

Comparing microplastic distribution and potential risk to zooplankton in American Samoan
coastal waters and the Equatorial Pacific

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Abstract:

Microplastics (MPs) are a growing threat to marine organisms due to risks of ingestion and toxin bioaccumulation. Zooplankton are especially vulnerable to MPs and are important as a key piece of the trophic web. However, MP abundance, type, and effect on zooplankton communities in the southwest equatorial Pacific remains understudied. Using data from a cruise on the R/V *Thomas G. Thompson* between December 28th, 2023 – January 10th, 2024, this study analyzes MP abundance and type, and compares it to zooplankton relative abundance to determine MP pollution and risk to zooplankton populations around American Samoa and the Equatorial Pacific. I hypothesized that higher levels of microplastic pollution would be found near American Samoa than at the Equatorial Pacific. I further hypothesized that a correlation exists between MP abundance and relative abundance of zooplankton species at-risk of MP ingestion. Zooplankton and MP samples were collected near American Samoa and the Equatorial Pacific using a 333 μm mesh Manta net. A dissecting scope was used to identify and count zooplankton and MPs. In comparing MP type and distribution, I found that the average MP concentration at coastal stations was 5.7×10^{-3} MPs/ m^3 , while the average MP concentration at equatorial stations was 1.3×10^{-4} MPs/ m^3 . 88% of all MPs collected were microfibers. However, no correlation between zooplankton abundance and MP abundance was found. Further research in the region is critical due to the direct connection to waste, quality of life, industry, subsistence, and ecosystem and human health in the tropical Pacific.

Plain Language Summary:

Microplastics (MPs) are a growing issue in marine ecosystems, posing a risk of ingestion to many organisms, including zooplankton, the group of marine plankton that survives through consuming other organisms. In fact, zooplankton are especially vulnerable to this process and are

important as essential prey to many marine organisms. However, MP abundance, type, and effect on zooplankton populations in the mid-west Pacific is relatively understudied. Thus, on a cruise aboard the R/V *Thomas G. Thompson* between December 28th, 2023 – January 10th, 2024, I collected data on MP abundance and type and compared it to zooplankton community abundance to determine risk to zooplankton populations between American Samoa and the Equatorial Pacific. Samples of MPs and zooplankton were collected using surface net tows and were counted and classified using a dissecting microscope. In comparing zooplankton diversity and abundance and MP type and distribution between the regions, I found that the concentration of MPs was as much as three orders of magnitude higher near American Samoa than in the open ocean. However, no specific correlation between zooplankton abundance and MP abundance was found. Studying this region is extremely important to research due to the direct connection to waste, quality of life, industry, subsistence, and ecosystem and human health in the tropical Pacific.

Introduction:

Due to elevated levels of plastic production over the past century, the harmful impacts of plastic pollution in the marine environment have increasingly garnered attention (Carpenter & Smith, 1972; Wong et al., 1974). Although much societal effort has been devoted to preventing large pieces of plastic from entering the oceans, the impact on marine ecosystems of the numerous, small (< 5 millimeters long) microplastics (MPs) is becoming of heightened concern (Arthur et al., 2009). These MPs, which include foam, microbeads, and microfibers, have been found in all the world's oceans, and are especially prevalent in the upper ocean due to their low densities and small size (Arthur et al., 2009). Chemically, the primary MP categories in the ocean are polyethylene (which is used in plastic bags and jugs), polystyrene (which is used in Styrofoam,) and polypropylene (which is found in ropes, bottle caps, and fishing gear) (Barboza and Gimenez, 2015). MPs are produced by the physical and mechanical weathering of larger plastics and can enter the ocean from land-based sources such as beach litter and subsequent runoff, aquaculture, and degradation from fishing gear, and (Watson, 2006; Hincosa and Thiel, 2009; Andrady, 2011). In fact, the recognition of ships as a major source of plastic pollution inspired a ban on dumping plastics at sea in 1988, as well as many subsequent plastic waste regulations (Xanthos and Walker, 2017). Importantly, because the chemical structure of MPs prevents biodegradation from bacteria and other natural processes, the effects on the ecosystem can be particularly long-lasting (Arthur et al., 2009).

MPs are both commonly found in the upper ocean and are resistant to biodegradation, meaning there is a great risk of MPs causing major ecological harm to marine life in surface waters. While the full effects of MPs on marine organisms are unknown, harmful effects generally occur due to the direct ingestion and subsequent bioaccumulation of MPs and the

bioaccumulation of chemical contaminants leached by the MPs (Masura et al., 2015). Because the size of MPs overlaps with the size range of the prey for many marine organisms, MPs may be ingested by many different marine taxa (Galloway et al., 2017; Botterell et al., 2019). This includes species like cetaceans (Besseling et al., 2015; Lusher et al., 2015, Nelms et al., 2019), seabirds (Amélineau et al., 2016), fish (Kühn et al., 2015), mollusks (Browne et al., 2008), and corals (Hall et al., 2015), as well as smaller marine species such as zooplankton (Cole et al., 2013; Desforges et al., 2015; Sun et al., 2017). Upon ingestion, MPs have been shown to cause a variety of harmful effects, including physical injury, impeded growth and reproduction, and reduced feeding (Gall and Thompson, 2015; Cole et al., 2015; Lee et al., 2013). In addition to harm from direct ingestion, MPs may also serve as bioaccumulation points of contaminants and other pollutants, from heavy metals to polychlorinated biphenyls, as well as leaching harmful chemicals over time (Koelmans, 2015; Botterell et al., 2019; Chen et al., 2019). Thus, organisms who ingest or encounter MPs and the associated pollutants are a vessel for bioaccumulating harmful contaminants up the trophic web. In addition to threatening the ecosystem, such bioaccumulation has been proposed to potentially impact human food security (Barboza et al., 2018), socio-economic well-being (Beaumont et al., 2019), and health (Galloway, 2015), although full human health impacts remain unconfirmed (Walkinshaw et al., 2020).

Zooplankton are of special importance in understanding the ecosystem risk of MPs. MPs fall into the same range size as common zooplankton prey, increasing risk of MP ingestion (Walkinshaw et al., 2020). Additionally, zooplankton are low on the trophic web, meaning they are at more risk of MP and pollutant accumulation, and may serve as a source of MP pollutant uptake by higher trophic levels (Walkinshaw et al., 2020). MP ingestion has been recorded in at least 39 species of zooplankton from 28 different taxonomic orders, often with negative effects

on feeding behavior, growth, development, reproduction, and lifespan (Botterell et al., 2019). However, MP bioavailability depends on a variety of physical, biological, and environmental factors, including the size, shape, age, and abundance of MPs and the size, life stage, and species of the at-risk zooplankton (Bai et al., 2021; Brooks, 2022). Due to this natural variability, in addition to the fact that many past studies were performed under laboratory and not *in situ* conditions, it remains essential to assess the threat level to and potential response of specific at-risk communities of zooplankton in understudied regions to fully comprehend the danger posed to specific marine ecosystems.

Although the threat of MPs has long been studied in the Pacific Ocean, for several vital regions there remains little to no quantification of marine MP pollution. Compared to the more extensive analysis of the North Pacific Subtropical Gyre and along the Eastern and Western Pacific boundaries, data on MPs is lacking from the southwest tropical and equatorial Pacific (Lavender Law et al., 2014). The data that exists point to a widespread abundance of MP pollution in the mid-west Pacific, composed primarily of microfibers (Wang et al., 2020). The most direct source of MP pollution to this region is from tropical islands, including American Samoa, Fiji, New Caledonia, and Tonga, as they provide a direct pathway for new anthropogenic plastics to enter the ocean through their watersheds. However, while it is important to note that the prevalence of directly introduced MPs is higher near tropical islands compared to the equatorial ocean, MP pollution is not limited to coastal regions (Silvestrova & Stepanova, 2021; Gala, 2023). Nearshore surface currents around American Samoa directed offshore can carry

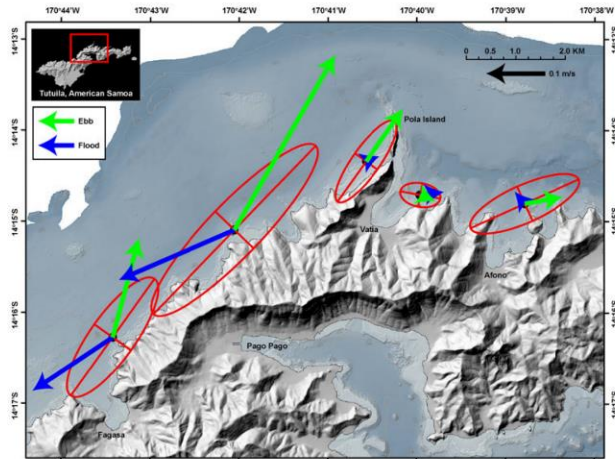


Figure 1. A map showing the direction of nearshore currents on the north coast of American Samoa (Storlazzi et al., 2015). Ebb tide currents are in green, and flood tides are in blue. Arrow length corresponds to speed and red ellipses show variability.

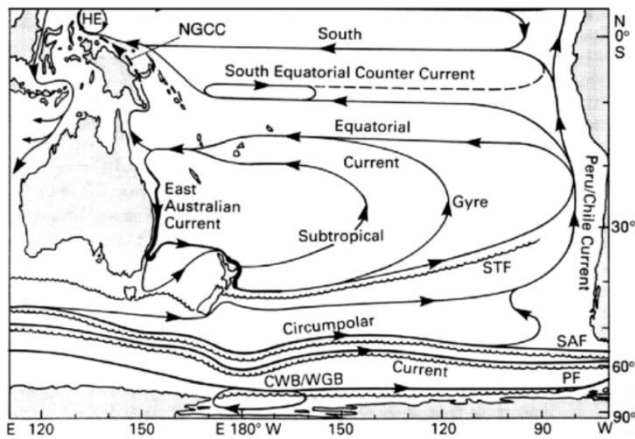


Figure 2. A map of the large-scale surface currents of the Southern Pacific (Qiu and Chen, 2004).

MPs to the open ocean, especially during ebb tides, which are associated with a particularly strong current along the American Samoan coast (Storlazzi et al., 2015) (Figure 1).

Ocean currents can transport MPs across the ocean for years before they sink, wash ashore, or become stuck in a gyre (Maximenko et al.,

2012). Although global circulation patterns tend to divert MPs away from the equatorial

Pacific Ocean, the dominant equatorial currents (the South Equatorial Current and the South Equatorial Countercurrent), driven by the trade winds, can transport MPs towards the equator (Qiu and Chen, 2004) (Figure 2). Notably, this dynamic may be affected by changes from El Niño Southern Oscillation, which may weaken Trade Winds

and reduce current circulation. However, data in this region is largely incomplete and could benefit from *in situ* measurements (van Sebille et al., 2015).

To determine how MP concentration and type changes between coastal and equatorial southwest Pacific waters, comparisons of MP abundance and diversity must be made between the equatorial Pacific Ocean and waters near American Samoa. Although quantification of MPs in American Samoan coastal waters is currently understudied, comparisons with similar ecosystems such as the nation of Samoa show significant levels of MP in coastal waters (Figure 3). In addition, the



Figure 3. A map showcasing microplastics found in waters around Samoa (New York University). Orange circles represent sampling locations and increase in size with higher levels of MPs. Purple lines represent roads and showcase the urban connection to MP pollution.

discovery of MPs in certain types of organisms around American Samoa, as well as the history of ineffective waste disposal on the island, suggests risk of MP pollution exists in nearshore waters (Polidoro et al., 2022) (Figure 4). The abundance and type of MP pollution in this region, as well as MP’s impact on zooplankton community dynamics, are of special concern due to the importance

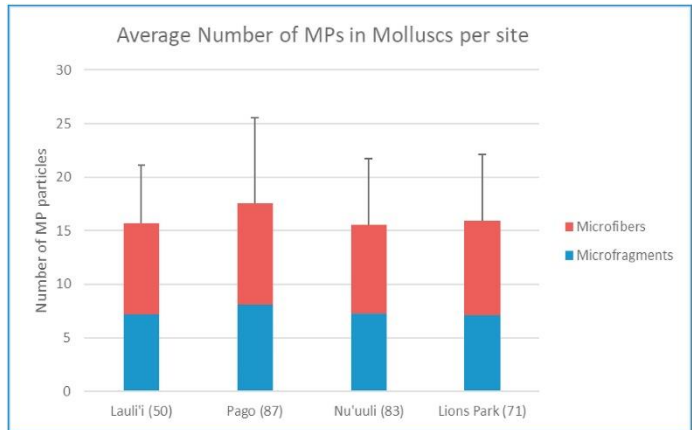


Figure 4. Average number of MPs in Molluscs at several sites around American Samoa (Polidoro et al., 2022). Number of particles is shown on the y-axis and the sites are on the x-axis. Microfiber count is in orange and microfragment count is in blue.

of fisheries and coral reefs to the territory’s culture, subsistence, and economy (Remington et al., 2019). As more than 75% of American Samoans consume seafood at least once per week, and over 99% of American Samoa’s exports are from the tuna canning industry, the territory is

heavily reliant on healthy fisheries (Remington et al., 2019). The tuna that sustains this vital industry is reliant on zooplankton: at young life stages, tuna consume zooplankton directly, and the prey they eat as adults, such as crustaceans and small fish, also prey upon zooplankton (Graham et al., 2007). Thus, it is essential for American Samoan industry and sustenance that potential risks to zooplankton are analyzed.

Zooplankton biomass and diversity does differ across the southwest tropical and equatorial Pacific regions: biomass near the equator is noticeably higher due to increased levels of primary production (Roman et al., 1995; White et al., 1995) (Figure 5). However, both the equatorial Pacific and the southwest tropical Pacific regions are dominated by copepods (Roman et al., 1995; Carlotti et al., 2018). Because copepods are a key link of the trophic web in these regions and have been shown to ingest MPs, it is crucial to understand the zooplankton community in their respective ecosystem and their ability to uptake and eventually bioaccumulate MPs (Bai et al., 2021).

In this study, zooplankton communities were compared between each region to determine which population is more at risk from future MP-induced ecosystem threats based on current levels of pollution. I hypothesized that there would be higher levels of microplastic pollution near American Samoa than in the Equatorial Pacific. I further hypothesize that a correlation exists between MP abundance and the relative abundance of zooplankton species known to be at-risk of MP ingestion. This is because MP abundance is a factor in increasing bioavailability, so

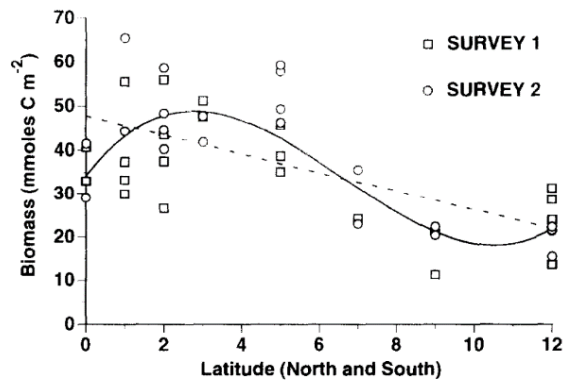


Figure 5. A graph showing zooplankton biomass integrated to 200 m depth on the y-axis plotted versus latitudes both N and S of the equator on the x-axis across two surveys (White et al., 1995). Survey 1 occurred during winter months and Survey 2 occurred during summer months. The lines are proposed lines-of-best-fit.

an elevated presence of MPs in coastal waters could lead to a higher risk of zooplankton microplastic ingestion.

Better quantification and comparison of MPs in the southwest and equatorial Pacific is critical in understanding potential changes to zooplankton community dynamics, resultant ecosystem impacts, and potential harm humans. This research might be used to inform policy decisions and waste management practices in American Samoa and similar island polities and underscore the need for continued MP analysis and monitoring as plastic levels continue to rise.

Methods:

Onboard Sample Collection: Sampling was conducted aboard the R/V *Thomas G. Thompson* from December 28th, 2023 – January 10th, 2024. The vessel departed from Pago Pago, American Samoa on the island of Tutuila, (14° 16' 46" S, 170° 42' 02" W), and at-sea samples were initially collected leaving Tutuila (Stations 1 and 2) and between Olosega (14° 10' 30" S, 169° 37' 4.8" W) and Ta'ū (14° 14' 0" S, 169° 28' 0" W) of the Manu'a Islands (Stations 3 and 4)

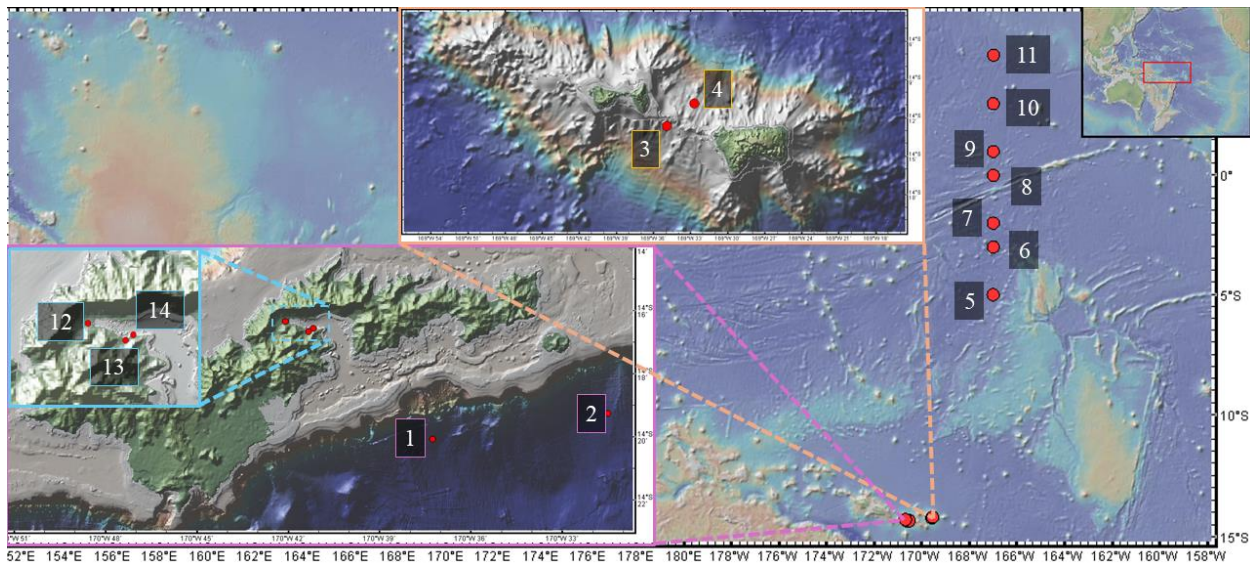


Figure 6. Shown is map of the cruise path: red dots indicate sampling stations, numbered in order of collection. An inset outlined in orange shows samples collected near the Manu'a Islands, an inset outlined in pink shows samples collected near Tutuila, and an inset in aquamarine shows samples collected in Pago Pago Harbor. The second cruise track has stations shown with red circles between 5° S and 5° N along the 167th meridian W. Latitude and longitude are on their respective axes and are repeated on the insets for scale.

(Figure 6). Additional samples were taken along a track following the 167th meridian W, between the 5° S and 5° N parallels (Stations 5, 6, 7, 8, 9, 10, and 11) (Figure 6). For these samples, MPs and zooplankton were collected using a 333 µm Manta net towed along the side of the ship for 15 minutes at 1-2 knots along the sea surface.

For samples collected within Pago Pago Harbor upon returning to Tutuila (Stations 12, 13, and 14), a 20 µm mesh phytoplankton net with a 0.25 m diameter was used. The net was manually dragged along the shore to collect the samples, and the samples were brought back to the vessel for processing. All samples were filtered through a double-mesh filtration system (500 µm and 333 µm) to isolate materials within the relevant size range and normalize for the difference in sample collection.

For all of the samples, the collection net rinsed once pulled from the water to ensure all of the sample was collected. 14 total samples were collected: two offshore Tutuila, two between Manu'a Island, one at each of the 5° S, 3° S, 1° S, 0°, 1° N, 3° N, and 5° N stations, and three while stationed in Pago Pago (Figure 6). This resulted in seven coastal samples (Stations 1, 2, 3, 4, 12, 13, and 14) and seven equatorial samples (Stations 5, 6, 7, 8, 9, 10, and 11). The samples, once collected, were transferred to 8 oz glass jars for onboard analysis.

Samples were processed as follows to determine the abundance of zooplankton and MPs. During transit, samples were prepared to determine the relative abundance and diversity of zooplankton collected. Following filtration through the double-mesh filtration system (500 µm and 333 µm), the samples were processed. Items caught on the 500 µm filter were rinsed, visually identified for relevant items (microfibers, large pieces of plastic) and noted, but were not processed, as they exceed the size range of MPs. For materials caught on the 333 µm filter, any visible plastics were rinsed and transferred onto a pre-weighed GF/F 47 mm diameter filter.

Zooplankton in the sample were then counted and classified, using a Wild Dissecting Scope. Counting occurred until the entire sample was enumerated or 300 of a single zooplankton classification was counted. The samples were subsequently transferred to a 50 mL falcon tube, frozen, and brought back to shore for further analysis at the University of Washington (UW).

Geophysical data on current strength and direction, and wind strength and direction were collected continually through the vessel's on-board instruments and a Teledyne RD Instruments Acoustic Doppler Current Profiler.

Sample Analysis in Lab: Collected samples were processed further in a lab through the UW Oceanography department according to the method outlined by Masura et al. (2015) to identify remaining plastic pollutants. This was done by 1) mixing net samples with 20 mL of 0.05 M Fe(II) solution, 2) adding 20 mL of hydrogen peroxide, 3) warming the solution to 75 °C on a hot plate for 30 minutes, 4) repeating steps 2 and 3 until organic materials were dissolved, 5) adding 6 grams of NaCl for every 20 mL of liquid, and 6) performing a density separation of the sample in a funnel. The samples were then allowed to sit overnight. Floating materials were assumed to be plastics, while settled material was drained, visually inspected, and discarded provided no MPs were found. Floating plastics were collected on a 333 µm filter and dried.

Microscopy and the Hidalgo-Ruz et al. MP identification and classification method (2012) were used to separate plastics into categories of pellets, microbeads, microfibers, fragments, films, rope, and foams. MPs collected on GF/F filters from at-sea filtering were dried, counted, and added to the final MP concentration. To determine the concentration of MPs per station, counts were divided by the amount of water sampled, measured from a flowmeter.

Data Analysis: For statistical analysis, data were exported to a data processing program. Zooplankton diversity was analyzed and compared, and relative abundance was calculated.

Plastic concentrations, classifications, and correlations were measured using standard statistical comparison models, including t-tests for comparing significance.

Results:

Zooplankton Relative Abundance: Calanoid copepods had the highest relative abundance at the most stations, making up over 50% of zooplankton at Stations 5, 7, 8, 9, 13, and 14 (Figure 7). Copepods were more prevalent at equatorial stations, while coastal stations had higher proportions of brachyuran zoea, amphipods, and shrimp-like crustaceans (Figure 7). Pteropods were common, with particularly high proportions at Stations 4, 10, and 11 (Figure 7). Groups including ostracods, gastropods, and worms appeared recurrently in low numbers (Figure 7).

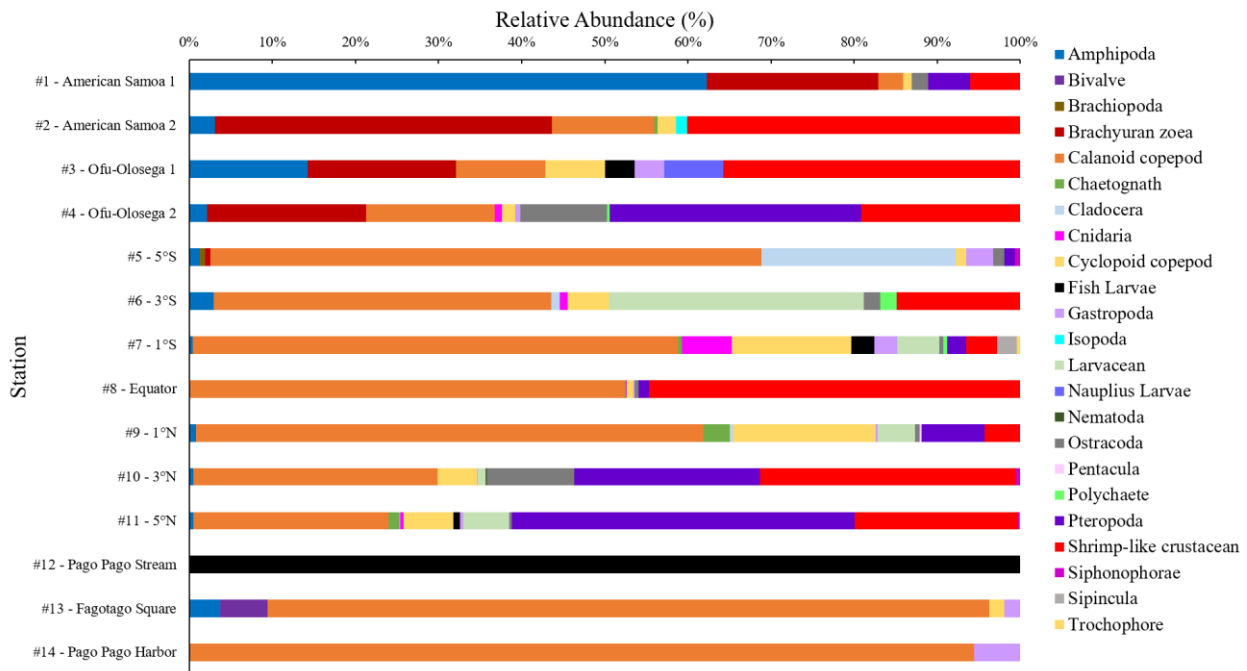


Figure 7. A stacked bar chart displaying relative abundance at each station. Different organisms are shown in colors according to the legend on the right. Relative abundance (%) is on the x-axis and the station is on the y-axis.

Microplastic Concentration: Station

14, Pago Pago Harbor, had the highest MP concentration (1.5×10^{-2} MPs/m³) (Figure 8). Notably, the five highest concentrations of MPs all occurred around Tutuila (Stations 1, 2, 12, 13, and 14) (Figure 8). Of the seven

equatorial samples, only Station 5 (3.2×10^{-4} MPs/m³), had a concentration higher than the lowest coastal sample concentration (Station 4, 2.5×10^{-4} MPs/m³), and most coastal stations had MP concentrations orders of magnitude higher than the equatorial stations (Figure 8). The largest difference in MP concentration was three orders of magnitude, between Station 14 (1.5×10^{-2} MPs/m³) and Station 8 (5.9×10^{-5} MPs/m³) (Figure 8). The average MP concentration at coastal stations was 5.7×10^{-3} MPs/m³, while the average MP concentration at equatorial stations was 1.3×10^{-4} MPs/m³. The difference

in between coastal and equatorial samples was statistically significant based on the results of an unpaired two factor t-test (p-value < 0.05).

Microplastic Type: A full explanation of

microplastic count and type appears in Appendix A, Table 1. Microfibers dominated the samples, making up 88%

of all MPs observed (Appendix A, Figure 11). Microfibers followed a similar pattern to MPs,

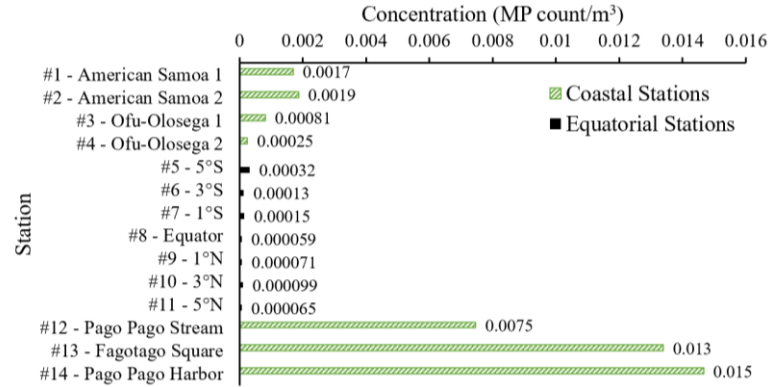


Figure 8. A bar chart displaying MP concentration at each station. Coastal stations are shown in striped green and offshore stations are shown in black. Concentration (MP count/m³) is on the x-axis and station is on the y-axis. The p-value, according to an unpaired two-factor t-test, is 0.03.

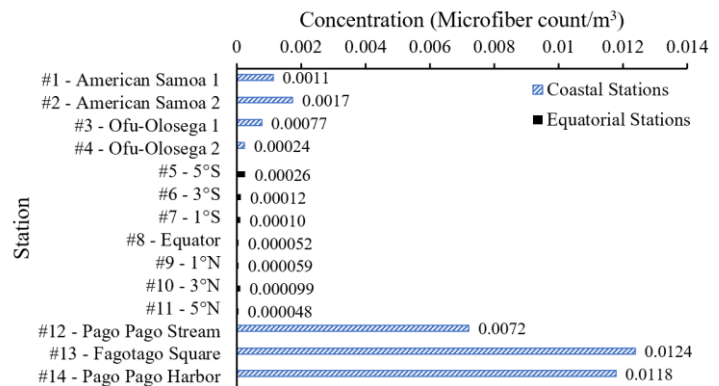


Figure 9. A bar chart displaying microfiber concentration at each station. Coastal stations are shown in striped blue and offshore stations are shown in black. Concentration (Microfiber count/m³) is on the x-axis and station is on the y-axis. The p-value, according to an unpaired two-factor t-test, is 0.03.

with the highest concentrations occurring around Tutuila (Figure 9). The highest concentration of microfibers again occurred in Pago Pago Harbor, but further inland at Station 13 (1.2×10^{-2} microfibers/ m^3) rather than at Station 14 (1.2×10^{-2} microfibers/ m^3) rather than at Station 14 (Figure 9). All equatorial samples had lower microfiber concentrations except Station 5 (2.6×10^{-4} microfibers/ m^3) overcoming Station 4 (2.4×10^{-4} microfibers/ m^3) (Figure 9). Based on the results of an unpaired two factor t-test, the difference in MP concentration between coastal and offshore samples was statistically significant (p-value < 0.05).

Zooplankton vs Microplastics:

As a way to predict potential risk of MP ingestion, the abundance of certain species of interest were compared to MP concentration. Copepod concentrations were found to have no correlation with microfiber concentrations ($R^2 = 0.1871$), with a p-value much greater than 0.05 from an unpaired two-factor t-test indicating the results were not statistically significant (Figure 10A). However, copepods do exist in relatively high proportions in areas of both high and low amounts of microfibers and at both coastal and equatorial stations (Figure 10B). No correlation was

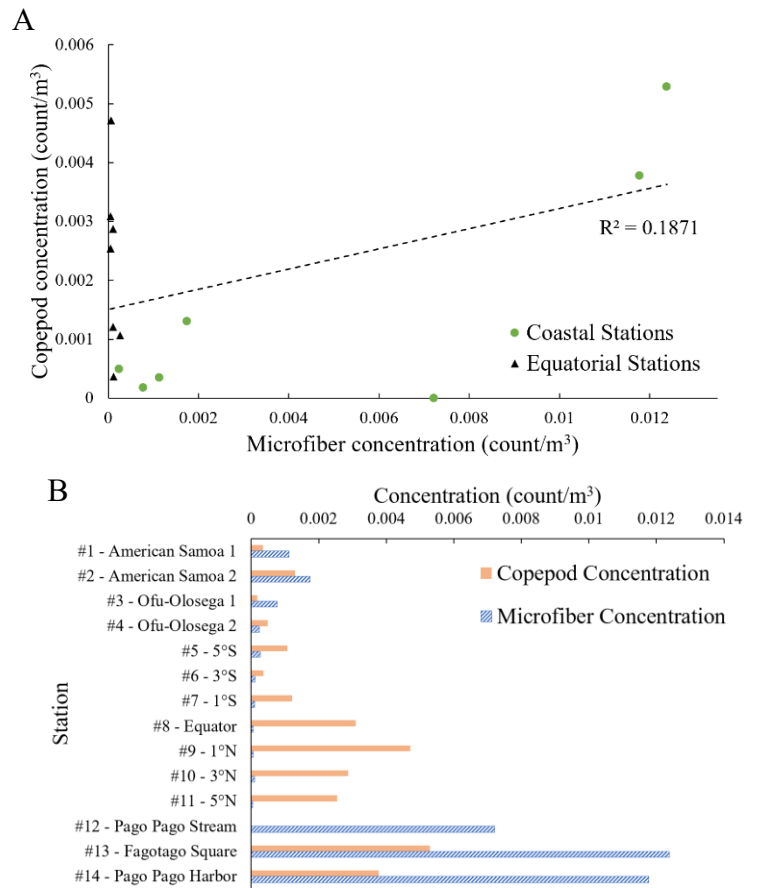


Figure 10. Comparison of microfiber concentration and copepod concentration (both calanoid and cyclopoid) at each station. (A) Scatterplot showing microfiber concentration (count/ m^3) on the x-axis and copepod concentration (count/ m^3) on the y-axis. Coastal stations are identified with green circles and equatorial stations are identified with black triangles. A trendline based on data from all 14 stations is shown with black dashes and has an R^2 of 0.1871. The p-value is 0.63 according to an unpaired two-factor t-test. (B) Double bar chart displaying microfiber concentration in striped blue and copepod concentration (both calanoid and cyclopoid) in orange. Concentration (count/ m^3) is on the x-axis and station is on the y-axis.

observed between MPs and any other species of interest.

Discussion:

Factors Affecting Microplastic Concentration:

There is a statistically significant correlation between MP concentration and proximity to the islands of American Samoa (Figure 8). Given that land-based sources are the predominant pathway for MPs to reach the marine environment, this data matches previous predictions (Beaumont et al., 2019). Specifically, MP pollution was centered around Tutuila, which is the home to 97.5% of the territory's population, rather than the Manu'a islands, although levels of MPs were elevated around Manu'a islands compared to the equatorial samples. However, this trend may be due to the number of samples taken at each location, and the samples at Tutuila taken much closer to the coast. Overall, because the ocean waters surrounding American Samoa are understudied, this study can affirm the potential impact of land-based plastic pollution in the region.

However, it is worth noting that the abundance of MPs is not negligible in the offshore environment. Both global and local circulation patterns may be influencing the increase in MPs in this region, but ocean current circulation patterns do not tend to lead to the accumulation of MPs in equatorial regions, perhaps explaining the lower concentration of MPs observed in those samples (Andrady, 2011). While ocean current data was collected for this cruise, it was not analyzed in this study, leaving open the potential for future analysis on the impact of currents in transporting MP pollution from the islands of American Samoa towards the equator. Analysis of currents performed by Storlazzi et al. (2015) implies that there may be some amount of northward transport of water from Tutuila, which may be a source of MP pollution in the equatorial ocean. This pathway should be investigated in future studies.

The majority of MPs identified in this study were microfibers, which matches with prior studies identifying microfibers as the most prevalent form of MP pollution in the ocean (Barboza et al., 2018). This also corresponds with data showing the prevalence of MP pollution coming off fishing equipment and marine vessels, often in the form of fishing gear and ropes, which may lead to high levels of microfiber pollution (Xanthos and Walker, 2017). In fact, it is possible that microfiber concentration could be even higher, since fibers are the type of MP that can most easily slip through net and sieve-based sampling methods. Although this study was not able to confirm the sources of any MPs collected, the appearance of several strands of rope across the samples is a good indicator that this source of pollution is one to be aware of in this region (Table 1, Appendix A). In contrast, foam was not common, only being found in small amounts and usually in the most heavily-polluted areas, consistent with prior data showing it to be relatively rare in offshore environments (Silvestrova and Stepanova, 2021).

Microplastics and Zooplankton Abundance:

Zooplankton relative abundance is largely impacted by oceanic conditions, including nutrients and predator-prey relationships. Although these conditions often correlate with distance from land, as does MP concentration, no specific correlation could be identified from this study on the impact of MPs on at-risk zooplankton communities. Meanwhile, other forces may have been confounding factors as well. The changes in organism relative abundance could be due to factors such as upwelling at the equator, which supplies nutrients for zooplankton in higher amounts than at other latitudes. Because samples occurred at both day and night, differences may also be attributable to the lack in consistency in the time of day that sampling occurred, as many zooplankton engage in diel vertical migration and would thus be able to avoid a surface sample. Further uncertainty is added due to a lack of replicate samples, incomplete spatial coverage, and

inability to fully identify many organisms collected. Because so many of the effects of microplastics on zooplankton are species-specific, it is difficult to use this study to draw any conclusions on how communities may be affected by changing MP conditions in future oceans. However, based on prior studies highlighting the risk of MP ingestion in copepods and the data from this study showing relatively high proportions of copepods in regions with high MP concentrations, there is cause for further research into effect in the region (Cole et al., 2015; Figure 10). If copepod populations are adversely affected by increasing MP concentrations, the balance of the marine ecosystem would be at risk, and in a fragile ecosystem such as American Samoa, which is highly reliant on fisheries, this could be disastrous. Many other zooplankton groups and species prevalent in this region have been noted to ingest MPs or otherwise see health impacts from this pollution, including ostracods, amphipods, euphausiids, and mysids, among others (Botterrell et al., 2019; Cheney, 2024). Thus, it is likely that community makeup could be impacted as plastic pollution worsens.

Broader Impacts:

There is currently room for the improvement of waste and plastic disposal practices in American Samoa and across many island nations in the Southern Pacific, due to the lack of long-standing waste infrastructure, policy, and awareness of the scale of the issue (Polidoro et al, 2022). In fact, island-wide recycling programs only began to be implemented in 2022 and the singular landfill on the island is already over capacity (<https://www.samoanews.com/sports/army-reserve-establishing-new-recycling-program-underserved-areas-beginning-am-samoa>). This dynamic is especially worrying in American Samoa, where there is a high reliance on the marine environment for food and industry (Remington et al., 2019). Specifically, coral reefs and tuna fisheries are essential to protect, both

of which rely upon healthy zooplankton which could be threatened by future MP pollution. This study helps point to the value in continued expansion of recycling programs in the region, as well as public education campaigns on the value of addressing plastic pollution directly. As further research on the intersection between MPs and both ecosystem and human health, dedicated monitoring, education, and policy efforts must be expanded.

Conclusion:

This study identifies that the concentration of MPs in samples near to the coast of American Samoan islands is significantly more than in the equatorial ocean. This finding is useful in understanding the growing threats to the region, especially as plastic pollution becomes a more prevalent issue. Thus, this study can help contribute to a growing body of literature about plastic pollution in the region, helping inform potential risks, best practices, and community responses to keep the ecosystem and the people who rely on it safe. Such measures includes reducing plastic use, increasing recycling and reuse rates, placing nets along watersheds to filter out plastic, and attending community clean-ups. This study is especially important as quantification of MPs in and around American Samoa is extremely limited, and more must be done in the near future.

No direct correlation could be established between MPs and zooplankton community impacts. Because of the literature showing that ingestion of MPs may be a rising problem in the marine environment, more studies must be done, both under laboratory conditions with specific species and *in situ*, to better understand the impact in this region. Subsequent studies should work to create a more complete picture of sources of pollution in the region (especially near rivers, which are major sources of runoff into the marine environment), map out potential hotspots of pollution surrounding American Samoa and throughout the South Pacific, and

investigate other species and organisms, including phytoplankton and megafauna. This way, science, knowledge, and community action can come together to help drive a more sustainable future in this vital region.

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Appendix A: Microplastic Breakdown by Station

Table 1. A table showing detailed breakdown of MP types per station, including large plastics.

Station	Latitude	Longitude	Fiber	Rope	Fragment	Film	Foam	MP Total	Plastics > 0.3 mm
#1 - American Samoa 1	-14.3346	-170.621	26	11	2			39	
#2 - American Samoa 2	-14.321	-170.525	44	3				47	
#3 - Ofu- Olosega 1	-14.2104	-169.582	21			1		22	
#4 - Ofu- Olosega 2	-14.1811	-169.545	26		1			27	
#5 - 5°S	-4.9969	-167.001	26	4		1		31	
#6 - 3°S	-2.9995	-167.001	15	1				16	
#7 - 1°S	-1.9997	-166.998	13	6				19	
#8 - Equator	-0.0002	-166.998	7	1				8	
#9 - 1°N	1.0023	-166.999	5	1				6	
#10 - 3°N	2.9991	-167	14					14	
#11 - 5°N	5.0358	-166.986	6				2	8	1 fragment
#12 - Pago Pago Stream	-14.2725	-170.702	86		3			89	1 Gatorade bottle (20oz)
#13 - Fagotago Square	-14.2778	-170.689	110	1	7		1	119	1 styrofoam piece, 3 fragments
#14 - Pago Pago Harbor	-14.2761	-170.686	53		13			66	1 styrofoam piece, 1 fragment, 1 bottle cap, 1 wrapper

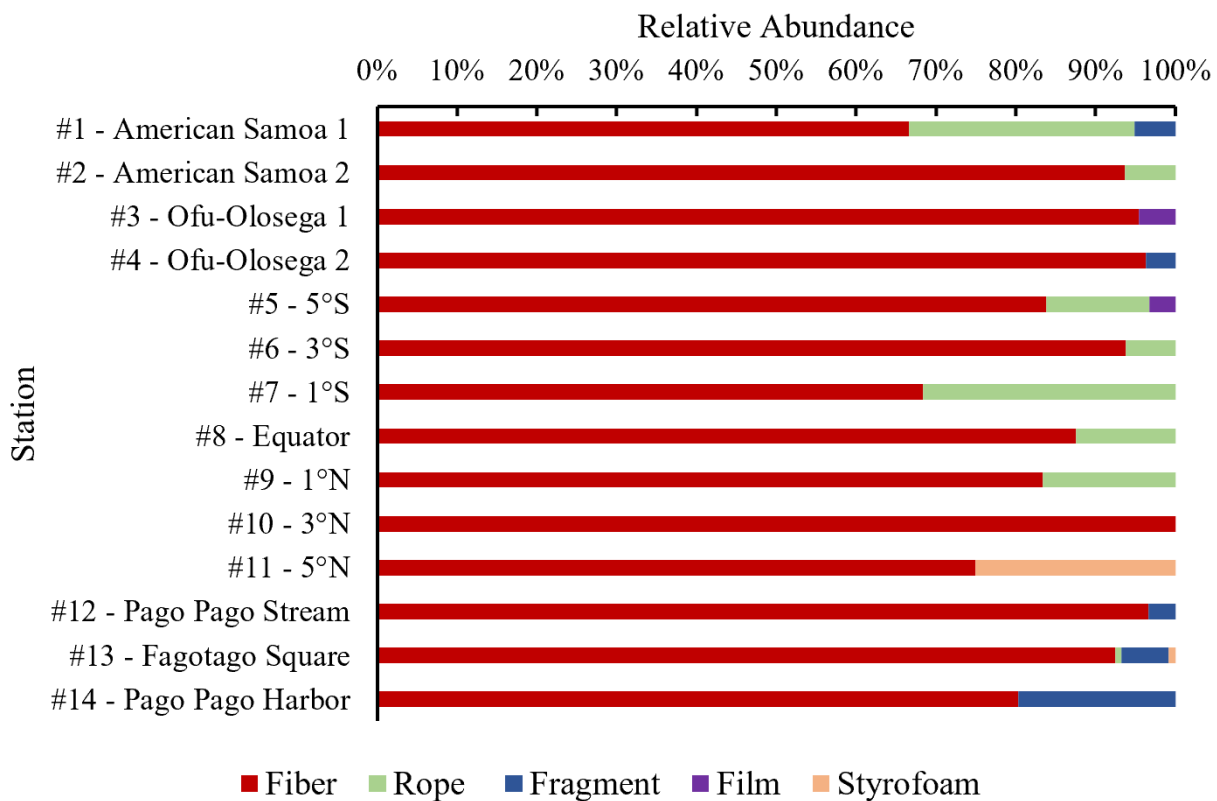


Figure 11. A stacked bar chart displaying relative abundance of MP type at each station. Relative abundance (%) is shown on the x-axis and station is on the y-axis. A legend correlating color and MP type appears at the bottom of the figure.