Synthetic Debris Identity Analysis from North Pacific Gyre Surface Samples

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Background

The North Pacific Gyre is one of the five major oceanic circulation systems often referred to as “The Great Pacific Garbage Patch or Trash Vortex”. It has two distinct high concentration areas bound by the North Pacific Subtropical Gyre. Reportedly, most man-made debris found in the gyre consists of microplastics, which are broken down pieces of plastic (NOAA, 2013). In 1997, researcher Captain Charles Moore collected surface samples in the North Pacific Gyre and published his findings citing 6-1 plastic by weight to plankton. (Moore, et al., 2001). In 2018, Moore collected 15 samples just outside the Eastern N. Pacific High accumulation zone again using a surface trawl. These samples were then sorted at the University of North Carolina Wilmington. Natural materials were separated from non-natural materials and were then sent to the Plastic Ocean Project lab to be further analyzed. The perceived synthetic materials removed from 2 of the 15 samples were analyzed using Fourier Transform Infrared Spectroscopy (FTIR) with the Attenuated Total Reflection (ATR) attachment. FTIR-ATR measures the range of wavelengths within the infrared region that is absorbed by a material, this advanced technology can help identify unknown materials, including plastic, found in the environment (Ioakeimidis et al., 2016).

Materials and Methods

Two of the 15 samples collected in 2018 using a surface trawl were processed at Dr. Seaton’s UNCW lab separating the plankton from potential plastics and then analyzed in the Plastic Ocean Project lab using FTIR-ATR.

- Forceps
- Attenuated Total Reflectance Spectroscopy Instrument (ATR), Thermo-Fisher brand
- Fourier Transform Infrared Spectroscopy Instrument (FT-IR, Thermo-Fisher brand)
- Veritas Laboratory Scale
- Nitrile Gloves
- Branson Sonicator
- Metal dissecting trays
- Kimtech Kimwipe Science Wipes
- Methanol
- Magnifying Lamps
- 200 micron filter paper
- .0025 inch sieve
- Glass sample jars
- Plastic and metal containers for natural and unnatural debris
- Dissecting Microscope
- Liquid nitrogen

The following methodology was used to process and analyse a High and a Low Concentration sample of plastic and plankton from the North Pacific Gyre :

Step One: Laboratory Preparation
- Contents of each sample were poured onto tared 200 micron filter paper atop another jar. Forceps and magnifying glass were utilized to sort suspected natural and unnatural debris from plankton, which were placed in separate containers.

Step Two: Weighing of Natural Material
- Suspected natural debris were placed on tared filter paper and weighed.

Step Three: Sonication of Suspected Unnatural Debris
- Debris placed inside beaker filled partially with DI water and sonicated for 5 minutes

Step Four: ATR and FTIR Analysis of Suspected Unnatural Debris
- Sonicated particles placed on methanol- treated ATR plate or FTIR 12-particle slide. Each was spectrally analysed using Omnic software. Particle spectral information saved onto data sheet and Excel spreadsheet.

Results and Discussion

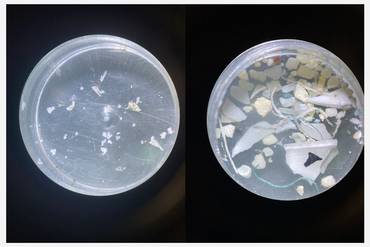


Figure 1: MO19, low concentration (left) MO16 high concentration (right) after sonication

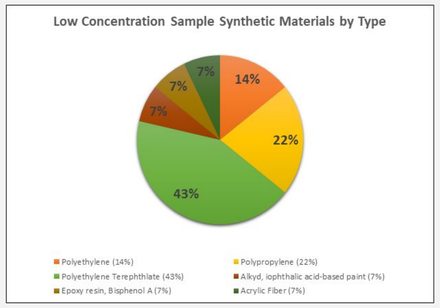


Figure 2: Low concentration (MO19) identity results

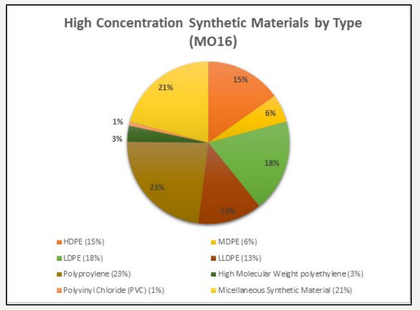


Figure 3: High concentration (MO16) identity results

For the low and high concentrations samples, the particles of debris was analyzed using the ATR and FTIR. For the low concentration sample, MO19, there were 14 total synthetic particles with none that were nonsynthetic. The top 3 types of synthetic material found in this sample are:
- 1. Polyethylene Terephthalate (43%)
- 2. Polypropylene (22%)
- 3. Polyethylene (14%)
-

For the high concentration sample, MO16, there was a total of 132 synthetic particles with 2 being nonsynthetic. The top 3 types of synthetic materials in this sample are:
- 1. Polypropylene (23%)
- 2. LDPE (18%)
- 3. HDPE (15%)

This research study provides data to support the prevalence and types of synthetic materials present in the Eastern North Pacific Subtropical Gyre as well as the abundance in comparison to plankton.

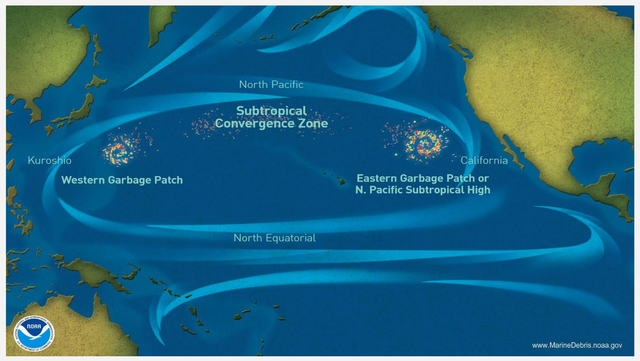
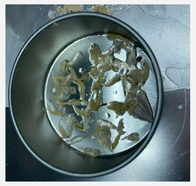


Figure 4: Image of the collection sight - Eastern Sub Tropical Patch or N. Pacific Subtropical High Pressure System.

Conclusion

The overall purpose of this research study is to determine the ratios of plastic to plankton from 15 North Pacific Gyre samples. In this time-limited research project, only 2 of the 15 samples were completely analyzed using FTIR-ATR to positively identify particles collected as synthetic. Our hypothesis was that at least 70% of unidentified material found in the samples would be identified as plastic. Of the 146 particles analyzed, only 2 were not synthetic, yielding 77% as plastic, 21% as other synthetic, and roughly 2% nonsynthetic. The 2 samples selected were a high concentration and a low concentration in order to normalize the data. This study is inconclusive since we only had time to analyze two samples. That said, the ratio of synthetic particles was higher than our hypothesis. Within those samples we were able to identify mostly Polyethylene Terephthalate (PET) as a main synthetic materials found in the low concentration sample. This kind of plastic is found in rayon for clothing, food and drink packaging, and also represents as fibers. Polypropylene was the most abundant synthetic material found in the high concentration sample. The use of Polypropylene ranges from plastic packaging, plastic parts for machinery and equipment, fibers and textiles. This ongoing research will provide important data comparing plastic to plankton especially outside the high accumulation zone.

Example Sample of Natural Material



Example Sample of Synthetic Material

Acknowledgements/ References

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Moore, C. J., Moore, S. L., Leecaster, M. K., & Weisberg, S. B. (2001). A comparison of plastic and plankton in the North Pacific Central Gyre. *Marine Pollution Bulletin*, *42*(12), 1297–1300. https://doi.org/10.1016/s0025-326x(01)00114-x

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