Analysis of Microplastic Contamination in Reflection Lake, Evansville, Indiana

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Abstract: This study took place at Reflection Lake, which is a man-made lake on the campus of the University of Southern Indiana, Evansville, IN. Runoff from nearby parking lots and roads is drained into the lake via culverts. The purpose of this study was to quantify the microplastic contamination in Reflection Lake.

Methodology was derived from a microplastics study by NOAA (Masura et al., 2015). It was determined that these data do not show a strong correlation between precipitation and microplastic concentration. Types identified were foams, films, fibers, fragments, pellets, and tire particles. Microplastics were found in all samples, ranging between .5 and 7.25 pieces per cubic meter, with foam being the most common type. Site A averaged 4.25 pieces/m^3 and Site C averaged 1.44 pieces/m^3. The results of this study are similar to those of similar microplastic studies of freshwater (Table 2).

Map showing the locations of sampling sites A and C

Background Information: Microplastics (plastic particles < 5 mm) are a growing concern in aquatic environments because of their common use in personal care products, plastic packaging, and other frequently used household items (McCormick et al., 2016; Erikson et al., 2013; Hylton et al., 2018). Large scale production of plastics became commonplace in the 1950s, and due to poor waste management, a significant amount of the plastic produced each year ends up as pollution in aquatic environments (Alfonso et al., 2020). When the plastic particles make their way into lakes and streams, they can disturb aquatic life for decades by causing digestive and respiratory issues after being consumed (Hylton et al., 2018).

Despite the prevalence of microplastic pollution in freshwater, most microplastic studies have taken place in marine environments (Yin et al., 2019). Freshwater microplastic studies are important because the long-term effects of microplastics are largely unknown. They can cause economic damage by harming stock species at major fisheries. They can transport invasive species and cause internal issues for wildlife, both of which have a negative effect on ecosystems. The build-up of harmful chemicals such as PCBs due to microplastics also harms wildlife (Yin et al., 2019).

Additional information will reveal how serious the issue is and lead to potential mitigation strategies, such as financial incentives for recycling, biodegradable alternatives to plastic, and limiting one-time use plastic (Driedger et al., 2015).

Methods: Sites A and C were selected because of their proximity to parking lots and roads, which drain into the lake via culverts. Sampling and processing followed the established methods and protocols established by the National Oceanic and Atmospheric Administration (Masura et al, 2015). Samples were collected using a 350-micron plankton net, which was thrown and retrieved just under the surface of the water 68 times, which corresponds to a sampled volume of approximately 4 cubic meters of water. Samples were wet sieved and organic materials were discarded after being rinsed with deionized water. The samples were then dehydrated in a drying oven for approximately 24 hours and subjected to a wet peroxide oxidation (WPO) process to chemically digest organic material without degrading plastics. WPO uses 20 mL of Fe II solution (0.05M) and 20 mL of hydrogen peroxide (30%). Samples were heated to approximately 70C while being stirred to ensure that as many organics as possible were digested. While still being heated, NaCl was added gradually to each sample until saturated. Samples were placed in a density separator for at least 24 hours (ideally, low density plastics float). The top and bottom halves of each sample were separated (most plastics should be in the top), sieved again, and moved to a drying oven. All samples were examined under a microscope to determine the total number of microplastics in each sample, and to characterize contaminants by shape. Organic material that had not been digested was removed by hand and discarded. If there was any question if a piece was plastic or organic, a probe was dragged across it and if the piece remained intact, it was considered to be plastic (Masura et al., 2015).

Possible sources of error in this study include microplastics lost if they were adhered to discarded organics. To mitigate this error, all organics were rinsed thoroughly during the wet sieve process. Plastics smaller than 350 microns may have been missed because they would fit through the mesh of the net. Some microplastics might not have been detected under the microscope because they were too small, or they were entangled with organic material that was not fully digested during the chemical process .

Picture of Site A sample from 9/28/21 in the density separator

Results: Every sample contained microplastics, ranging from .5 to 7.25 pieces per cubic meter (Table 1). The different types of microplastics include pellets, fibers, fragments, foam, tire particles, and films, and all were represented in these samples (Figure 1). Foam was the most common microplastic contaminant, comprising 40% of the samples. Pellets and films were the least common, making up only 3% and 4% respectively of the samples (Figure 2 & Table 3).

Site A had a higher concentration of microplastic than Site C during every sampling event except for 10/15/21. Site A averaged 4.25 pieces/m^3 and Site C averaged 1.44 pieces/m^3 (Table 1). The samples from 10/4/21 and 10/15/21 were precipitation event-based to determine if there is a relationship between precipitation and concentration of microplastics . It is not clear from these data if there is a correlation between precipitation and microplastic concentration (NOAA, 2021).

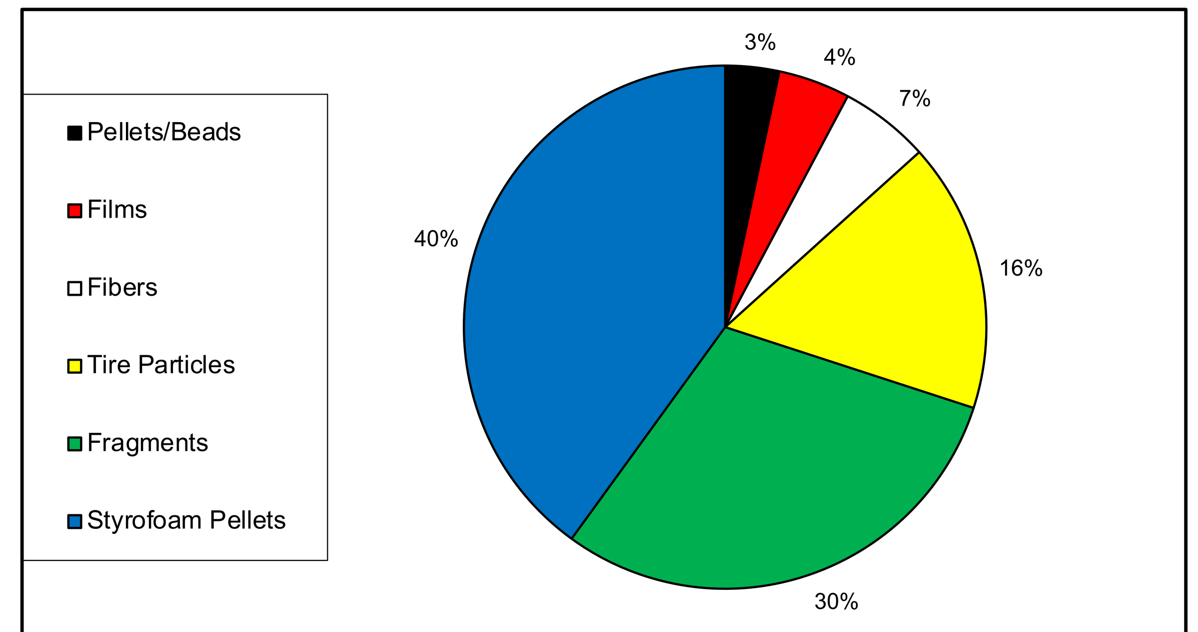


Figure 2: Frequency of each type of plastic in all the samples

Table 1: Number of microplastics per cubic meter in each sample. Blue highlighted samples were precipitation event-based.

	Site A	Site C
9/28/21	6	--
9/29/21	--	.5
10/4/21	.75	2.25
10/15/21	7.25	1.25
10/22/21	3	1.75
Average	4.25	1.437

Table 2: Mean microplastic concentrations from recent freshwater studies in the United States, compared with this study.

Source & Notes	Microplastics: pieces/m^3 (mean)
This study, Site A	4.25
This study. Site C	1.44
Ludge, 2020: Reflection Lake at USI	2.61
Hylton et al., 2018: White River, IN	0.71
McCormick et al., 2016: Upstream from wastewater treatment effluent	2.36
McCormick et al., 2016: Downstream from wastewater treatment effluent	5.73
Baldwin et al., 2021: Delaware River watershed	7.50
Baldwin et al., 2016: Great Lakes Tributaries	4.2

Discussion: The results of this study are consistent with those of similar freshwater studies (Table 2). This study found a greater average concentration of microplastics at Site A than the previous study of Reflection Lake (Ludge, 2021). This could be because Site A was downwind during three of the four sampling events. Campus population might have also played a role in these results, as the previous study was early in the COVID-19 pandemic when many classes were online. Another confounding factor is the time of year that these studies took place. The samples for the first study were collected during the Spring of 2021, and samples for this study were collected during Fall of 2021.

Although foam was the most common type of microplastic found and pellets and films were the least, it is possible that this conclusion is biased because the foam pieces are easier to see because of their size and color. Pellets and films are harder to see because as was observed during the sieve process of every sample, they are smaller, more likely to stick to organics, and often blend in more easily because of their color. The concentrations of microplastics found in this study most likely represent a minimum of what is actually present in the lake.

Site A consistently had higher concentrations of microplastic than Site C. It was noted that Site A was downwind during sampling every time except for the 10/15/21 sample, which plays a role in the fact that it was the only time Site C had a higher concentration than Site A.

Table 3: total number of microplastics of each shape category in each sample.

	1A 9/28/21	1C 9/29/21	2A 10/4/21	2C 10/4/21	3A 10/15/21	3C 10/15/21	4A 10/22/21	4C 10/22/21
Pellets/ Beads	0	0	0	0	1	0	1	1
Fibers	0	0	0	1	3	0	1	0
Fragments	4	2	2	6	7	2	2	2
Foam	13	0	1	2	8	2	6	4
Tire Particles	5	0	0	0	9	1	0	0
Films	2	0	0	0	0	0	2	0
Total	**24**	**2**	**3**	**9**	**28**	**5**	**12**	**7**

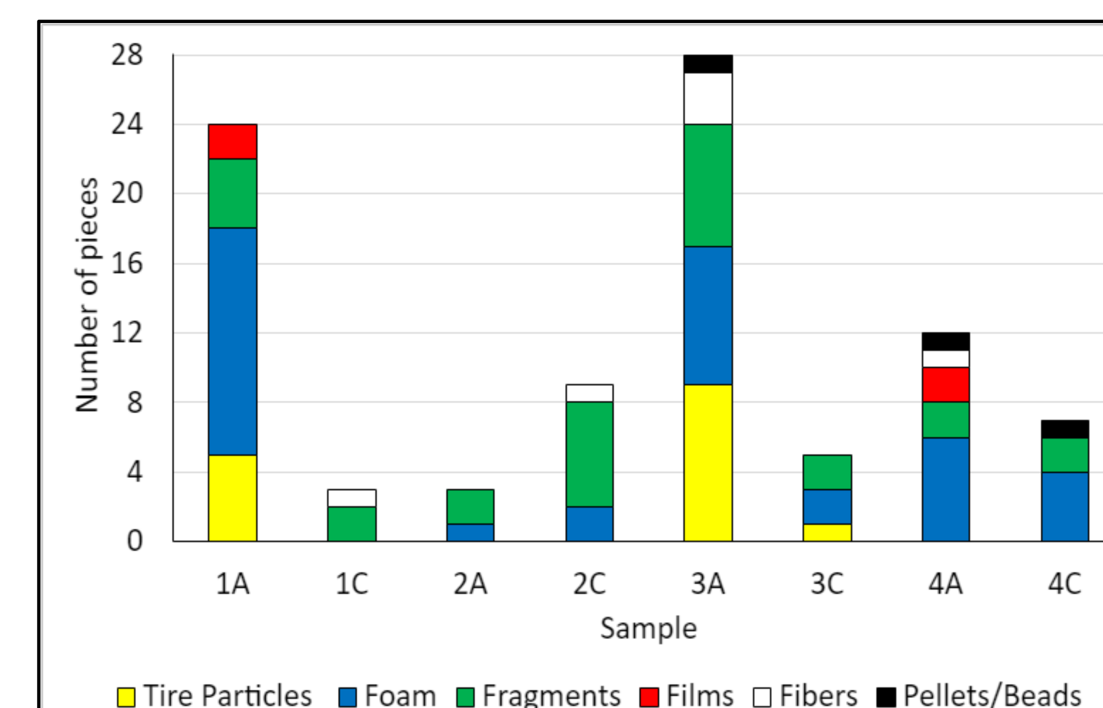
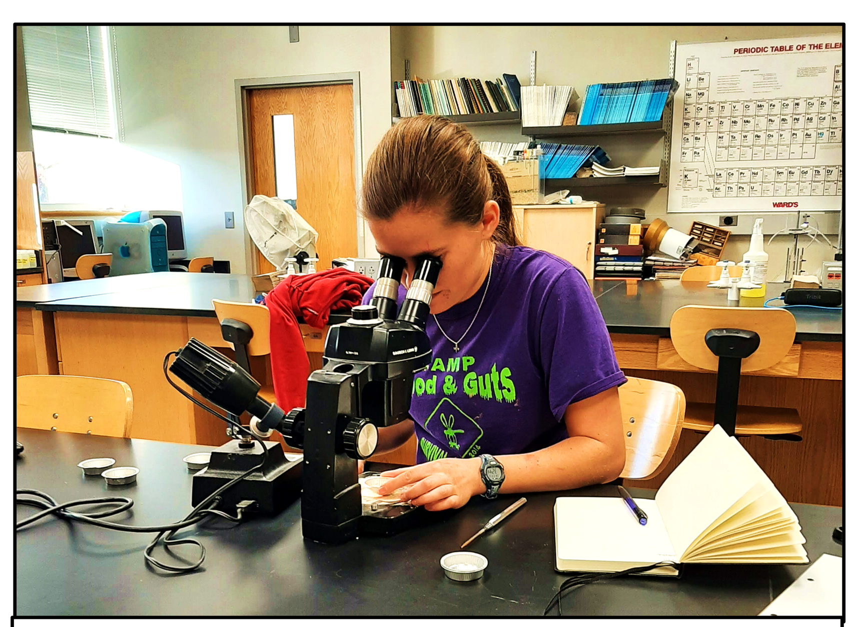


Figure 1: Quantities of microplastic types, by sample



Microscope examination and shape characterization of the Site A sample from 10/22/21

Photo of Site A sample from 9/28/21: foam, fragment, tire particle, and Styrofoam. Field of view = 25mm

Sample collection at Site A on 10/15/21

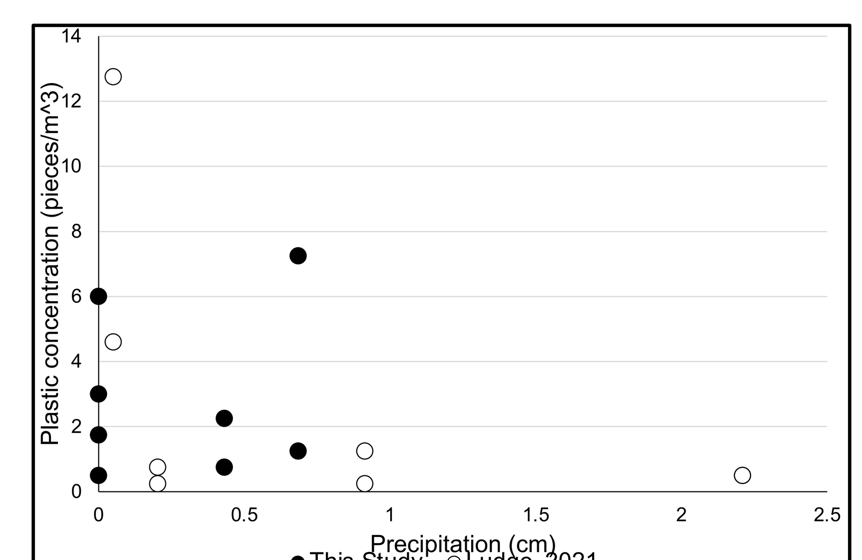


Figure 3: Concentration of microplastics (pieces/m^3) vs precipitation (cm) 48 hours before each sampling event (Ludge, 2021; NOAA, 2021).

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Photo of Site C sample from 10/22/21: 1 fragment and 1 pellet. Field of view = 1.95mm

Photo of Site C sample from 10/4/21: 2 Styrofoam pellets and 6 fragments. Field of view = 10.3mm

Photo of Site A sample from 10/15/21: 3 fragments, 1 pellet, and 1 tire fragment. Field of view = 9mm

Photo of Site A from 10/15/21: 1 fragment and 1 foam piece. Field of view = 17mm

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