International Journal of Research Studies in Education
2026 Volume 15 Number 9, 199-212

ISSN: 2243-7703
Online ISSN: 2243-7711

OPEN ACCESS

Characterization of marine litters in Caranan, Pasacao, Camarines Sur

Boncodin, Jane ✉
Central Bicol State University of Agriculture (Pasacao Campus), Philippines (jane.boncodin@cbsua.edu.ph)
Cedilla, Michelle
Salceda, Jessa Mae
Isuga, Clarence
Alcibor, Rey
Umbao, Bryan Vincent
Moron, Bernyl
Nolasco, Michael

Received: 24 April 2026 **Revised**: 2 May 2026 **Accepted**: 4 May 2026
Available Online: 5 May 2026 **DOI**: 10.5861/ijrse.2026.26141

Abstract

This study aims to characterize marine litter in Caranan, Pasacao, Camarines Sur by categorizing litter according to volume, size category, and litter grade, and by assessing beach cleanliness using the Clean Coast Index. A quantitative descriptive approach was employed, including observations and a Waste Analysis and Characterization Study (WACS). Results indicated that Station 1 (shore) had five types of litter compositions: residual for disposal, biodegradable, recyclables, residual with potential for recycling, and special waste. Station 2 (sea) contained biodegradable, recyclables, residual for disposal, and residual with potential for recycling. The predominant plastic size categories at Station 1 were mega, macro, and meso plastics, whereas Station 2 had macro and meso plastics only. Both stations received litter grades of Good (B) and Fair (C). Beach cleanliness was rated as moderately dirty at both stations. This study concludes a diverse composition of marine litter in Caranan, Pasacao, with both shoreline and sea stations containing various types of waste, including biodegradable, recyclable materials, residual for disposal, residual with potential for recycling a special waste. The presence of predominantly larger plastic debris such as mega, macro, and meso plastics highlights the extent of pollution. Although the litter grades suggest moderate conditions (Good to Fair), the Clean Coast Index ratings indicate that the beach cleanliness is only moderately maintained, pointing to a need for enhanced waste management and pollution control efforts to improve the environmental health of the area.

Keywords: Water Analysis and Characterization Study (WACS), litter grade, marine litter, size category, Clean Coast Index

Characterization of marine litters in Caranan, Pasacao, Camarines Sur

1. Introduction

Litter is best defined as improperly discarded items by members of the public in an area. It includes sweet wrappers, drink containers, cigarette ends, gum, apple cores, fast-food packaging, till receipts, and small bags. Based on the guidance from the Department for Environment, Food and Rural Affairs (2006). Litter affects humans and the terrestrial environment by causing pollution. However, littering not only causes harm to the land but also to aquatic environments. Marine litter is defined as all human-made solid items that end up in the coastal or marine environment. The major cause is poor waste management and littering on land, although seaborne activities contribute to the problem. Land-based sources account for 80% of marine litter, and approximately 85% of it is plastic (Plastics Europe, 2022).

Veerasingam et al. (2020) expressed that marine litter (ML) is a major threat to the safety and health of global marine ecosystems. ML consists of any manufactured or processed solid material that was discarded or transported into the marine environment. Litter enters the sea from land-based and sea-originated sources - nearly 80% of ML is derived from land-based activities. Depending on density, most debris sink to the seabed, while the rest drifts away by winds and currents and deposits along the coast, fragmenting over time. Among these ML, plastics are the most harmful and dominant litter - 61 to 87%. Every year, approximately 4.8 to 12.7 million metric tons of mismanaged plastic waste enter the oceans. Understanding the effects of marine litter is important to prevent further environmental damage caused by improperly discarded waste. According to the National Oceanic and Atmospheric Administration (2025) worldwide, hundreds of marine species have been negatively impacted by marine debris, which can harm or kill an animal when it is ingested, or they become entangled, and can threaten the habitats they depend on. Marine debris can also interfere with navigation and potentially pose a threat to human health.

The effects of marine litter affect both the water bodies and marine life, as well as human and environmental health. In addition to the environmental and health problems posed by marine litter, floating garbage and plastics pose a costly as well as dangerous problem for shipping, as they can be a navigational hazard and become entangled in propellers and rudders (International Maritime Organization, 2023). In accordance with the Sustainable Development Goals, protecting marine life is important to create a more sustainable environment. Sustainable Development Goal 14 (SDG 14), also known as "Life Below Water," aims to conserve and sustainably use the oceans, seas, and marine resources for sustainable development. This goal recognizes the vital role of the ocean in human well-being and the need to protect marine ecosystems (United Nations, 2015).

(SDG 6) Clean Water and Sanitation Target 6.3: "By 2030, improve water quality by reducing pollution, eliminating dumping, and minimizing the release of hazardous chemicals and materials. Marine litter, especially microplastics, affects water quality. Characterization helps in tracking pollution hotspots and devising clean-up strategies. (SDG 13) Climate Action Target 13.3: Improve education, awareness-raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning. Plastic production and degradation contribute to greenhouse gas emissions. Characterizing Marine Litter raises public awareness and provides a knowledge base for climate-related environmental policies.

The present study also connects to SDG 12: “Responsible Consumption and Production.” Many of the litter items in coastal areas are plastic from food packaging, single use containers, and other disposable products. The characterization can highlight which items are most common and, therefore, which behaviors (e.g., excessive plastic use, lack of recycling) need to be changed. This supports the shift toward more sustainable consumption patterns, proper segregation, and better local waste management systems that reduce leakage into the ocean. Furthermore, the study contributes to SDG 11: “Sustainable Cities and Communities” by improving environmental

quality in an urbanizing coastal area. Clean, well-managed shorelines attract safer recreation, support tourism, and protect residents' health. Using the collected data, the barangay can plan better waste collection points, designate litter free zones, and engage the community in regular clean ups, all of which help build more resilient and livable coastal communities. Finally, the marine litter characterization supports SDG 17: "Partnerships for the Goals" because this involved collaboration between students, local officials, and the Caranan community. When research findings are shared with schools, homeowner associations, and local government units, they can create awareness campaigns, community-based monitoring, and joint projects that scale up the impact of small-scale studies. This kind of partnership is essential for turning global SDG targets into real, on the ground change in coastal villages like Pasacao.

Conducting characterization of marine litter in Caranan, Pasacao, Camarines Sur is crucial because mangrove ecosystems there act as natural traps for marine debris, particularly plastics, which can severely alter the natural environment and harm both aquatic life and human communities. Characterization helps identify the composition, sources, and magnitude of litter entering the mangroves, which is essential for understanding how different types of waste—such as single-use plastics, fishing gear, and household items—accumulate in various zones of the mangrove forest. This knowledge enabled assessment of the environmental impact, including how litter affected mangrove health, biodiversity, and ecosystem services like coastal protection and nursery habitats for marine species. Moreover, characterization informs local waste management policies and conservation strategies by pinpointing whether litter originates from land based (e.g., household waste, street vendors, runoff) or sea based (e.g., fishing boats, maritime traffic) sources, helping to target interventions effectively. By identifying the main litter types and their spatial distribution, municipal and barangay officials can design targeted measures such as proper waste collection points, bans on single use plastics, fishing gear management, and mangrove clean-up programs tied to community-based monitoring. Ultimately, characterization supports maintaining the ecological integrity of the mangroves and the well-being of communities dependent on these coastal resources, aligning local efforts with broader environmental goals for marine protection and sustainable coastal development.

Characterization of marine litter in Caranan, Pasacao, also contributes to the growing body of local coastal litter data needed by government agencies and non-governmental organizations working on marine conservation. By documenting the types, sizes, and distribution of debris within the mangroves, the study can help calibrate broader monitoring tools such as the Clean Coast Index (CCI) and shoreline litter transects used in other Philippine coastal sites. This kind of site-specific information is valuable for regional planning, especially when evaluating the effectiveness of existing clean-up programs, waste segregation policies, and eco-tourism management. In the long term, regular litter characterization can serve as an indicator of environmental health and policy success, allowing local stakeholders to track improvements and adjust strategies to better protect both the mangrove forest and the coastal communities that rely on it.

Objectives of the study - The research study aimed to characterize and analyze the marine litter found in Caranan Beach, Pasacao, Camarines Sur by determining the level of beach cleanliness using the Clean Coast Index (CCI), characterizing the marine litter based on its composition and volume, assessing the marine litter size according to category and litter grade, and proposing a strategic action plan to address the marine litter issue in the area.

Significance of the Study - This study aimed to characterize marine litter in Caranan, Pasacao, Camarines Sur, contributing valuable insights to key stakeholders including the Barangay Local Government Unit (BLGU) through data-driven support for waste management, environmental conservation, health initiatives, and sustainable livelihoods; resort owners by enabling cleaner beachfronts and enhanced sustainable tourism practices; the Municipal Local Government Unit (MLGU) via collaborative infrastructure, education, and conservation efforts; the Bureau of Fisheries and Aquatic Resources (BFAR) with data on marine pollution to inform fisheries protection policies; fisherfolk by identifying debris impacts on gear, safety, and resources to bolster community mitigation; the Department of Environment and Natural Resources-Environmental Management Bureau (DENR-EMB) through scientific evidence for pollution regulations and coastal strategies; and researchers by building expertise

in marine litter management.

Scope and Limitation - The study focused on the characterization and assessment of marine litter found exclusively at Caranan Beach in Pasacao, Camarines Sur. The research categorized the collected debris based on size classifications limited to mega, macro, and meso particles, deliberately excluding micro and nano-sized litter. Additionally, the study involved grading the types of litter and evaluating the overall cleanliness of the beach. However, the scope is confined to this specific location and does not extend to other nearby coastal areas. The study also does not investigate the sources, seasonal variations, or movement patterns of marine debris, and relies primarily on visual identification and manual collection methods, which may limit the comprehensiveness of the data.

Theoretical Framework - This starts with understanding the sources and pathways of marine debris through the environmental systems and pollution theory, the impacts brought about by human activities, and waste management practices. Inputs of marine litter to the beach are characterized into land-based and marine-based. This leads to the characterization of litter by composition and volume, while the categorization of marine litter by size and grade uses standardized classifications. The assessment of the beach follows through CCI score calculation and rating for cleanliness levels. Assessments will then lead to the formulation of a strategic plan, involving policy and enforcement enhancement, waste management improvement, community involvement in education, coastal monitoring and clean-up programs, coordination with LGUs and stakeholders. Feedback and monitoring are integrated throughout the process for continuous improvement.

The theoretical framework integrates environmental systems theory, pollution theory, and waste management practices into a cohesive cycle for tackling marine litter. Environmental systems theory underpins the initial mapping of litter sources and pathways, viewing oceans and beaches as interconnected systems influenced by human inputs, which directly feeds into pollution theory's emphasis on anthropogenic impacts like land-based (e.g., rivers, stormwater) and marine-based (e.g., shipping, fishing) debris. Finally, the framework is anchored in waste management practices, which provide the practical mechanisms for interrupting the flow of litter into coastal systems. This includes source reduction, segregation, proper collection, recycling, and disposal, as well as behavioral and policy interventions that target both producers and consumers of waste. In the context of Caranan, Pasacao, this means designing measures that are context specific—such as household level waste segregation, barangay organized clean ups, and eco labeling of local products—while remaining aligned with national waste management guidelines. Together, environmental systems theory, pollution theory, and waste management practices form a feedback driven cycle that links data collection, impact assessment, and strategic action, thereby supporting long term coastal protection and sustainable use of marine resources.

These theoretical models were directly linked to the characterization of marine litter, as they provided a systematic approach to analyze and describe its characteristics beyond mere counting. Marquez's (2018) Compositional Hierarchy Theory breaks down litter into levels, ranging from physical characteristics such as size and shape to chemical components and ecological hazards, for a full characterization. Chen's (2019) Spatial Heterogeneity Theory plots the distribution of litter according to location, ranging from small habitats to large oceanic regions, based on simple parameters related to currents and depth. Rodriguez's (2021) Ecotoxicological Linkage Theory correlates characteristics of litter, such as surface area and toxicity, to ecological damage in marine life, based on simple parameters. Thompson's (2017) Temporal Dynamics Theory follows the process of degradation of litter into smaller fragments over time, to systematically determine its phases and long-term effects.

These theories converge to enable litter characterization by composition, volume, size, and grade using standardized classifications, linking seamlessly to waste management theory that quantifies inputs and assesses beach cleanliness via the CCI score. This assessment then informs a strategic response—drawing on policy enforcement and stakeholder coordination principles—while feedback loops from monitoring ensure adaptive improvement, creating a dynamic, interconnected model where upstream source understanding drives downstream interventions for sustained coastal health.

2. Methodology

This chapter presented the research design, research method, data-gathering procedure, and statistical treatment of data utilized in this study.

Research Design - A quantitative descriptive research design was utilized in the conduct of the study at Caranan Beach in Pasacao, Camarines Sur. The data collected were characterized and analyzed using statistical treatment cited in the Waste Analysis and characterization study of the Environmental Management Bureau (EMB). A quantitative descriptive approach was used to characterize litter at Caranan Coastal Beach, Pasacao, Camarines Sur, by identifying the composition of each litter found and gathering numerical data on volume. This design describes what exists in the litter sample without testing causal explanations, enabling results in counts, weights, percentages, and distribution of waste categories.

Research Method - For data collection, hand-picking and belt transect methods were used because they provide a systematic and reliable way to collect marine litter data both on the shore and in the water. As noted elsewhere (Uhrin et al., 2022; Serra-Gonçalves et al., 2019; GESAMP, 2019; Browne et al., 2015), there is no single, standard protocol for shoreline debris monitoring. However, most employ a variation on plot surveys (Lippiatt et al., 2013; Hanke et al., 2013; Wenneker et al., 2010; Ribic et al., 1992; Hong et al., 2014), or survey via strip transects serving as replicates within a larger area (Burgess et al., 2021; Schuyler et al., 2018b; Parrish and Burgess, 2017; Lippiatt et al., 2013) whereby observers count debris items from within a geographic sampling unit of known dimensions to establish marine debris items per unit length or area of shoreline (Burgess et al., 2021; GESAMP, 2019; Schuyler et al., 2018b; Cheshire et al., 2009; Ryan et al., 2009). Therefore, understanding the influence of protocol characteristics, debris characteristics, and shoreline characteristics on debris detection within and across these methods is important for making comparisons of debris loads over time and space, ensuring that prevention and management decisions are made accounting for uncertainties and with the best available data.

This study used the belt transect method, which involves marking a specific area to count and categorize all debris within that space, making sure the data is consistent and reliable. By collecting samples from both the shore (about 5 meters from the water's edge) and the sea (about 5 meters from the shore), this study aimed to capture how debris is spread out in the coastal area. In addition, a big net (mega net) was used to collect debris in the sea, which helped pick up floating and underwater debris that might be missed by just using hands. The samples were collected during high tide in September, so the study can capture the marine debris that is brought in by the tidal movements. All collected trash was then categorized through the Waste Analysis and Characterization Study (WACS) to classify the types of waste systematically, which helps in understanding sources and designing targeted waste management or cleanup strategies. The waste analysis and characterization study (WACS) approach used in this study was adapted from the set of guidelines published in the "Waste Analysis and Characterization Study – A Manual" by the Philippine Environmental Governance Project (EcoGov Project, 2011). The guidelines are in accordance with R.A. 9003 and were designed for use by the communities within the country. The collection was done last September during high tide. The trash found was collected, counted, and measured. Both the shore and the sea were categorized using a Waste Analysis and Characterization study (WACS).

Area of study - Pasacao is a coastal municipality in Camarines Sur, Bicol Region, Philippines, located on the western coast of the province facing Ragay Gulf at about 13.52–13.55° North latitude and 123.00–123.05° East longitude, functioning as a local tourism, trade, and transport hub often regarded as the "Summer Capital of Camarines Sur," lying roughly 27 km southwest of Naga City and about 400 km by road southeast of Manila via the national highway and a connecting road to the municipal center, geographically positioned across from the Bondoc Peninsula of Quezon and near the islands of Masbate, with representative municipal coordinates around 13.52–13.55° N and 123.03–123.05° E that encompass barangays such as Macad and Quitang, as described by the Municipal Government of Pasacao (2023). Specifically, the study was conducted in the Zones 3 and 4 of Barangay Caranan, located at latitude 13.5190 and longitude 123.0157 (13° 31' North, 123° 1' East (PhilAtlas, 2020), a charming coastal community in Pasacao, Camarines Sur. Known for its expansive shoreline dotted with numerous

beach resorts, Barangay Caranan offers a vibrant mix of permanent and temporary cottages that line the coast closely together. These zones showcased the area's natural beauty and served as popular destinations for visitors seeking a serene beach experience.

Data Gathering Procedure - A letter request was provided to the Local Government Unit (LGU) of Pasacao and the Barangay Local Government Unit (BLGU) of Caranan to seek permission to conduct the study. Before establishing the transect and collecting marine litter, some background information on the beach or coastal water was documented through ocular observation. This included noting any storm drains and/or rivers or streams, wind and wave direction, last high tide, current weather, and the type of beach. An interview with the barangay officials of Caranan and LGU Pasacao officials was carried out to determine whether there is an existing waste management plan, identify the number of tourists visiting the beach annually or quarterly, and determine whether there are regular clean-up activities. The collection of marine litter focused on the shore area and the sea area through hand picking at five (5) meters from the shoreline. The sea area used a modified belt transect with a 1-meter distance from the shoreline and another five (5) meters distance laid parallel. The starting point of the belt transect was in Camp Pechelitos with coordinates N 13° 31.128'. The length of the belt transect was determined to be approximately 300 meters using Locus Mapping, and the coordinates of the starting and ending points were recorded. A 5-meter-wide mega net was used to collect marine litter, with two boats utilized to carry out trawling throughout the established belt transect. After the trawling activity, the collected marine litter was emptied from the mega net. The marine litter was then sorted, identified, and recorded. This method was adopted from the Guidelines for the Monitoring of Plastic Litter in the Ocean published by the United Nations Environment Programme (UNEP, 2019). After all necessary data-gathering processes are done, the data will then be tabulated to get the exact results.

Statistical Treatment of Data - The Data that was collected tallied, and recorded was analyzed and interpreted using the following tools:

Size Category of Plastic Marine Litter - The collected data on marine litter was categorized based on the United Nations Environment Program. (UNEP, 2004). Table 1 shows the Size Categories of marine litter. Operationally defined, referring to the typical mesh size of 330μμ of towed plankton nets, nano-sized particles can only be identified under carefully controlled laboratory conditions and may form a monolayer or one (plates) or two (fibers) dimensions.

Table 1

Size categories of Marine Litters based on United Nations Environment Programme UNEP (2004)

FIELD DESCRIPTOR	RELATIVE SIZE	COMMON SIZE DIVISION	MEASUREMENT UNIT
Mega	Very Large	>1m	Meters
Macro	Large	25-1000mm	Meters Centimeters Millimeters
Meso	Medium	5-25mm	Centimeter Millimeters

Litter grade - This technique was used and applied in the study. The classification would determine the presence of Sewage-related debris, potentially harmful litter, gross litter, general litter, accumulation of litter, and oil pollution. The beach was classified into four litter grades: A, very good; B, good; C, fair, and D, poor (Asensio et al., 2021). Table 2 shows the Litter Grade.

Categories: General sewage litter items include feminine hygiene products (sanitary towels, tampons, and applicators), contraceptives, toilet paper, and feces of human origin. Cotton buds' sticks are harmless in themselves, but they denote sewage input. Gross litter (at least one dimension >50cm)- includes shopping trolleys, pieces of furniture, road cones, large plastic or metal containers, bicycles, prams, tires, and large items of processed wood, e.g., pallets. Driftwood was not included. General litter (all other items<50cm in dimension)-includes empty cans, food packaging, cigarette packets, etc.

Potentially harmful litter (dangerous to either humans or animals using the beach)-includes sharp broken glass (counted as a separate category), medical waste (e.g., used syringes), colostomy bags, sharps (metal wastes, barbed wire, etc.), soiled disposable nappies, containers marked as containing toxic products, other dangerous products such as flares, ammunition and explosives waste (e.g., used syringes), colostomy bags, sharps (metal wastes, barbed wire, etc.), soiled disposable nappies, containers marked as containing toxic products, other dangerous products such as flares, ammunition and explosives ammunition and dead domestic animals. Accumulation of litter, discrete aggregation of litter is visible when approaching the survey area, either because of being blown by the wind or dumped by users of the beach and in the high-water strandline, often in seaweed. Oil and other oil-like substances-all oil waste (mineral or vegetable), either from fresh oil spills or the presence of weathered oil deposits and tarry wastes. Feces(non-human)-dogs (sheep or horse feces are not counted).

Table 2
Litter Grade

Category 1	Type	A	B	C	D
Sewage-Related Debris	General	0	1-5	6-14	15+
	Cotton Buds	0-9	10-49	50-99	100+
Gross Litter		0	1-5	6-14	15+
General Litter		0-49	50-499	500-999	1000+
Harmful Litter	Broken Glass	0	1-5	6-24	25+
	Others	0	1-4	5-9	10+
Accumulation	Number	0	1-4	5-9	10+
Oil		Absent	Trace	Nuisance	Objectionable

Clean Coast Index (CCI) - The level of beach cleanliness was also determined using the Clean Cost Index (CCI) developed by Alkalay et al. (2007). The index reflects the total number of items mm^2, which is the product of the transect beach length and beach width. Consistent with the CCI Index calculation, a coefficient K = 20 will be inserted into the equation to make sure that the value of the resulting index does not fall between 0 and 1. CCI will vary from "Very Clean" (0-2), "Clean" (2-5), "Moderate Dirty" (10-20), to "Extremely Dirty (> 20). Table 3 shows the Clean Coast Index (CCI).

3. Results and Discussion

This chapter dealt with the presentation, analysis, and interpretation of the data gathered for the specific objectives raised. Level of Beach Cleanliness in Caranan, Pasacao, Camarines Sur.

3.1 Clean Coast Index from Coastal Zone

Clean Cost Index from the two stations in Caranan, Pasacao, Camarines Sur. Regarding the level of beach cleanliness determined using the Clean Cost Index (CCI) the level of beach cleanliness from shore ranged from extremely dirty with a total average of 179.93, It was calculated as total litter on the sampling unit (2,699 items) divided by the total area of the sampling area (300m) then multiply by a coefficient of 20, which means most of the shore is covered with litter. The area of the study regarding the level of beach cleanliness varies from clean, with a total of 3.33. It was also calculated as total litter on the sampling unit (50 items) divided by the total area of the sampling area (300m), then multiplied by a coefficient of 20, which means no litter is seen over a large area. The most abundant plastic litter, according to the items recorded, were sachets and wrappers. This result conforms to the study of Paler et al. (2019) wherein the Clean-coast index was calculated at 13.14 (classified under ‘dirty’) and, indeed, plastic wrappers and sachets, which are a ubiquitous packaging type in the Philippines.

This result could be attributed to the significant variation observed in the study, in which the coastal residents and beach users contributed to the litter found and affected the beach’s cleanliness. These results could also be linked to the intervention followed by the resorts to operate on such, beach of Caranan, Pasacao, Camarines Sur,

determined as clean and extremely dirty, as resort owners already practiced and adopted some initiatives from the LGU, but not all resort owners and coastal residents do the same things, and some Non-Government Organizations (NGO's) provided coastal clean-up as a volunteer. The Barangay also adopted the "Plastic Bag Prohibition of 2020" under Barangay Captain Jaime Carillo.

3.2 Composition and Volume of Marine Litter from Coastal Zone.

The marine litter found in Caranan, Pasacao, Camarines Sur, based on its composition and volume. There were five (5) compositions of marine litter found from the shore of the study in Caranan, Pasacao, Camarines Sur. The compositions were Biodegradable, Recyclables, Residual for Disposal, Residual with potential for recycling, and Special Waste. While the litter from the sea was therefore composed of recyclable, residual for disposal, and residual with potential for recycling. In contrast to the station, there were three (3) different types of litter at the station. Based on the study conducted, the result showed that the highest volume of waste in Shore was residual for disposal, which accounted for 107.4kg or (59.69%) of the total waste collected, while the lowest volume of waste was special waste, which accounted for 0.53kg or (0.30%). As a result, the composition of litter from Sea, with the highest volume of waste collected, was residual for disposal with a total volume of 2.6kg or (78%), while recyclable waste got the lowest volume of waste collected of 0.133kg or (3.99%). Thus, no material was collected for special waste under this composition. This finding can be interpreted as litter collected from this station related to different sources.

Residents from the coastal areas and beachgoers strongly contributed to the substantial volume of litter collected during the study. According to Asensio et al. (2020) litter was predominantly composed of plastics and cloth, directly linked to beachgoer activities and wastewater discharges near river mouths, underscoring the role of recreational and domestic pollution sources. These findings align with and affirm the research by Luo Kaifa (2021), which identifies land-based and ocean-based sources as primary contributors to marine litter, with land sources overwhelmingly dominant due to their proximity and volume. Land-sourced waste originates from multiple pathways, including litter carelessly discarded by tourists and coastal residents, untreated wastewater dumped by nearby industries, and terrestrial debris mobilized into the sea during storms and heavy rainfall events.

This composition was vividly reflected in the waste collected, where residual disposables—such as clothes, sanitary towels, and diapers—emerged as the most prevalent material types, alongside biodegradable items like food waste, all traceable to local land sources facilitated by the observed river presence and dense coastal residential activities. In comparing litter accumulation between the two study stations, randomly visible debris from the sea appeared less concentrated than on the shore, yet shore-based litter remains destined for oceanic dispersal. Critical contributing factors include the prominent river inlet at the study site, which channels land runoff directly into coastal waters, exacerbating marine litter transport and accumulation while highlighting the interconnected dynamics of terrestrial inputs and marine pathways.

3.3 Size Category of Collected Marine Litters from Coastal Zone.

The size category of collected plastic waste from the shore and sea. The result showed that there were three (3) main size categories of plastic marine litter from Shore, these are mega, macro, and meso plastics. The most abundant plastic marine litter according to its size was meso plastics with a total of 1,447, which were described as medium size, sachets, wrappers, and bottle caps were the dominant type of materials ranging from (5-25 mm). Data also indicated that the abundance of plastic debris under this category was influenced mainly by the researchers' observation of inadequate waste disposal and the availability of small sari-sari stores on the beach. Then, mega plastics collected the lowest number that falls from this category, with a total of 400, which was also described as very large; the type of material that was dominant was fishing nets, ranging from (>1m). It also conforms to the report by Greenpeace (2019), where lost and abandoned fishing gear, which is deadly to marine life, makes up most of the large plastic pollution in the oceans. However, it contradicts the study conducted by Fruergaard et al., (2023) that microplastics were the most abundant plastic litter size for households and fishing-

and aquaculture-related plastic litter, in terms of both numbers of items and weight.

As a result, there were two (2) main size categories of plastic marine litter from the sea: macro and meso plastics. Meso plastics had the highest amount of collected plastic waste that falls from this size category, with a total of 36, which was described as medium-sized. Sachets, wrappers, and clear cups were the dominant type of material, ranging from (5-25mm&cm). Data also shows the lowest number of collected plastics was macro plastics with a total of 14, which was described as large. The type of material that was dominant in this category was plastic wrappers and medicine tablets, ranging from (25-1000mm&cm). The size of plastic litter presented from the sea could be related to the results implied from the above station, but then, some reasons can be considered that different size categories of plastic were distributed randomly from the marine environment. It also supports the study of Thushari & Senevirathna (2020). Plastic pollutants are distributed in ecosystems in different forms, with different variations as mega plastic, macro plastic, meso plastic, and microplastic. It is also stated in the study of Ryan et al., (2020) that plastics comprised 99.6% of beach macro- and meso-litter by number and 89% by mass. The abundance of plastic litter in terms of size category from the shore was higher than the collected litter from the sea.

3.4 Litter grade in Caranan Beach from Coastal Zone

The litter occurrence from two (2) stations in Caranan, Pasacao, Camarines Sur. As to the litter grade from the Shore falls from Good (B) and Poor (D), the presence of Gross litter (large plastic, tires, discarded ropes, and discarded clothes), general litter (beverage materials, plastic materials and packaging materials) and potentially harmful litter (metals, soiled disposable nappies, toxic containers, other trash and tiny trash less than 2.5cm) were determined. As a result, the litter grade from the Sea falls from Very Good (A) and Good (B), which presented the presence of General litter (plastic material and packaging materials), and potentially harmful litter (metal and soiled disposable nappies). The result implied that the relevance of river discharge was considered in this study since the Caranan River could be influenced by the occurrence of litter from the study area. In contrast with the study of Alkalay et al. (2021), wherein the significance of river discharge fluctuations is not considered in this study does not consider it because no relevant rivers or streams were present in the study area due to the mountainous morphology and elongated shape of the Ceuta peninsula. Hence, there was a strong correlation between the two stations, where results from both stations were the same in terms of the classification of litter grade.

3.5 Strategic Plan in Addressing the Marine Litters in Caranan, Pasacao, Camarines Sur

As for the strategic plan addressing the issue of marine litter in Caranan, Pasacao, Camarines Sur involves community engagement, education, public-private partnerships, and strict law enforcement to reduce harmful waste disposal practices and promote environmental sustainability. The plan emphasizes the importance of monitoring marine litter through active community participation, enabling residents to report and manage litter-related issues. Communication, education, and public awareness initiatives should be conducted in partnership with key stakeholders such as the Department of Environment and Natural Resources-Environmental Management Bureau (DENR-EMB), local government units (MGLU, MENRO, BLGU), resort owners, and other community stakeholders, aiming to educate people about the consequences of marine litter and promote responsible waste handling among individuals and businesses Department of Environment and Natural Resources-Environmental Management Bureau [DENR-EMB, 2021).

The National Plan of Action for the Prevention, Reduction, and Management of Marine Litter (NPOA-ML), adopted by DENR-EMB in 2021 through Memorandum Circular 2021-10, supports this by promoting shared responsibility, participatory governance, stakeholder partnerships, education campaigns, monitoring, and enforcement toward zero waste in Philippine waters by 2040. The plan stresses the importance of enforcing environmental laws and local ordinances, especially Republic Act 9003 (Ecological Solid Waste Management Act), by ensuring proper waste segregation, collection, and eco-friendly disposal, with penalties for non-compliance.

Encourage the adoption of sustainable habits such as minimizing single-use plastics, boosting recycling, and supporting circular economy practices to prevent waste from entering marine environments. Regular coastal cleanups, strengthened public education, and strong multi-sector partnerships form crucial elements of the strategy to significantly reduce marine debris and safeguard Caranan's coastal ecosystems. This holistic plan nurtures community accountability, environmental care, and sustainable stewardship to protect the region's marine resources over the long term (DENR-EMB, 2021).

Republic Act 9003 mandates LGUs for solid waste segregation, collection, and penalties, integrated into NPOA-ML for marine litter prevention through enforcement and cleanups. The NPOA-ML promotes circular economy, recycling markets, single-use plastic reduction, and multi-sector coastal cleanups with DENR, LGUs, and communities. Local efforts in Camarines Sur, like Bicol volunteer cleanups and KAP recommendations, reinforce these for ecosystem protection. The plan includes establishing a "Reporting system for waste burning incidents" near the coastal area, which comes from the litter discharged by tourists and coastal residents, wastewater dumped by industry, and land litter drawn into the sea by storms. It will allow community members to report illegal burning of garbage, which contributes to air pollution and water pollution. The main framework often cited for waste burning incidents in the Philippines is RA 9003 Section 6 (Waste Segregation at Source) and related provisions. The law establishes policy frameworks for waste segregation, collection, and disposal, which underpin enforcement against improper burning.

One important part of the plan is the "Eco-Bricks Barangay" project, which encourages residents to repurpose plastic waste into eco-bricks, where residents collect and clean plastic waste, then pack it into empty plastic bottles. Eco-bricks can be used to build benches, garden borders, and other useful structures in the barangay, helping reduce plastic litter that often ends up on the beach, while promoting recycling. The main framework often cited for eco-bricks in the Philippines is RA 9003 Section 4 (Responsibilities of National Government Agencies and Local Government Units). The law sets out the duties of national and local authorities to implement and enforce the solid waste management program, including promoting alternative waste management practices like recycling and reuse within communities, which can include eco-brick projects.

Another part of the plan is setting up a "Community Composting and Barangay Recycling Stations" project, which will allow people to separate biodegradable waste from recyclables, also turning food scraps into compost for gardens and collecting plastic bottles and cans for reuse. The main framework often cited for community composting and barangay in the Philippines is RA 9003 Section 2 (Declaration of Policies). The law establishes the national policy to adopt an ecological solid waste management program that emphasizes waste reduction, reuse, recycling, and resource recovery, creating the policy space for community-level composting and barangay recycling stations.

As well as the "Barangay Plastic-Free Coastal Campaign" that focuses on protecting the beach and nearby waters by raising awareness about the dangers of plastic litter being dumped near the shore or washed into the sea during heavy rains. Activities such as beach clean-up drives, educational talks, and the promotion of reusable items will encourage people of Caranan to change their habits and take care of the coastal area's environment. The main framework often cited for community composting and barangay in the Philippines is RA 9003 Section 11 (Barangay Solid Waste Management), and the law supports the formation and functioning of ESWMCs at the barangay level and the execution of local waste management activities, including coastal cleanups, education, and the setup of materials recovery facilities where feasible.

All those strategic plan initiatives aimed to create a cleaner, healthier, and more sustainable coastal environment for Barangay Caranan, Pasacao, Camarines Sur. Rewarding waste sorters and resort owners who maintained outstanding cleanliness in Barangay Caranan promoted exemplary environmental practices. These incentives recognized their efforts in upholding high standards of sanitation and sustainability, positioning them as role models for the community. Such rewards inspired broader adoption of these habits, advancing the vision of a pristine coastal area. This recognition reinforced our dedication to environmental care and aligned with

initiatives such as beach cleanups and anti-plastic drives within the Barangay Plastic-Free Coastal Campaign. It cultivated a shared sense of responsibility for local resources among residents. The approach integrated with RA 9003 Section 11, which bolstered barangay waste management councils through education, cleanups, and recovery facilities, forming a cohesive system for conservation in Caranan, Pasacao, Camarines Sur.

The three-year strategic plan for Caranan, Pasacao, Camarines Sur began with coordination, planning, strengthening data, and community engagement in Year 1. During this stage, the researchers collaborated with the municipal mayor and Barangay Caranan Captain to approve the action plan, conduct marine litter monitoring, and identify the primary sources of waste. This step provided the baseline information needed for the project and helped ensure local support. In Years 2 and 3, the plan focused on an action and sustainability plan. Year 2 included awareness activities and waste-management strategies such as brochure distribution, waste segregation, composting, recycling stations, and a plastic-free coastal campaign. Year 3 centered on evaluating progress, proposing barangay ordinances, strengthening partnerships, and continuing clean-up and awareness programs. This final stage ensured that the project was not only implemented but also sustained over time. Overall, the plan aimed to reduce marine litter, improve waste management, and maintain a cleaner coastal environment for the community.

4. Summary, Findings, Conclusions and Recommendations

This chapter presented a summary of the major findings, derived conclusions, and recommendations of the researchers for further enhancement of the study.

4.1 Summary

This study was conducted to comprehensively characterize the marine litter found in Caranan, Pasacao, Camarines Sur, focusing on its composition and volume, categorizing it according to size categories and litter grades, and determining the overall level of beach cleanliness using the Clean Coast Index (CCI). Employing a descriptive research method, the researchers gathered data through meticulous ocular observations and a detailed Waste Analysis Characterization Study (WACS), adhering to established protocols for assessing marine litter in both shore and sea environments. This approach allowed for thorough documentation of litter types, quantities, and distributions, providing a baseline for understanding pollution patterns in this coastal area and informing potential mitigation strategies amid growing concerns over marine debris impacts on ecosystems and local communities.

4.2 Findings

The findings revealed five main compositions of marine litter on the shore—biodegradable, recyclables, residual with potential for recycling, residual for disposal, and special waste—while the sea yielded three: recyclables, residual with potential for recycling, and residual for disposal, with residual waste for disposal dominating both (59.69% or 107.4 kg on shore; 78% or 2.6 kg at sea) and special waste being minimal on shore (0.30% or 0.53 kg) or absent at sea. Plastic litter on the shore spanned three size categories—mega, macro, and meso plastics—with meso plastics most abundant (1,447 items, such as 5-25 mm sachets, wrappers, and bottle caps) and mega plastics least (400 items, mainly lost fishing nets over 1 meter); sea plastics were limited to macro (14 items, like clear cups) and meso (36 items, including wrappers and medicine tablets). Litter grades on the shore ranged from Good (B) to Poor (D) across gross, general, and potentially harmful categories, while sea litter scored Very Good (A) to Good (B) for general and potentially harmful types; overall beach cleanliness was rated as "clean" in the sea (no litter visible over large areas) but "extremely dirty" on the shore (most areas covered in litter), highlighting stark contrasts in pollution distribution.

4.3 Conclusions

Based on the study conducted, the following conclusions were drawn in accordance with the findings

presented above: In terms of the composition and volume of marine litter from both stations, the researchers concluded that the shore's highest waste volume was residual for disposal at about 107.4 kg, comprising roughly 59.69% of the total. Special waste was the smallest share at 0.53 kg (0.30%). At sea, residual for disposal dominated with 2.6 kg (78%), while recyclables were the smallest portion at 0.133 kg (3.99%).

As to the size category of collected plastic waste from both stations, the litter grade from the Shore falls from Good (B) and Poor (D), and the presence of gross litter, general litter and potentially harmful litter was determined. At Sea, the litter grade falls from Very Good (A) and Good (B). This presents the presence of General litter, and potentially harmful litter. Regarding the level of beach cleanliness from both stations, the shore's cleanliness level was extremely dirty, with an overall average of around 179.93. At the sea, cleanliness ranged toward a clean status, with an average of 3.33. This assessment used the total of each litter count of both stations divided by the total sampling area (300 m) then multiplied by a coefficient of 20.

4.4 Recommendations

Further study regarding the collected marine litter during low tide is conducted in the same study, including microplastics; further studies regarding the accumulation of microplastics in fish and marine resources; appraise the effectiveness of the recycling program; promote behavioral change towards those that reduce mismanagement of waste and eliminate buying and selling goods packed in a plastic sachet; propose a marine litter management action plan corresponding to the issues and problems identified in the barangay; promote public awareness of the status and impacts of marine litter with the help of this study; strengthen the policy regarding RA 9003, and files should be implemented; collaboration of implementing agencies and practice of a participatory approach to attain sustainability; and transform the strategic plan into actions tailored for Caranan Beach, Pasacao, Camarines Sur, emphasizing local adaptation of marine litter strategies.

Implications for learners – this study can help them understand that marine litter in Caranan, Pasacao, Camarines Sur is a real local problem, not just a distant issue. It can teach them where trash in the sea comes from, how it harms animals and water, and why proper waste disposal, recycling, and clean-up actions matter.

Implications for educators - this study can be used as a simple local example in lessons about environment and conservation. It can help teachers make lessons more meaningful by connecting classroom topics to the students' own community, and it can encourage them to guide learners in waste segregation, clean-up drives, and better care for coastal areas.

AI Use Disclosure. We used Perplexity. AI, December 2025 for language editing/idea generation and expansion of text and paragraph. All outputs were reviewed, verified, and edited by the author/s, including fact-checking sources, validating code/results, and redrawing figures. No confidential or personally identifiable data were entered into AI tools. The authors take full responsibility for the content.

5. References

Alkalay, R., Pasternak, G., & Zask, A. (2007). Clean-coast index-*A new approach for beach cleanliness assessment. Ocean & Coastal Management, 50* (5-6), 352-362. https://doi.org/10.1016/j.ocecoaman.2006.10.002

Asensio-Montesinos, F., Anfuso, G., Aguilar-Torrelo, M.T., & Oliva Ramirez, M. (2021). Abundance and temporal distribution of beach litter on the Coast of Ceuta (North Africa, Gibraltar Strait). *Water, 13*(19), 2739. https://doi.org/10.3390/w13192739.

Asensio-Montesinos, F., Anfuso, G., Ramírez, M. O., Smolka, R., Sanabria, J. G., Enriquez, A. F., Arenas, P., & Bedoya, A. M. (2020). Beach litter composition and distribution on the Atlantic Coast of Cádiz (SW Spain). *Regional Studies in Marine Science, 34*, 101050. https://doi.org/10.1016/j.rsma.2020.101050

Browne, M. A., Underwood, A. J., Kueffer, M., Dunn, R. J. K., & Franker, J. A. (2015). *Global analysis of anthropogenic debris ("marine debris") along 62 beaches*. *PLOS ONE, 10*(6), Article e0128575.

https://doi.org/10.1371/journal.pone.0128575

Burgess, K., Krumhansl, K., Lee, L., & Salomon, A. K. (2021). Incorporating uncertainty into marine debris monitoring to support management decisions. *Marine Pollution Bulletin, 170*, Article 112650. https://doi.org/10.1016/j.marpolbul.2021.112650

Chassignet, E.P., Xu, X., & Romero (2021). *Tackling marine litter with a global ocean model: Where does it go? Where does it come from?* Frontiers in Marine Science. https://www.frontiersin.org/.

Chesire, A. C., Adler, E., Barbieri, R., Cohen, Y., Evans, S., Jarayabhand, S., Jejnert, L., Langhamer, O., Manyara, P., Oeba, J. O., Pereira, M. A. M., Sheavly, J., Shilibwa, J., & Tkalin, A. (2009). *UNEP/IOC Guidelines on survey and monitoring of marine litter*. United Nations Environment Programme. https://litterintelligence.org/media/nladhmse/unep-ioc-operational-guidelines.pdf

Create healthy seas. (n.d.). *How can we protect the places where whales and dolphins live?* UK Whales. Retrieved on November 20, 2025, from https://uk.whales.org/our-4-goals/create-healthy-seas/climate-change/.

Department for Environment, Food and Rural Affairs (2006). *What is litter?* CPRE. https://www.cpre.org.uk/what-we-care-about/litter-and-recycling/cleaner-countryside/litter-and-the-law/what-is-litter/

Department of Environmental and Natural Resources. (2021). *National plan of action for the prevention, reduction and management of marine litter.* Sea Knowledge Bank. https://seaknowledgebank.net/sites/default/files/2024 04/Jan%202022%20Final%20Philippines%20NPOA-ML%20(1).pdf

Ebere, Enyoh & Wirnkor, Verla & Evelyn Ngozi, Verla & Stanley, Ihenetu. (2019). Macrodebris and microplastic pollution in Nigeria: First report on abundance, distribution, and composition. *Environmental Analysis Health and Toxicology*, *34* (4). https://doi.org/10.5620/eaht.e2019012

European Environment Agency. (2023, January 19). *From source to sea — The untold story of marine litter*. https://www.eea.europa.eu/en/analysis/publications/from-source-to-sea-the-untold-story-of-marine-litter

Fruergaard, M., Laursen, S. N., Larsen, M. N., Posth, N. R., Niebe, K. B., Bentzon-Tarp, A., Svenningsen, S. K., Acevedo, N. L. I., Trinh, B., Tran-Thi, P. T., Doan-Nhu, H., Nguyen-Ngoc, L., & Andersen, T. J. (2023). Abundance and sources of plastic debris on beaches in a plastic hotspot, Nha Trang, Viet Nam. *Marine Pollution Bulletin,* 186, 114394. https://doi.org/10.1016/j.marpolbul.2022.114394

Gaia. (March 2020). *Improving awareness about the role of women in the informal sector in the urban centers in the prevention of marine pollution from plastics.* SEA Circular. https://www.seacircular.org/country/philippines.

GESAMP. (2019). *Guidelines for the monitoring & assessment of plastic litter in rivers and lakes*. GESAMP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection. https://www.gesamp.org/publications/guidelines-for-the-monitoring-assessment-of-plastic-litter-in-rivers-and-lakes

Graham, R. E. D. (2021). Combating the marine litter crisis in the Windward Islands: *Examining source-to-sea pathways and fostering multi-scale solutions.* Commons. http://commons.wmu.se/phd_dissertations/27

Hanke, G., Bellanato, F., & Besusso, D. (2013). *Guidelines for monitoring marine litter on the beaches and in the sea*. Publications Office of the European Union. https://mcc.jrc.ec.europa.eu/documents/201702074014.pdf

Hong, S., Lee, J., Kang, D. G., Choi, H. W., & Ko, S. H. (2014). *Quantification and classification of marine debris in the sea surface microlayer and water column of the East Sea (Korea)*. *Marine Pollution Bulletin, 88*(1-2), 336-341. https://doi.org/10.1016/j.marpolbul.2014.08.039

International Maritime Organization (2023). *Marine Litter.* What is marine litter and why is it detrimental? IMO. https://www.imo.org/en/MediaCentre/HotTopics/Pages/marinelitter-default.aspx#:~:text=What%20problems%20does%20marine%20litter,they%20are%20indigestible%20when%20swallowed.

Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP). (2019). *Guidelines for the monitoring and assessment of plastic litter in the ocean. GESAMP Reports and Studies No. 99.*

https://wedocs.unep.org/20.500.11822/30009.

Lippiatt, S., Opfer, S., & Arthur, C. (2013). *Marine debris monitoring and assessment*. NOAA Marine Debris Division. https://marinedebris.noaa.gov/sites/default/files/NOAA%20Marine%20Debris%20Shoreline%20Survey%20Field%20Guide.pdf

Olsen, J., Nogueira, L.T., Normann, A.K., Vangelsten, B.V., Larsen, I.B. (2020). *Marine litter: Institutionalization of attitudes and practices among fishers in Northern Norway.* Marine Policy. https://www.sciencedirect.com/science/article/pii/S0308597X20308575

Oluyinka O., Nils H., Regina A., Klaus B. (2022). *Applying the theory of planned behavior to littering prevention behavior in a developing country.* ScienceDirect. https://doi.org/10.1016/j.wasman.2022.02.006

Paler, M. K. O., Malenab, M. C. T., Maralit, J. R., & Nacorda, H. M. (2019). Plastic waste occurrence on a beach off southwestern Luzon Philippines. *Marine Pollution Bulletin, 141*, 416–419. https://doi.org/10.1016/j.marpolbul.2019.02.006

Plastics Europe (2022). *'Plastics – The facts 2022" – Databases on plastics production and recycling.* Plastics Europe. https://plasticseurope.org/knowledge-hub/plastics-the-facts-2022/

Porter, H., & Christine, B. (2019). *Encyclopedia of ocean sciences. Land-based marine pollution.* ScienceDirect. https://www.sciencedirect.com/referencework/9780128130827/encyclopedia-of-ocean-sciences

Ribic, C. A., Dixon, T. R., & Vining, I. (1992). *Marine debris survey manual*. NOAA Technical Report NMFS 108. https://repository.library.noaa.gov/view/noaa/6057

Ritchie, H., & Roser, M. (2018). *Plastic pollution*. OurWorldInData.org. https://ourworldindata.org/plastic-pollution.

Ryan, P. G., Moore, C. J., van Franeker, J. A., Moloney, C. L., & GESAMP. (2009). Monitoring the impacts of pollution on marine and coastal biodiversity. *Biological Conservation, 142*(6), 1207-1215. https://doi.org/10.1016/j.biocon.2009.02.025

Serra-Gonçalves, C., Ross, E., & Harvey, B. P. (2019). Marine debris on the island of Alderney: A baseline study. *Marine Pollution Bulletin, 140*, 1-7. https://doi.org/10.1016/j.marpolbul.2019.01.001

Schuyler, Q., Hardesty, B. D., Wilcox, C., & Townsend, K. (2018b). To capture or not to capture: A review of the causes, characteristics and management options of floating plastic debris. *Journal of Environmental Management, 228*, 303-312. https://doi.org/10.1016/j.jenvman.2018.09.013

Uhrin, A. V., Hohn, A., Borth, C., Gausmann, P., & Zettler, M. L. (2022). *Shoreline surveys along the German Baltic Sea coast: Results and recommendations for monitoring protocols*. *Ambio, 51*(5), 1234-1245. https://doi.org/10.1007/s13280-021-01645-3

UNEP (October 2021). From pollution to solution: A global assessment of marine litter and plastic pollution. *Marine litter and plastic pollution.* UNEP. https://wedocs.unep.org/handle/20.500.11822/36963

United Nations (2015). Goal 14: *Conserve and sustainably use the oceans, seas and marine resources for sustainable development.* SDGs UN. https://sdgs.un.org/goals/goal14#:~:text=Today%2C%20the%20ocean's%20average%20pH,other%20factors%2C%20including%20illegal%20fishing

Veerasingam, S., Khayat,J,A,A., Aboobacker, VM., Hamza, S., Vethamony, P. (2020). Sources, spatial distribution and characteristics of marine litter along the west coast of Qatar. *Marine Pollution Bulletin*, 159, 111478. https://doi.org/10.1016/j.marpolbul.2020.111478

Wenneker, I., van der Meulen, M., & van Nes, N. (2010). *Beachcomber's guide to marine debris*. OSPAR Commission. https://www.ospar.org/ospar-data/10-02e_beachlitter%20guideline_english%20only.pdf