<u>***September 2021 Principals' Staff Committee:***</u>

Progress Report from the Chesapeake Bay Program Plastic Pollution Action Team

MATT ROBINSON

Watershed Protection Division

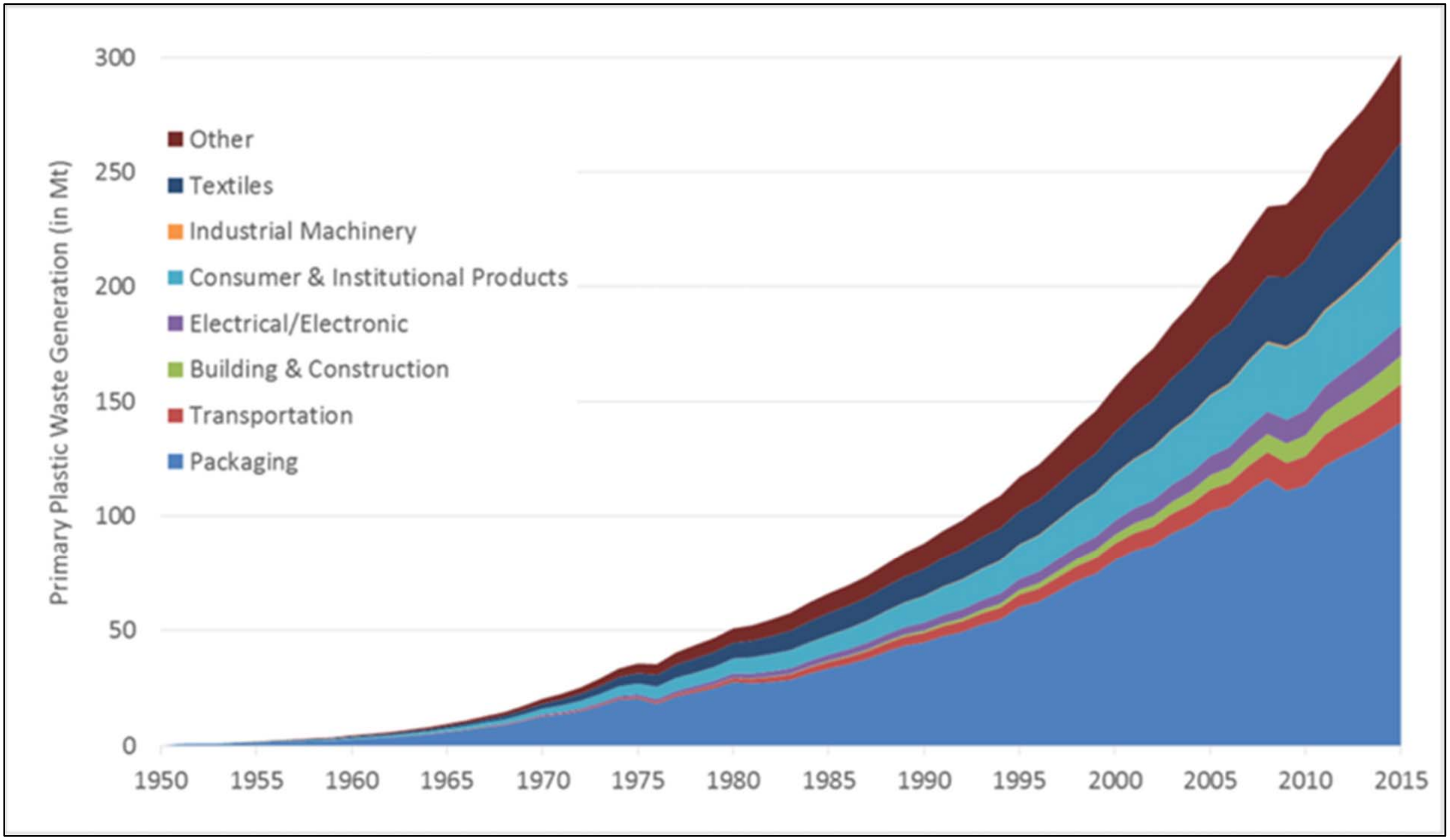
DC Department of Energy and Environment

& Chair, Chesapeake Bay Program Plastic Pollution Action Team

Chesapeake Bay Program
Science. Restoration. Partnership.

DEPARTMENT OF ENERGY & ENVIRONMENT

History of Plastic Production



Geyer et. al (2017)

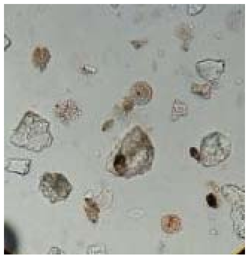
The Problem with Plastic Pollution…

Trash in the Anacostia River, Washington DC, (Photo by Masaya Maeda, Anacostia Watershed Society, 2010).

- Plastic pollution is everywhere. It's in the water, air, and soil.
- Americans generate over 35 million tons of plastic waste every year (U.S. EPA, 2019).
- Over 11 million metric tons of plastic pollution is estimated to enter the oceans annually. That number is expected to triple by 2040 (Pew Charitable Trusts, 2021).
- By 2050, there will be more plastic in the ocean than fish (by weight) (World Economic Forum, 2016).
- Estimated that 90% of all seabirds on earth have consumed some form of plastic (Wilcox et al., 2015).

Size Matters…

Plastic Pollution Size Continuum



Small Microplastics

Large Microplastics

Mesoplastics

Macroplastics

0.33 – 1mm

1-5 mm

5-200 mm

>200 mm

Process of Degradation

Most microplastics in the ocean are derived from larger plastic particles

Size Matters…

- Two types of "micro" plastic pollution:

Primary Microplastics
(e.g. pre-production pellets)

Secondary Microplastics
(i.e. Breakdown from larger particles)

Evidence and Potential Consequences of Plastic Pollution in Chesapeake Bay and its watershed

- Bikker et. al (2020) – 100% of water samples collected in the Chesapeake Bay mainstem contained microplastics.
- Penn Environment (2021) – 100% of water samples collected at 50 non-tidal sites in Pennsylvania contained microplastics.
- Lopez et al. (2021) – Fate and transport models for Chesapeake Bay have show 94% of microplastics are retained within rivers causing the bay to be a giant plastic "trap."
- Seeley et al. (2020) - Through lab experiments, found that presence of microplastics alters saltmarsh microbial community composition and nitrogen cycling processes. Polyvinyl Chloride (PVC) particles were found to inhibit both nitrification and denitrification.
- Cohen et al. (2021, unpublished data) - preliminary lab findings suggest that plastic microfibers hinder natural feeding in blue crabs, leading to delayed molting.

Evidence of Human Health Effects

- Schwabl et al (2019) found microplastics in 100% of human stool samples (n=8) taken from individuals ages 33-65.

- Ragusa et al. (2021) found microplastics in four (4) out of six (6) human placentas.

- Goodman et al. (2021) found that polystyrene microplastics decreased proliferation of human lung cells and altered morphology.

- Microplastics have been found to be sources of endocrine disruptors (e.g. phthalates) and they adsorb to and accumulate harmful organic chemicals (e.g. PCBs, PAHs).

"We definitely know we're exposed, there's no doubt. We drink it, we breathe it, we eat it." – Chelsea Rochman, University of Toronto

A Little History…

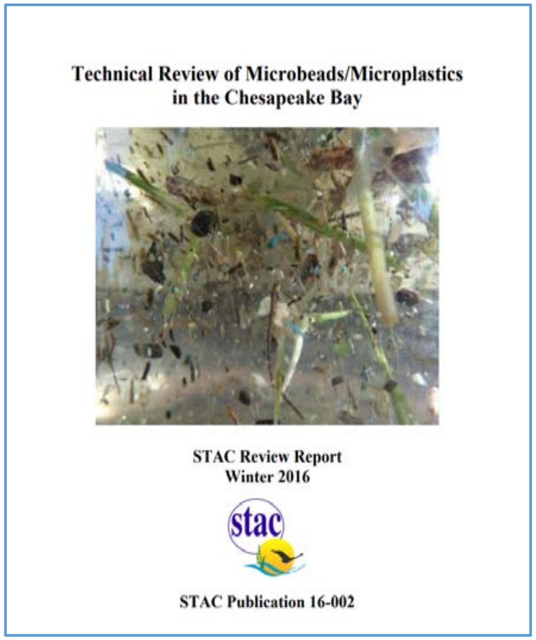
- STAC published two reports, one in 2016 and another in 2019, on plastic pollution in Chesapeake Bay.

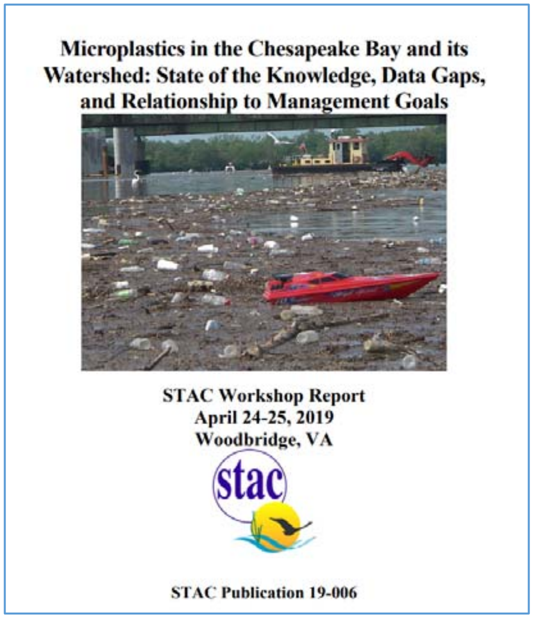
- Both reports agreed that:

    1. Plastic pollution is ubiquitous and represents a significant and widespread threat to the Chesapeake Bay.
    2. Monitoring for plastic pollution is lacking.

- 2019 report entitled, ***Microplastics in the Chesapeake Bay and its watershed: State of the Knowledge, Data Gaps, and Relationship to Management Goals,*** further suggested:

    1. The CBP should create a cross-GIT Plastic Pollution Action Team to address the growing threat of plastic pollution to the bay and watershed.
    2. CBP should undertake ecological risk assessments (ERAs) focused on effects of microplastics on multiple ecosystem endpoints.
    3. The CBP should develop a source reduction strategy to address plastic pollution.
    4. Utilize the existing monitoring network.





Progress to Date

- In Fall 2019, the Management Board created the Plastic Pollution Action Team for two years.
- The Management Board assigned the Plastic Pollution Action Team the following tasks:

1. Provide oversight of the development of preliminary ecological risk assessments of microplastics for one or more subwatersheds to the Chesapeake Bay (e.g. Potomac).

1. Use the components and results of the preliminary ERAs to develop a strategy that identifies and if possible, prioritizes gaps in information concerning the effects of microplastic pollution on the Chesapeake Bay ecosystem, and highlights future research questions that need to be answered.

3. Present results from ERAs to the MB in order to guide future action on addressing plastic pollution.

4. Monitor policy advances at the state and federal level that could potentially impact, advance or complement this work to inform the science strategy and to identify potential policy or management options that could be utilized for source reduction strategies.

Progress to Date

- Plastic Pollution Action Team convened in Spring of 2020, with 36 members from federal agencies, state agencies, and academia.

- Chaired by Matt Robinson, DC Department of Energy and Environment, and Vice-Chaired by Kelly Somers, EPA Region III

- EPA Region III Trash Free Waters Program secured funding in 2019 to contract Tetra Tech to work with the Plastic Pollution Action Team and STAC on implementing three of the STAC recommendations/Plastic Pollution Action Team Charge Tasks:
    1. Development of a Standardization of Terminology document for conducting microplastic research in the Chesapeake Bay and watershed.
    2. Development of a preliminary ERA for Striped Bass in the Potomac River
    3. Development of a microplastic monitoring and science strategy for the Chesapeake Bay

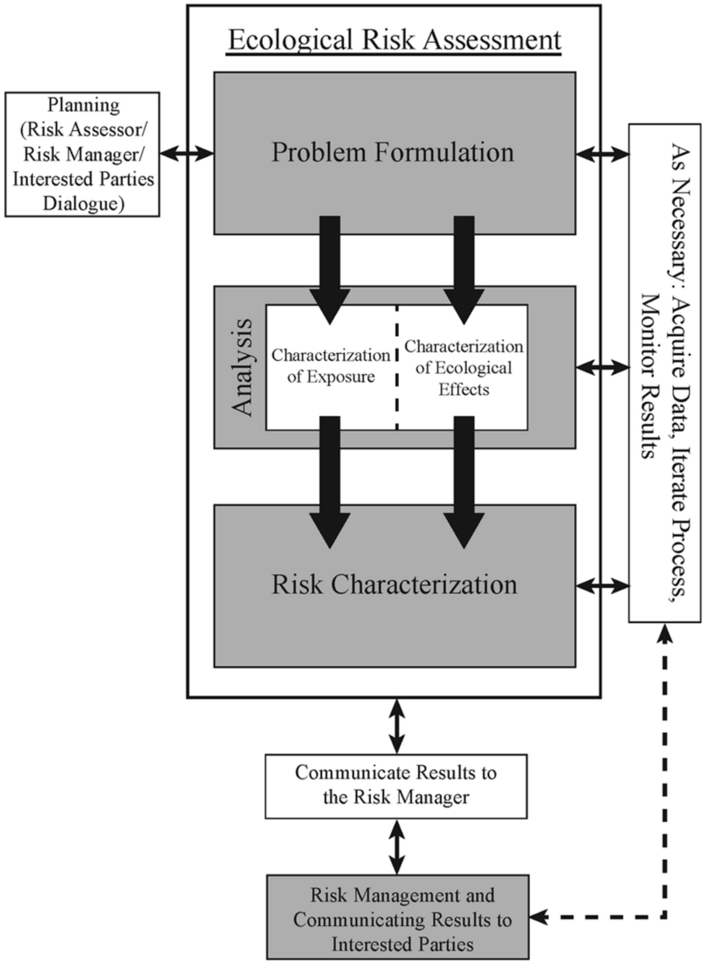
- Plastic Pollution Action Team met six times between June 2020 and April 2021, and all three tasks listed above were completed by Tetra Tech.

- STAC conducted a merit review of the standardization of terminology document and technical review of the ecological risk assessment.

What is an Ecological Risk Assessment

- **U.S. EPA definition:** *Process for evaluating how likely it is that the environment might be impacted as a result of exposure to one or more environmental stressors, such as chemicals, land-use change, disease, and invasive species.*

- The Ecological Risk Framework consists of three main components:
  1. Problem Formulation: Determine the ecosystem endpoint
  2. Risk Analysis: Identify testable linkages between sources, stressors and assessment endpoints
  3. Risk Characterization: What are the risk and effects? Ex. LC50 – Lethal concentration to kill 50% of a population



Developing the Ecological Risk Assessment

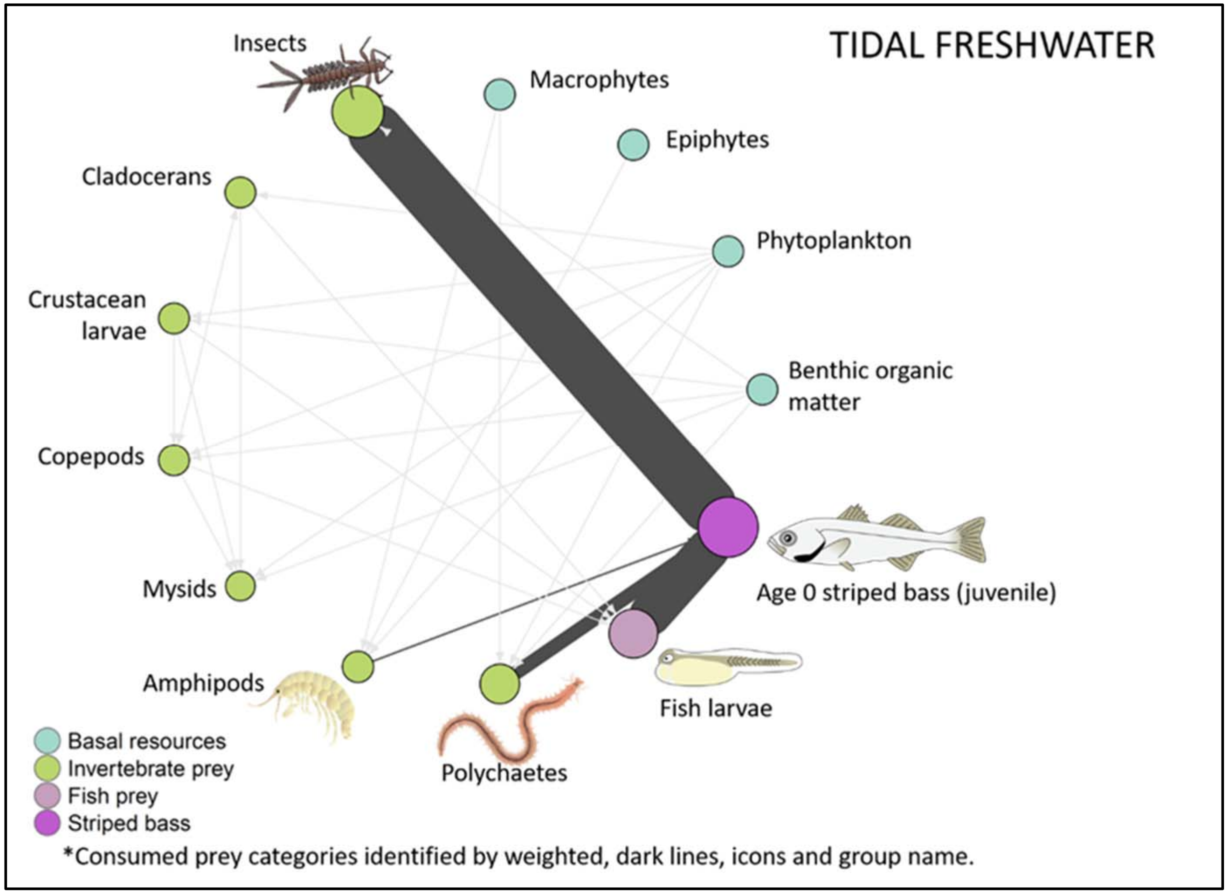
- Ecosystem Endpoint: Striped Bass (*M. saxatilis*) ages 0-2years. Why?
  1. Apex predator and Iconic Bay Species - Food chain analysis for this species encompasses a multitude of trophic levels and other species.
  2. Wealth of knowledge on 0-2 age classes based on state juvenile index surveys and diet studies (Boynton et al, 1981; Idhe et al, 2014).

- Geographic Location: Potomac River. Why?
  1. Appropriate scale waterbody given the current funding.
  2. Contains species and habitats prevalent throughout the entire bay.
  3. The second most important nursery for Striped Bass along the east coast.

ERA Model Development

- Existing information was gathered by conducting a literature review.
- Qualitative food web models were developed to identify microplastic pathways to Striped Bass ages 0-2 years.
- Using this analysis, semi-quantitative food web interaction scenarios were developed for Striped Bass living in different salinity regimes (e.g. tidal freshwater, oligohaline).

Example Semi-quantitative food web interaction



Models completed for tidal freshwater, oligohaline, mesohaline, and bay mainstem.

Microplastic pathways

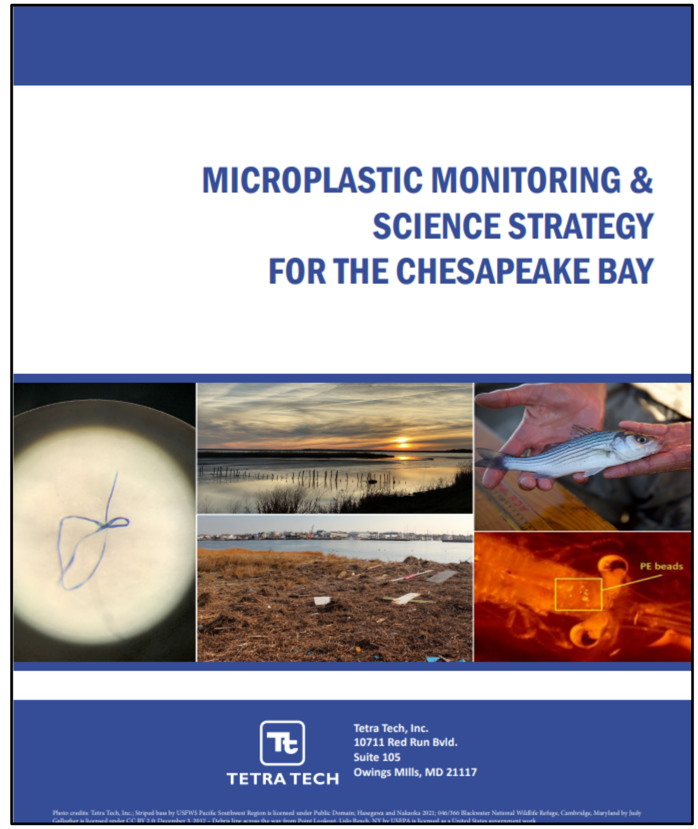
- Literature review conducted on studies looking at presence of microplastics in Striped Bass prey taxa.
- Studies conducted outside of the Chesapeake Bay and its watershed were included in the literature review.
- 14 different taxa were identified as potential vectors for microplastics to Striped Bass.
- These taxa were given high priority for future research on Striped Bass.
- Additional information gaps were also identified and included in the science strategy.

Major Taxa	Confirmed MP presence or consumption? (Y/N)	Location	Citation	Notes
Amphipods	Y	Laboratory	(Jeong et al. 2017, Mateos Cárdenas et al. 2019)	Jeong et al proposed an adverse outcome pathway for microplastic exposure that covers molecular and individual levels.
Mysids	Y	Laboratory	(Setälä et al. 2014, Lehtiniemi et al. 2018, Wang et al. 2020)	Hasegawa et al (2021) demonstrated trophic transfer of microplastics between mysids and fish predator
Polychaetes	Y	Newfoundland; laboratory; Norway	(Mathalon and Hill 2014, Setälä et al. 2014, Knutsen et al. 2020)	
Blue crab	Y	Murderkill and St. Jones Rivers, DE; Texas;	(Santana et al. 2017, Cohen 2020, Waddell et al. 2020)	Santana et al found little trophic cascade; Cohen's work in similar systems to tidal Potomac;
Crustacea (other)	Y	Florida; North Sea	(Devriese et al. 2015, Waite et al. 2018)	Waite et al found MPs in *Panopeus*, a known prey item for striped bass;

Example table showing literature date on microplastic presence in Striped Bass prey taxa

Development of the Science Strategy

- Original Purpose of Science Strategy
  "…will help guide future research on the impacts of microplastic pollution in the Potomac River, Chesapeake Bay, and contributing watersheds. Using the information gaps identified in the development of the preliminary ERA conceptual model, [the PPAT] shall draft a document that outlines the necessary research that is needed to address these gaps"



- The Plastic Pollution Action Team organized the science strategy around four management questions.

- The Plastic Pollution Action Team made science/research recommendations for answering these management questions.

Management Questions

1. What health risks are posed by microplastics?

2. What are the sources, pathways, composition, and fate of microplastic loadings into the Chesapeake Bay?

3. What management actions or policies may be effective in reducing microplastic pollution?

4. How can government and resource managers develop sound policies to reduce [micro]plastic pollution and assess the economic impacts?

Recommendations

1. Design and implement a microplastic monitoring program, integrated into the existing Chesapeake Bay watershed monitoring framework.

2. Support research to understand microplastic pathways in the Bay, including trophic pathways that may affect living resources such as Striped Bass, Blue Crabs, Oysters, and other species critical to the Bay ecosystem.

3. Ensure adequate infrastructure resources are available to process microplastic samples, including analytical equipment.

4. Continue to support the Plastic Pollution Action Team in order to direct research, management, and policy development.

So where COULD the microplastics be coming from?

- Rochman et al. (2021) (unpublished data) – Collected samples from stormwater runoff, agricultural runoff, and wastewater effluent at 12 sites throughout the Chesapeake Bay watershed (i.e. MD, VA, DC).

- The most common particle types found were fibers (35%), fragments (26%), and foam (16%), suds (7%), film (6%), fiber bundle (5%), and black rubbery fragment (4%).

- Polyethylene (PE), polyethylene terephthalate (PET), polypropylene (PP), and polyurethane (PU) were the most common types of polymers found. Below are potential "macro" sources for these polymers:

PE →



PET →



PP →



PU →


What are the most common types of “macro” plastic items found in the Chesapeake Bay and watershed.

- Data has not been compiled by the Plastic Pollution Action Team yet to support conclusions on the most common sources of macroplastics. The Plastic Pollution Action Team is not currently in a position to make recommendations on source reduction yet.

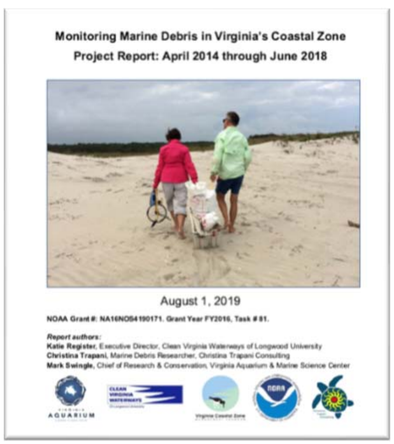
- However, data has been collected by several bay states on the most common types of litter found in local waterways and watersheds.

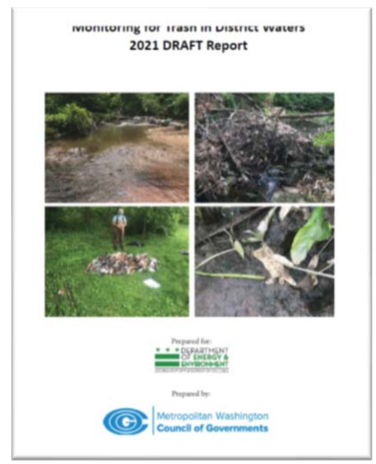
  ❖ Virginia Marine Debris Beach Surveys 2014- 2018 (Clean Virginia Waterways, 2019)

  ❖ Pennsylvania Litter Study (Keep America Beautiful, 2019)

  ❖ Baltimore Harbor Water Wheel Data (Waterfront Partnership of Baltimore, 2021)

  ❖ DC Trash Trap Data and Annual Watershed Trash Monitoring (DOEE, 2021)

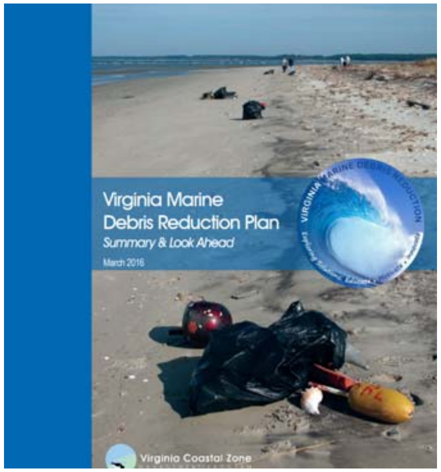


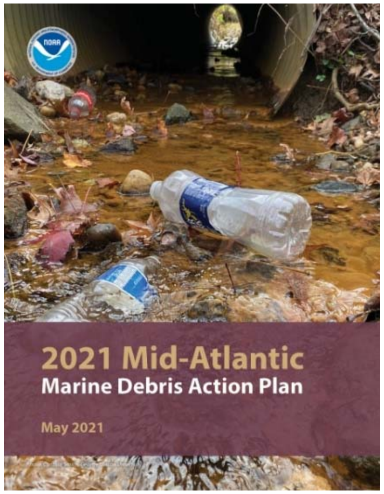


Current Policy Approaches Being Taken by Bay States

- Innovative laws
  - o Bag Laws (DC, NY, DE)
  - o Foam Ban (DC, MD)
  - o DC Plastic Straw Ban
  - o VA Executive Order on Single-Use Plastics

- Management Plans
  - o VA Marine Debris Reduction Plan
  - o Mid-Atlantic Marine Debris Reduction Plan





Current Best Management Practices Being Implemented by Bay States

- Trash traps – Baltimore; DC; Fairfax Co, VA; Prince George's Co, MD
- Catch Basin Inserts – Baltimore
- Clean Teams Program – DC
- Enhanced Street Sweeping Programs – DC
- Education and Outreach Campaigns – DC; Maryland



Acknowledgements

- The "Original Alarm Sounders"
  - Ann Swanson and the Chesapeake Bay Commission
  - Julie Lawson (CAC/DC Mayor's Office of the Clean City) – conducting the original Chesapeake Bay Trash Trawl
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- Mark Trice (MD DNR), Chelsea Rochman (Univ of Toronto), and Jonathan Cohen (Univ of DE) for providing unpublished data
- All the members of the Plastic Pollution Action Team!!!

Points for Discussion – Next Steps for the Action Team

- Should the Action Team continue beyond its initial 2-year term?
- If so, what should be the Action Team's priorities?