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Fall 2025

Which Consumer Waste Type is Most Prevalent in the Anclote River Watergoat?

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Abstract

This investigation studied the relevance and composition of consumer product waste gathered by a Watergoat barrier located in the Anclote River in Pasco County, Florida. The objective of this study was to determine which variety of consumer garbage was most frequently identified in the river based on weight and quantity. An in-situ based data collection method, known as Escaped Trash Assessment Protocol (ETAP), was used in partnership with various volunteers and members of the community. The protocol included material withdrawal from the environment, weighing collected waste, identification of two outlier waste types, mean weight, and the sorting and categorization of that waste. The garbage was organized into categories like paper, metal, plastic, glass and other, and furthermore inspected by its physical state (heavily degraded, partially intact, and intact). Plastic was the most prevalent in terms of quantity and glass was the dominating category for weight for the bags that were ETAPed across the span of the eleven month collection period. This led to the conclusion that plastic and glass consumer waste remain a large contributor to pollution of waterways and trash interception technologies such as the Watergoat are effective tools for blocking this garbage before it flows into larger marine environments along Florida's coast. These findings indicate that there is a need for upstream garbage regulation methods, public education to help mitigate waste at its source, and continued deployment of in-situ trash interception technologies such as the Watergoat.

Introduction

Waste from humans in oceanic and marine ecosystems is a globally acknowledged ecological issue. Large amounts of waste such as metal, glass, styrofoam and paper gain access to bodies of water due to runoff from populated areas, drainage methods and unauthorized disposal. After it is in bodies of water, this waste has the ability to be moved across large regions, winding up in seas and marine ecosystems where it leads to environmental degradation, the destruction of the food chain, and presents great hazards to the well being of the public (Jambeck et al., 2015; Lebreton et al., 2017).

A major concern associated with this debris is plastic pollution. Plastic is strong and has the ability to float, giving it the ability to be especially harmful to marine ecosystems as plastic presence persists through the water column. This plastic can be degraded into smaller pieces over time eventually forming microplastics through physical degradation factors such as sunlight, chemically-induced breakdowns, or mechanical abrasion. These small plastics are usually less than 5mm and can persist in the environment for hundreds of years (NOAA, 2018). Microplastics (MPs) can be ingested by a large range of marine animals, giving them the ability to disrupt food chains, and leech harmful chemicals into marine environments (Pilapitiya and Ratnayake, 2024).

The large surface area and hydrophobic surface of MPs make them a suitable medium for carrying many pollutants such as endocrine disruptor chemicals (EDCs), heavy metals, and other toxic organic chemicals, making them harmful to mammals through bioaccumulation and biomagnification processes. Approximately, 1000 EDCs alter the expression of various hormone receptors and interfere with the synthesis, secretion, transport, and action of hormones, leading to endocrine and developmental abnormalities (Ullah et. al., 2023). Ingesting microplastics disrupts the marine food chain by: harming small organisms at the base, reducing their nutrition and survival, spreading toxins up the food chain through bioaccumulation, altering predator-prey relationships, leading to unbalanced ecosystems. Potentially adversely affecting humans who eat contaminated seafood. Overall, it is a threat to the ocean ecosystem.

It is speculated that these waterways are responsible for the movement of more than 80% of the plastic garbage that makes its way into the oceans (Meijer et al., 2021). In Florida, the problem is especially tailored, as more than 99%t of Florida's exterior waters are categorized as harmed or polluted as a result of human interference (FDEP, 2024). Having more than 1,300 miles of a coast and an intricate array of waterways and streams, Florida is especially endangered to the effects of oceanic degradation due to pollution.

Centered in Pasco County, the Anclote River spans 29 miles and is a prime example of a waterway that faces extreme amounts of pollution from upstream commercial, urban and recreation places. This waste is not only a danger to downstream marine and coastal ecosystems but can also negatively impact the human population living in close proximity to the river. To address this issue of mass amounts of consumer waste being thrown into waterways that is exemplified by the Anclote River, solutions including the Watergoat have been placed in Florida rivers through working groups such as the Water Warrior Alliance that is aided by National Oceanic and Atmospheric Administration (NOAA) and the University of Florida.

There are several in-stream trash trap devices that are used to trap trash such as. Watergoats, Brutbin, Littatrap, Mr Trashwheel, etc. While some large traps named Storm Water Systems' "Bandalong" or Baltimore's "Mr. Trash Wheel" are cleaned out by cranes or automatic conveyors, the Watergoat used in this study is a passive, non-powered system designed for small, narrow waterways (Meijer et al., 2021). Watergoats are trash traps consisting of plastic buoys with eco-friendly netting underneath and anchored to the banks of waterways and floats with the water level. Water flows through, carrying trash and the floating litter is caught by the Watergoat's barrier. Trash is manually removed by volunteers before it overflows or sinks. Benefits of watergoats include preventing plastic pollution from entering oceans thereby protecting marine life and water quality, and compared to the other non-point source pollution methods they are fairly simple to install, maintain and they are smaller in size. Also as opposed to beach cleanups, trash per person is not necessary for driving as a unit of effort since the watergoat trash is collected in a contained area and can be cleaned by any number of people. Therefore,its efficiency in plastic removal is not determined by the amount of volunteers present.

The Watergoat used in this study is part of a larger project, known as Operation Trash Reduction for Aquatic Preserves (TRAP). It is supported by The National Oceanic and Atmospheric Administration's (NOAA) Marine Debris Program with money given by the Bipartisan Infrastructure Law in partnership with Florida Department of Environmental Protection's (FDEP) Aquatic Sanctuaries, Pasco County and other areas in this location.

The primary objective of this investigation was to identify the most prevalent categories of consumer waste caught by the Watergoat placed in the Anclote River. This study's goal was to test the hypothesis that plastic would be the most prevalent category of waste in terms of quantity and weight because of plastics' widespread usage, its ability to chip off and multiply easily, as well as its buoyancy. This scientific assumption was created based on initial observations and general trends of waste in the region, especially in urban areas. The research that these investigations provided is significant because it acknowledges a particular space of the public's knowledge in the comprehension of regional garbage flow in networks of waterways (Pilapitiya and Ratnayake, 2024).

Even though the role that rivers play in worldwide movement of waste is recorded well, data centered to a specific area is crucial to aid regional and local policy, enhancing the positioning of waste regulation technologies such as the watergoat (Florida Department of Environmental Protection, 2024). Further, understanding the composition and the state of the garbage in the watergoats aids in understanding waste destruction methods, origins of garbage and possible threats to the environment relating to particular garbage categories. Through using a process of sampling and a categorization, this investigation has the potential to offer scalable, numerical information that can enlighten wider marine regulative methods. The data found in this study will support a larger amount of data driven interferences to lessen marine waste at its origin and increase the efficiency of in situ pollution capture methods.

Methodology

A standardized clean-up method was implemented to effectively remove trash from the Anclote River at a watergoat garbage capture area. The methodology began with a documentation of the site with a photograph to assess the state of the site before intervention. A "before" picture was taken to visually capture the amount of garbage accumulated in the concentrated region of the river. After the photographic documentation, a preparation area was created on nearby grassy land by opening a tarp and setting up a work table. This set up area was deemed as the data collection and organization area. A data analysis report was created encompassing general area information, volunteer data (number of participants, etc.). On-site, an area for documenting the number and weight of gathered trash bags post cleanup along with a separate region for tactical garbage gathered (trash not pulled out of the river). Following this setup, all volunteers completed a sign-up sheet and waiver for liability reasons. A briefing for safety was conducted pre-clean-up to inform volunteers of correct methods and potential hazards such as heatstroke. Gloves, safety vests and other protective gear were distributed and mandated for proper use

Figure 1. Collection of garbage from Anclote River

Figure 2. Garbage bags prepared for weighing

throughout the whole project. Industrial grade buckets for garbage collection were fitted with compostable bags to make for easy movement and disposal of the garbage collected from the river.

The volunteers then utilized 15-foot and five foot poles brought to the site to manually take out litter from the far end of the watergoat, and then transferred the collected waste into the prepared buckets. Once the buckets were filled, the compostable bags were securely tied and set down on the tarp that was placed earlier. Every bag was then assigned a number and placed in order for an easier ETAP of the garbage. This removal method was repeated multiple times until the Watergoat space appeared free of apparent garbage.

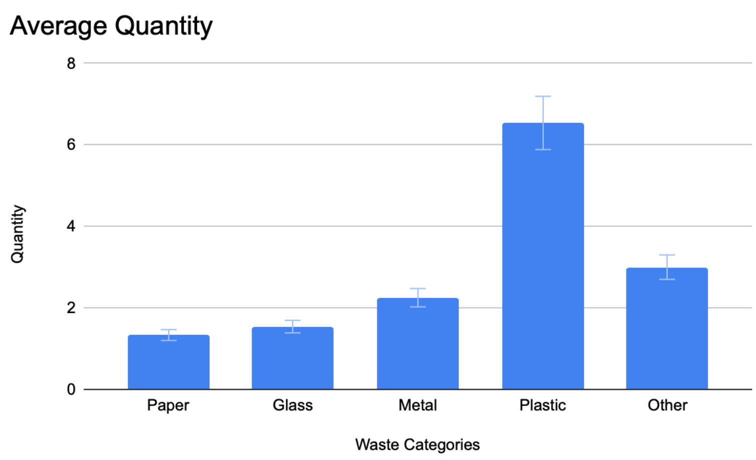
After completion of the process, each individual trash bag was weighed utilizing a calibrated scale and each bag's respective weight was noted with its identifying number given. From the recorded set, three representative bags which were the heaviest, lightest and one of the mean weight were chosen for deeper analysis. These three bags were then put aside while the left over bags were put away and disposed of in a waste dumpster close to the site. The items of the chosen three bags were then dumped onto the tarp for characterization of individual materials.

The volunteers utilized wooden rulers to sift through the garbage in order to ease precise sorting. All the waste was then categorized into various material classes as per the sheet which were paper, glass, metal, plastic and “other” with more specific characterizations listed. Within each category of materials, the items were then also classified by their physical condition as intact, partially intact or heavily degraded as per the ETAP classification guidelines. Each bag was weighed individually using the same scale as before and the condition, type of item and mass were recorded on the ETAP data sheet.

After the collection of the data, all the leftover garbage, encompassing organic matter and waste were disposed of in a nearby dumpster. Lastly an “after” photograph of the Watergoat was taken to visually document the outcome of the cleanup effort. This photograph serves as a comparative reference to determine the pictorial success of the garbage removal compared to initial conditions. This process was repeated for one day across the course of 11 months.

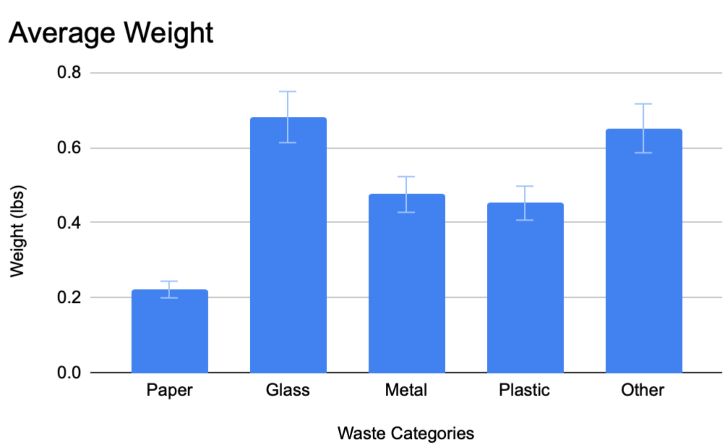
Results

Figure 1: Average Quantity of Consumer Waste per Category Across 11 months



The data collected from the Anclote river watergoat across the span of 11 months displays crucial information about the makeup of consumer waste. The plastic category which encompassed styrofoam, food wrappers, and bags dominated the quantity of waste with an average of 6.54 items per cleanup (Figure 1 and Table 1).

Figure 2: Average Weight of Consumer Waste per Category Across 11 months (lbs)



The glass category, which included beverage bottles and food packaging, displayed the highest average weight of 0.681 pounds per item for a singular cleanup (Figure 2 and Table 2).

Figure 3: Total Weight of Consumer Waste (lbs) Collected Per Month

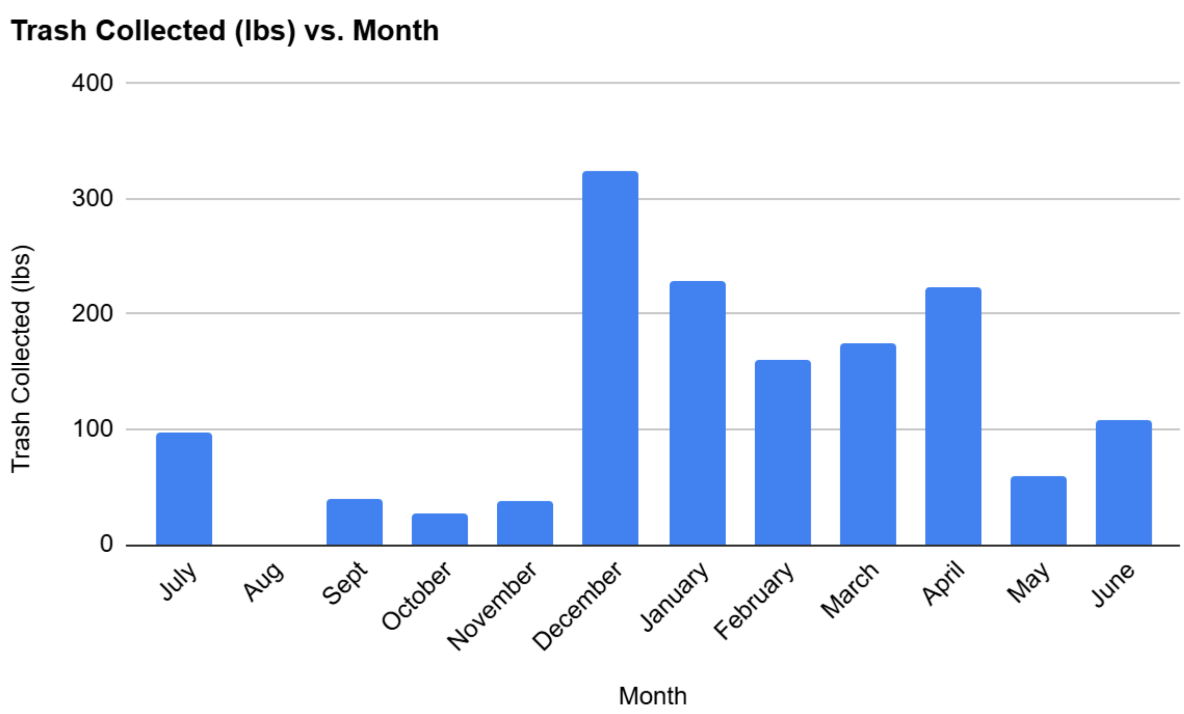


Table 1: Average Quantity of Individual Waste Categories Across 11 Months

Waste Categories	Quantity (lbs)
Paper	1.333
Glass	1.54
Metal	2.25

Plastic	6.54
Other	3

Table 2: Average Weight of Individual Waste Categories Across 11 Months

Waste Categories	Average Weight (lbs)
Paper	0.222
Glass	0.681
Metal	0.475
Plastic	0.452
Other	0.651

Discussion

Plastic is the dominant category in quantity, supporting our initial hypothesis. This is consistent with other water-interception results (citation here). However, the glass category had the heaviest total weight on average. It is important to note that glass is more dense than plastic. This highlighted the widespread use of glass and plastic as well as their fragmentation abilities and considerations for metrics of interest in prevailing pollution types – such as composition versus weight. While prior studies have put an emphasis on the impact that plastic has on marine environments, this study found that glass is also a major contributor to marine pollution due to its dominance in the weight category. but the use of glass is increasing day by day and as a result their disposal also gets increased. As glass is an inert material compared to the other categories, it would likely have a higher weight than quantity. The very fine pieces (micro/nano) mixed in dirt or soil will ultimately become a part of our ecosystem. It can be consumed by humans/animals (contact, breathing, eating etc.), marine creatures (gulf, breathing etc.) and last but not least the plants (absorbed by roots). Small organisms at the base of the food web, such as zooplankton and bottom-feeders can engulf the nanomaterials as they feed. Since nanomaterials cannot be digested easily, the nanomaterials collect in these organisms and with time it becomes more concentrated in their systems as compared to the neighboring water or soil. In future, these organisms can be consumed by bigger organisms and thus the concentration increases yet again (Kumari et al., 2022). Glass can break into pieces and cause physical damage to marine life, if small pieces are swallowed it can cause internal damage, it can disrupt corals physically. Compared to plastic pollution it is less likely to enter the food chain in larger amounts. Plastic is more harmful overall due to its chemical toxicity, ingestion risks, and disruption of the marine food web. Plastic pollution has a longer-lasting ecological impact, while glass poses physical risks to marine life and habitats.

As per figure 3, it can be deduced that in the summer to fall season there was notably less amount of trash as opposed to the winter and spring season. This may be due to major hurricanes pushing the trash out of the watergoat on the trees and the surrounding area. For the winter months people tend to purchase and discard greater amounts of goods because of the holiday season.

Other interesting items were captured by the watergoat, such as a chicken wrapped in grocery bags, carcasses of a fish and an otter, as well as kindergarten playmat, toy truck, grocery cart, wheel, a mannequin head, and large pieces of wood. These findings highlight the various sources of pollution that watergoat capture.

Biological waste removed from the watergoat area can improve air and water quality by providing a better living environment for wildlife, prevent eutrophication, control invasive species, and restore natural flow of water bodies with less obstructions from consumer pollution. Leaf litter provides a carbon substrate, food source, and habitat for stream invertebrates, while also providing a labile source of organic carbon for microbes, so has widespread benefits for stream ecosystems (O'Brien et al., 2017). But nutrient overload can cause eutrophication leading to sustained algal blooms which can lower the water column dissolved oxygen concentration and light transparency, conditions which lead to a loss of biodiversity. (Environmental Protection Agency, 2025). However, the removal of biological waste on a larger scale can disrupt the ecosystem of the water body and cause the loss of habitat, and accidental damage to native species, so the amount of organic waste removed by the watergoat should be considered.

The removal of biological waste trapped by Watergoat can provide important ecological benefits. By improving oxygen levels and overall water quality, and creating a healthier environment for marine life. Clearing excess organic matter helps prevent eutrophication, controls invasive species, and restores the natural flow of the water body contributing to ecosystem balance.

Leaf litter, a lead biological waste, plays an essential ecological role. It provides carbon substrates, food sources, and habitats for stream invertebrates, while also acting as a labile source of organic carbon for microbes, thereby supporting a wide array of stream organisms (O'Brien). However, when nutrient inputs become excessive, this organic matter can contribute to eutrophication, which leads to sustained algal blooms. These blooms can significantly reduce dissolved oxygen levels and light penetration in the water column, ultimately causing a loss of biodiversity (Jacobo).

Despite these risks, removal of biological matter must be approached with caution. Over-removal can disrupt native ecosystems, destroy native habitats, and lead to accidental harm to native species. Therefore, a balanced approach that maintains the ecological functions of natural organic inputs while preventing their accumulation to harmful levels is crucial.

Based on these results, a key takeaway from this study is that more mitigation strategies have to cater to broader categories of marine pollution rather than just plastic even though it is a widespread source. These findings also highlight the watergoat's ability to serve as one of a multi-use pollution regulators effective at collecting various types of debris.

It is important to note that there are potential limitations to this study as data collection did not account for seasonal gaps, such as the rainy season or hurricane season impact on the transport of waste downstream. Also, the area of the data collected was controlled to only one watergoat rather than multiple areas of observation. Another limitation was that the ETAP method used recorded information from three bags as opposed to all waste that came out the river, leading to a more concentrated dataset.

In terms of future directions, this project has the potential to be scaled up to multiple sites where multiple Watergoats could be weighed and recorded. Monitoring could be expanded to adjacent rivers or waterways across Florida for a more diverse sample set and for potential variability in trash composition. To go further, seasons could be taken into account as well as the condition of the trash for a more in-depth analysis. Other environmental factors such as determining where the Watergoat is placed could also be taken into account while doing data analysis as well. This is because the trash found in the waterfront is largely impacted by establishments upstream. SCUBAnauts will continue its adoption of the Anclote River Watergoat.

Through this project, the crucial role of targeted trash interception technologies such as the Watergoat was highlighted. It deepened our understanding of regional waste relationships of the Anclote River in Pasco County and offered community-based data collection, inspiring a new flood of engagement and potential solutions to create robust and healthier marine environments.

Acknowledgements

I would like to have this opportunity to share my extreme gratitude for those who helped support my research investigation. First I would like to thank Dr. Monica Wilson, University of Florida and the Water Warrior Alliance for introducing me to the concept of a Watergoat, and helping me in joining this initiative. Their willingness to have me on board as a lead for this investigation was the reason why I was able to conduct this project. Next, I would like to thank Mrs. Katie Cooper and Ms. Lauren Twele for their endless help in conducting cleanouts when I was not able to and their willingness to help out throughout this entire process. A heartfelt thank you to Ms Dubickas for her guidance in writing the report and presentation.

Their contribution to this investigation and belief in the principle driving this investigation inspired me across this project. Finally, I am extremely grateful for every volunteer who helped in cleaning out the Watergoat in rain or shine, it was truly appreciated. I want to also thank SCUBAnauts International as a whole for constantly pushing me to be the best scientist and diver I can be and for being such an amazing community of people who have always given me nothing but support and encouragement.

Citations

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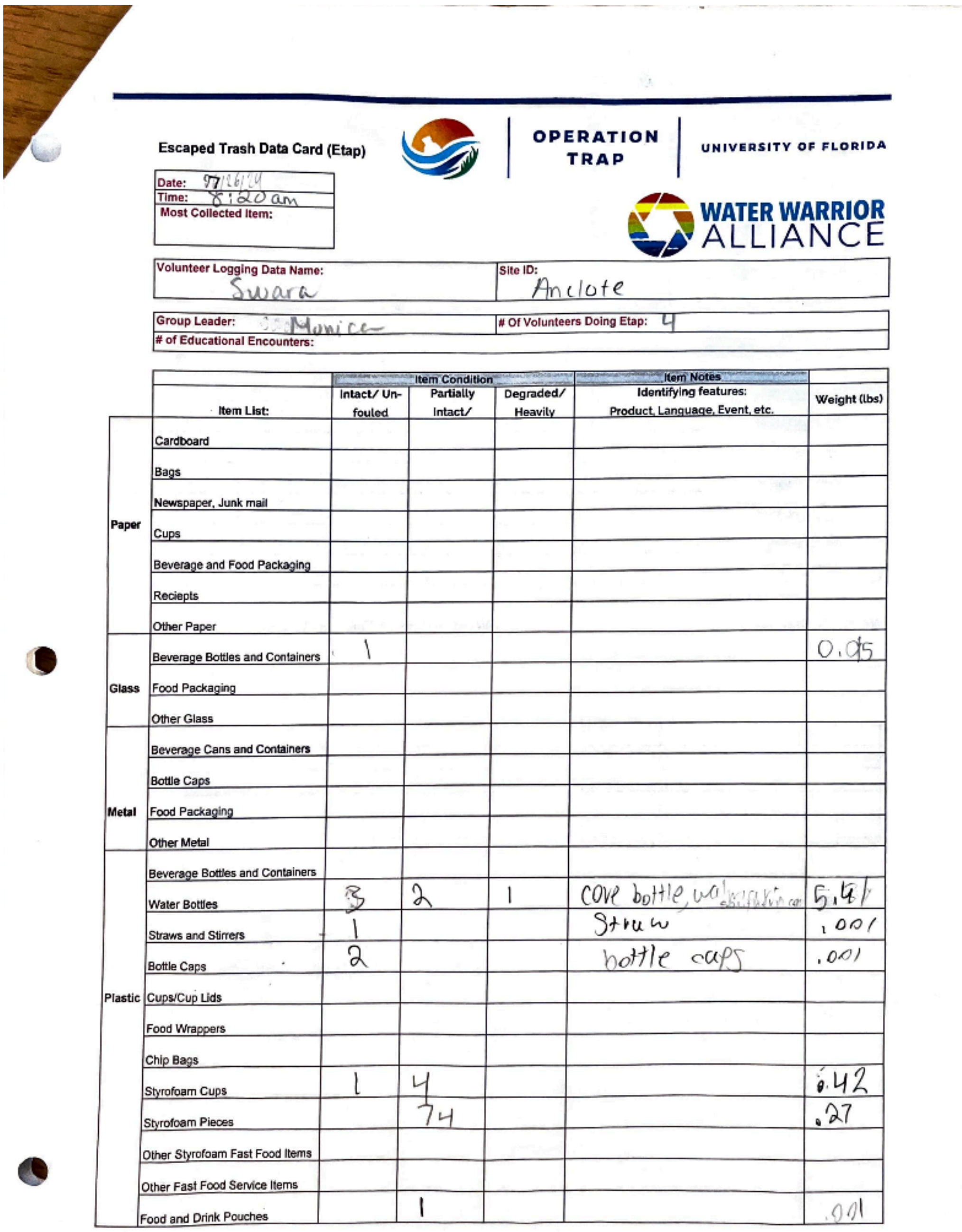
"Leaf litter additions enhance stream metabolism, denitrification,and restoration prospects for agricultural catchments."

Appendicies

Filled Out Data Sheet Example:



Escaped Trash Data Card (Etap)

OPERATION TRAP | UNIVERSITY OF FLORIDA

WATER WARRIOR ALLIANCE

Date: 7/26/24
Time: 8:20 am
Most Collected Item:

Volunteer Logging Data Name: Swara
Site ID: Anclote

Group Leader: Monica
Of Volunteers Doing Etap: 4
of Educational Encounters:

	Item List:	Item Condition: Intact/ Un-fouled	Partially Intact/	Degraded/ Heavily	Item Notes: Identifying features: Product, Language, Event, etc.	Weight (lbs)
Paper	Cardboard					
	Bags					
	Newspaper, Junk mail					
	Cups					
	Beverage and Food Packaging					
	Reciepts					
	Other Paper					
Glass	Beverage Bottles and Containers	1				0.95
	Food Packaging					
	Other Glass					
Metal	Beverage Cans and Containers					
	Bottle Caps					
	Food Packaging					
	Other Metal					
Plastic	Beverage Bottles and Containers					
	Water Bottles	3	2	1	cove bottle, wa[illegible]	5.4
	Straws and Stirrers	1			Straw	.001
	Bottle Caps	2			bottle caps	.001
	Cups/Cup Lids					
	Food Wrappers					
	Chip Bags					
	Styrofoam Cups	1	4			0.42
	Styrofoam Pieces		74			.27
	Other Styrofoam Fast Food Items					
	Other Fast Food Service Items					
	Food and Drink Pouches		1			.001

Plastic	Other Food Packaging					
	Bags/ Film					
	Hard Fragments					
	Other Plastic			5		.001
Other	Cigarettes/ Tobacco and Packaging		6			.001
	Entertainment Items/ Electronics					
	Fishing Gear/ Rope	1			bober	.001
	Textiles and Shoes					
	Toiletries/Personal Hygiene Products		1		floss pick	.001
	Medical Waste					
	Paint and Other Hazardous					
	Bulky Items					
	Vehicle Related					
	Sports Equipment	4			tennis balls, lantern	1.18
	Illegal Dumping					
	Write in: ballon, christmas bow	2			foil ballon	.07

Weight of Bags

	Bag #	Weight (lbs)	ETAP (yes or no)
	1	10.93	
	2	9.86	
	3	5.04	y
	4	6.61	
	5	9.8	
	6	15.79	y
	7	11.01	
	8	8.63	y
	9	12.42	
styro 1 –		3.27	
styro 2 –		2.39	
styro 3 –		2.68	

Weight of Bags of Tactical Cleanup

	Bag #	Weight (lbs)
	1	3.4
	2	9.47
	3	13.95
wood – plank	1	7.26
	2	6.24
	3	10.85

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