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Peconic Estuary Partnership

Project: Identification, Distribution, and Source Assessment of Microplastics in the Peconic Estuary

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BACKGROUND

Microplastics (MPs) have become an omnipresent component of the man-made litter that pollutes aquatic environments. These micro-sized particles, whose diameters range from 5 mm down to submicron, can be intentionally created (e.g., microbeads, industrial pellets) or derived from the breakdown of larger plastic items (Arthur et al., 2009). The majority of MP debris in aquatic systems originates from terrestrial sources and is transported to coastal areas by rivers (Lusher, 2015; Zhang, 2017), discharged by sewage treatment plants (Alimi et al., 2018), discharged as surface runoff (Mintening et al., 2017), or is windborne. Once entering coastal areas, they can be transported vertically within the water column, laterally along the coast or advected to the open ocean via current, tidal, or wind forces (Enders et al., 2015; Kanhai et al., 2017; Rios et al., 2010).

As a consequence of aggregation and vertical transport, some MPs reach and accumulate in benthic habitats, where they are ingested by diverse groups of benthic organisms, including commercially important mollusk and fish species (Imhof et al., 2012; Martin et al., 2017; Woodall et al., 2014). However, the consequences of MPs in aquatic food webs are still largely unknown (Lohmann, 2017). For instance, MPs can adsorb persistent organic contaminants, such as PCBs, from the water column or sediment pore waters. Hence, MPs have been hypothesized to serve as efficient carriers of organic contaminants into food webs, enhancing bioaccumulation in upper trophic levels (Zettler et al., 2013). Furthermore, MPs originating from municipal water pollution control plants (WPCPs) or discharged as runoff could act as transport vectors for attached/adsorbed pathogenic microorganisms. For example, Enterobacteriaceae pathogens have been abundant on polypropylene within estuaries near municipal WPCPs (Oberbeckmann et al., 2018).

Current estimates indicate that approximately 5.25 trillion macro and micro plastic particles have found their way into surface waters of the global ocean (Eriksen et al., 2014). However, this only accounts for 1% of the mismanaged plastic waste stream believed to enter the oceans annually (Enders et al., 2015). One of the causes of this mismatch could be that techniques used to sample, detect, and identify plastics are only suitable for particles >0.3 mm, (e.g., plankton tow nets) ignoring a potentially important fraction of marine plastic debris. In addition, most MP studies focus on quantifying MP abundance but ignore polymer identity, mass or volume, effectively eliminating the possibility for plastic mass flux calculations. Moreover, the effect of physical, chemical and biological processes in aquatic systems on the breakdown of MPs remains unclear, and thus their exchange and export of MPs among ecosystem compartments needs to be resolved.

The Peconic system is a shallow, well-mixed estuary located between the north and south forks of Long Island with an area of ~155,000 acres. This coastal environment supports diverse marine communities and 140 globally and locally rare species. The Peconic Estuary and its watershed have been identified as one of the Nature Conservancy´s Last Great Places in the western hemisphere. The estuary provides feeding habitat as well as spawning and nursery grounds to a variety of aquatic and terrestrial species. Despite this, studies of the transport and fate of MPs

in this ecosystem do not exist. Consequently, data on MP concentrations, distributions, sources, fates, and the subsequent effects on resident organisms are unknown for the Peconic Estuary.

This project was the first to begin to address MP dynamics in the Peconic Estuary. Our goal was to determine the primary factors (e.g., intensity of the Peconic river discharge, touristic activity) affecting concentrations of specific MP polymers and their distribution within this coastal environment. We sampled waters throughout the Peconic Estuary system at 19 water stations during the wet (pre-tourism) and dry (tourism) seasons (Figure 1). In addition, we conducted systematic beach surveys of MPs at 6 strategic beach supratidal (or intertidal??) stations during both seasons to determine the degree of localized beach deposition.

Combining the above approaches will establish a general baseline for MP loads and distributions within the Peconic Estuary system. The survey design and analytical approach will provide insights into MP sources and transport processes. The dataset is also likely to generate a myriad of follow-up hypotheses to guide future MP research in this system and elsewhere. Achieving our proposed objectives will further contribute to our understanding of how plastic pollution might affect the Peconic Estuary's ecology and will generate new information that is critical for decision-makers regarding future ecosystem restoration.

PROJECT OBVECTIVES

- Determine concentrations, volumes, and distribution of MPs suspended in Peconic Estuary waters and deposited across beach sediments during wet and dry seasons.
- Identify the chemical composition of MP polymers recovered and its estimated volume to derive polymer mass for MP mass flux calculations.
- Perform source assessments of MPs based on chemical identities, morphological attributes, and distributional patterns.

METHODS

We surveyed the spatial distributions of MPs during two contrasting periods. Once during August 2024, when Peconic River discharge was lowest, and touristic activity was higher and a second campaign in late April 2025 to capture the spring freshest and lower touristic activity. During each sampling event, we collected three complementary sample types to capture a broad size spectrum and environmental compartment of MP contamination. Surface waters were sampled using discrete water collections to target particles <300 μm, a size fraction historically underrepresented in monitoring efforts. Larger particles (>300 μm) were collected using zooplankton net tows. Finally, beach sand were sampled at three locations to identify potential accumulation zones of marine plastic debris.

Field Activities

The field activities started in August 14, 2024 in collaboration with the Office of Ecology of the Suffolk County Department of Health Services (SCDHS). We divided Peconic Bay into two areas due to the extensive area covered by the sample design. On August 14, we sampled the

west Peconic Bay, including the Peconic River, Flanders Bay, Great Peconic Bay, and Little Peconic Bay. We visited 13 bay stations (Figure 1) collecting discrete surface (~ 0.5 meter) water samples for the analysis of the micron-size MP (~1 to 300 µm) and conducted six nets tows (Figure 3) to collect samples for the analysis of the macro size fraction (>300 µm).

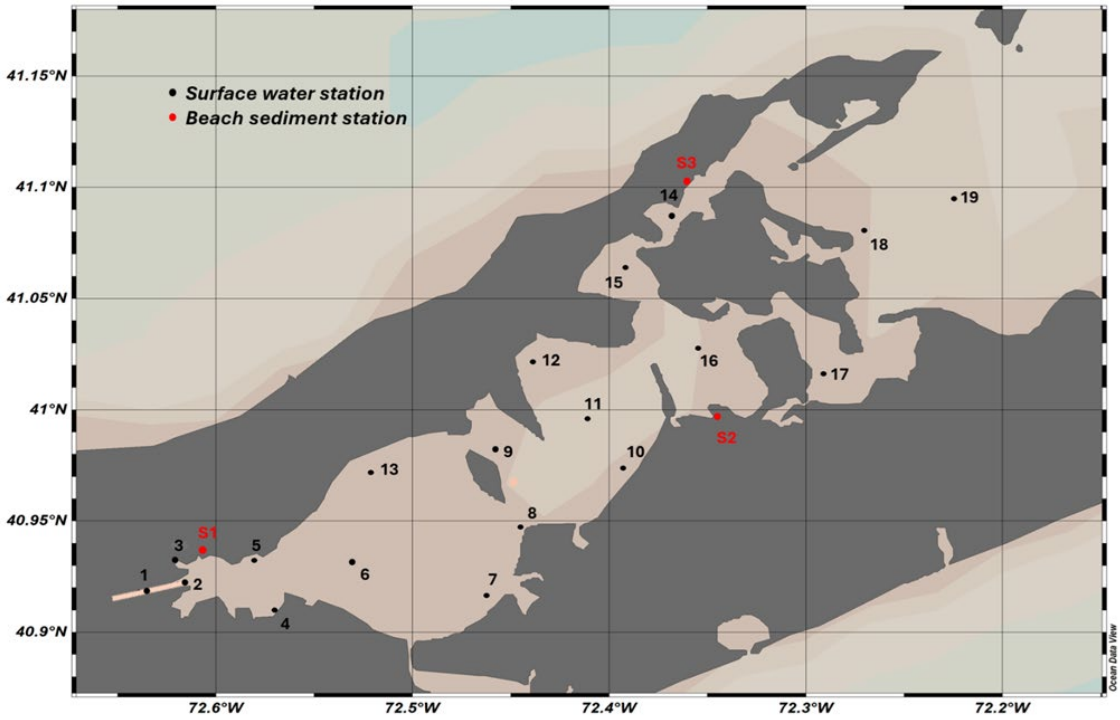


Figure 1. Map of the study area showing the location of 19 bay water and 3 beach sediment sampling sites. Water samples (black circles) and beach sand samples (red circles).

The east Peconic Bay was sampled on August 21, 2024. We collected discrete surface water samples from 6 stations (stations 14-19) for the analysis of the micron-size MP (~1 to 300 µm) and conducted six nets tows to collect samples for the analysis of the macro size fraction (>300 µm). In addition, on August 28, we conducted systematic beach surveys of MPs at three strategic beach sediment stations (Figure 1). Sample sites covered the north and south shores of the estuary, targeting creeks and potential point sources, for example, the oyster farm at Hogneck Bay (station 12) and the Peconic River (station 1).

Due to the high abundance of Ctenophores that rapidly clogged our plankton net during the August 14 sampling effort, we could not collect valid net samples. A second trip to the west Peconic Bay was conducted on October 10, 2024, during which we collected 6 samples for the analysis of the large size fraction (>300 µm).



Figure 2. Pictures showing some sample stations in Peconic Bay (a) and (b) Station 12, Oyster farm at Hog Neck Bay. (c) Plankton net deployed at station 4. (d) Office of Ecology of the Suffolk County Department of Health Services (SCDHS) research boat at the dock in Greenport.

The second field campaign was conducted during April 2025, also in collaboration with the Office of Ecology of the Suffolk County Department of Health Services (SCDHS). We followed the same sampling design of our previous sampling campaign, with 19 stations across the east and west Peconic bay. We visited 19 bay stations collecting discrete surface water samples for the analysis of the micron-size MP (~1 to 300 µm) and conducted 12 nets tows to collect samples for the analysis of the large size fraction (>300 µm). In addition, we conducted systematic beach surveys of MPs at three strategic beach sediment stations (Figure 1). Sample sites covered the north and south shores of the estuary, targeting creeks and potential point sources, for example, the oyster farm at Hogneck Bay (station 12) and the Peconic River (station 1).

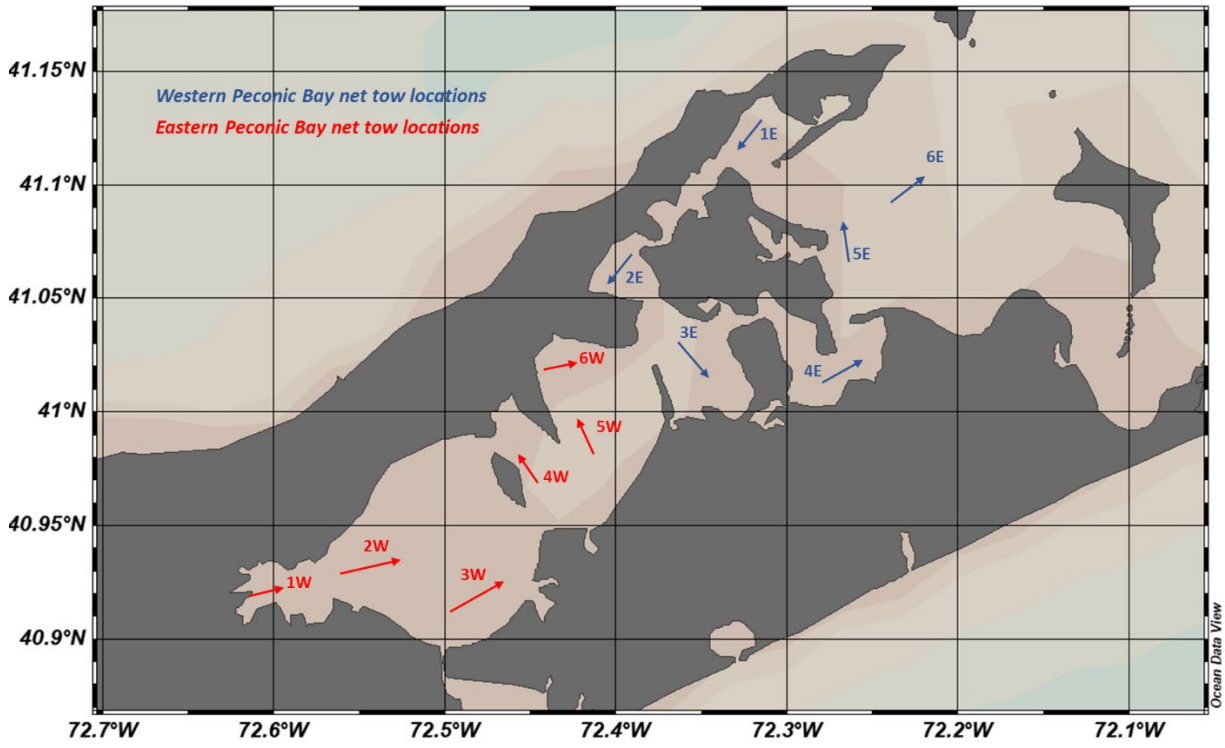


Figure 3. Map of the study area showing the location of 12 surface net tows. Eastern Peconic Bay stations (red arrows and numbers) and western Peconic bay stations (blue arrows and numbers).

Collection of Discrete Water Samples

Surface water samples were collected from the SCDHS boat directly into 1 L glass bottles. In addition, one field blank was secured during each field trip to account for inadvertent contamination. Water samples were processed in the laboratory by filtering through a metal 300 and 60 µm sieves and then through a 0.2 µm Al_2O_3 to capture all MP particles between 0.2 and 300 µm in diameter. Each filtered sample was oxidized using hydrogen peroxide (30%) at 60°C for 12 h to remove excess organic material (Gago *et al*., 2019; Medina Faull et al., 2021). Polymers identified as plastic via Raman spectra were sized, counted, and subjected to image analysis to derive volumes.

Collection of Sediment Samples

Sediment samples were collected at 3 sandy beaches located in key areas of the estuary (Fig. 1). At each beach, five samples at least 5m apart were collected at the strandline (transect in the highest tidal extent). MPs were sampled from the top 5 cm of sediment using a metal spoon and combining several scoops at arm length in an arc-shaped area at the strandline to collect ~250 g of sediment (Imhof et al., 2012). Samples were stored in glass bottles, transported back to the laboratory and frozen until further analysis.

The extraction of MPs from beach sediment samples was achieved via density separation according to Imhof et al. (2012). A filtered saturated sodium chloride solution (NaCl) was used for the separation medium. After density separation, the extracted sample was filtered through a 300-µm stainless steel sieve, and any remaining sample material was collected in a glass bottle. Plastic particles larger than 300 µm in diameter were visually sorted and analyzed using our confocal Raman microspectrophotometer to confirm chemical identity. Plastic-positive particles were photo-documented using an AMscope camera model MU130 connected to a Discovery V.8 binocular (Carl Zeiss) microscope from the microbial marine ecology laboratory at SoMAS. Each particle was measured (surface area and mass) and any remaining sample was filtered separately through an Anopore inorganic filter (25 mm diameter and 0.2 µm pore size). These filters were analyzed using Raman microspectroscopy to measure MP concentrations and identify polymer materials contained within the samples.

Collection of Net Tows Samples

Net tows were conducted in parallel with discrete water sampling. Surface MPs (>300 µm) were collected using a zooplankton net fitted with 300 µm mesh and a detachable cod end. At each station, the net was deployed from the upwind/upcurrent side of the boat and towed at the surface for 10 minutes at ~2.5 miles/h, maintaining a consistent net position at/just below the air–water interface. A calibrated mechanical flowmeter (General Oceanic) mounted in the net mouth was used to quantify the volume of water filtered during each tow; initial and final flowmeter readings were recorded for every deployment. Upon retrieval, the net was rinsed externally with 0.2 µm filtered distilled water to ensure that all retained material was capture into the cod end. Cod end contents were transferred into pre-cleaned bottles. To assess and minimize contamination, field personnel avoided synthetic clothing, when possible, sample containers remained closed except during transfer, and field blanks were collected at least once per sampling day and processed alongside environmental samples.

To quantify the number of MP particles L^{-1}, the volume filtered was calculated from flowmeter output as:

$$V = A \times L \qquad (1)$$

where V is volume (m^3), A is net mouth area (m^2), and L is tow length through water (m) derived from the flowmeter. Tow lengths were computed from flowmeter revolutions using the manufacturer's calibration constant:

$$L = k \times \left(R_f - R_i\right) \qquad (2)$$

where R_f and R_i are the final and initial flowmeter readings, and k is the distance-per-revolution calibration factor (m rev^{-1}). Concentrations were reported as particles per L by dividing particle counts by V.

Raman Analysis

Filter-captured MP particles were identified and quantified using a Renishaw® inVia™ confocal Raman microspectrophotometer housed in the NAno Raman Molecular Imaging Laboratory (NARMIL) at Stony Brook University. This instrument is configured with a modified upright Leica® DM2700TM epifluorescence microscope, a computer-controlled motorized x-y-z stage with 0.1 µm step size in all dimensions, four laser lines (457/514 nm Ar^+ ion laser, 633 nm He/Ne laser, 785 nm diode laser), and a spectrograph coupled to a 1040 × 256 Peltier-cooled CCD detector. Spectra were obtained using the 633 nm He/Ne laser at ~ 9.3 mW power at the sample. Spectra were acquired using 1200 lines mm^{-1} diffraction grating, a spectral range of 200–2500 cm^{-1}, and single CCD exposures of 0.7 s $spectrum^{-1}$. These instrumental settings was applied for all reported analyses.

Filter-based quantification of MP/NP particles:

After totaling the number of particles from 30 regions of interest (ROI), the number of MP particles per liter of sample (N) was calculated according to Eq. 3.

$$N: (Af*n)/(b*M*V) \quad (3)$$

where *Af* is the total exposed filter area (mm^2), *n* is the total number of MP/NP particles counted across all ROI, *b* is the number of ROI examined, *M* is the area of one ROI (mm^2), and *V* is the volume (L) of sample water filtered. Analytical uncertainty of the total number of particles (N) in each sample will be established by calculating the standard error from all 30 ROI counted per sample. Total number of particles per L will be reported as N ± 1 (standard error). The limit of detection (LOD) of the method corresponds to the detection of a single particle in a single microscopic ROI, though this varies depending on the volume filtered and the number of ROI analyzed. For example, if 1 L of water was filtered (*V*) and 30 ROI were analyzed (*b*). Applying equation 1, assuming that *n*=1 (only one particle was found across all 30 ROI), the LOD would be ~ 1800 particles L^{-1}.

MP/NP particle size, volume, and mass calculations:

Microplastic particle size, volume, and mass were calculated according to Medina Faull *et al*. (2021). With the aid of image analysis software (Renishaw® WiRE™ 5.2), each particle's dimensions, area, and equivalent spherical diameter (ESD) was determined. Areas were measured by counting total plastic-positive pixels assigned to each particle image. This particle area (*Ap*) was used to calculate the ESD by applying Eq. 4 from (Engel, 2009):

$$ESD=(\sqrt{(Ap/\pi)})*2 \quad (4)$$

With this information, an idealized spherical volume estimate for each particle were calculated by using the equation described by (Hillebrand *et al*., 1999) (Eq. 5):

$$V=4/3*\pi*(ESD/2)\text{^}3 \quad (5)$$

Masses of each plastic polymer in the MP/NP pool were then calculated using the volume estimates and published specific densities (g cm^{-3}) of each plastic polymer. To estimate the uncertainty propagated in the mass calculation (Mass relative error, RE = SD/mean) for each particle, analytical uncertainty in both the volume algorithm and mean density will be considered by applying the following equation (Harris, 2010):

$$\text{Mass RE}=\sqrt{((\text{RE vol})\text{^}2+(\text{RE den})\text{^}2)} \quad (6)$$

Statistical Analysis

A particle size distribution analysis was conducted based on the entire particle inventory from all 3 study sites (NECV, GSC, PAO, N = 304 particles). For this, differential particle size distribution (Burd & Jackson 2002) was used to describe the relationship between particle size (ESD) and abundance (number of particles). This relationship is generally approximated by a power-law function:

$$n = bd^{-k} \quad (7)$$

where n is a particle size distribution index, b is a constant, k is the slope (in log-log form), and d is particle diameter.

RESULTS AND DISCUSSION

A total of 68 samples were collected across Peconic Bay during two sampling campaigns (August 2024 and April 2025), comprising 34 samples per campaign. All samples, including 38 discrete water samples (particles <300 µm), 24 net tows (particles > 300 µm), 6 beach sediment samples, 4 laboratory blanks, and 4 field blanks, were processed according to the procedures outlined in the QAPP. Here, we present preliminary results from the August 2024 campaign only, which included 19 discrete water samples and 12 net tows. We are still processing beach sediment samples collected from stations in both the western and eastern basins of Peconic Bay, no data from these samples are yet available for this report.

We generated a novel dataset from MP particles in two size fractions <300 µm and >300 µm contained in discrete water samples and net tows collected from the Peconic Bay. Results highlight the numerical primacy of small MP particles in this coastal environment, a size fraction that has been totally overlooked in almost all marine MP surveys that primarily only sample the surface ocean by towing plankton nets (300 or 500 µm mesh). In addition, we were able to determine MP particle identities and sizes from which masses were computed. These refinements are critical because mass-based inventories will enable more accurate and meaningful estimations of global oceanic plastic inventories, thereby providing vital information for mass flux calculations of MPs through aquatic ecosystems.

Particle size distribution (<300 µm)

Across all regions of interest (ROIs) interrogated by Raman microspectroscopy, a total of 84 microplastic (MP) particles were identified from the August 2024 samples. In these discrete water samples, MP particles were strongly dominated by the fine size fraction. Equivalent

spherical diameters (ESD) ranged from ~1 µm to >61 µm, with approximately 60% of detected particles exhibiting ESD < 3 µm and the majority falling within the 1–6 µm size range (Fig. 3). Only three particles larger than 10 µm were detected across all discrete samples, and just one particle exceeded 60 µm ESD. Furthermore, the pre-sieving step in sample processing did not yield a single particle larger than 200 µm in any field sample, indicating that larger microplastic particles were comparatively rare in discrete water samples during this sampling campaign.

An exception was observed at Station 12, where several (14) particles larger than 60 µm were retained on the filter, suggesting localized enrichment of bigger MPs particles at that site. Otherwise , the metal 300 and 60 µm sieves never retained any MPs from discrete water samples. These 14 particles were identified as polypropylene (PP) red fragments, similar to those collected during net tows in the same station (see below).

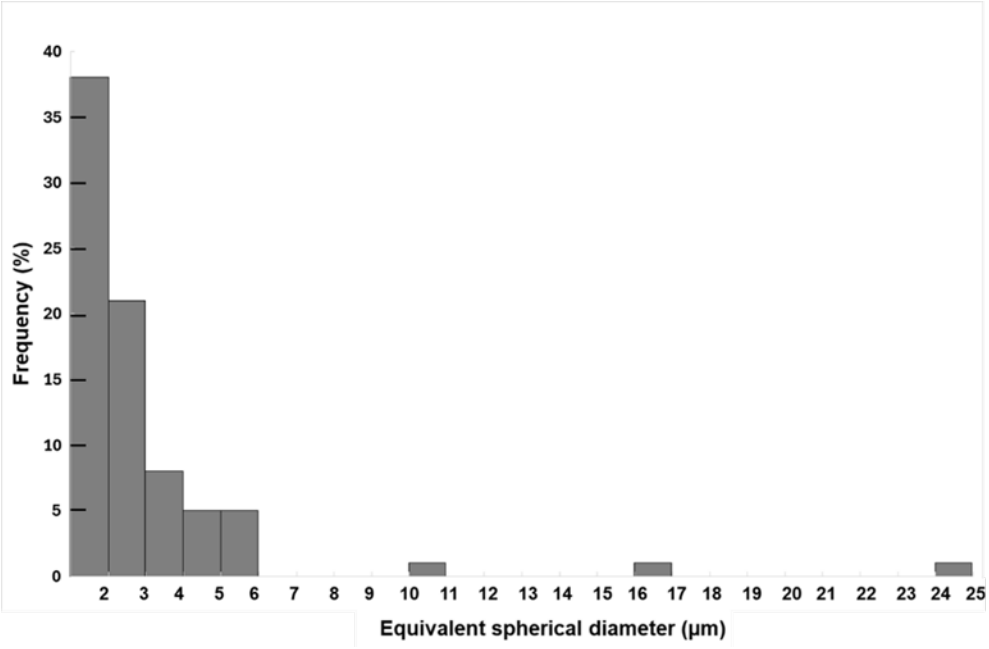


Figure 4. Particle size frequency distribution of all MPs found in ~1 L samples from Peconic Bay (N = 81 MP particles). Equivalent spherical diameter (ESD) of each particle was calculated using WiRE™ 5.1 image analyses software. Each bin width was calculated using the Freedman-Diaconis rule (Wilks, 2006).

Particle size distribution analysis was conducted based on the entire particle inventory from all stations. Figure 5 illustrates the relationship between particle size (ESD) and abundance (number of particles). This relationship is approximated by a power-law function, with a scaling exponent (λ): -2.15 (r^2 = 0.94, p < 0.001). This indicates a steep increase in particle abundance with decreasing size. Such scaling relationships are commonly associated with fragmentation-dominated systems in which larger plastic debris progressively breaks down into smaller particles through mechanical and photochemical degradation processes (Cozar et al., 2014)

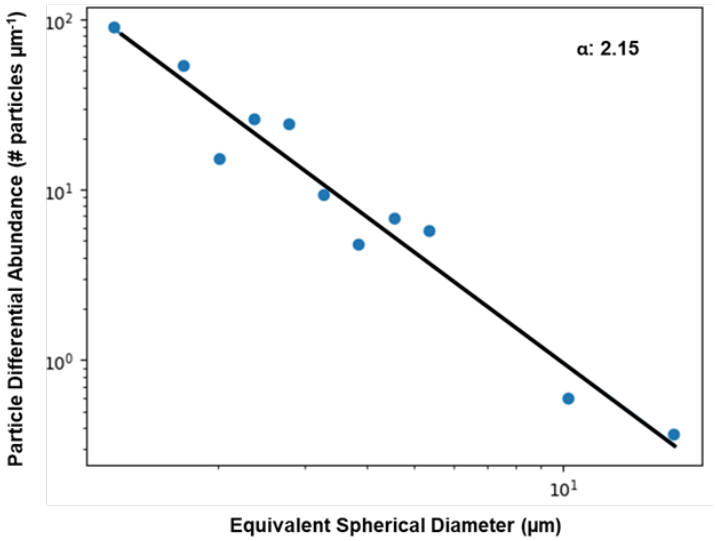


Figure 5. Particle size distribution analysis incorporating the entire particle inventory collected from all stations (N = 81 particles). Particle differential abundance is the particle abundance normalized by the width of each size bin (# Part μm^{-1}).

Based on fragmentation models, Cozar et al. (2014) suggested that in a steady-state system, continuous input of large plastic items subjected to three-dimensional fragmentation processes should yield a scaling exponent (*k*) of ~3 in Eqn. 5. A *k* of 3 indicates an equivalent number of particles among all logarithmically-scaled size bins examined (Kooi & Koelmans, 2019). In the present study, *k* was slightly lower (2.15), indicating a departure from steady-state conditions. MP particles >10 µm ("large MPs") were extremely rare in our samples, possibly affected by size-dependent removal processes reducing their residence times, such as aggregation, vertical transport, ingestion, or degradation.

Spatial distribution of MPs (< 300 µm)

MP particles sampled from the Peconic Bay stations during August 2024 varied in size from 1 to 61 µm ESD and 60% of this inventory were less than 3 µm. MPs were found in 13 stations, with abundances ranging from non-detectable levels at stations 7 and 8 to 50 ± 18 x 10^3 part L^{-1} (station 11) with a mean concentration of 12 ± 3 x 10^3 part L^{-1} (mean ± SE part L^{-1}). Microplastic particle concentrations exhibited strong spatial heterogeneity across Peconic Bay (Fig 6). Stations 10, 11, and 12 showed elevated particle concentrations, suggesting the presence of localized accumulation areas within the system instead of a gradient from the Peconic river (as potential source of MPs) towards the east.

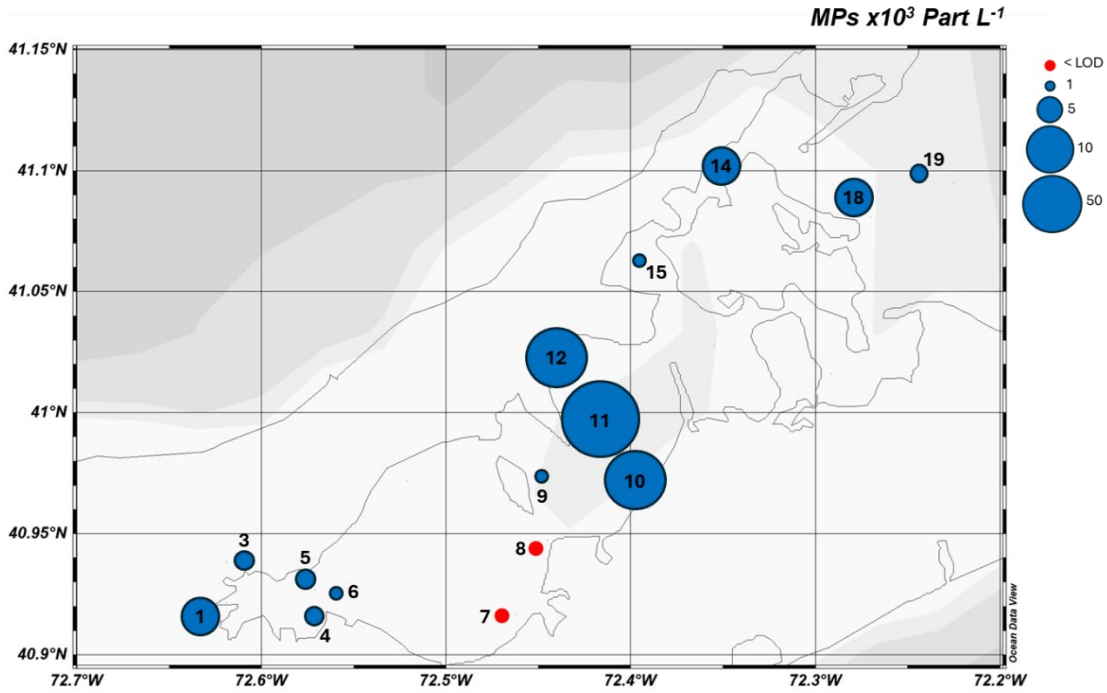


Figure 6. MP abundances (particle L^{-1}) among Peconic Bay stations approximated by bubbles size. Figure prepared partially on Ocean Data View (Schlitzer, R., https://odv.awi.de, 2023).

Our results also demonstrate that particle abundance does not directly correspond to the mass distribution of microplastics within the bay. Although small particles dominated numerical abundance in discrete samples, the total microplastic mass was largely controlled by relatively fewer large particles. For example, highest MP masses were detected at station 4 (Fig. 7), this high value was driven primarily by the presence of 1 particle identified as PcCu with an ESD of 61 µm (mean ESD of remaining particles = 5.56 ± 0.52 µm).

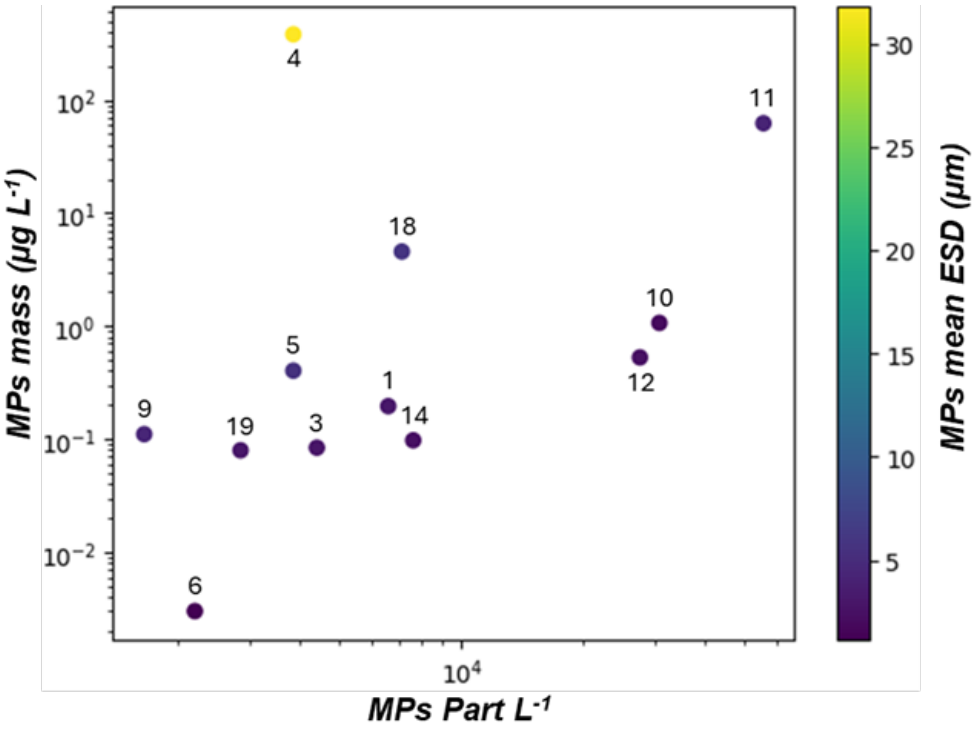


Figure 7. Relationship between abundance (Part L^{-1}) and mass (ug L^{-1}) in all stations sampled in the Peconic Bay. Log-Log scale, Color-coded by Mean ESD.

This decoupling between particle number and mass is expected given the cubic relationship between particle size and mass. A small number of "larger" particles can contribute disproportionately to the total MPs mass pool, whereas extremely small particles may dominate particle counts while contributing comparatively little mass. These findings emphasize the importance of reporting both particle abundance and mass metrics when assessing MPs, as each metric reflects different aspects of MPs contamination within aquatic environments.

Spatial distribution of MPs (> 300 µm)

A total of 12 tows were conducted during August 2024 across Peconic Bay, with six tows in West Peconic Bay and six in East Peconic Bay. However, due to clogging of the net during several deployments, an additional six tows were conducted in October 2024 in West Peconic Bay. During the initial August sampling, the excessive presence of Ctenophore jellyfish in the samples made it difficult to detect and quantify MP particles.

During the August-October survey, West Peconic Bay showed high concentrations of MPs larger than 300 µm. MP concentrations ranged from 20 particles L^{-1} at Station 1W to 2 particles L^{-1} at station 4W (Fig. 8). Across all samples, particles were consistently dominated by red fiber-like particles composed of polypropylene (PP), with a lengths between 50 µm to 4000 µm and a constant diameter of 50 µm, as well as cylindrical fragments of black polystyrene (PS) with an approximate diameter of 100 µm . Because of the similarity in particle morphology

across samples, potential contamination was considered. However, analysis of laboratory and field blanks, along with comparisons to samples collected using the same net and rope during other surveys, revealed no evidence that these particles originated from sampling equipment or laboratory procedures.

In contrast, East Peconic Bay exhibited lower MP concentrations (Table 1). MP abundance ranged from no detectable MPs at Stations 1E and 4E to a maximum of 0.1 particles L^{-1} at Station 3E and 5E. PP was the dominant polymer detected in these samples, followed by polyethylene terephthalate (PET). Some particles also exhibited Raman spectra consistent with phthalocyanine copper (PcCu) pigments.

Table 1. Net tows stations during the 2024 sampling campaign. Stations in the west Peconic Bay were sample in August and October, however only data from October is presented due to clog of the net in August. Zooplankton net with an aperture of 300 um were used to collect samples

Station	Date	Total vol filtered (L)	# particle detected	Part/L
1E	Aug 24	59,000	0	0
2E	Aug 24	59,000	2	0.07
3E	Aug 24	59,000	3	0.10
4E	Aug 24	59,000	0	0
5E	Aug 24	59,000	3	0.10
6E	Aug 24	59,000	1	0.03
1W	Oct 24	59,000	1193	20
2W	Oct 24	59,000	828	14
3W	Oct 24	59,000	270	5
4W	Oct 24	59,000	120	2
5W	Oct 24	59,000	302	5
6W	Oct 24	29,000	173	6

Microplastic concentrations in the east Peconic Bay measured using surface net tows (> 300 µm) fall within the range commonly reported in the literature for similar methodologies. For

example, using manta net mesh size of 200 µm, Montoto-Martinez et al, 2022, in comparative coastal study around the Canary Islands, Spain, found MP concentrations ranging from 0,12-to-0,75-part L^{-1}. In contrast, the west Peconic Bay showed high concentrations of MP during October 2024, indicating a more impacted environment.

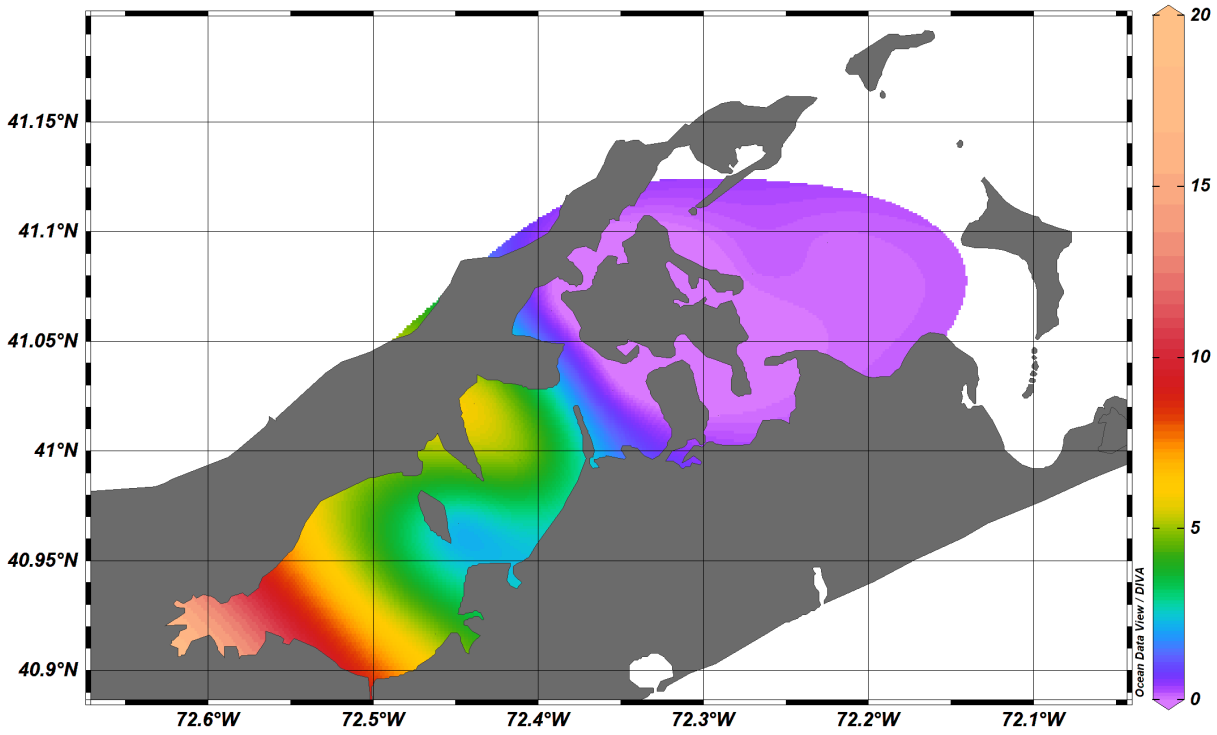


Figure 8. MP abundances (particle L^{-1}) among Peconic Bay stations sampled using net. Figure prepared partially on Ocean Data View (Schlitzer, R., https://odv.awi.de, 2023).

Polymer composition and potential local sources

The polymer composition was broadly consistent across size fractions, with PP, PS, PE and PET detected in both the large particles collected by net tows and the smaller particles analyzed in discrete water samples. This compositional continuity across size classes supports the interpretation (scaling exponent $\lambda = -2.15$) that the small particle fraction is, at least in part, derived from the fragmentation of larger particles within the system.

Within the small size fraction, polyethylene (PE) and particles exhibiting Raman spectra consistent with phthalocyanine copper (PcCu) were most frequently detected (Fig 9). PcCu is a widely used pigment in plastic manufacturing and has been reported in other microplastic studies, often associated with colored plastics and surface coatings (Medina Faull et al., 2024; Van Cauwenberghe et al., 2018). The numerical dominance of PcCu-containing particles (72% of all particles) suggests that pigment represents a significant source of secondary MPs in the system.

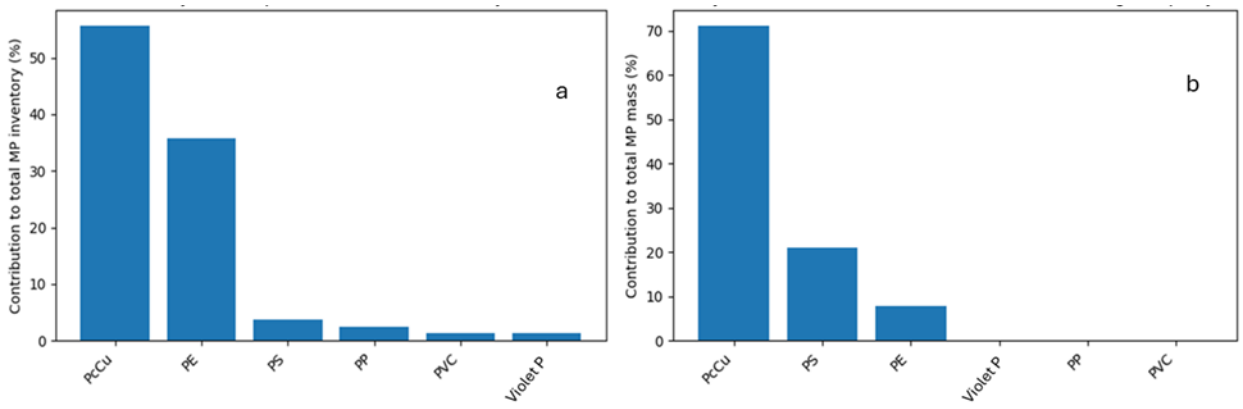


Figure 9. Polymer diversity among all stations in the Peconic Bay expressed as percent contribution to total MP particle inventory (a) and percent contribution to the total MP mass (b). Abbreviation key: PS = Polystyrene, PE = Polyethylene, PP = Polypropylene, PcCu = phthalocyanine copper blue, PVC = Polyvinyl chloride.

In contrast, the larger size fraction collected by net tows was consistently dominated by fiber-like particles composed of red PP (Fig. 10) and fragments of black polystyrene (PS). The PS fragments exhibited cylindrical morphologies. One potential source of these materials is aquaculture activity within Peconic Bay. Oyster farming has expanded in the region and relies heavily on plastic infrastructure, including ropes, cages, floats, and protective mesh. The prevalence of PP fibers and PS fragments in the large size fraction is consistent with materials commonly used in these operations. While definitive source attribution would require targeted source-tracking analyses, the co-occurrence of these polymers with aquaculture infrastructure and their progression across size fractions supports the hypothesis that oyster farming activities represent an important, spatially constrained source of MP in the bay.

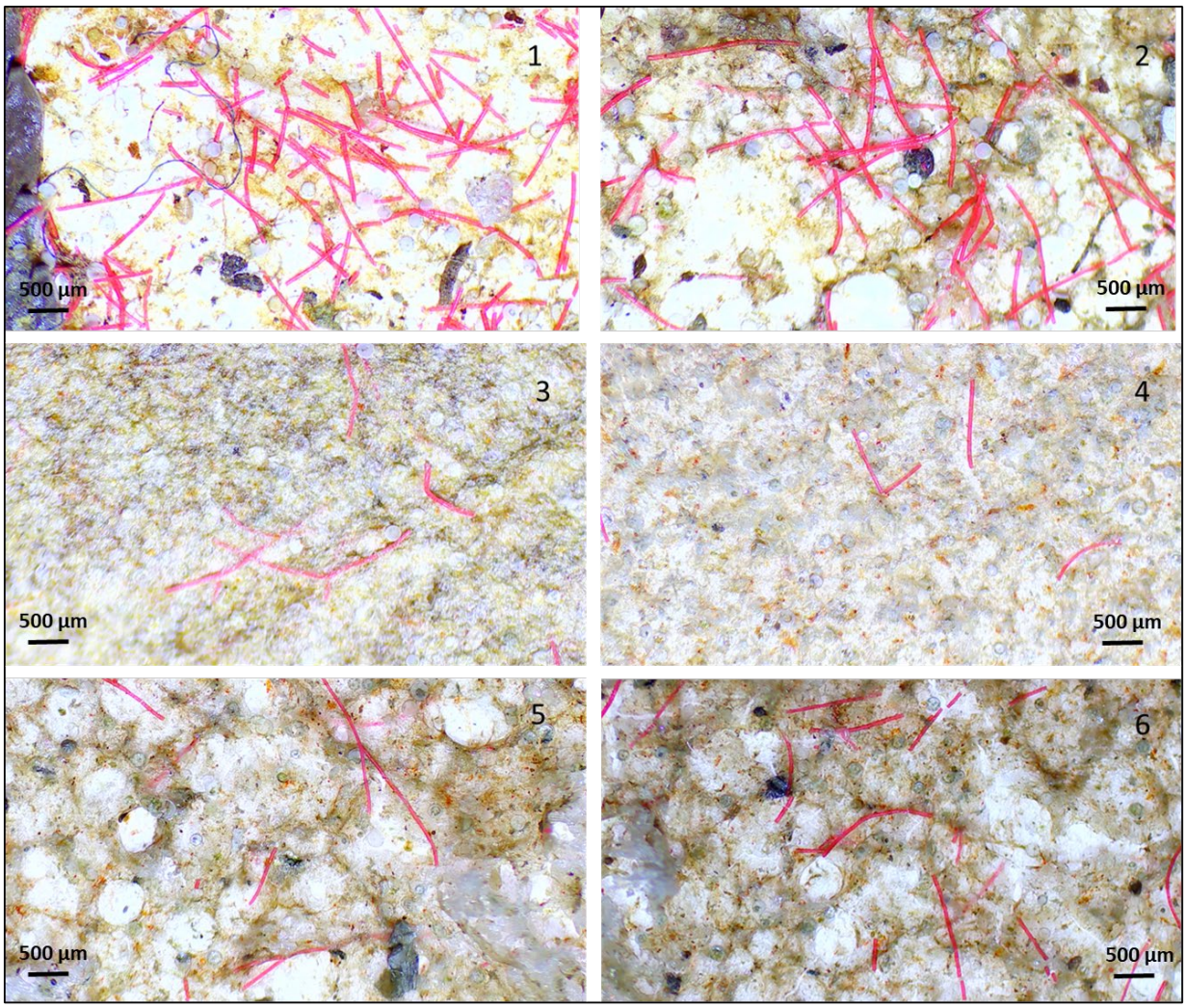


Figure 10. Particles collected during net tows at six stations across western Peconic Bay. The majority of microplastics (MPs) identified in these samples were red PP microfibers, with lengths ranging from ~50 to 4000 µm. These microfibers exhibited a relatively uniform diameter of approximately 50 µm across all analyzed particles. Numbers in each photo represent the stations.

Overall, PP, PE and phthalocyanine copper (PcCu) dominated the total particle inventory, together accounting for over 90% of detected particles. The overwhelming contribution of PcCu-bearing particles highlights the importance of considering additives and pigments, in addition to base polymers, when assessing microplastic sources and transformation pathways. Taken together, these results suggest a system in which locally derived, polymer-specific inputs are progressively fragmented, generating a small-particle pool enriched in pigment-associated microplastics.

Finally, while this report focuses on the August 2024 sampling event, samples from April 2025 remain under analysis, including discrete water samples, net tows, and sediment collections. This data will enable a more comprehensive assessment of seasonal variability

within Peconic Bay. Completion of all remaining analyses, including full statistical treatment and inter-station and inter-season comparisons, is targeted for August 2026. Progress to date has been moderated by several factors affecting data throughput, including intermittent instrument malfunctions, the high demand on the Nano Raman Imaging Molecular Laboratory (NARMIL) from multiple concurrent projects, and the processing of samples from external principal investigators utilizing the facility. Despite these constraints, the integration of all datasets will provide a robust, system-level understanding of microplastic distribution, composition, and sources in the bay, and will support future efforts in management strategies.

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