Microplastic Pollution: A Survey of Wastewater Effluent in the Lake Champlain Basin

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Abstract

Microplastic is defined as particulates <5mm in size characterized as fragments, fibers, films, pellets, and beads. Microplastic pollution was first documented in the 1970s and interest has grown from initial characterization, to affects within marine and freshwater food chains, ultimately impacting human health. Due to their small size, porosity, and density variation, microplastics often escape wastewater treatment processing (WWTP). Commencing in 2015, we surveyed WWTP post-treatment effluent (N = 59) from the city of Plattsburgh, NY and beginning in fall 2016 from St Albans, VT (N = 29). Ticonderoga, NY (N = 23), and Burlington, VT (N = 9). Effluent samples were collected and digested using wet peroxide digestion methods, followed by microscopic characterization based on type and size. Plant specifications varied yielded varied microplastic trends in quantity and type. Specifically Plattsburgh largely emitted fibers and fragments, St. Albans emitted a majority of foam, Ticonderoga emitted mostly fibers, and Burlington emitted a majority of fragments. Estimated microplastics released per day ranged from St. Albans (30,268), Plattsburgh (14,105), Burlington (16,843), and Ticonderoga (7,841). Microplastics are an emerging concern for aquatic life as they can bioaccumulate and adsorb harmful chemicals which bioaccumulate up the food chain. They have been found to impair feeding and reduce survival in many aquatic species. This research further documents wastewater treatment plants as a significant source of microplastics entering Lake Champlain and serves as a basis for future microplastics in the Lake Champlain watershed. As plants are not designed to capture these small particulates, consumer behavior must evolve to reduce this pollution threat.

Microplastics

- Microplastics derive from personal care products, marine debris (e.g., fishing line, plastic lures, rakes), pre-production plastic nurdles, and photo- and mechanical degradation of larger plastics.
- Postulated sources of these microplastics may be traced to sicker environments that contain microbeads, used for exfoliation and/or from clothing, in the form of polyester and acrylic fibers such as synthetic jackets and sweaters (Thompson et al. 2011, Hartline et al. 2016).
- Microplastics are characterized as a) films, b) pellets/threads, c) fibers, d) fragments, e) foams, and f) beads (Fig. 1).
- More recent findings have suggested >1500 fibers are emitted from washing dried fleece clothing (Thompson et al. 2011).
- Mason et al. (2016) observed 17 wastewater treatment facilities and concluded that 4 million microplastics per facility per day are being released into our waterways. Between 3-23 billion (average ≥13 billion) of these microplastics were contributed annually to waterbodies from their campus.
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Methods

WWTP Sample Collection:
- Pump sample flow rates were determined in the final stage of processing before and after 24 hr collection at WWTP.
- The hose from the pump ran over the 355µm sieve for 24hrs (Fig. 3a).
- Sieve contents were placed in a beaker for wet peroxide digestion in a fume hood (Figs. 3c, d).
- As particles float throughout the environment, they can adsorb hydrophobic compounds, which bioaccumulate up the food chain.

Results

Microplastics typically were medium (355µm)–sized particulate. They were observed in the wastewater systems in small quantities, ranging from 3 to 4 million microplastics per facility per day. The microplastics found in this study were primarily composed of fibers, foams, and fragments. These microplastics can have significant ecological impacts, as they can bioaccumulate and adsorb harmful chemicals, which can bioaccumulate up the food chain.

Conclusion

Plants in consumer products are not completely captured in typical WWTP processing. Through grant efforts, can help WWTP upgrade technology and infrastructure. It rests on the individual and community behavior to reduce plastic purchases upstream.

Fibers are ubiquitous and perhaps pose greater threat than microbeads biomagnifying through the aquatic food chain. Browne et al. (2011) noted >1900 fibers can be emitted from one synthetic garment.

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Literature Cited


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