Assessing Microplastics

as an Emerging Pollutant In Freshwater Watersheds

Region 7 and Region 3

ORD, Cincinnati

Regional Need- What is background of MPs in our water resources? Sources?

Marcellus and Utica Extraction Boom

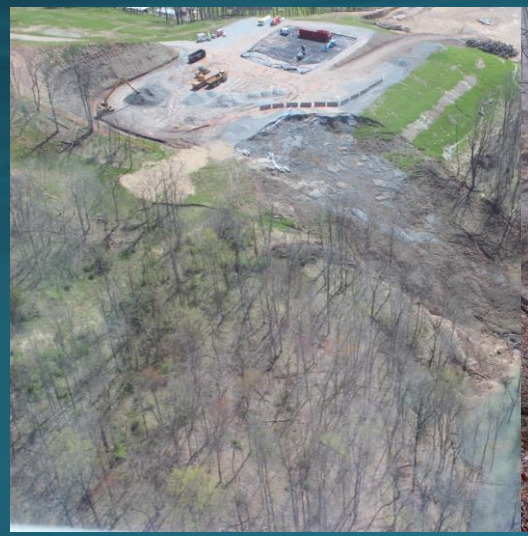
Oil and Gas

Pipelines & Infrastructure

Needed infrastructure for getting product to market

Ethane Cracker Plants

3rd most marketable product from ONG wells



Ethane Cracker Plants – 3 planned in Ohio River watershed (PA, OH, WV)

A view of Royal Dutch Shell's cracker plant while it was under construction last year in Beaver County. -- Celeste Van Kirk

Nurdle, 1 mm to 5 mm in size

Nurdles: Point and Nonpoint Sources

Marine Pollution Bulletin 129 (2018) 52–60

(Rochman et al., 2013; UNEP, 2014), but the importance of this factor compared to uptake via normal feed contamination or exposure to other naturally occurring particles in the environment is still uncertain (Koelmans et al., 2016). Additionally some of the additives used in plastic products have been shown to migrate from microplastics to biota (Rochman et al., 2013).

Plastic pollution can also lead to significant economic losses, for example through losses in revenue from tourism and the cost of beach cleaning (UNEP, 2014; Mouat et al., 2010; Leggett et al., 2014). Although these costs are based on the total amounts of plastic on beaches, pellets are commonly found during beach cleaning campaigns and thereby a contributing factor to the costs.

The occurrence of plastic pellets in the environment was linked to industrial outlets already in the 70s where researchers first started calling for precautionary measures within the industry (Hays and Cormons, 1974). Even so, a study in the river Rhine from 2015 showed that 60% of the identified plastic particles were spherules, with a possible linkage to different industries along the river (Mani et al., 2015). Similarly pellets were measured at a mean density of 693 items per 1000 m^3 in the river Danube with the highest value of 138,219 per 1000 m^3 during a heavy rainfall (Lechner et al., 2014). These were, according to a press release by a close plastic production company, at least in part due to losses at a production site (Borealis, 2014). In Austria plastic is classified as a filterable substance, and the limit for discharge is 30 mg/L. This limit, extrapolated to a year's worth of discharge amounts to 94.5 tons/year, is a threshold that researchers have questioned due to the high volumes it allows for (Lechner and Ramler, 2015). Although the actual levels that leach into the environment from the production plants are unknown a recent study in the UK indicates a national yearly loss of 5–53 billion pellets (Cole and Sherrington,

The expansion of and changes in the production has required a long row of updated and revised permits throughout the years. The current permit was approved in 2007, but the decision
postponed because of lack of information. S
particles was not mentioned in the decision
miljödomstolen Vänersborg, 2013), twenty ye
formulations and legal recommendations to
provided by the US EPA (US EPA, 1992). The p
showed high amounts of plastic particles in t
pany was assigned to investigate it further. T
also show that the company has reported tha
that are used in the plastic are classified as t
ganisms (Mark- och miljödomstolen Vänersbo

In 2014 the company issued a press releas
to not lose a single pellet" explaining its z
(Borealis, 2014). In the company's yearly env
scription of their sewage and storm water treat
storm water drains has during recent years b
tion site through a polyethylene separator, kn
remove particles that float or sediment. The
nunge Å, a small creek running by the produ
into the industrial harbor. The industrial sewage system colle
from process areas; this water is led through a density sep
separate light density liquids and polyethylene. After treat
water is led to Askeröfjorden (Borealis, 2016) (see Supple
material 2A for a more detailed record of the company permi

The produced polyethylene pellets are loaded for shipp
moved from the production site by road transport but can
further transported by boat, ferries or railroad (Mark- och
miljödomstolen Vänersborg, 2015; Borealis, 2016). Records from in-

volunteers are cleaning nurdles on the coast of Hong Kong's Lamma island in 2012. Hundreds of millions of the plastic pellets were dumped when containers were knocked off a vessel during a typhoon.

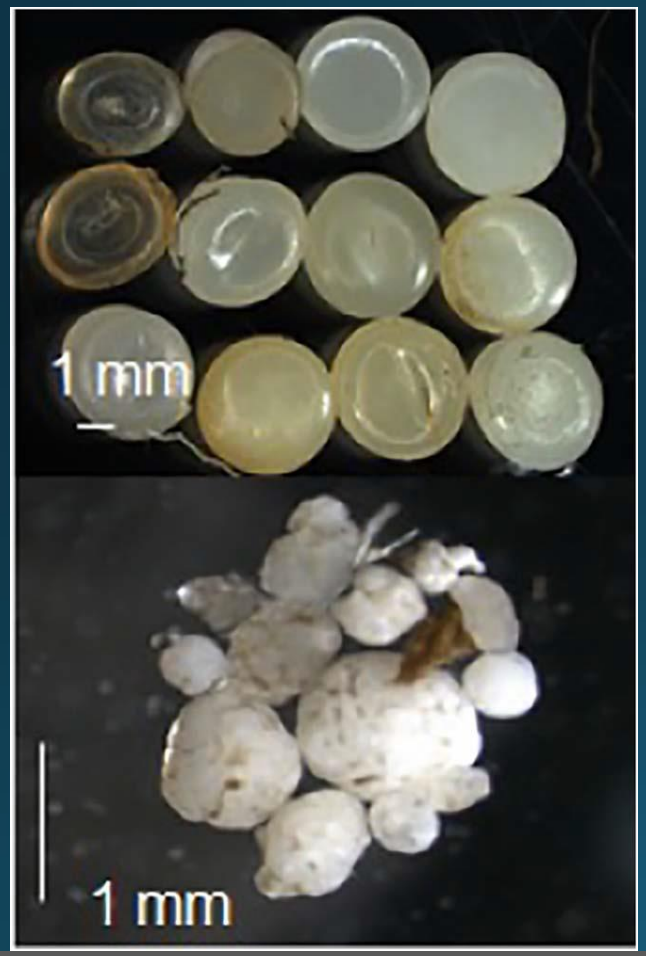
EPA 842/B92/010December 1992
Plastic Pellets in the Aquatic Environment:Sources and Recommendations

The Environmental Protection Agency (EPA) is concerned about the presence of pellets in the aquatic environment for several reasons:
(1) pellets are ubiquitous;
(2) pellets have been found in considerablequantities in coastal areas of the United States; and
(3) laboratory studies and field observations suggestthat ingested pellets may harm or kill aquatic wildlife, including several endangered or threatened species.

- Plastic pellets are present in harbor areas that are inaccessible to cargo ships and other major ship traffic, implying that these vessels are not the only source of plastic pellets in the environment (EPA, 1990b, 1992a,b).
- Harbors of cities with older combined sewer overflow (CSO) systems contained significant percentages of pellets in the floatable debris (EPA, 1990b, 1992a,b).
- Harbors near known production, transport, and processing centers had higher concentrations of pellets (EPA, 1990b, 1992a,b).
- Pellets are present in CSO and storm water outfall discharges and solids collected in sewage treatment facilities (EPA, 1992c).

These findings suggest that the plastics industry remains a likely source of pellet releases into the environment and indicate that significant land-based pellet sources currently exist.

California 2008 "nurdle law"



Typical particles found in the runoff from the production plant. The upper image shows translucent pellets and the lower image shows fluff and fragment found in the lower size-fractions.

Specifically names pre-production plastic pellets (nurdles) as a **pollutant**
The law indicates that nurdles can replace food in animals' stomachs, leading to starvation.
Warns of potential toxic effects on humans and animals from compounds such as bisphenol A and nonylphenol, used in plastic manufacture.

Potential sources of preproduction plastics range from manufacturers, transporters, warehousers, processors, and recyclers located throughout California.

Preproduction plastic spilled during its creation, transport, use, and disposal can be mobilized by storm water.

Nurdle by Nurdle, Citizens Took on A Billion-Dollar Plastic Company — and Won

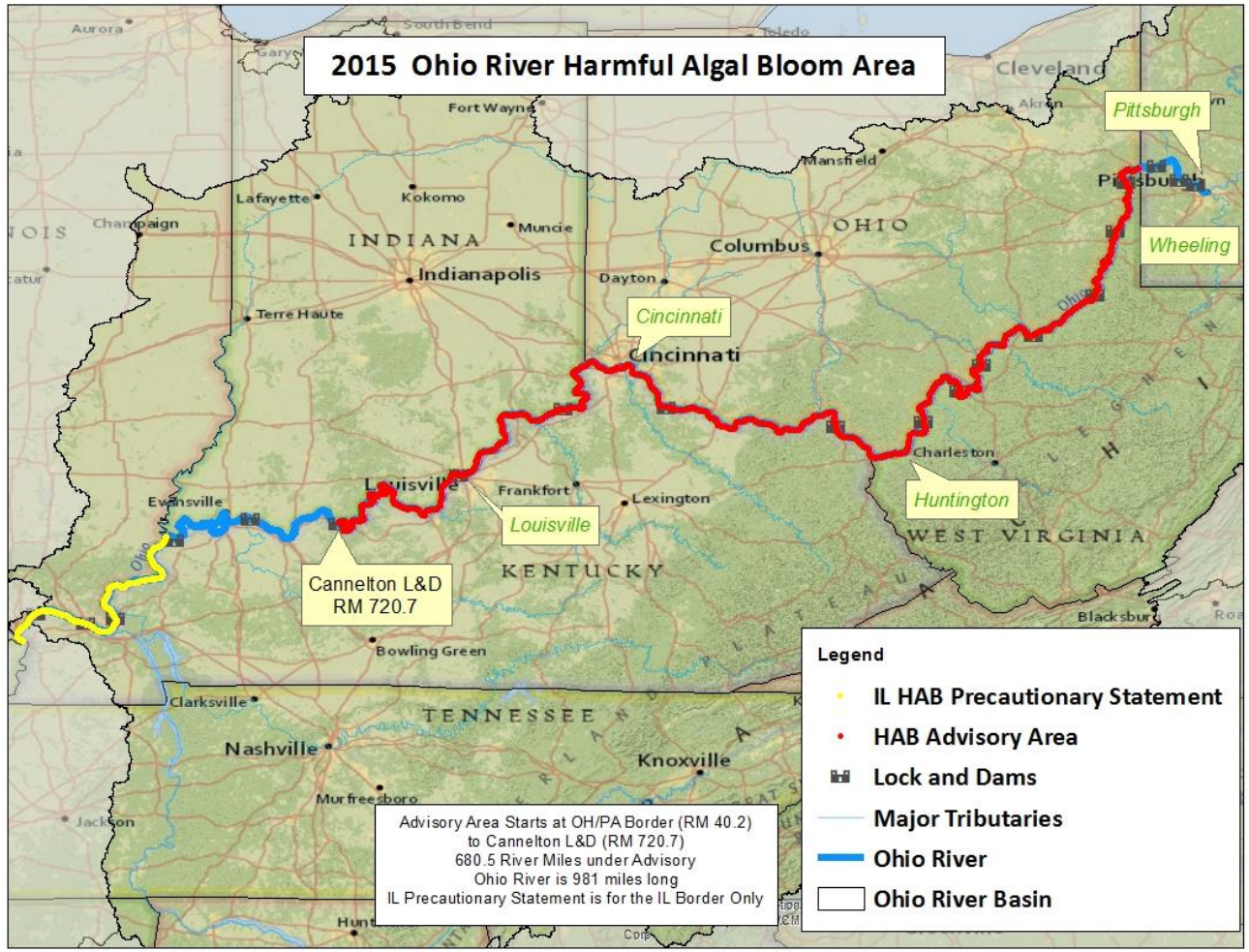
The largest-ever settlement of a Clean Water Act lawsuit filed by private citizens was handed down December a 2019 by a U.S. District Court judge in Waterkeeper v. Formosa.

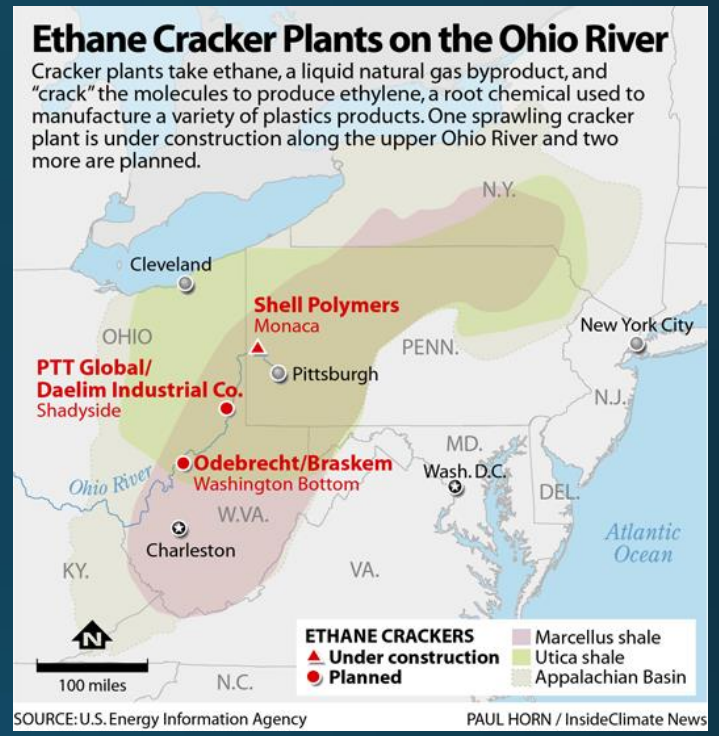
A sample of plastic nurdles found and collected by Andrew Wunderley, executive director for Charleston, SC Waterkeeper, along the shore at Seabreeze Marina during a spot check of the location Tuesday, Dec. 17, 2019, in Charleston. file/Grace Beahm Alford...LAWSUIT MARCH 2020

Water contaminated with nurdles in Lavaca Bay

Pollutant: "Dredged spoil, solid waste… sewage, garbage…chemical wastes, biological materials…and industrial, municipal, and agricultural waste discharged into water"(does not include sewage from vessels or injected wastes)

Frequency, Magnitude, & Duration?

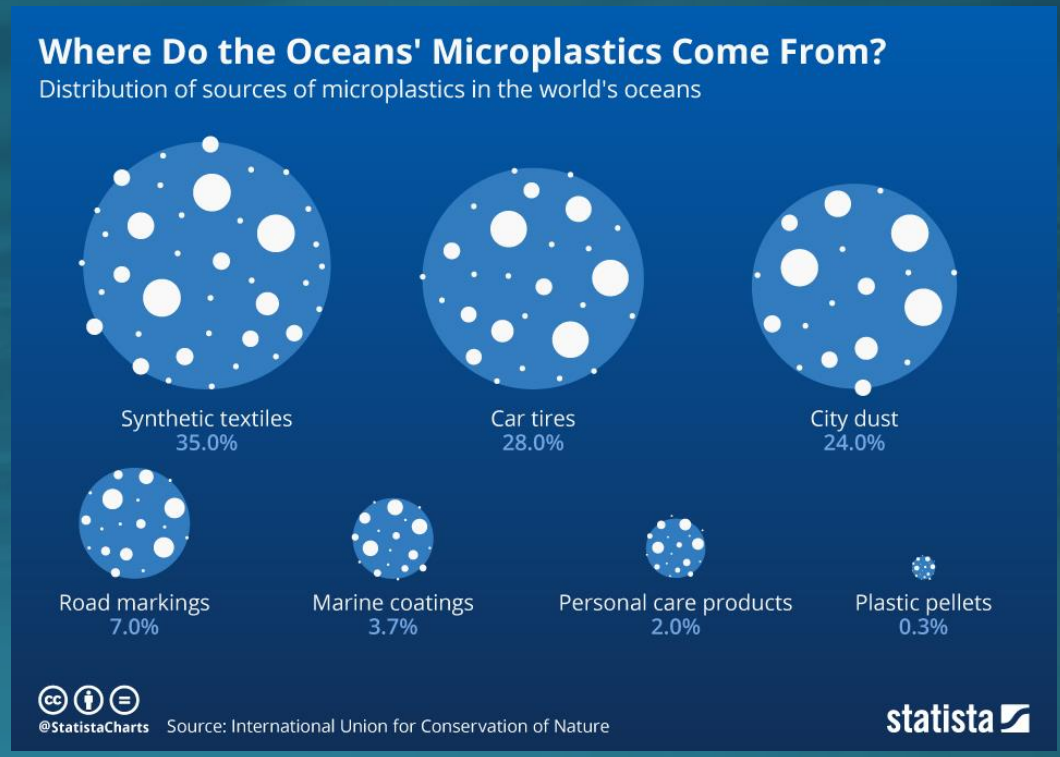




Assessing Microplastics as an Emerging Pollutant in Freshwater Rivers

What are Microplastics?

- Defined as a polymer particle less than 5 mm long
- Enter the environment as a primary microplastic or through fragmentation/degradation as secondary microplastics
- UN estimates that 300 tons of plastic is produced annually and less than half of that is recycled
- Examples of types of microplastics are fibers, microbeads, fragments, nurdles (small plastic pellets used to manufacture plastic goods) and foam
- Emerging contaminant of concern



Detection of Microplastics (<5mm)

#1. Protocol Developed for sampling

Ambient Water Sample

#2. Regions sample and process from Missouri, Kansas, and Ohio watersheds

Concentration of particles :
Filtration and/or centrifugation

Other techniques (IRMS, Pyrolysis GC-MS)

Flow cytometry:
200nm-20um
*150 nm size

Macro PARISS:
Absorption and Reflection
*2.5 micrometer

Nikon Ti2 PARISS:
Nile red staining
*220 nm

Raman Imaging

FTIR

#3. Protocol developed for state, river basins and tribes for assessing microplastics as a pollutant in freshwater aquatic systems

Particle Analysis by Laser Directed Infrared (LDIR)

- LDIR Chemical Imaging System
- Obtains IR spectra of all particles and identifies the polymer type
  - Uses an IR reference library
- Obtains particle size and shape parameters and polymer type for particles ≥10 µm is the detection limit

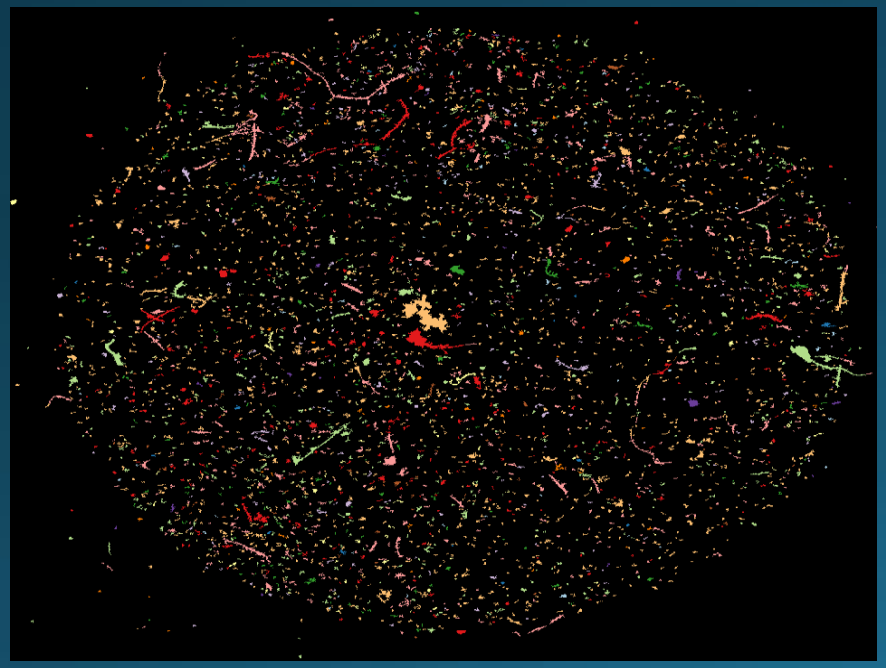
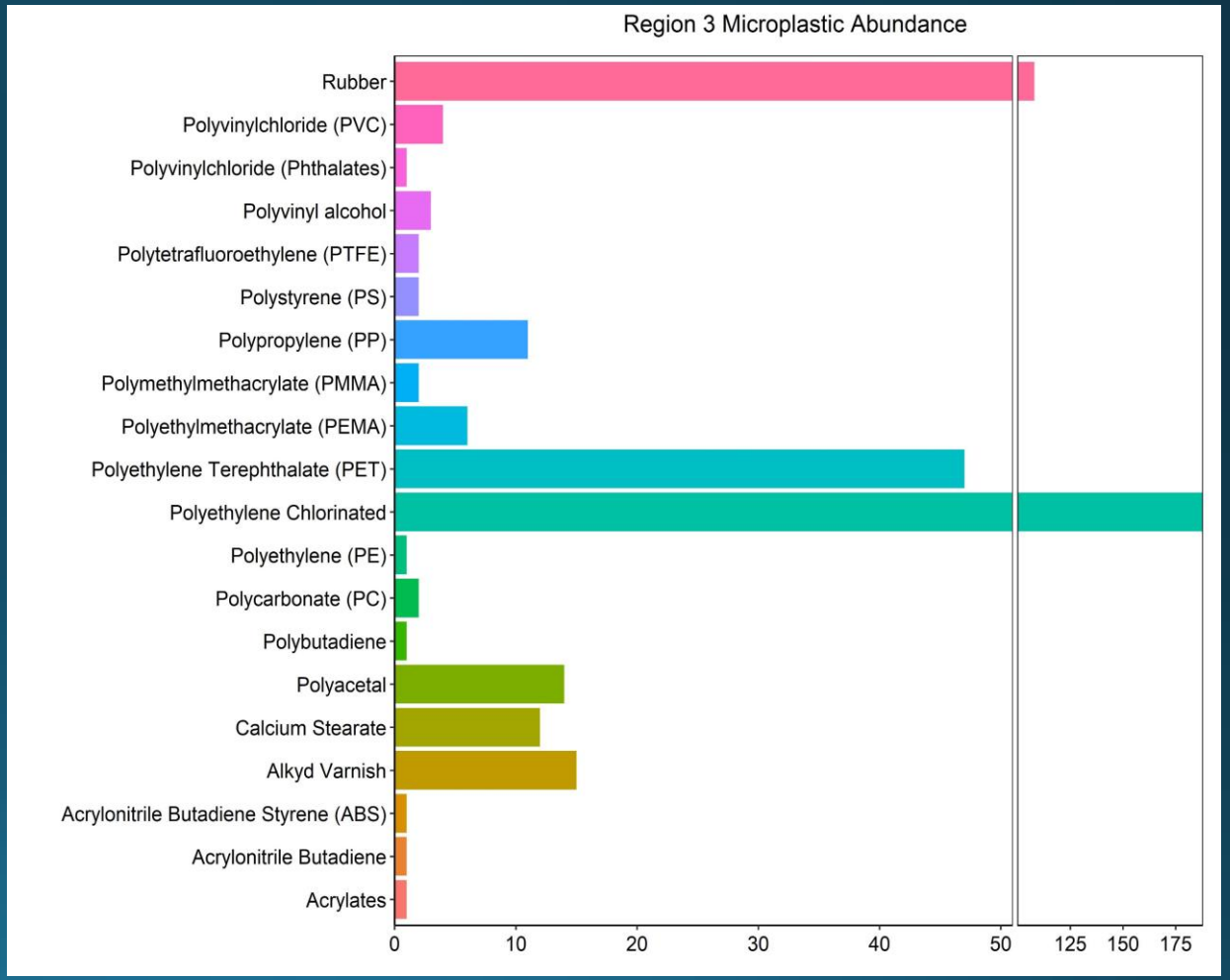
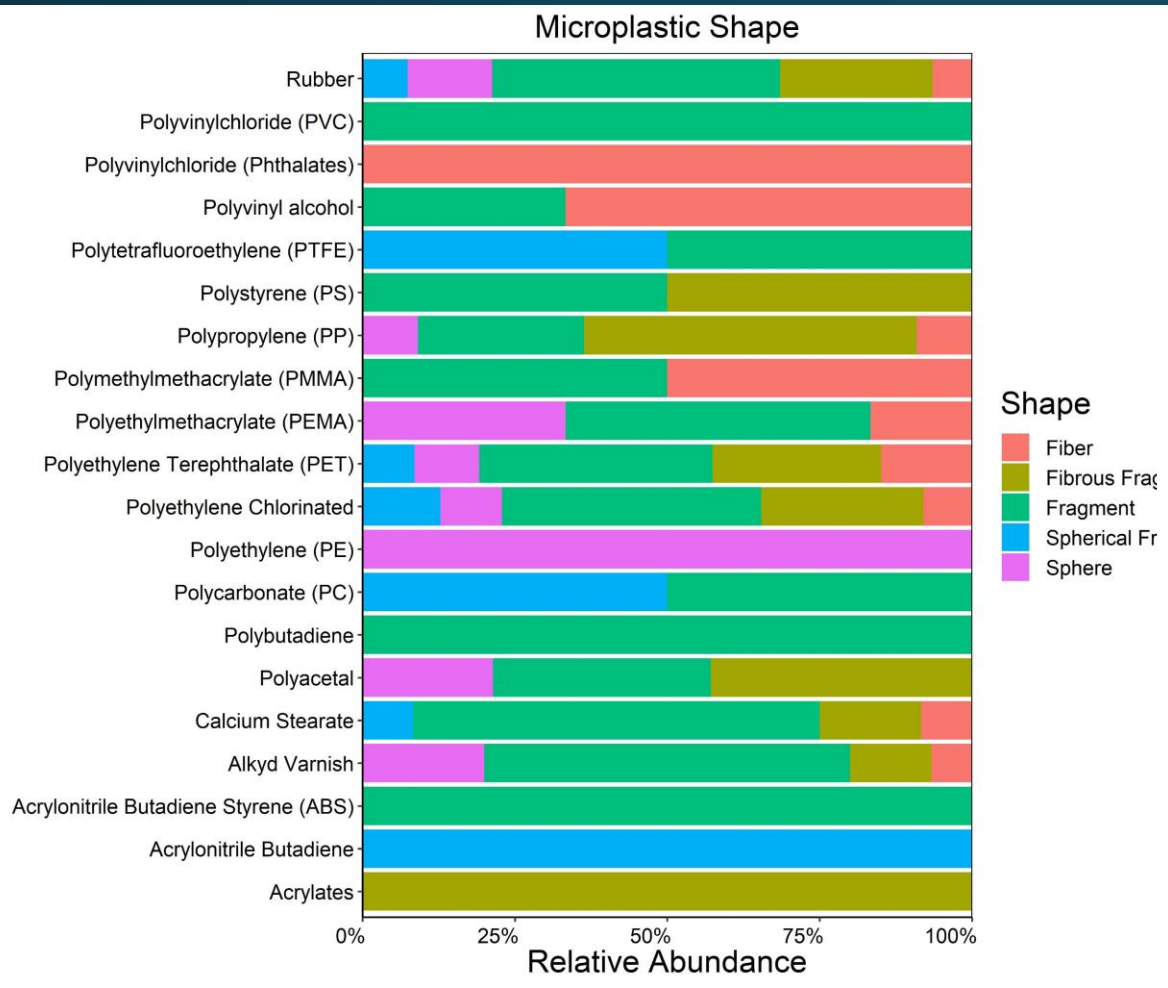
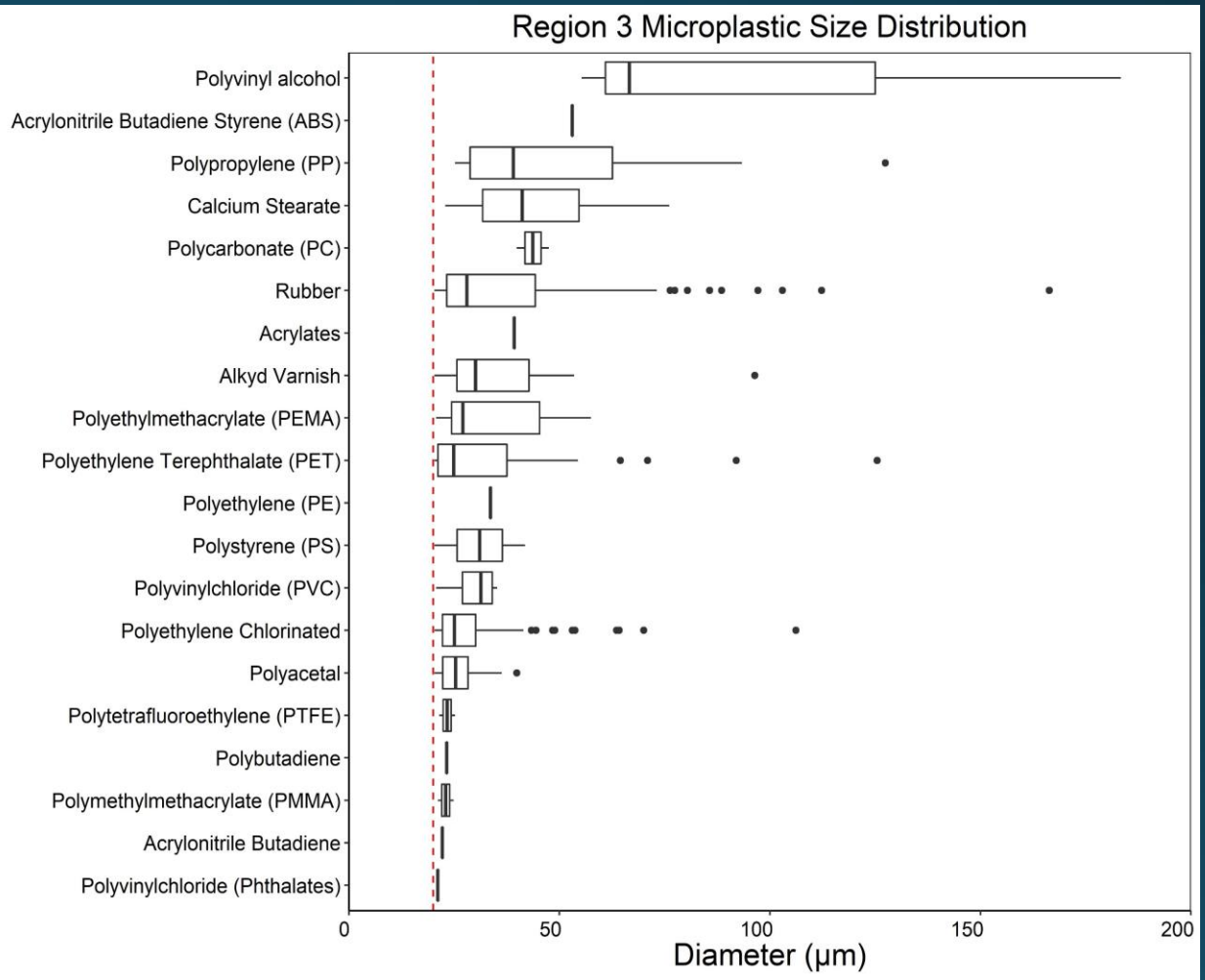


Image of 100µL from River Surface Water



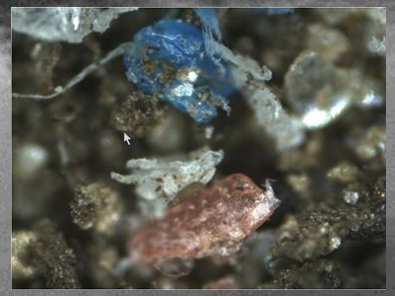
Plastic Particle Shape and Polymer Abundance





The specific objectives for R3 are:

- To identify, quantify and characterize of MPs in a large river such as the Ohio river
- To help develop a standard sampling protocol for MPs in freshwaters resources
- To evaluate existing methodologies, instrumentation, and approaches to best identify, characterize, and quantify MPs in freshwater
- To help establish a standard guidance for the separation, analysis, and identification of MPs from freshwater resources using different instruments



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