STAC Chesapeake Bay Microplastics Workshop

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Microplastics in the Chesapeake Bay

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Microplastics in Chesapeake Bay

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Study tested the hypothesis that microplastics would be more abundant in proximity to urban sources

Environmental Science & Technology

Article

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Microplastics in Four Estuarine Rivers in the Chesapeake Bay, U.S.A.

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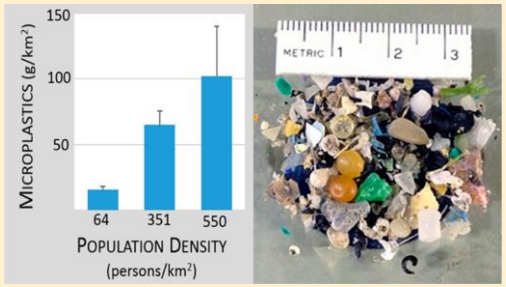
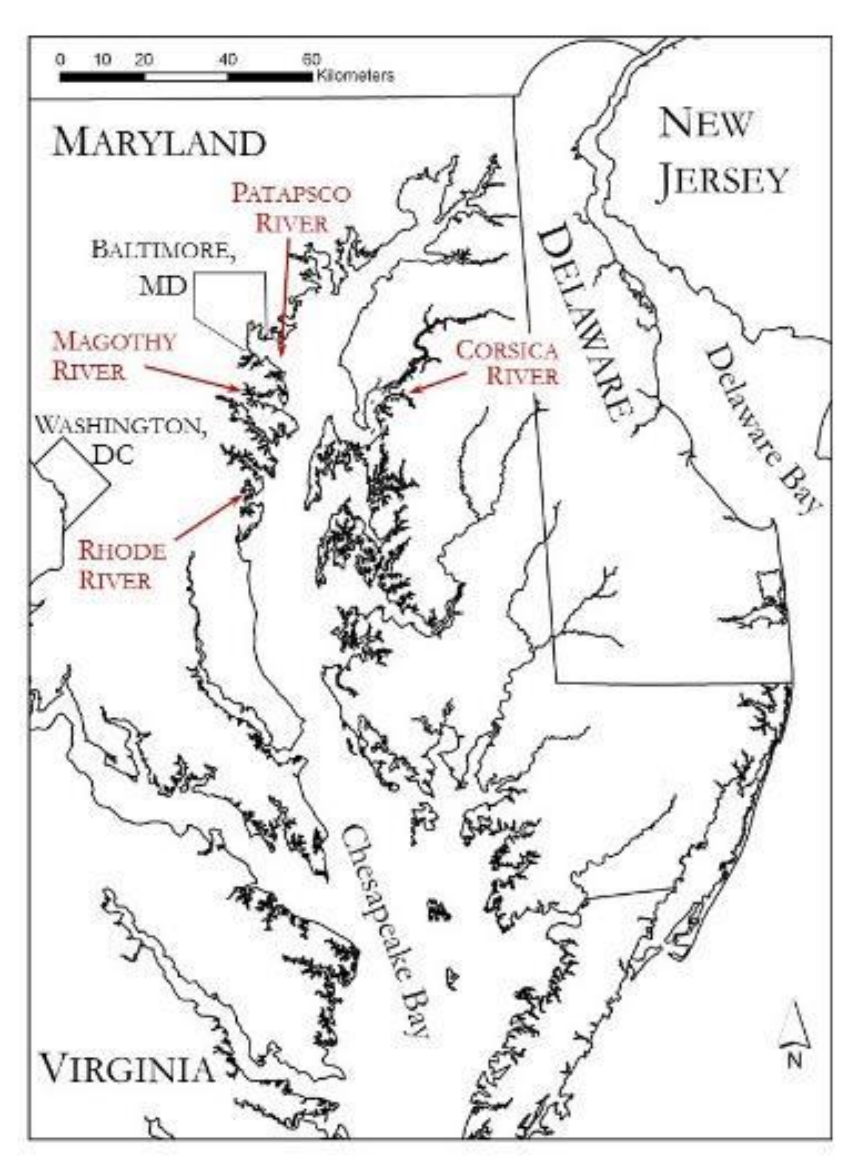
Supporting Information

ABSTRACT: Once believed to degrade into simple compounds, increasing evidence suggests plastics entering the environment are mechanically, photochemically, and/or biologically degraded to the extent that they become imperceptible to the naked eye yet are not significantly reduced in total mass. Thus, more and smaller plastics particles, termed microplastics, reside in the environment and are now a contaminant category of concern. The current study tested the hypotheses that microplastics concentration would be higher in proximity to urban sources, and vary temporally in response to weather phenomena such as storm events. Triplicate surface water samples were collected approximately monthly between July and December 2011 from four estuarine tributaries within the Chesapeake Bay, U.S.A. using a manta net to capture appropriately sized microplastics (operationally defined as 0.3−5.0 mm). Selected sites have watersheds with broadly divergent land use characteristics (e.g., proportion urban/suburban, agricultural and/or forested) and wide ranging population densities. Microplastics were found in all but one of 60 samples, with concentrations ranging over 3 orders of magnitude (<1.0 to >560 g/km^2). Concentrations demonstrated statistically significant positive correlations with population density and proportion of urban/suburban development within watersheds. The greatest microplastics concentrations also occurred at three of four sites shortly after major rain events.



Microplastics in Chesapeake Bay



Sites had watersheds with broadly divergent land-use characteristics (e.g., urban/suburban, agricultural and/or forested) and wide ranging population densities

Table 1. Characteristics of Watersheds Proximate to Chesapeake Bay Surface Waters Sampled for Microplastics between June and December 2011[a]

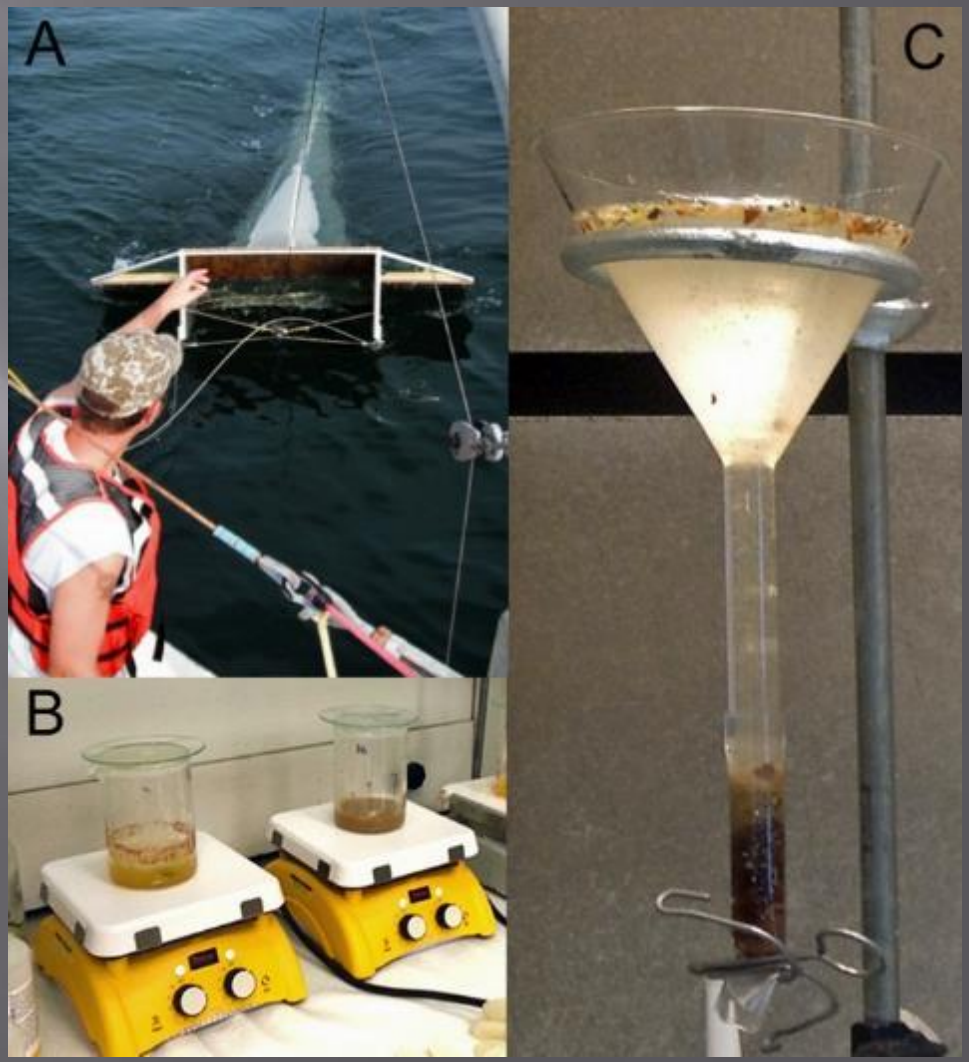
watershed characteristics	Patapsco River	Magothy River	Rhode River	Corsica River
population	899 000	32 350	4300	3500
watershed area (km^2)	1637	92	67	97
tidal river/bay area (km^2)	123	21.8	12.8	5.6
population density (persons/km^2)	550	351	64	36
total developed (%)	54	59	12	13.5
urban/industrial (%)	28	5	0	3.1
suburban/residential (%)	26	54	12	10.4
agricultural/pasture (%)	18	0.5	16	60.4
forested (%)[b]	17	32	68	24.4

Microplastics in Chesapeake Bay

A Surface water samples were collected approximately monthly between July and Dec. 2011 using a manta net (0.3-5.0 mm)

B Labile organics were dissolved with 30% hydrogen peroxide

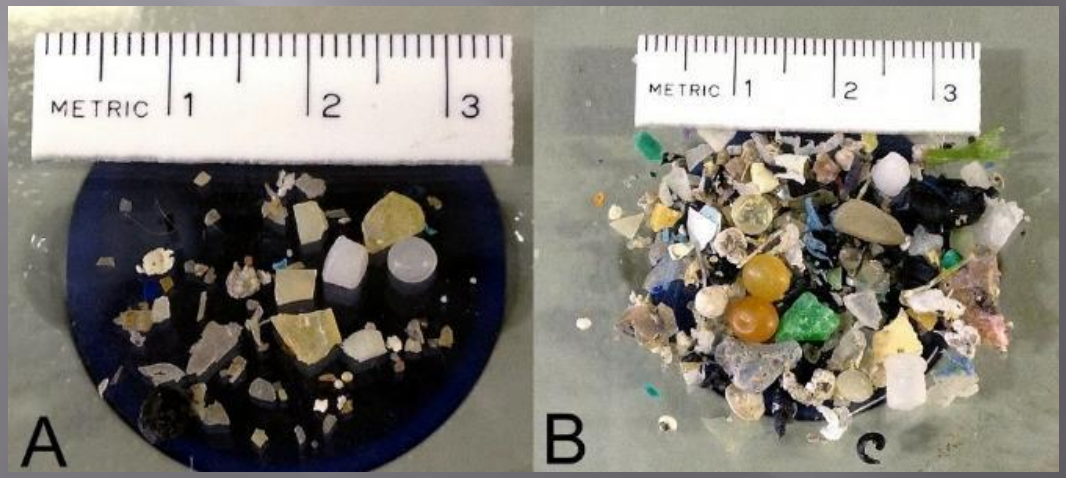
C Hypersaline brine solution (300ppt) allowed density separation and visual sorting plastics

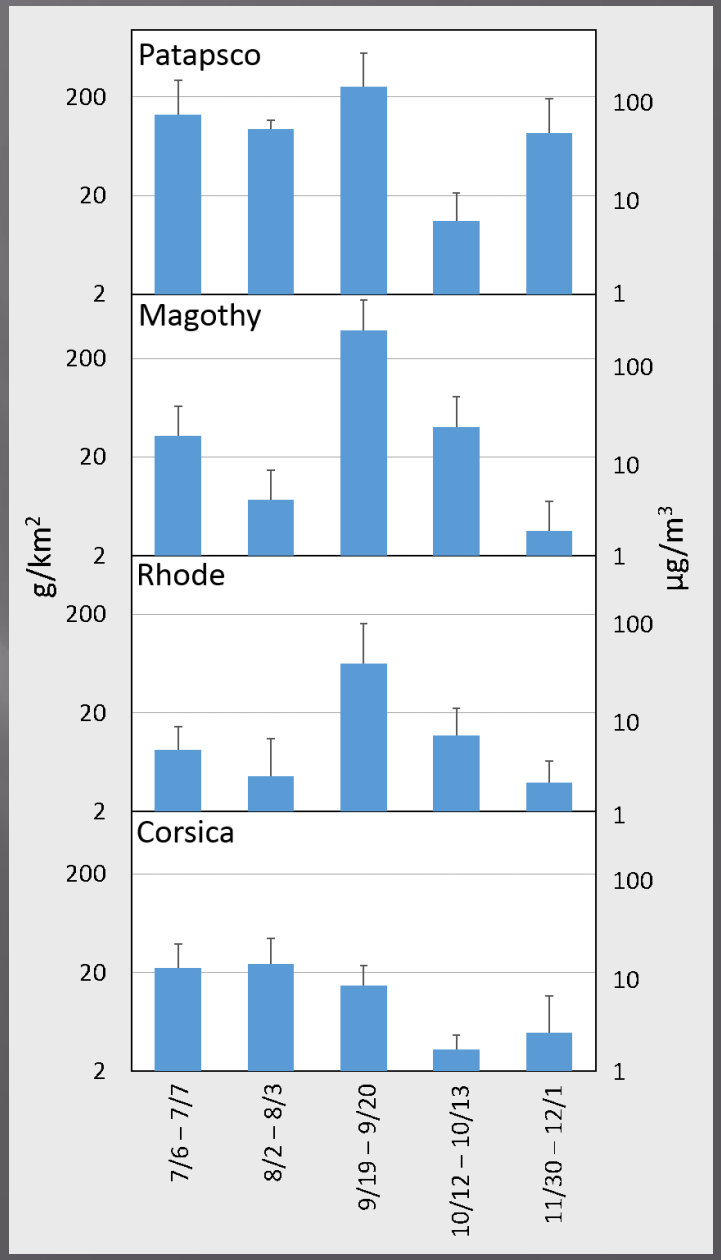


Microplastics in Chesapeake Bay

Microplastics were found in all but one of 60 samples

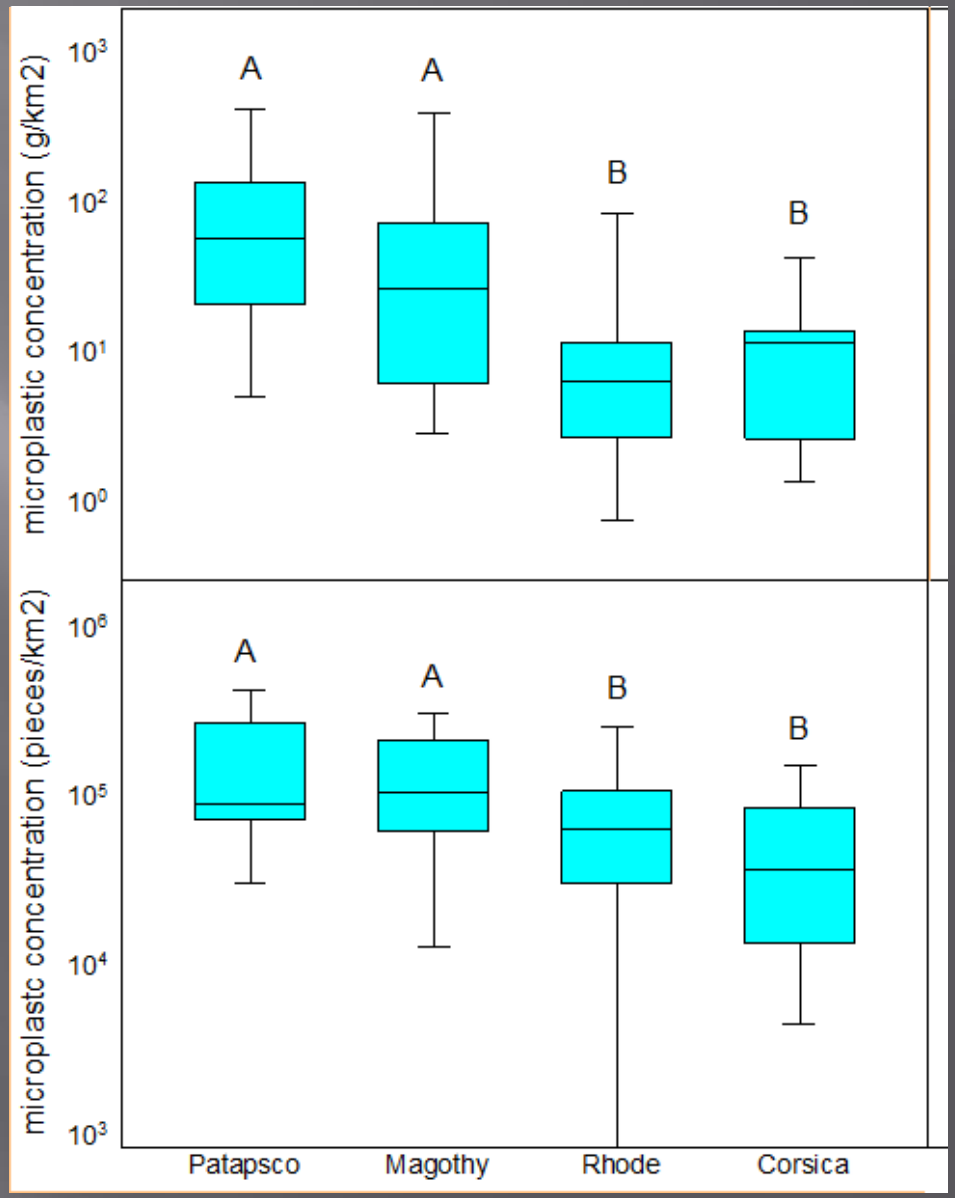
Abundance was highly variable within and across sites and sample dates





Microplastics in Chesapeake Bay

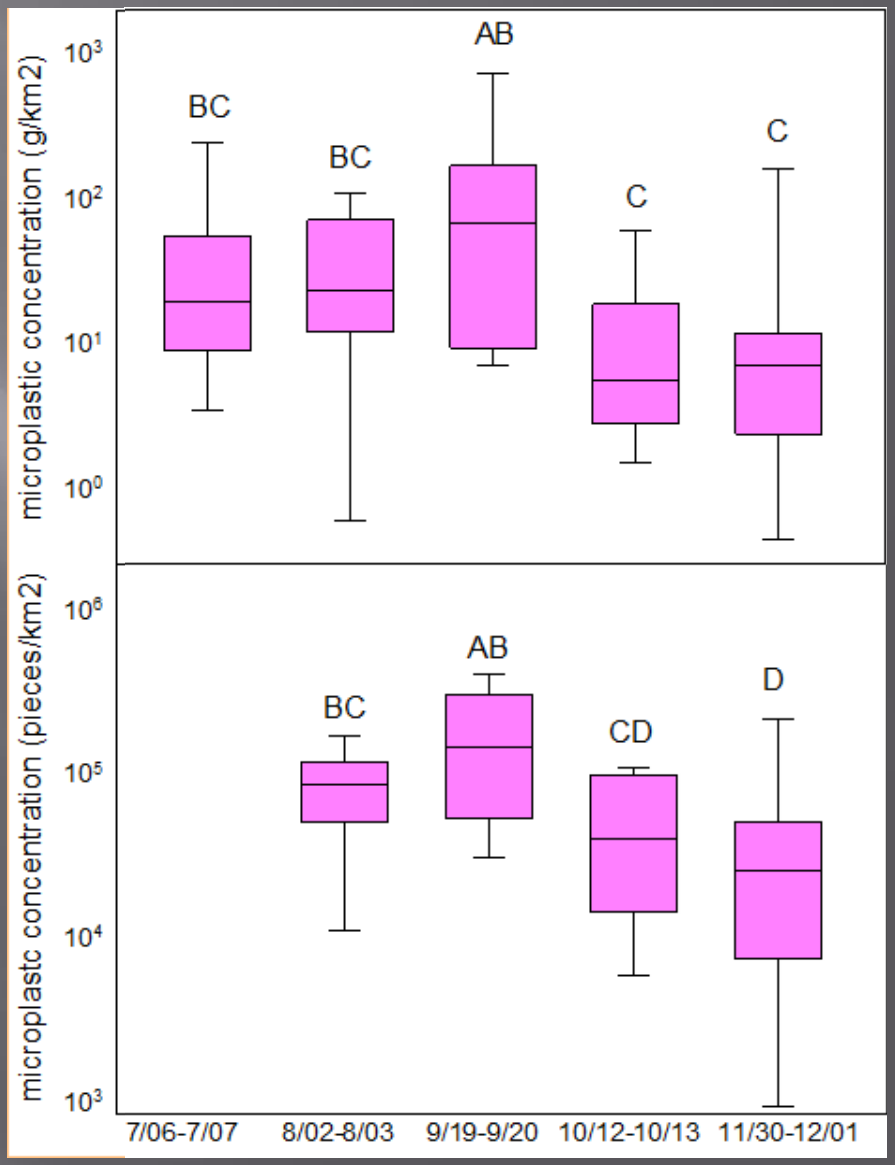
Abundances were significantly higher in Patapsco and Magothy samples compared to Rhode and Corsica samples



Microplastics in Chesapeake Bay

Highest microplastics abundances occurred several weeks after hurricane *Irene* and tropical storm *Lee*

Not statistically significant but suggest relationship to runoff

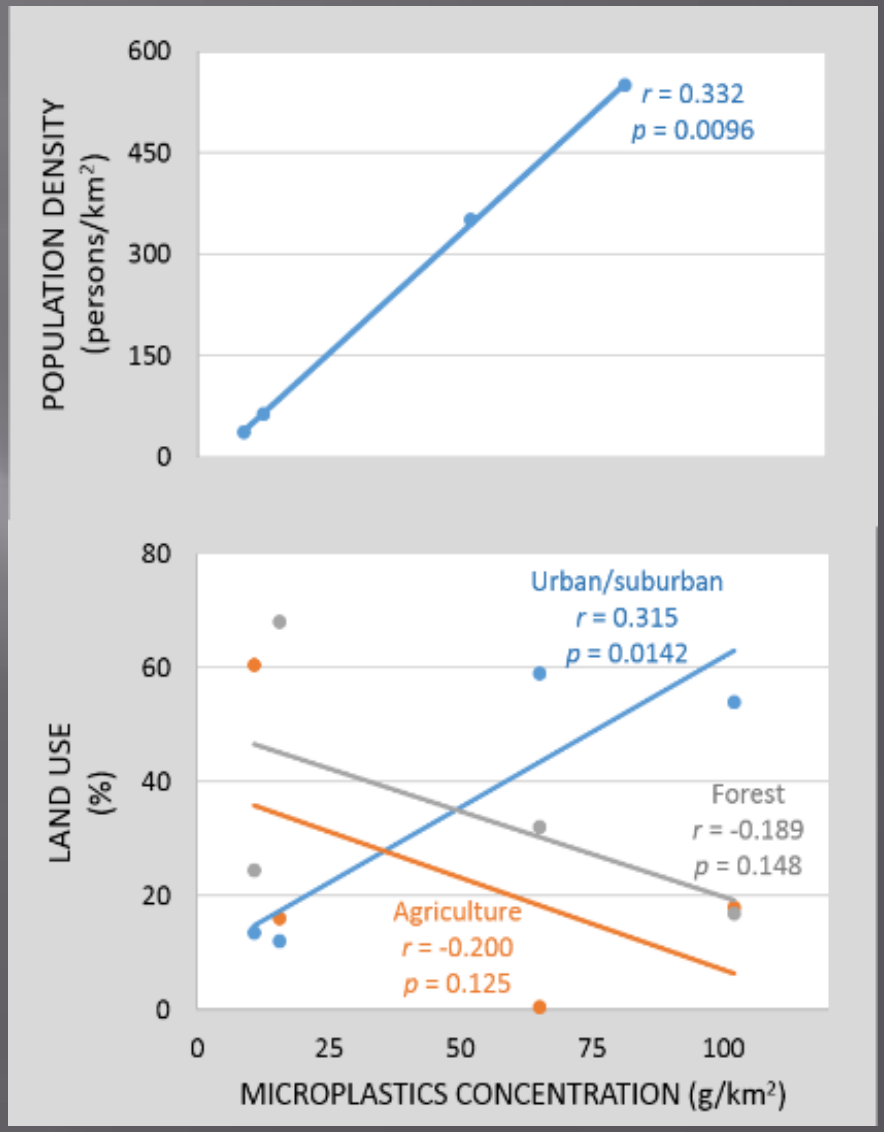


Microplastics in Chesapeake Bay

Concentrations correlated positively with:

- Population density
- Imperviousness
- Urban/suburban development
- Inversely with % agricultural / forested land-use

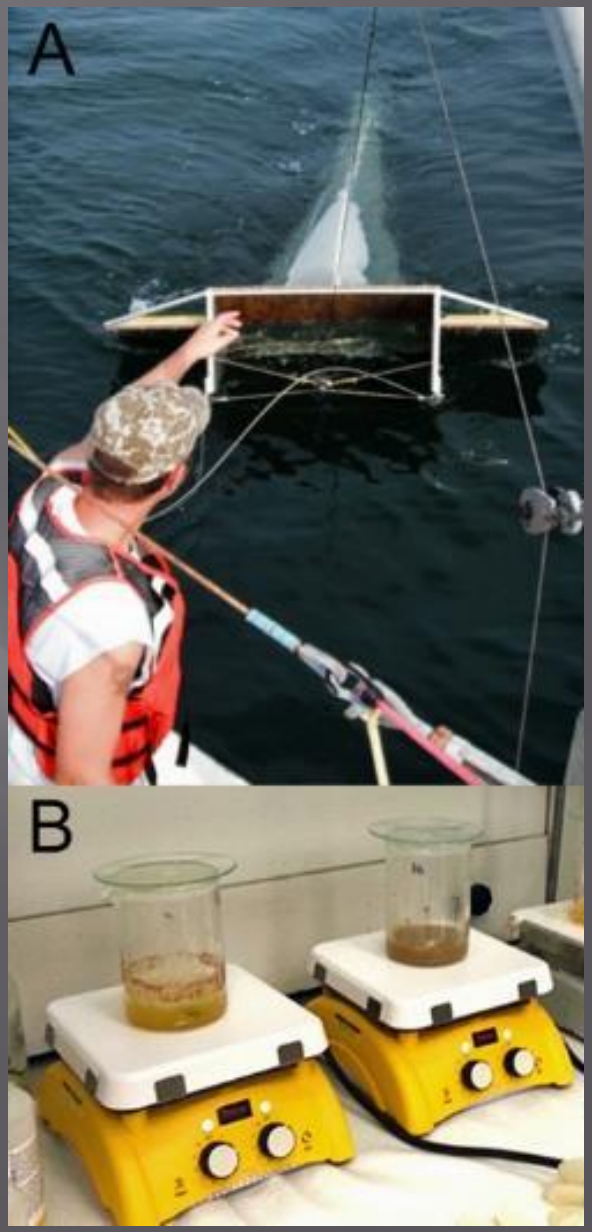
No big surprises – human activities are clearly the sources



Microplastics in Chesapeake Bay

Some notable limitations

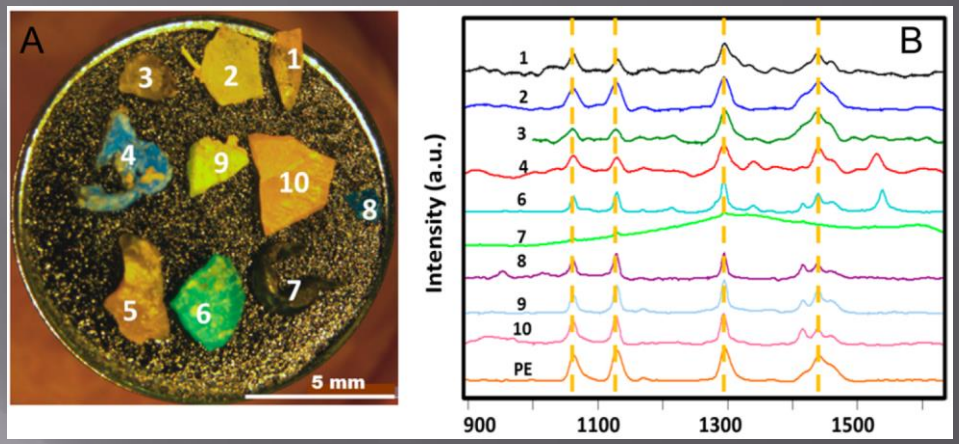
- ***Surface water samples collected by manta net***
  - Only reflects buoyant material from top ~15 cm of water column
  - Only includes particles > 300 µm
- ***Digestion with H_2O_2 might have compromised some materials***
  - Mass is reduced
  - Pieces fragment during processing
  - Fibers identified as third most abundant category behind films and particles
    - newer studies tend to indicate fibers dominate total MP

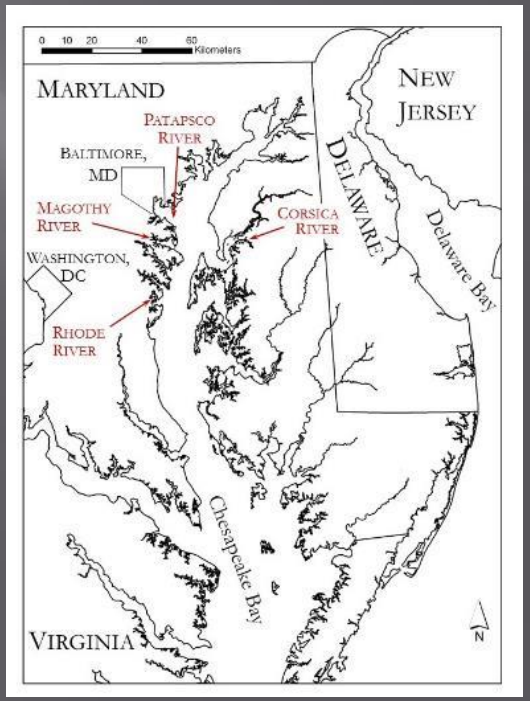


Microplastics in Chesapeake Bay

Some notable limitations

- ***Limited FT-IR confirmation of visual sample sorting***
  - Only 10 items validated (all were polymers!)
  - All were ≥ 1.0 mm
  - Smaller items not addressed
- ***Small study***
  - Only four locations
  - Moderate # of samples
- ***Data approaching 8 years old***
  - Samples collected 2011

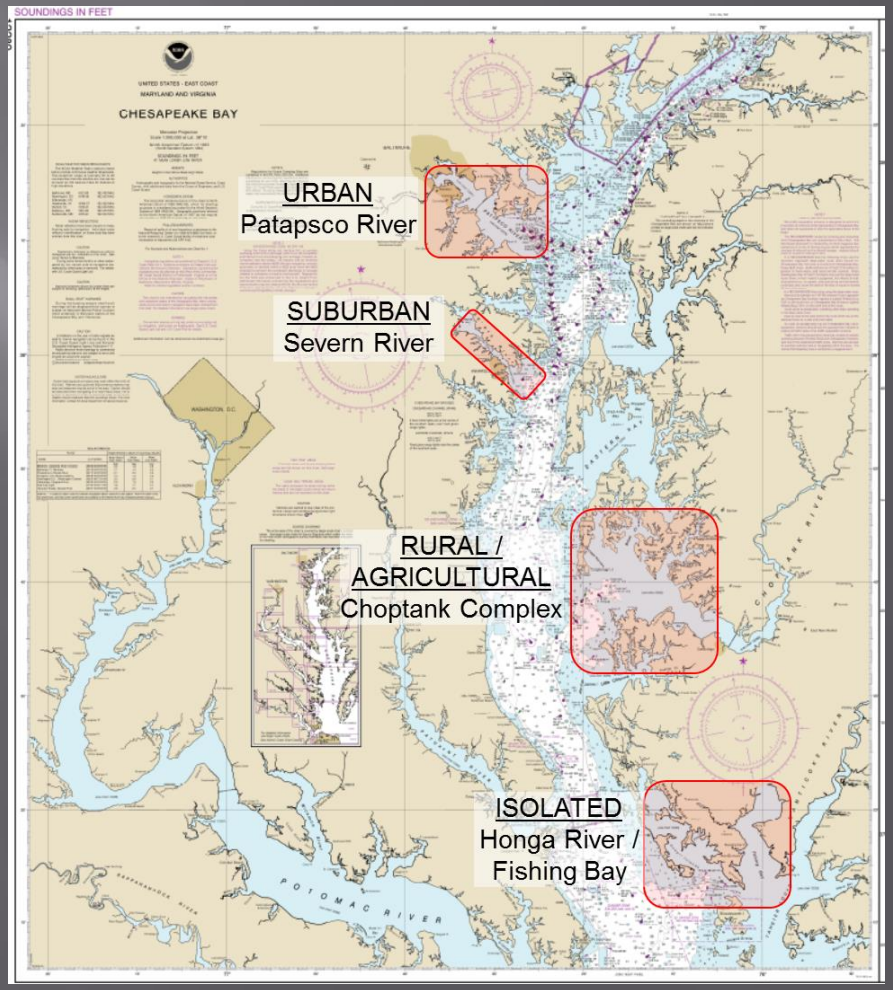




Microplastics in Chesapeake Bay

Several new research efforts underway

- ***Abundance and Variety of Microplastics in Surface Waters, Sediments, and Oysters***
  - 2-year MD Sea Grant funded project
  - Investigates MP abundance in relation to land-use practices
    - *Urban* – Patapsco River
    - *Suburban* – Severn River
    - *Agricultural* – Choptank River
    - *Isolated* – Honga / Fishing Bay
  - Three stations / system



Microplastics in Chesapeake Bay

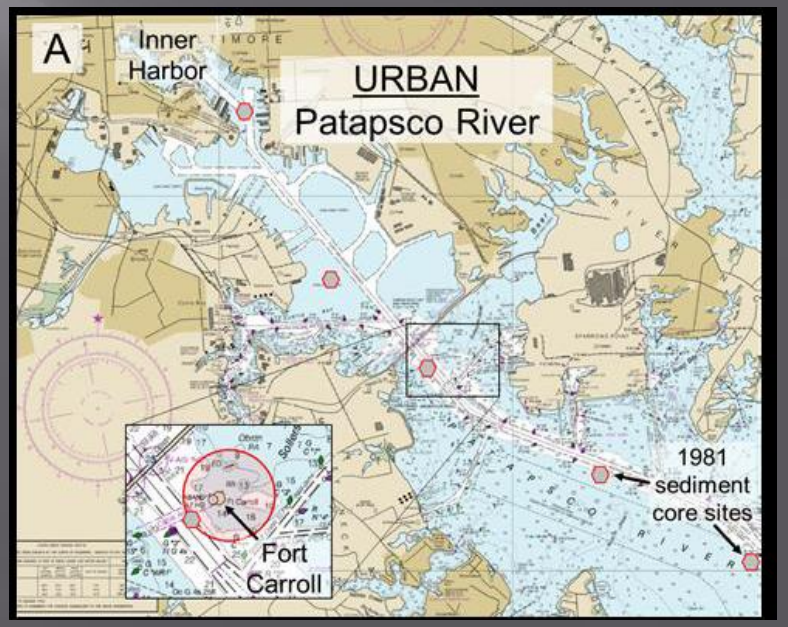
Several new research efforts underway

- ***Abundance and Variety of Microplastics in Surface Waters, Sediments, and Oysters***
  - At each station - water samples collected at surface and ~ 15 cm above the bottom
    - 250 L replicate samples collected onto 100 µm sieves
    - 20 L replicate samples collected for capture on 1 µm glass-fibre filters
  - Oysters collected by MD DNR during fall survey or from CBF sanctuaries
    - 3 – 4 reefs / system
    - 12 oysters / reef
    - + 12 for 3-d depuration study

Microplastics in Chesapeake Bay

Several new research efforts underway

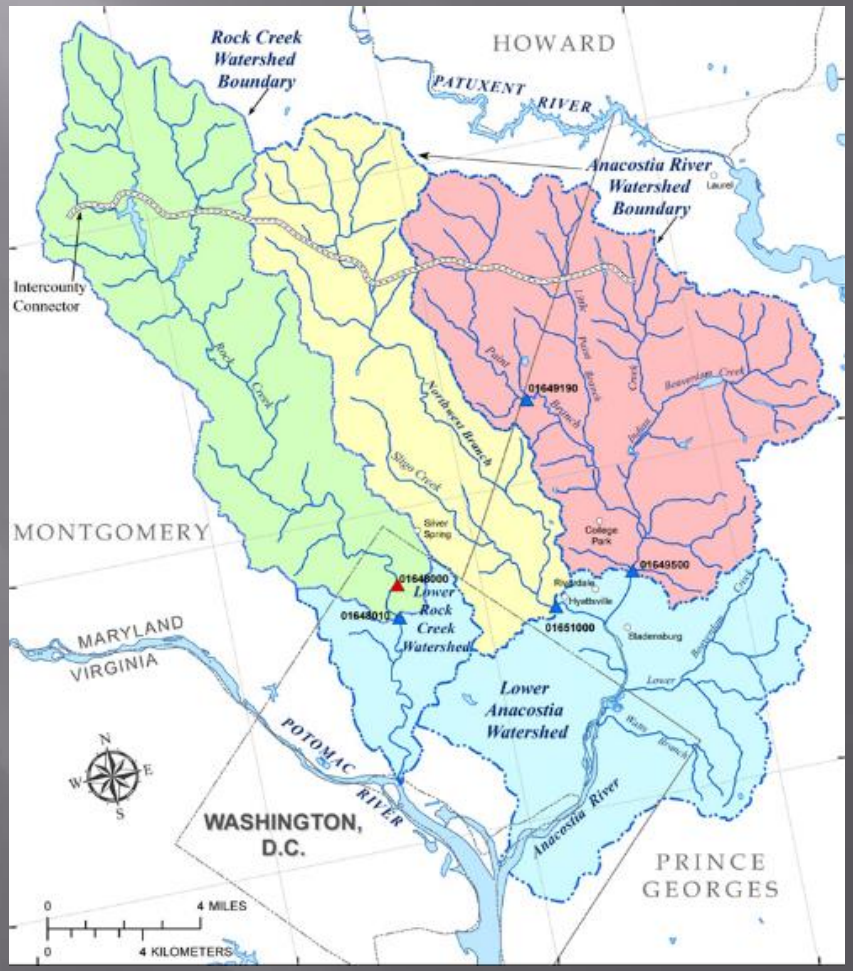
- ***Abundance and Variety of Microplastics in Surface Waters, Sediments, and Oysters***
  - Sediments will be collected from several locations within each system
    - Proximate to oysters reefs
    - Away from oyster reefs
  - Baltimore Harbor sediment cores to be collected to 1 meter
    - Will compare to cores collected in 1980-81, sectioned to 2-cm increments and archived at CBL
    - Will match via lat/long samples along transect from Inner Harbor to river mouth
    - Fort Carroll site



Microplastics in Chesapeake Bay

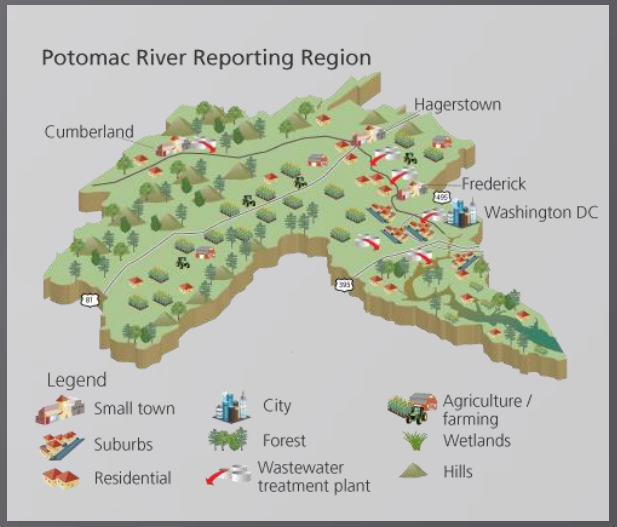
Several new research efforts underway

- *Investigations in the Potomac & Anacostia*



Microplastics in Chesapeake Bay

Several new research efforts underway



- ***Investigations in the Potomac & Anacostia***

  1) Prevalence and effects of microplastics in freshwater worms

  - Small internal grant from UMD – AGNR
  - Determine MP burdens in field-collected annelid worms across land use categories in Potomac and Anacostia Rivers
  - Assess potential detrimental effects of MP to worms
    - Laboratory feeding experiments using large *(Lumbriculus variegatus)* and small *(Pristina leidyi)* worm species
    - Tabulate ingestion / egestion rates
    - Measure effects: reduced survival / growth / reproduction / etc

Microplastics in Chesapeake Bay

Several new research efforts underway

- ***Investigations in the Potomac & Anacostia***

  2) Mussels as Monitors for Microplastics

  - Unfunded, but:
    - participation of US FWS (intern support) and MD DNR (mussel expertise)
    - also UMD – ENST intern support
    - also, coordination with Anacostia Watershed Society (mussels / volunteers)
  - Deploy caged mussels within Anacostia River and tributaries to investigate spatial / temporal relationships to MP abundance
  - Laboratory feeding experiments using several mussel species
    - Tabulate ingestion / egestion rates
    - Measure effects: reduced survival / growth / etc


Questions????

Photo credit

Photo credits: Will Parson - Chesapeake Bay Program Multimedia Specialist

http://www.chesapeakebay.net/blog/post/photo_essay_microplastics_in_the_chesapeake_bay