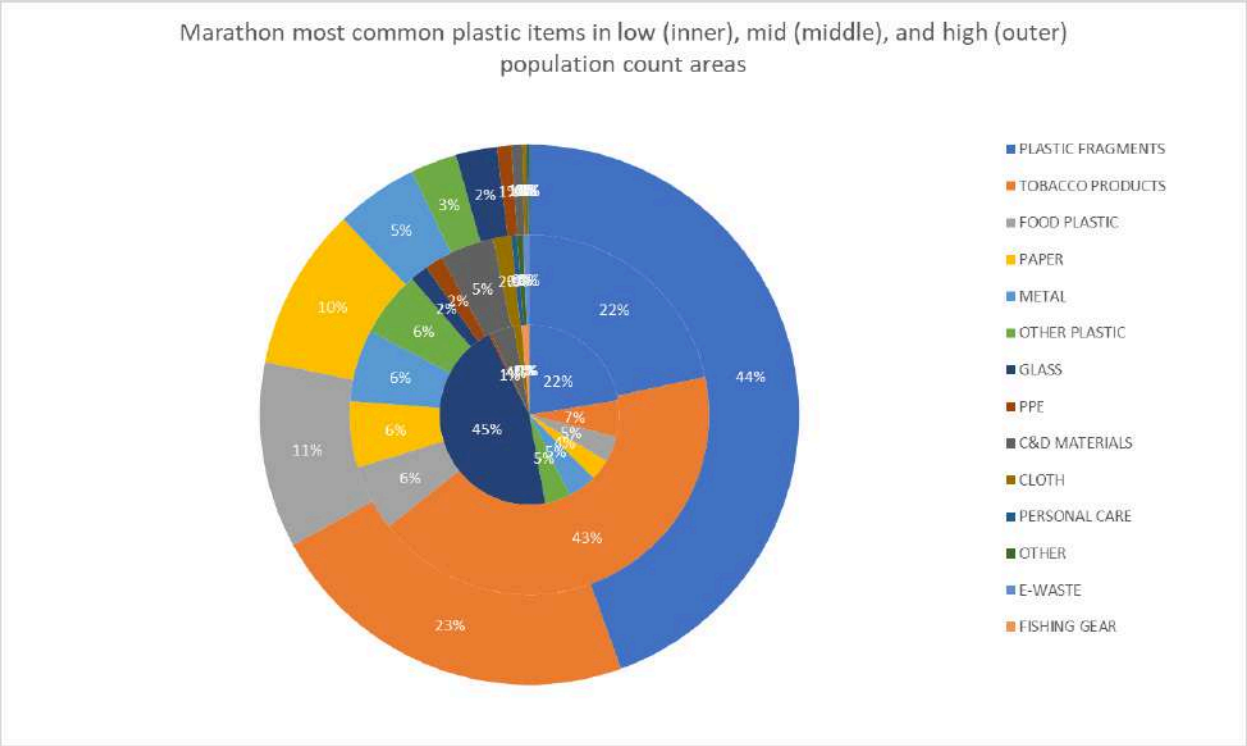

Figure 30: Characterization of litter in Marathon

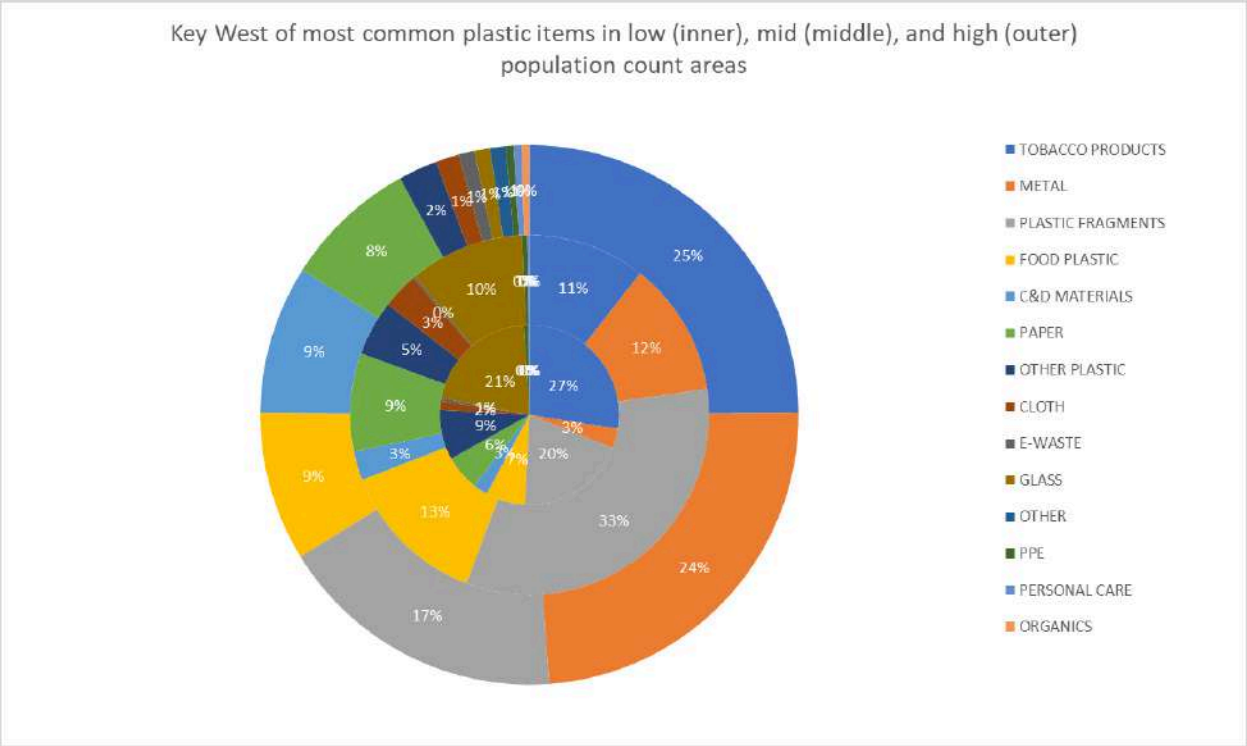

Figure 31: Characterization of litter in Key West