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Marine litter characterization on coastal ecosystem at Balogo, Pasacao Camarines Sur

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Abstract

Protecting vulnerable Philippine coastal ecosystems requires addressing marine litter. This study assessed marine litter at Sitio Pongol Balogo (13.5008°N 123.0621°E, ~5.4 m elevation) via line transects, ten-day low-tide surveys, and protocols from AMMM (2023), JICA WACS (2025), and International Coastal Cleanup. Single-use plastics were the primary contaminants, with biofilm-covered fragments risking ecology and health. A local trash trap achieved ~75% efficiency by mass and over 70% by count. Though promising, adjustments for smaller items and maintenance are needed. Sustainable management demands integrated research, policy, technology, and cross-sector collaboration to preserve biodiversity and economies.

Keywords: environmental sustainability, plastic pollution, waste management, trash trap, recycled materials

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1. Introduction

One of the most common and rapidly expanding man-made changes to the world's oceans and coasts is litter. Marine litter, a pervasive human-induced change to oceans and coasts, rival's climate change as humanity's top environmental challenge. Now ubiquitous in ecosystems like beaches, it's recognized as a geological indicator (Paler et al., 2022). Primarily plastics—due to their durability and ubiquity in single-use items (bottles, sachets, bags)—dominate, with common types including PET, PVC, PP, HDPE/LDPE, PS, and "Other" (resin code 7) composites (Geyer et al., 2017; Campbell, 2024). These persist via poor disposal and weak management. In the Philippines, litter surges from single-use plastics and ineffective systems, ranking it among top ocean polluters (0.28–0.75 million metric tons/year; Kobayashi & Abreo, 2024; Jambeck et al., 2015). Laws like RA 9003 (Ecological Solid Waste Management Act, 2001) and RA 9729 (Climate Change Act, 2009), authored by Sen. Loren Legarda, plus local policies, aim to counter this. The UNEP (2016) defines marine litter as "persistent, manufactured solids discarded in marine/coastal environments," entering via rivers, winds, tides (Williams & Rangel-Buitrago, 2019). Global plastic production hit 299 million tons annually, fueling research since the 1960s. It impedes SDGs: health risks (3), education/awareness (4), clean water (6), sustainable cities (11), consumption (12), climate (13), life below water (14), and land ecosystems (15).

Locally, in Balogo, Pasacao, Camarines Sur, litter threatens biodiversity, fishing/tourism livelihoods, and appeal—clean beaches rank high for visitors alongside safety, facilities, water quality, and scenery (Krelling et al., 2017). Data gaps persist despite awareness. This research characterizes Balogo's coastal litter (plastics, glass, metal, rubber, textiles; Lincoln et al., 2022) by type, source, abundance, and impacts to guide management. Strategies span short-term removal/mitigation and long-term prevention/behavior change, with community advocacy key for ecosystem/socioeconomic gains (Mariana et al., 2023; Rangel-Buitrago et al., 2019).

Statement of the Problem - The study addressed four specific research questions to guide its investigation. First, it examined the types and probable sources of marine litter present in the study area. Second, it assessed the physical properties of collected marine litter, focusing on size, material, and condition. Third, it determined what trash trap could be designed and installed in the selected estuary area. Fourth, it evaluated the level of effectiveness of the installed trash trap, measured in terms of volume and mass.

Objectives of the Study - This study examines marine litter from four key perspectives: identifying the types and sources of marine litter present in the study area; determining the physical properties of the collected litter in terms of size, material type, and condition; designing a trash trap suitable for installation in the selected estuarine area; and evaluating the effectiveness of the installed trash trap based on the volume and mass of waste it captures.

Significance of the Study - This study provides valuable data supporting informed decision-making for sustainable coastal management. Key beneficiaries include the Department of Environmental and Natural Resources (DENR), which gains critical information for policy development and resource management; the Bureau of Fisheries and Aquatic Resources (BFAR), which uses findings to strengthen conservation strategies; and the Municipal Local Government Unit, which applies results to formulate waste management regulations and allocate resources effectively. Local businesses benefit through reduced environmental impacts and increased public awareness, while communities experience improved coastal conditions that may enhance tourism and fisheries. Additionally, researchers obtain essential data for understanding pollution impacts and developing mitigation strategies, and students enhance their research capabilities and environmental awareness through study engagement.

Scope and Limitations of the Study - This research analyzed marine litter in Sitio Pongol, Balogo, Pasacao, Camarines Sur's coastal ecosystems, focusing on shorelines and characterizing macro-plastics via visual surveys

(and possible sediment sampling). Analysis covered litter type, quantity, and abundance in intertidal/nearshore zones using statistics, excluding deeper waters, resort waste, and chemical pollutants. A trash trap in the estuary captured floating debris for characterization, ignoring banksides or land trash. The study skipped full ecological assessments, community-led collection, and broader pollutants to stay focused within time/resource limits.

Theoretical Framework - This study is grounded in three interconnected theories. Eva Pongrácz's Waste Management Theory (2004) emphasizes comprehensive waste understanding through definition, management activities, and stakeholder roles within regulatory contexts, with waste characterization as a key input to guide policy and practices. Medidoub's Circular Economy Theory (2020) offers an alternative to linear models, promoting restorative systems through the "cradle-to-cradle" principle, 3Rs (reduction, reuse, recycling), and strategies like product-as-a-service to minimize waste and enhance resource efficiency. Zoltán Somogyi's Theory of Global Environmental Sustainability (2024) frames human activities within Earth's finite, interconnected systems, stressing ecological limits, systems thinking, and balancing present needs with future protection through adaptive governance and global cooperation. Together, these form a coherent framework: Waste Management Theory provides operational foundations for waste characterization and handling; Circular Economy Theory advances regenerative system redesign; and Global Environmental Sustainability Theory ensures practices align with long-term ecological balance and equity.

2. Methodology

The study was conducted at Balogo, Pasacao, along the Camarines Sur shoreline. According to Philatlas (2025), Balogo is one of the 19 barangays of the municipality of Pasacao. It is situated at approximately 13.5008° North, 123.0621° East, on the island of Luzon, with an elevation of about 5.4 meters (17.7 feet) above mean sea level. It is located near the quarter of San Cirilo and the village of Santa Rosa Del Norte. This area provided a suitable setting for analysing marine litter, and the impacts on coastal ecosystems and community health were assessed.

Research Method - This study used a descriptive-quantitative approach with field surveys, litter collection, sorting by type/size/source, and statistical analysis to characterize marine litter, identify contributors/patterns, and assess impacts on Balogo, Pasacao, Camarines Sur's coastal ecosystem—informing targeted waste management strategies.

Sampling Design - A modified line transect method assessed marine litter in Zone 6, Sitio Pongol, Barangay Balogo's coastal zones, guided by AMMM (2023), JICA WACS (2025), and International Coastal Cleanup protocols (Barnardo et al., 2023) for standardized macro-plastic monitoring, sourcing, and baselines. Low-tide surveys (avoiding springs) spanned mornings (7:00–12:00, higher yields) and afternoons (1:00–4:30 pm), influenced by tides, activities, winds, and currents (Nascimento et al., 2021). AMMM-based sample sizes; data analyzed via descriptive stats, frequency, and spatial methods for composition, distribution, and source trends.

Materials Used - Materials for data collection (Figure 5; Appendix F, p. 86) included writing tools, data sheets, demarcation signs, camera, GPS/cellphone, 100m tapes, gloves, sacks, markers, PPE, and weighing scale to meet research goals. Per AMMM (2023), macro-litter spans 2.5 cm to <1 m (Kroon et al., 2018), aiding comparable assessments of sources, movement, and fate in ecosystems.

Data Gathering Procedure - The study began with a ten-day data collection in Barangay Balogo, Pasacao, Camarines Sur, focusing on macro-plastic marine litter. The researcher defined the study area, collaborated with local stakeholders, and considered data limitations during analysis. A coastal survey and sampling protocol were developed to identify litter types and sources, supported by data from the Municipal Local Government Unit. Litter was systematically collected, categorized by type, size, weight, and source (land- or sea-based), and documented through photographs. The data were encoded in a spreadsheet and analyzed using descriptive statistics (frequency, percentage, and mean) and visualization techniques to identify patterns and spatial distribution. Data cleaning and verification ensured accuracy, while the Waste Analysis and Characterization System (WACS) was

applied to estimate litter quantities, identify recoverable materials, and generate recommendations for improved coastal waste management.

Statistical Treatment - The study of marine litter in Balogo, Pasacao, utilized a comprehensive blend of descriptive and quantitative analyses to evaluate waste accumulation and its origins. By applying simple statistics and the Waste Analysis Characterization System (WACS), researchers identified the frequency of materials like plastics and metals while linking them to specific human activities, such as local tourism and beach resort operations. Spatial variation was meticulously tracked by calculating litter density (items per meter) using mean and standard deviation to pinpoint daily accumulation rates. Ultimately, these findings were visualized through GIS mapping and statistical charts to provide a clear, data-driven overview of debris hotspots and environmental trends along the coastline.

3. Result and Discussion

Identification of Marine Litter - The analysis of marine litter collected over a ten-day period provides key insights into its composition and potential sources, revealing a diverse range of plastics with notable differences in abundance (Table 1). Unfortunately, persistent plastic waste continues to accumulate globally in various environments. Alongside improved waste management, biodegradable alternatives to conventional plastics are desirable for certain applications (Vollmer et al., 2020; Cywar et al., 2022).

Single-used Plastics - Single-use plastic items dominate marine litter in the area, with food wrappers leading at 4,758 pieces, driven by residents' and visitors' heavy consumption of packaged snacks and poor disposal habits. This aligns with Fuentes et al. (2024), which projects the Philippines as the top global contributor to oceanic plastic pollution by 2025, particularly via riverine emissions. Their study near Davao City, Mindanao—using stratified random sampling—identified 13,970 debris items across 309 transects at coastal, river, and inland sites, plus 1,405 items from sea trawls, with food wrappers and labels (whole or fragmented) most prevalent, underscoring the Filipino “tingi” culture of small-quantity buying and trading.

Table 1
Overall total of marine litter collected on coastal (October 4-13, 2025)

DAY 1-10 SUMMARY OF DATA- TRASH COLLECTED

Most likely to find items:	Total	Packaging Materials:	Total
Cigarette Butts:	29	6-Pack Holders	0
Food Wrappers (candy, chips, etc.)	4,758	Other Plastic/Foam Packaging	56
Take Out/Away Containers (Plastic):	110	Other Plastic Bottles (oil, bleach, etc)	23
Take Out/Away Containers (Foam):	180	Strapping Bands	22
Bottle Caps (Plastic):	356	Tobacco Packaging/Wrap	11
Bottle Caps (Metal):	78	Other trash:	
Lids (Plastic):	2,280	Appliances (refrigerators, washers, etc.)	1,477
Straw/Stirrers:	281	Balloons	9
Forks, Knives, Spoons:	1,210	Cigar Tips	1
Beverage Bottles (Plastic):	401	Cigarette Lighters	170
Beverage Bottles (Glass):	18	Construction Materials	21
Beverage Cans:	3	Fireworks	0
Grocery Bags (Plastic):	41	Tires	470
Other Plastic Bags:	1,581	Personal Hygiene:	
Paper Bags:	2	Condoms:	1
Cups & Plates (Paper):	27	Diapers:	153
Cups & Plates (Plastic):	517	Syringes:	5
Cups & Plates (Foam):	15	Tampons/Tampon Applicators:	1
Fishing Gear:		Tiny Trash Less than 2.5cm:	
Fishing Buoys, Pots & Traps	0	Foam Pieces 2.5cm	25
Fishing Net and Pieces	15	Glass 2.5cm	6
Fishing Line (1 yard/meter= 1 piece)	13.5	Plastic 2.5cm	343
Rope (1 yard/meter= 1 piece)	15	Dead/Injured Animals:	
Others:	3,916	None	

Plastic lids, plastic utensils, and other plastic bags - Other common marine litter items—like plastic lids

(2,280 pieces), utensils (1,210 pieces), and bags (1,581 pieces)—further highlight the prevalence of disposable plastics tied to food consumption and take-out services. Packaging fulfills key roles such as containment, protection, handling, transport, storage, convenience, information, and presentation, making it ubiquitous across industries, as supported by the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC, 2018).

Beverage-related Litter - Beverage-related litter forms a significant category, featuring 401 plastic bottles, 356 plastic caps, and 78 metal caps, while glass bottles (18 pieces) and aluminum cans (3 pieces) remain minimal—emphasizing plastic containers' greater threat due to their high volume and environmental persistence. Global plastic production has surged owing to its versatility, hygiene, flexibility, durability, and broad applicability (Plastic Europe, 2019).

Tobacco product wastes - Tobacco product waste—including 29 cigarette butts, 170 lighters, and 1 cigar tip—was documented, lower in volume than food plastics but highly toxic and durable, making it a key focus for anti-littering campaigns. EU directives ban single-use plastics like tobacco filters where alternatives exist, amid Romania's tobacco use nearing the EU average (Eurostat, 2022). Globally, the International Coastal Cleanup recorded 2,412,151 cigarette butts as top beach litter (Bergevin, 2018), with 842,837 from the US, 390,637 from the UAE, 353,025 from the Philippines, and 148,638 from Canada—their non-degradable plastic filters posing major environmental risks.

Appliances/Communication Devices and Tires - The data highlight substantial amounts of larger, persistent debris like appliances (1,477 pieces) and tires (470 pieces), signaling major challenges in bulk waste disposal that demands specialized collection and recycling. Without proper management, these items can leach hazardous substances, severely harming marine habitats. E-waste, dominated by large household appliances (50%), ICT equipment (30%), and small consumer electronics (20%) (Lundgren, 2012 cited by Premakumara, 2016), reached an estimated 2.49 kg per capita in the Philippines in 2012 (Yoshida et al., 2016), with generation poised to rise amid population growth and expanding electronics markets.

Fishing-related Litter - Fishing-related debris appeared in low quantities, with 15 pieces of fishing nets, 13.5 units of fishing line, and 15 ropes recorded, posing severe entanglement risks to marine life and fueling *"*ghost fishing*."* Though minimal overall, their presence points to localized fishing activities rather than being the main marine litter source in the area. Richardson et al. (2019) estimate that 5.7% of fishing nets and 29% of fishing lines are abandoned, lost, or discarded at sea, squandering chances for sustainable options like recycling.

Personal Hygiene and Unspecified Items - Miscellaneous items like diapers (153 pieces), syringes (5 pieces), condoms (1 piece), and construction materials (21 pieces) reveal diverse sources tied to nearby residential and construction activities. Medical waste such as syringes signals the urgent need for improved segregation and disposal to curb public health risks. Disposable diapers, viewed as a premium product, are more common among higher-income, better-educated households (Muia, 2018).

Others - The "others" category encompasses diverse items like medical products (empty pill capsules, medicine bottles), accessories, beauty items, motorcycle parts, toys, shaving tools, school supplies, toothbrushes, clothes clips, unidentified plastics, slippers/shoes, large foam and glass pieces (3,916 pieces total), reflecting marine litter as any synthetic or processed material dumped, disposed, or abandoned in marine environments or beaches. Classified by materials such as plastics, metals, and glass, this litter stems from rising populations, elevated living standards, and urbanization (SEPO, 2017), with plastics dominating due to their widespread use since the 1950s for versatility, lightness, corrosion resistance, and low cost (Torres & De-la-Torre, 2021; Póvoa et al., 2021). Waste composition points to consumer activities, especially single-use plastics from food and beverages, best addressed by preventing generation from coastal settlements and beachgoers through stakeholder efforts for cleaner beaches (Sarafraz et al., 2016).

Sources of Marine Litter - The sources of marine litter depend on two category the land-based sources and

sea/ocean-based sources, based on observation the possible sources in the study area shown on (Figure 1).

Land-based Sources - Land-based sources dominate marine litter, including public littering, improper waste disposal, urban runoff, tourist activities, accidental losses, and extreme events, with a large portion entering oceans via direct dumping or transport through wind, rain, tides, rivers, and stormwater drains (Weideman et al., 2020). Veiga et al. (2016) emphasize preventing trash entry into these habitats at the source to address this growing issue.

Sea/ocean-Based Sources - Marine litter in open oceans and shorelines stems from sea-based sources, amplified by factors like proximity to urban/recreational areas, fishing zones, shipping routes, climate, currents, and tides. Plastic litter surges near urban centers, underscoring local contributions, with much returning to city beaches via river mouths and stormwater (Ryan et al., 2020). Tracking ocean waste volumes remains challenging due to the seas' immense scale.

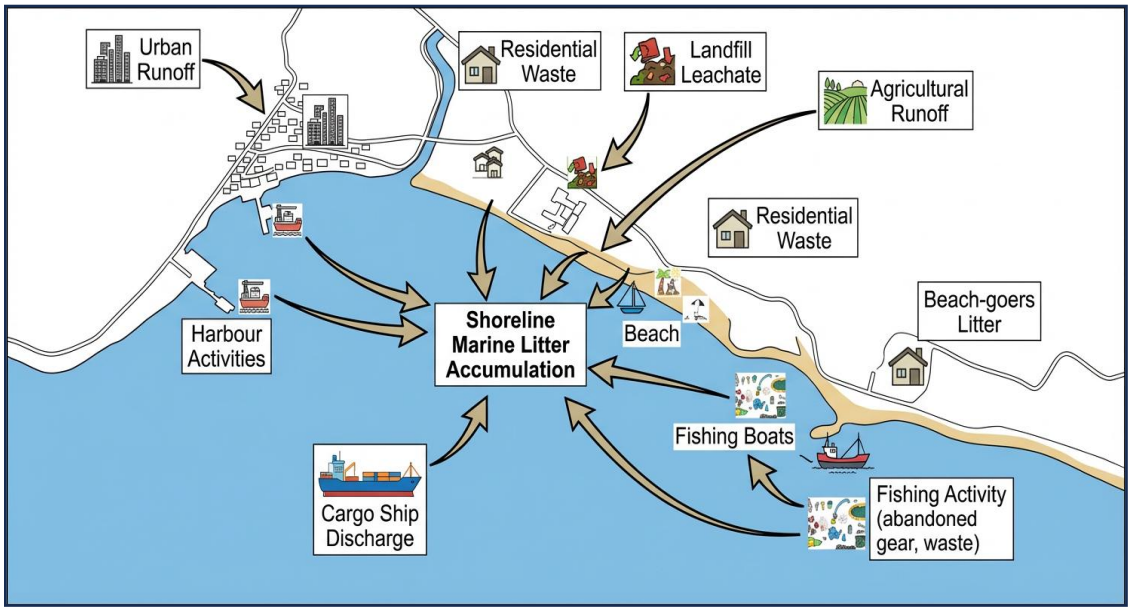

Figure 1. Schematic drawing of potential sources and pathways of marine litter.

Physical Properties of Marine Litter - Marine litter refers to the growing volume of human-made solid waste accumulating on shorelines and in oceans, with key physical traits—size (macro debris >25 mm), material (e.g., polyethylene, polypropylene, polystyrene, PVC), and condition (freshly discarded or degraded) and critical to its environmental impact. Material type dictates degradation rates and ecosystem interactions, enabling bioaccumulation as substances enter the food chain (Thushari & Senevirathna, 2020). Condition affects marine life attraction, while plastics act as passive tracers, evolving via chemical (degradation, biofouling) and physical processes that alter shape, size, and density (Chubarenko et al., 2016; Pernille Louise Forsberg et al., 2020).

Size - The dataset spans waste sizes: small fragments (<2.5 cm foam, plastic, glass) from larger plastics' breakdown, boosting surface area for microplastic formation, ingestion by marine life, and food chain entry (Dimassi et al., 2022); medium items like food wrappers, cigarette butts, bottle caps, and lids, wind/water-transported from direct littering and poor management, with packaging plastics comprising ~40% of 380 million annual global tons (Ugwu & Obele, 2023); and large debris such as tire remnants and appliance parts, which accumulate, damage habitats, and persist due to inadequate management, low awareness, weak policies, and urbanization (Purba et al., 2023).

Material - Marine litter is dominated by key plastics like polypropylene (PP) and polyethylene (PE, including HDPE and LDPE), the most abundant and versatile materials from consumer items (e.g., food wrappers, straws, forks) and fishing gear (e.g., nets, ropes). These polymers promote biofilm growth and fragmentation, serving as

substrates for marine life while degrading over time; PP also prevails in hygiene products like syringes and diapers, reflecting their global production due to affordability and durability (Geyer et al., 2017). Polyethylene terephthalate (PET) and polyvinyl chloride (PVC) follow, with PET common in fragmented beverage bottles and lids—highly recyclable despite mechanical breakdown—and PVC in rigid industrial items like construction materials, tires, and packaging, indicating a shift to heavier waste (Râpă et al., 2024). Polystyrene (PS) appears mainly in lightweight, buoyant foam products such as take-out containers, cups, plates, and protective packaging (Turner, 2020). The "Other" (O) category encompasses non-plastics like organic waste, paper, glass, metals, and composites, which degrade faster but leach toxins like heavy metals and absorb pollutants, threatening ecosystems (Gallo et al., 2018).

Condition - Collected marine debris primarily appears as biofilm-covered, fragmented, or intact/unspecified items, with widespread biofilm growth signaling extended aquatic exposure (Rummel et al., 2017). Biofilms modify plastic buoyancy, sinking, and mobility, drawing marine organisms for potential ingestion while expanding surface area to accelerate degradation and weathering. Fragmentation, driven by UV exposure, abrasion, and stress, breaks items like lids and bags into microplastics under 2.5 cm, heightening ingestion risks and hindering cleanup (Tu et al., 2020). Dominated by plastics in these states, the litter traces to land-based mismanagement, underscoring needs for improved waste practices, fewer single-use items, and awareness; biofilms may even aid bioremediation of microplastics (Debroy et al., 2022).

Trash Trap - A trash trap, or litter trap/boom, serves as a straightforward barrier in rivers or estuaries to intercept floating debris and block its path to the ocean, often built from interconnected plastic bottles as buoyant, reusable materials spanning the waterway (Gacu, 2022). It includes a mesh to snag solid waste while allowing water flow, anchored by ropes to tension posts on riverbanks—lightweight, durable, and easy to assemble without machinery for straightforward debris collection and safe disposal. While effective for immediate waste capture and reducing marine litter's environmental toll (Helinski et al., 2021), these devices offer short-term relief, as root causes like overconsumption and poor waste management demand ongoing solutions through policy, sustainability, and awareness.

Design phase of Trash Trap - Trash trap functions and design parameters were assessed for optimal performance in normal and harsh conditions, drawing from guidelines like the COBSEA & CSIRO (2022) Marine Litter Monitoring Methods Handbook and the African Marine Litter Monitoring Manual (AMMM, 2023). Criteria were derived from relevant literature to ensure effectiveness. Materials were surveyed and selected based on component efficacy, local availability, and affordability—as detailed in Table 2—prioritizing those that meet specifications, remain cost-effective, and reliably fulfill the trap's purpose.

Table 2
Materials Used in Trash Trap

Material	Description
Plastic Bottles	Reusable waste used as a floating barrier, easily assembled due to size, holds plastic bottles together, synthetic, with high strength and durability, available locally, flexible, elastic, heat- and water-resistant.
Nylon String (Fishing Line)	Used to secure the floating barrier, durable, easy to install, and tangle-free.
Fishing Net	Functions as the mesh cover for the floating barrier to trap solid waste, durable, easy to set up, available at local hardware stores.
Rope	Serves as the tension cable linking the posts on both sides of the river, the strongest type of rope, flexible, stretchable, elastic, capable of absorbing shock loads, available locally.
Mosquito Net	A lightweight and sturdy mesh fabric that covers the floating barrier, blocking small debris and insects. It is easy to install, durable, resistant to environmental conditions, and commonly available at local hardware stores.

Site Selection of Trash Trap - Key factors guided the selection of optimal sites for trash trap installation, confirmed through thorough on-site inspections and validation of estuaries. Traps were deployed at the estuaries in Sitio Poñgol Balogo, Pasacao, Camarines Sur, where assessments measured widths and positions to inform fabrication. Components were assembled per instructions, securely fastened to ensure reliability during data collection.

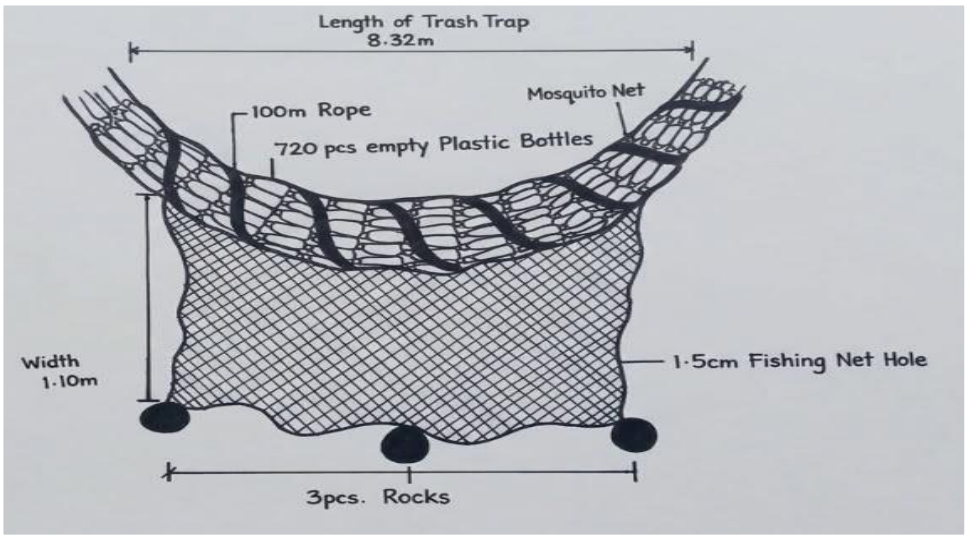

Figure 2. Sketch Design of Trash Trap

Installation and Waste Characterization - Trash traps were installed at the designated site in Sitio Poñgol, Balogo, Pasacao, Camarines Sur (Figure 3), followed by three days of initial observation to gauge effectiveness. Daily monitoring occurred over ten days (Figure 4), with collected waste meticulously recorded, listed by type, and weighed (wet weight in kg) for precise quantification. This process enabled evaluation of the trap's design efficiency in capturing and retaining debris.

Figure 3. Trash Trap Installation

Figure 4. Waste Characterization

Functionality and Efficiency of Trash Trap - Rising solid waste production, especially plastics from households, businesses, and communities, threatens rivers, estuaries, and coasts through improper disposal, fueling marine litter that endangers ecosystems, socio-economics, and human health via microplastics in the food chain (Pilapitiya & Ratnayake, 2024). Trash traps capture floating debris pre-coast, while ten-day monitoring and characterization (Table 1 and Table 3) reveal plastics as the dominant fraction, with food wrappers leading at 5,014 pieces, followed by plastic lids (1,508), grocery bags (739), bottle caps (209), and other bags (157)—all tied to land-based household and commercial sources, informing targeted waste management. Trash traps captured notable non-packaging items like 893 cigarette lighters and 778 large appliances, pointing to urban runoff and poor disposal in nearby communities. Comparing datasets (Table 4), plastics and food packaging prevail in both marine litter and trap collections, though marine samples show more fishing gear while traps reflect land-based urban waste via waterways—highlighting needs for community-level controls near rivers and coasts. This aligns with production-waste comparisons (Geyer et al., 2017), and trap performance metrics (piece count, dry mass over ten days) underscore their role in curbing pollution at the source, safeguarding ecosystems per UNEP (2021).

Table 3
Collection of marine litter in Trash Trap

TRASH TRAP TEN DAYS TOTAL COLLECTION OF TRASH			
MOST LIKELY TO FIND ITEMS:	TOTAL	PACKAGING MATERIALS:	
Cigarette Butts:	52	6-Pack Holders	0
Food Wrappers (candy, chips, etc.)	5,014	Other Plastic/Foam Packaging	59
Take Out/Away Containers (Plastic):	16	Other Plastic Bottles (oil, bleach, etc)	11
Take Out/Away Containers (Foam):	39	Strapping Bands	16
Bottle Caps (Plastic):	209	Tobacco Packaging/Wrap	0
Bottle Caps (Metal):		OTHER TRASH:	
Lids (Plastic):	1,508	Appliances (refrigerators, washers, etc.)	778
Straw/Stirrers:	41	Balloons	7
Forks, Knives, Spoons:	85	Cigar Tips	18
Beverage Bottles (Plastic):	76	Cigarette Lighters	0
Beverage Bottles (Glass):	4	Construction Materials	2
Beverage Cans:	1	Fireworks	0
Grocery Bags (Plastic):	739	Tires	12
Other Plastic Bags:	157	PERSONAL HYGIENE:	
Paper Bags:	5	Condoms:	2
Cups & Plates (Paper):	15	Diapers:	42
Cups & Plates (Plastic):	63	Syringes:	0
Cups & Plates (Foam):	31	Tampons/Tampon Applicators:	0
FISHING GEAR:		TINY TRASH LESS THAN 2.5 CM:	
Fishing Buoys, Pots & Traps	0	Foam Pieces 2.5cm	160
Fishing Net and Pieces	18	Glass 2.5cm	0
Fishing Line (1 yard/meter= 1 piece)	33.5	Plastic 2.5cm	893
Rope (1 yard/meter= 1 piece)	17	DEAD/INJURED ANIMAL:	
OTHERS:	4, 155	None	

Table 4
Summary of total number of Marine Litter pieces and Dry Mass collected from Coastal Areas and Trash Trap

TRASH TRAP SUMMARY OF DATA			EFFICIENCY	
DAY	Total No. of Marine Litter	Dry Mass	Total No. of Marine Litter	Dry Mass
1	2,066.5 pcs	13.2 kg		
2	1, 055 pcs	11.025 kg		
3	1,753 pcs	8.625 kg		
4	1,009 pcs	9.75 kg		
5	1,761 pcs	6.975 kg	76.51%	75%
6	1,155 pcs	3.225 kg		
7	926 pcs	3.075 kg		
8	2,107 pcs	13.5 kg		
9	1,855 pcs	10.5 kg		
10	560 pcs	3.75 kg		
TOTAL:	**14,247.5pcs**	**83.625 kg**		

The monitoring data demonstrates that trash traps are a highly effective interim solution for protecting marine ecosystems, successfully capturing a consistent 75% of debris by mass. While the trap intercepted over 14,000 pieces of litter, its efficiency in terms of individual item counts fluctuated between 66.5% and 83.7%, suggesting that factors like water flow, debris size, and maintenance impact its ability to catch smaller, lighter fragments. These findings, supported by research from Lebreton et al. (2017) and Shah et al. (2021), emphasize that while interception systems are crucial for reducing the bulk of plastic waste entering the ocean, their design must be continually optimized. Ultimately, these traps are vital tools within a broader waste management strategy, serving as a necessary defense while long-term efforts to reduce consumption and improve disposal practices are implemented.

4. Conclusion and Recommendations

This chapter outlines conclusions drawn from the study's findings and provides targeted recommendations for

various stakeholders. The conclusions clarify the implications and significance of the research results, while the recommendations' purpose actionable measures for policymakers, future researchers, and notably the Municipality of Pasacao, Camarines Sur, to safeguard the local coastal ecosystem.

Conclusion - The study concludes that the Balogo shoreline requires a multi-faceted intervention strategy to combat the overwhelming presence of plastic waste, which constitutes over 90% of local marine litter. Central to this strategy is the implementation of floating trash traps, which proved highly effective by intercepting approximately 75% of debris by mass and successfully capturing dominant pollutants like food wrappers and beverage containers. While the technology provides a strong immediate defense for intertidal ecosystems, long-term success hinges on a collaborative approach involving government bodies and public education to promote sustainable habits. By combining consistent monitoring with adaptive management and local community engagement, these interventions can provide a scalable model for protecting coastal health and reducing the flow of persistent plastic into marine environments.

Recommendations - The Researchers recommended the following:

- Strengthen the implementation of Pasacao's "no single-use plastics" ordinance, introduced in October 2025, by enhancing coordination with barangay-level enforcement teams and aligning local actions with national policies such as the National Solid Waste Management Commission Resolution No. 1363. Empowering barangay enforcers to educate businesses and reduce harmful packaging entering coastal areas.
- Conduct community workshops and educational campaigns about recycling, appropriate trash segregation, and the effects of marine litter on the environment.
- Design a trash trap for the study area, it should use durable, locally available materials to reduce costs and maintenance, adopt a modular, accessible design for efficient waste collection with minimal impact on water flow, and involve the community and stakeholders in monitoring and maintenance to ensure the effectiveness.
- To evaluate the effectiveness of waste management programs and trash traps in the research area, establish a routine monitoring and assessment system. In order to enable prompt improvements and evidence-based decision making, this should involve regular data collecting on waste volume and types, installed system performance, and community compliance.

***Implication for School and Education*.** This study offers a local foundation for environmental education by focusing on marine litter characterization in the coastal ecosystem of Balogo, Pasacao, Camarines Sur. The findings can be integrated into science curricula to help students grasp the impact of marine litter on coastal environments, transforming local shores into practical learning sites.

***Implications for Students*.** For students, this study links theoretical knowledge with environmental stewardship by highlighting the impacts of marine litter on the coastal ecosystem of Balogo, Pasacao, Camarines Sur. It helps students understand the importance of reducing pollution while developing skills in field data collection, waste characterization, and ecosystem monitoring.

AI Disclosure. We used **Grammarly, v1.2.255.1882**, February 2025, for grammar checking, **QuillBot** (February 2025) for paraphrasing and sentence refinement, **Perplexity AI**, **v26.16**, October 2025, looking for Related Literature and Studies, also for fact-checking, and **ChatGPT GPT-5**, September 2025, for asking questions, clarification, and fact-checking. All outputs were reviewed and edited by the authors. No confidential or personally identifiable data was entered into AI tools. The authors take full responsibility for the content.

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