

Developing a Preliminary Conceptual Ecological Risk Assessment and Science Strategy for Microplastics in the Potomac River

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Background and Project Outline



Microplastics in the Chesapeake Bay



Assessing the State of Science



Identifying the Problem and Potential Solutions



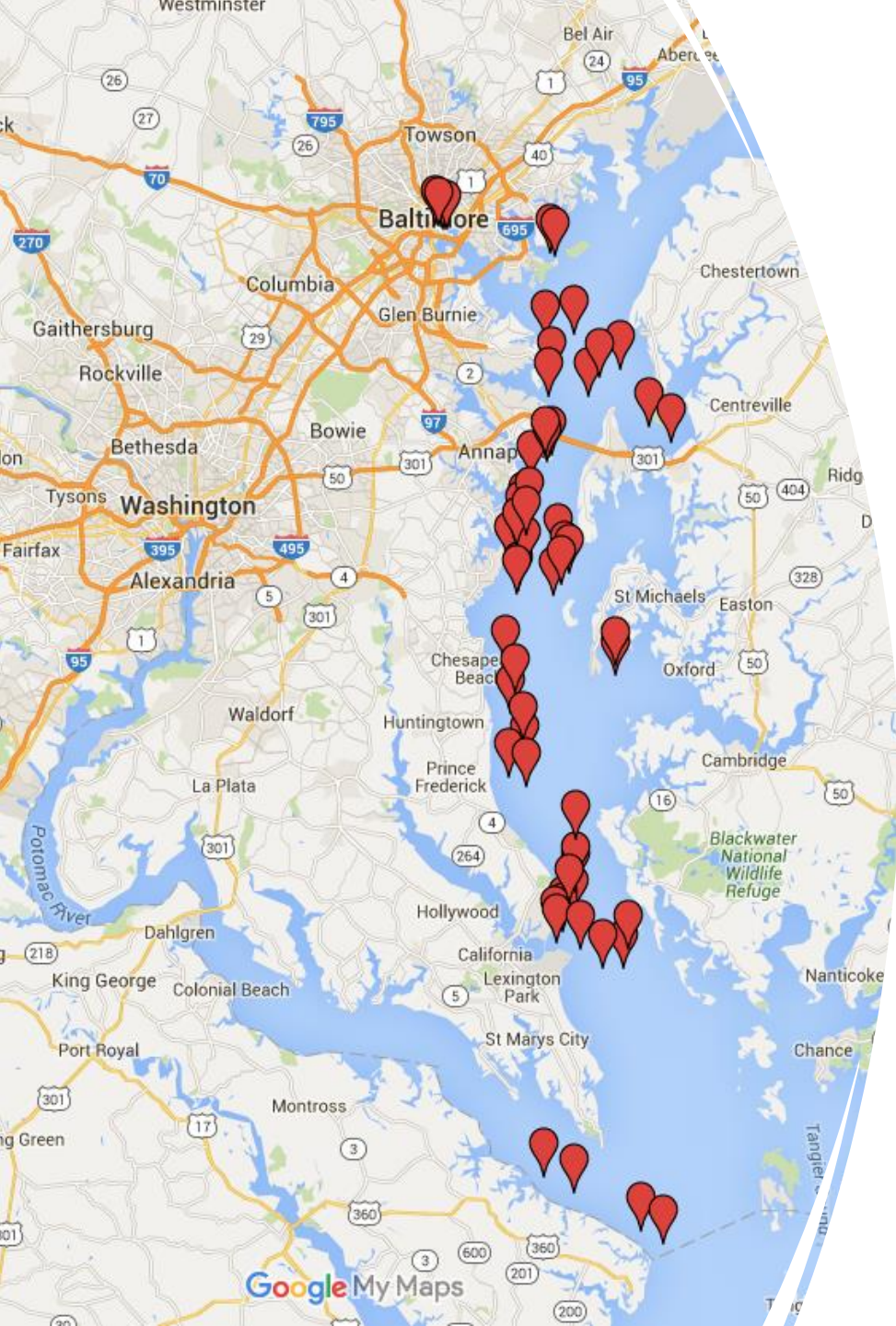
Creating conformity among size and unit terminologies



Identifying the Risks



Developing a Strategy



Microplastics are Ubiquitous in Chesapeake Bay

- **Selection of Publications**

- Yonkos et al. (2014) found microplastics in 59 out of 60 samples in four tidal tributaries to the upper Chesapeake Bay. Concentrations highly correlated with urban/suburban landuse.
- USGS has found microplastics in every sample taken at five non-tidal stations in the Chesapeake Bay watershed (Fisher, 2019).
- In 2018, 95% of smallmouth bass (*M. dolomieu*) sampled in the central Susquehanna River had microplastics in their guts (Parks, 2019).
- Brander (2019) found that juvenile Black Seabass (*Centropristis striata*) fed with fish fed with pre-cleaned microplastics displayed increased oxygen consumption. Juveniles exposed to microfibers in the water column displayed increased oxygen consumption.
- Knauss (2019) found that Eastern Oyster (*C. virginica*) larvae that ingested polystyrene microbeads displayed a significant increase in algal clearance.

- **2015 Bay Trash Trawl conducted by Trash Free Maryland (sites with red flags)**

- surveyed 30 sites for microplastics in the Chesapeake Bay mainstem and tidal tributaries.
- 100% of samples contained microplastics.
- Highest concentrations found in urban and suburban tributaries.

Microplastics and other anthropogenic particles in the surface waters of the Chesapeake Bay

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Surface water

ABSTRACT

Microplastics are a ubiquitous environmental contaminant whose distributions have been correlated with land-use and population density. Although there are numerous studies quantifying microplastics in the environment, local studies help inform sources, pathways, and policy. Here, we measure the concentration of microplastics in the surface waters across the Chesapeake Bay – the largest estuary in the USA. Thirty surface water samples from throughout the Chesapeake Bay were collected with a manta trawl. Samples were manually processed for microplastics and other anthropogenic particles. Fourier-transform infrared spectroscopy (FTIR) was used to determine the chemical composition of the particles. Higher concentrations were found near major cities and where larger rivers or tributaries met the Chesapeake Bay. Fragments, films, and fibres were the most common morphologies found, and polyethylene and polypropylene were the most common plastic types. These results can be used to inform mitigation strategies for microplastic pollution in the Chesapeake Bay region.

Microplastics in the Chesapeake Bay

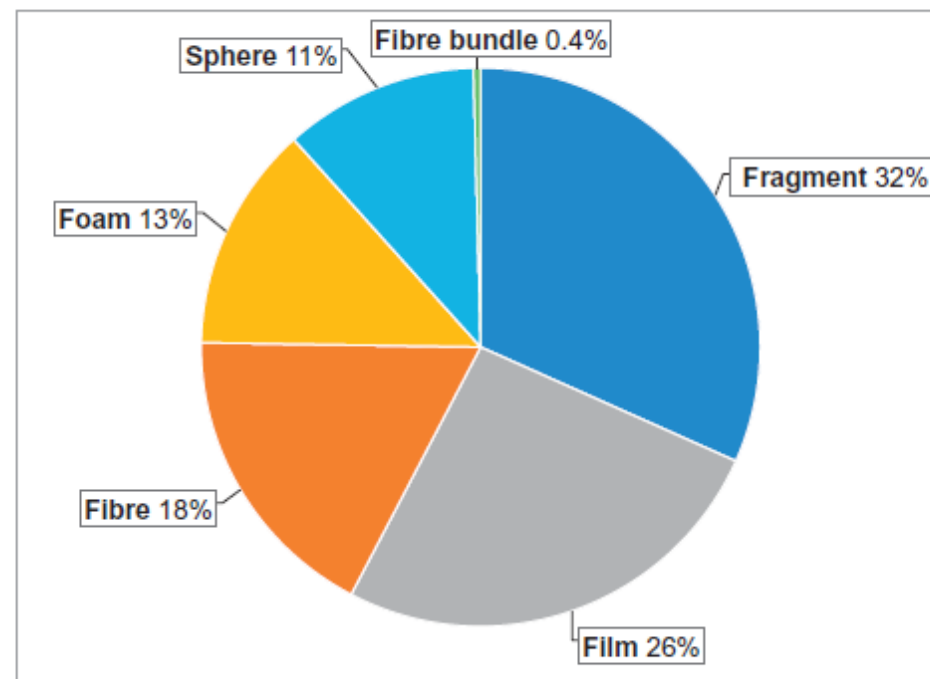


Fig. 3. Morphology of particles from thirty surface water samples (after blank correction) in the Chesapeake Bay.

Workshop Goals



Assess the state of the knowledge on microplastic pollution in the Chesapeake Bay and its tributaries



Assess possible effects of microplastics on various habitats and associated living resources



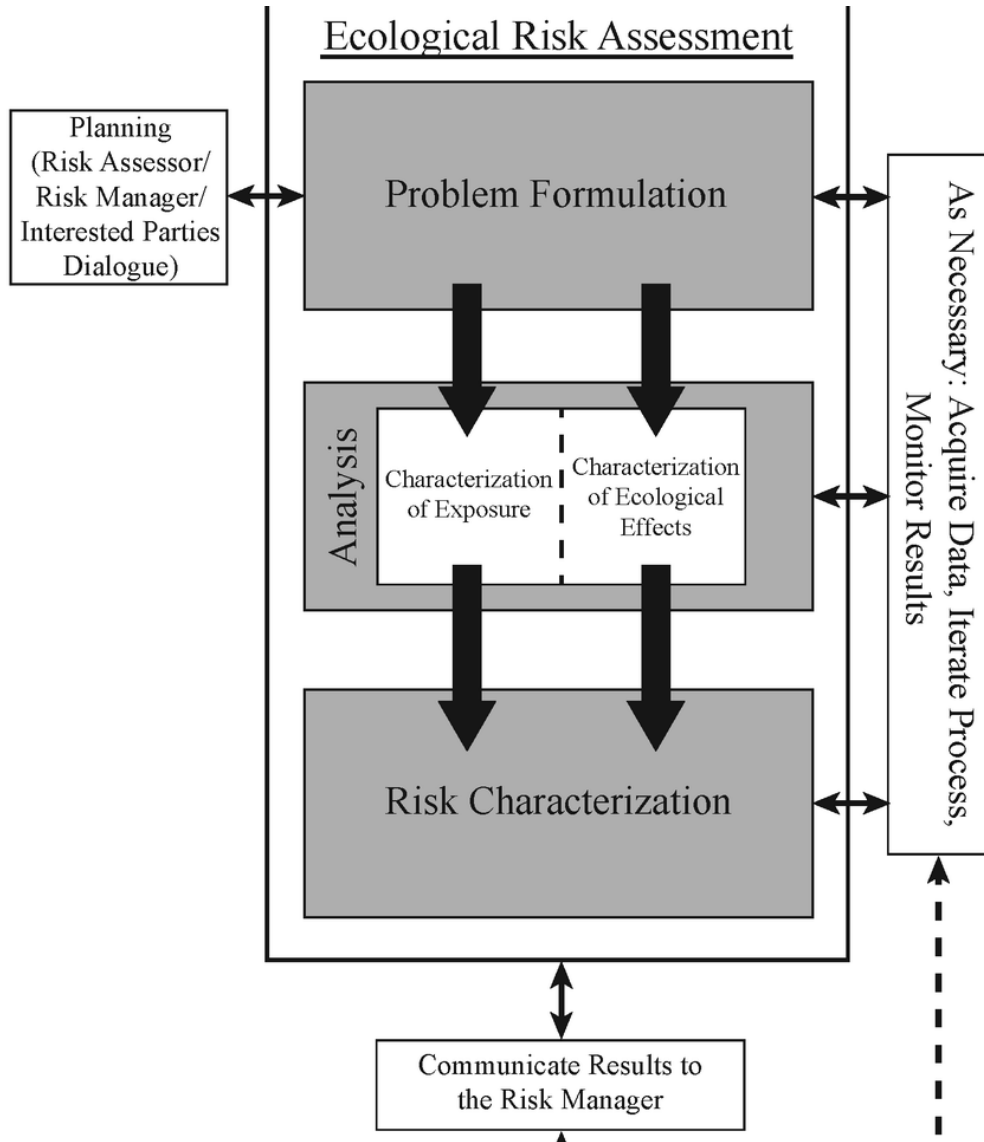
Identify existing policy and management tools being used to address plastic pollution in the watershed and beyond, and their effectiveness



Identify research gaps moving forward, and develop recommendations for future studies or new tools

Workshop Format

- Steering committee decided early on that the workshop should be formatted around conducting an **ecological risk assessment (ERA)**
- The Ecological Risk Framework consists of the following components:
 1. **Problem Formulation:** Determine assessment endpoints and measurement endpoints
 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



Workshop Recommendations

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. The Scientific, Technical Assessment and Reporting Team should incorporate development of ERAs of microplastics into the CBP strategic science and research framework, and the Plastic Pollution Action Team should oversee the development of the ERAs focused on assessment of microplastic pollution on multiple living resource endpoints.
3. STAC should undertake a technical review of terminology used in microplastic research, specifically size classification and concentration units, and recommend uniform terminology for the CBP partners to utilize in monitoring and studies focused on plastic pollution in the bay and watershed.
4. The CBP should develop a source reduction strategy to assess and address plastic pollution emanating from point sources, non-point sources, and human behavior.
5. The CBP should direct the Plastic Pollution Action Team and STAR Team to collaborate on utilizing the existing bay and watershed monitoring networks to monitor for microplastic pollution.

Project Tasks and Deliverables

01

Develop an ecological risk assessment (ERA) conceptual model looking at the effects of microplastics on various ecological endpoints in the Potomac River.

02

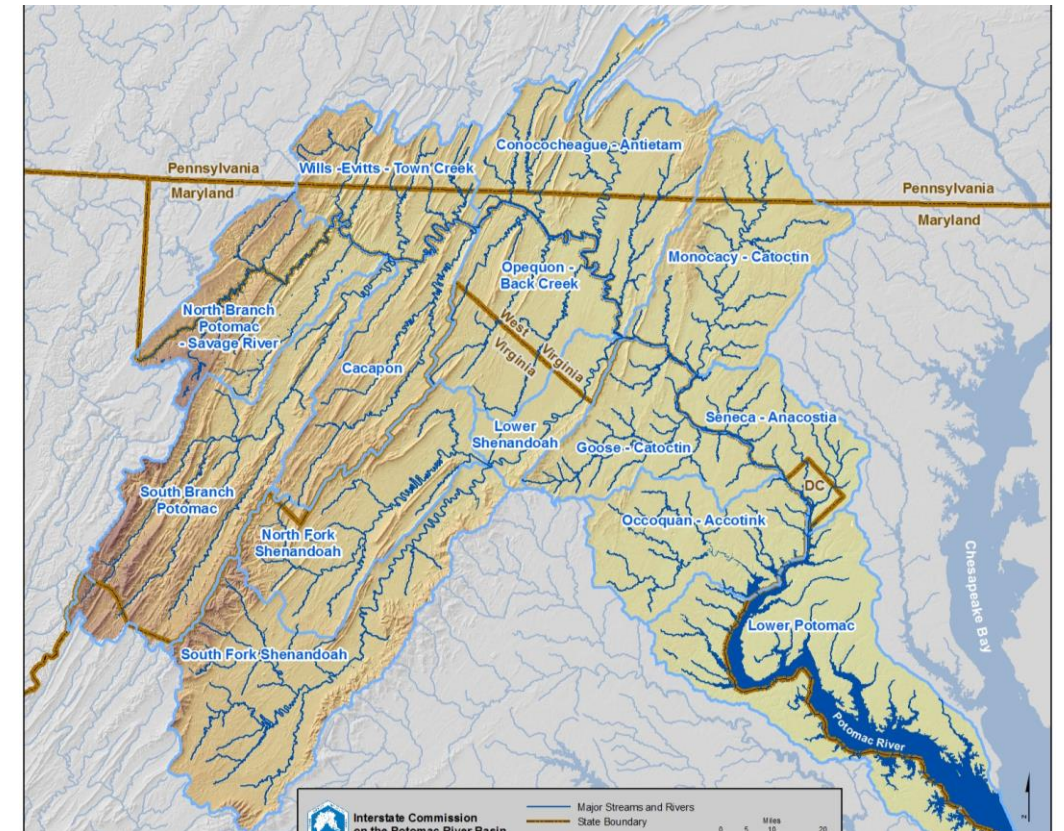
Compile the best available science to develop a preliminary ERA using the EPA framework. A gap analysis will be conducted to identify needs for future study.

03

Develop uniform size classification and concentration unit terminology that can be adopted for future microplastic research in the Potomac River, and possibly elsewhere in the Mid-Atlantic Region.

Potomac River Estuary

- Why the Potomac River?
 - Scale is appropriate.
 - Many of CBP's restoration goal species are found in the Potomac.
 - ERA development will still engage multiple stakeholders.



The Plastic Pollution Action Team

- The Plastic Pollution Action Team is comprised of various stakeholders from Federal, State, Local, NGO and Academia
- The PPAT was given a charge by the CB Management Board
- The PPAT is responsible for guiding the various deliverables in this project and providing expertise.

Task 1: Uniform Size Classification and Concentration Unit Terminology

Classification	Size	Rationale
Microplastic	5 mm - 1000 nm (1µm)	<ul style="list-style-type: none">--NOAA and GESAMP precedence--Upper size limit is consistent with previous monitoring studies in Chesapeake Bay and tributaries--Use of 333 µm as a lower bound potentially excludes the inclusion of laboratory or monitoring studies that include data below that value-- The lower size limit is consistent with the SI naming convention.
Nanoplastic	1 nm - <1000 nm (1µm)	<ul style="list-style-type: none">--The upper limit is consistent with the SI naming convention.--Limit is inclusive of particles <100 nm as defined for non-polymer nanomaterials in the field of engineered nanoparticles-- The lower size limit is consistent with the SI naming convention.

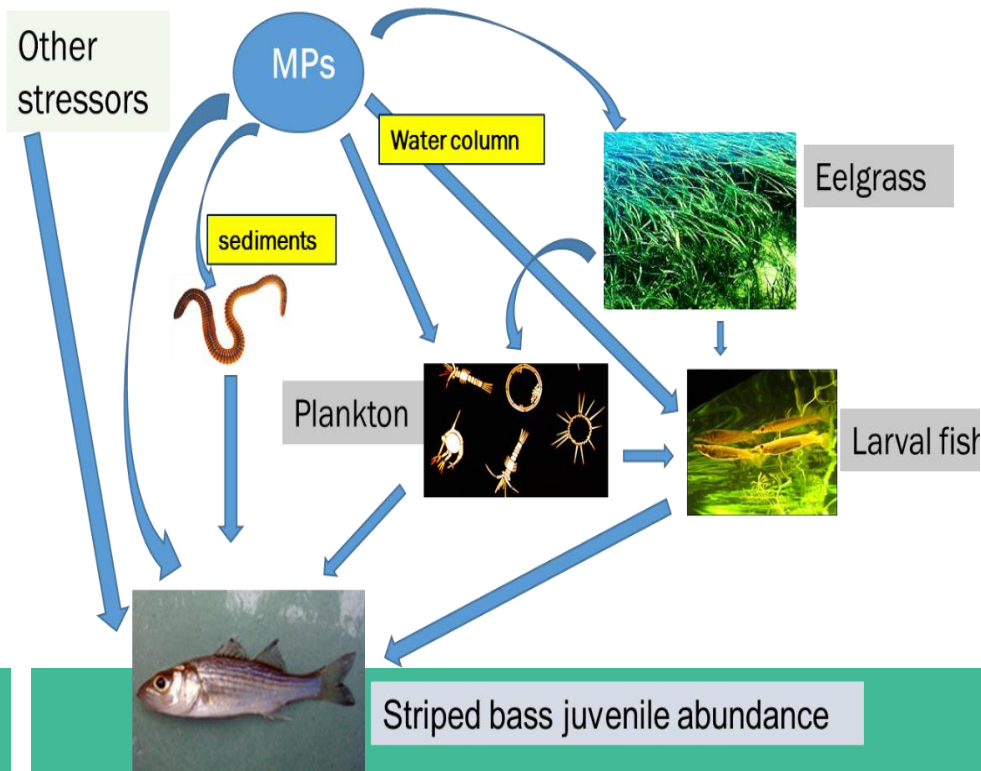
Concentration Units Guidelines

- Established across common sampling media
 - Water Column
 - Sediment
 - Organisms
 - Submerged Aquatic Vegetation
 - Shoreline



Here, a sample of ocean microplastics is displayed during a 2015 trash trawl survey on the Chesapeake Bay. (Photo by Will Parson/Chesapeake Bay Program)

Task 2: Preliminary Eco Risk Assessment Process

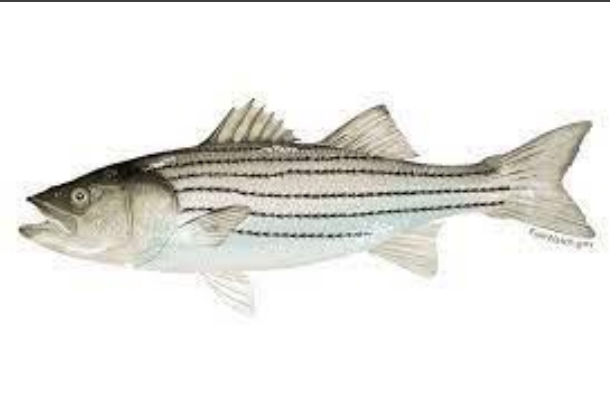


Biological endpoints of potential interest

Qualitative food web interactions that could lead to microplastic intake by Striped Bass;

Semi-quantitative food web interaction scenarios for Striped Bass living in different salinity regimes.

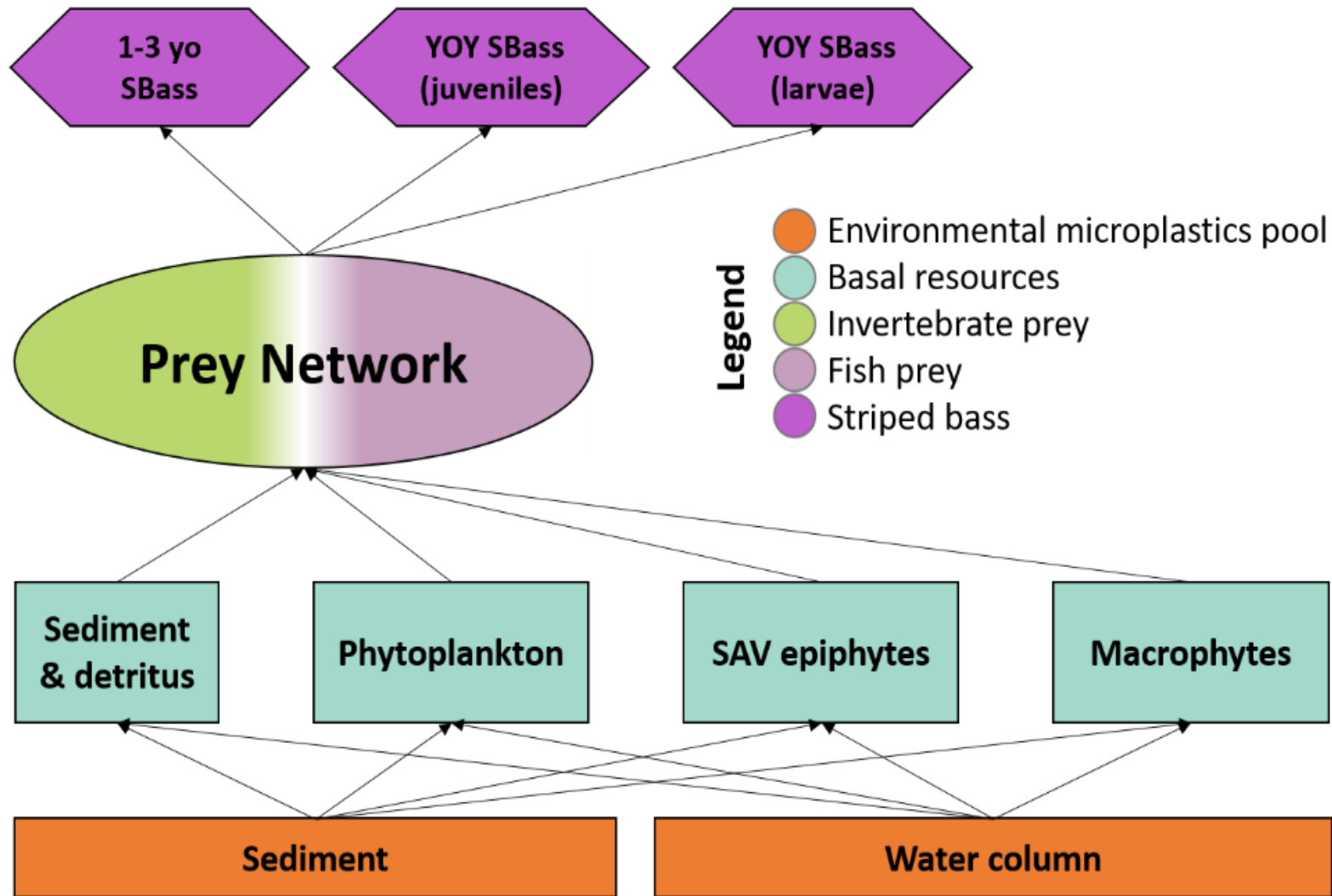
Biologic Endpoint Criteria



- Parameters
 - Upper Trophic Level
 - Represented Chesapeake Bay Agreement
 - Data Rich
 - Common
 - Wide Distribution

- Species Discussed
 - Blue Crabs
 - American Shad
 - Forage Gish
 - American Eel
 - Eastern Oysters
 - White Perch
 - **Striped Bass**

Biological Endpoints



Potential Assessment Endpoints

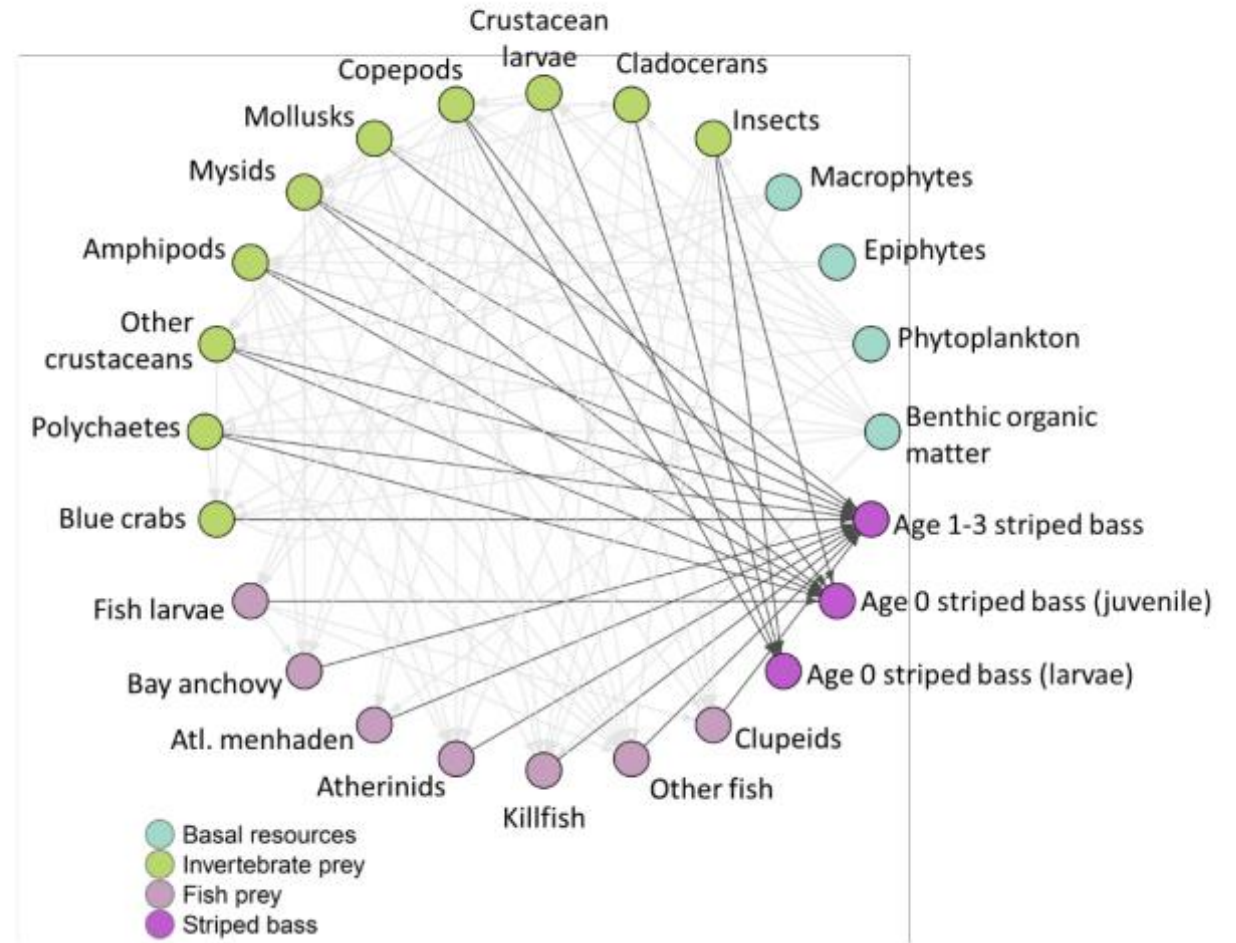
Individual Assessment Endpoints

- Growth rates
- Fecundity
- Predator susceptibility
- Direct mortality
- Physiological condition
- Behavior change

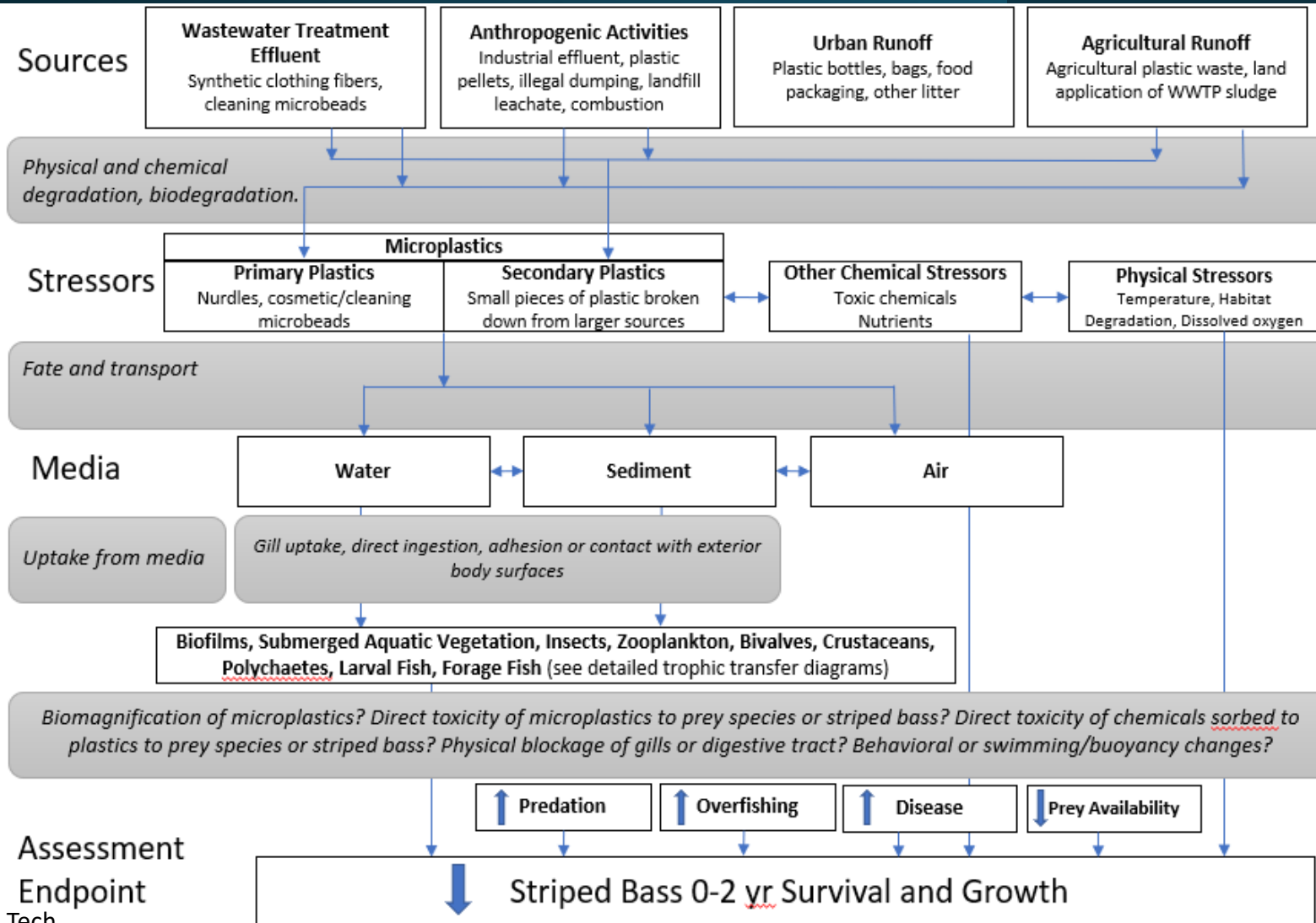
Population Assessment Endpoints

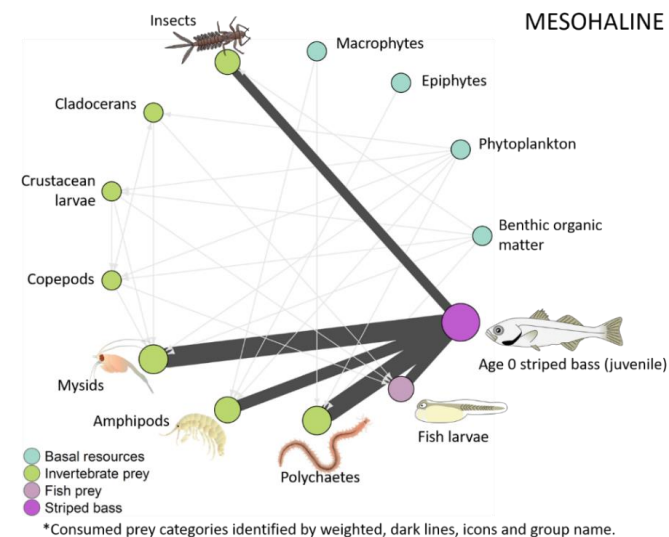
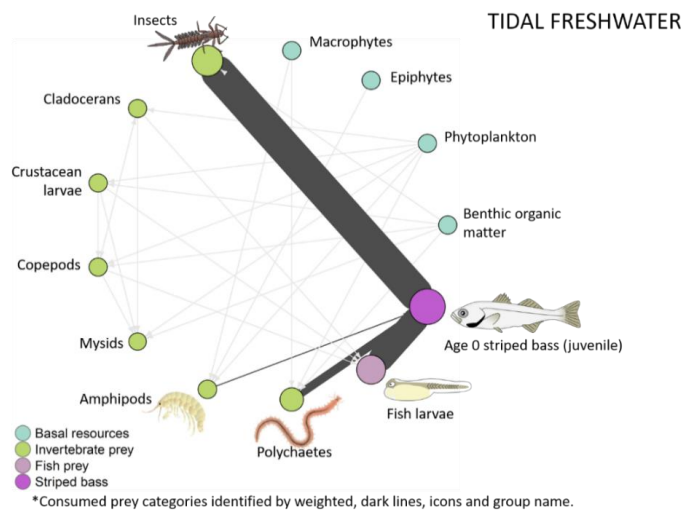
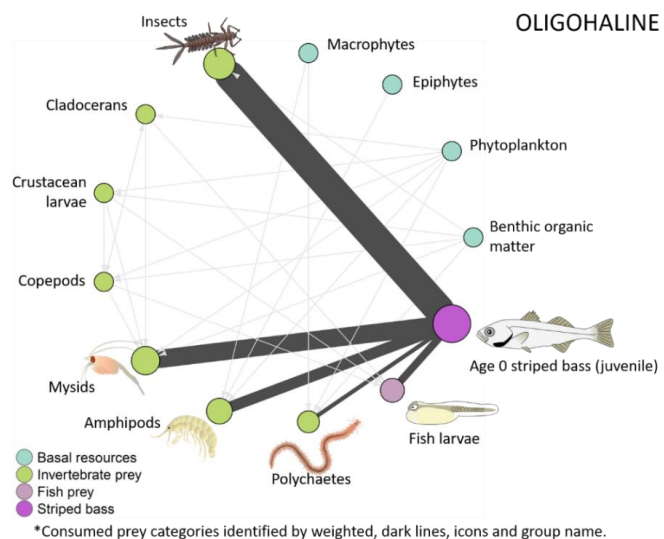
- Catch-per-unit-effort
- Size-at-age
- Age-structure
- Mortality
- Spawning stock biomass

Qualitative food web interactions



Conceptual Model





Semi Quantitative Results

Semi Quantitative Results

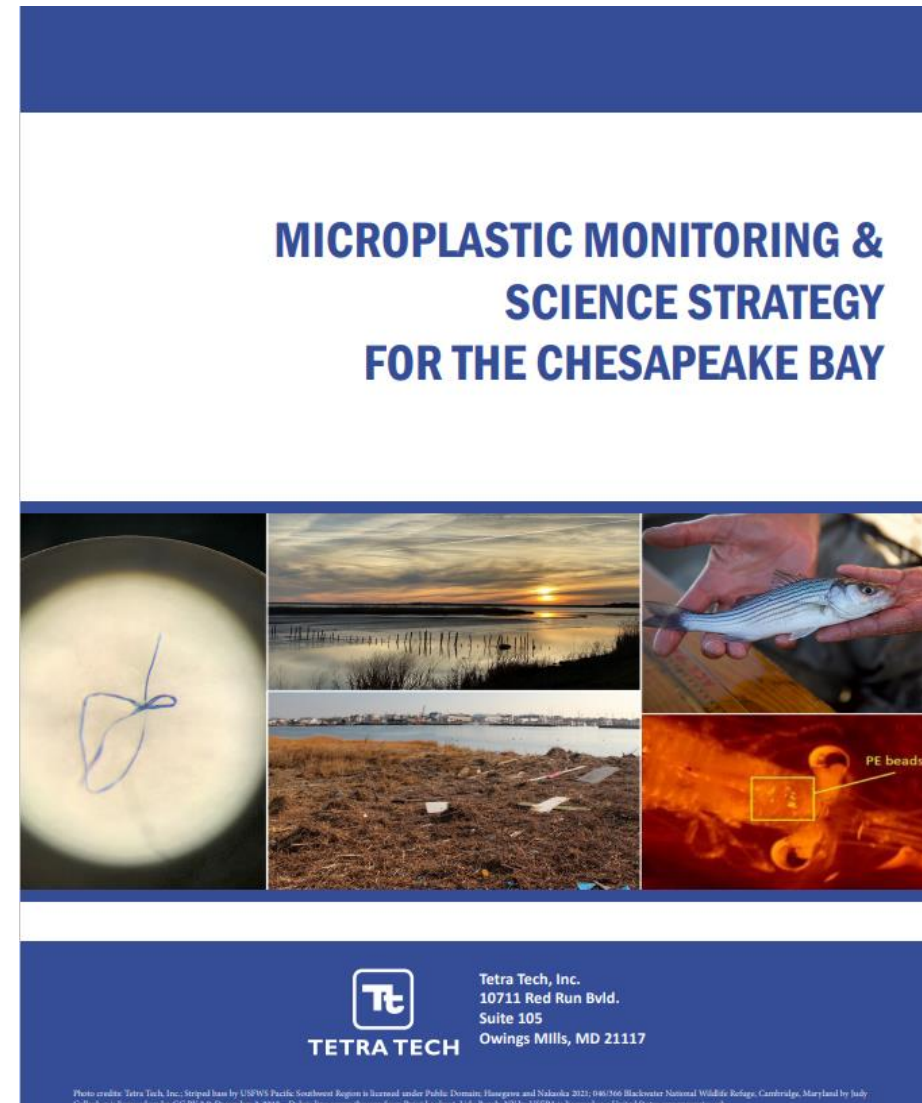
- It is hypothesized the MP may contributed to decreased growth and survival by several mechanisms:
 - Physical blockage of guts resulting in reduced feeding
 - Behavioral changes such as swimming behavior increasing predation risk
 - Toxicity to striped bass because organic contaminants adhere to plastics

Prey category	Age-0				Age-1	Age-2	Priority-level
	Larval	Juvenile			SA	SA	
	OLIGO	TF	OLIGO	MESO	MAIN	MAIN	
Insects		47.5	40	12.5			
Cladocerans	26.2						
Larval zooplankton	1						
Adult copepods	40.3						
Bivalves					0.9	1.2	
Mysids		0	24.5	27	4.5	21	
Amphipods		1.5	15	15.5	1.9	5	
Other crustaceans					2.8	4	
Polychaetes		12	5.5	25	4.4	9.4	
Bay Anchovy					57.8	15.6	
Fish larvae		35.5	10	14			
Atl. Menhaden					1.9	17.9	
Other fish					7.6	8	

Task 3:

Monitoring and Science Strategy

- Modeled after San Francisco Bay's Microplastic Strategy
- This strategy document provides an overview of management needs regarding implementing policies to reduce plastic pollution, which would result in reduction in microplastics.
- This strategy is intended to be a starting point to develop research priorities, monitoring efforts, and policy development.
- It is expected to be updated in the future as more work and research is completed



Management Questions Posed to the PPAT

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

What health risks are posed by microplastics?

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

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

Identified Data Gaps



Lack of observational and experimental data on the types, sources, and fates of microplastics in the ecosystem



Need more understanding on trophic transfer



Need more direct studies on the prevalence, intensity and efforts of microplastics contamination on focal species, their prey and the environment

Recommendations



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



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;



Ensure adequate infrastructure resources are available to process microplastic samples, including analytical equipment; and



Continue to support the PPAT in order to direct research, management, and policy development;



Studies have shown microplastics are ubiquitous throughout the bay and its tributaries. They have been found in both tidal (Yonkos, 2014; Rochman, 2019) and non-tidal waters (Fisher, 2019).



There is general agreement that plastics represent a widespread, but largely *unquantified*, threat to the Chesapeake Bay ecosystem.



There are a number of piecemeal efforts to monitor plastics in the Bay, but no systematic effort and no organized effort directed at researching plastic pollution.



The ERA reveals there could be significant impacts on a valuable Chesapeake resource, Striped Bass (e.g. 14 prey taxa...). Further refinement of the ERA is needed to provide more accurate estimate of the effects to the resource.



Implementation of the science strategy will put us on a path for understanding the impacts of plastic pollution on Striped Bass and other ecosystem endpoints

Conclusions

Next Steps

Immediate:

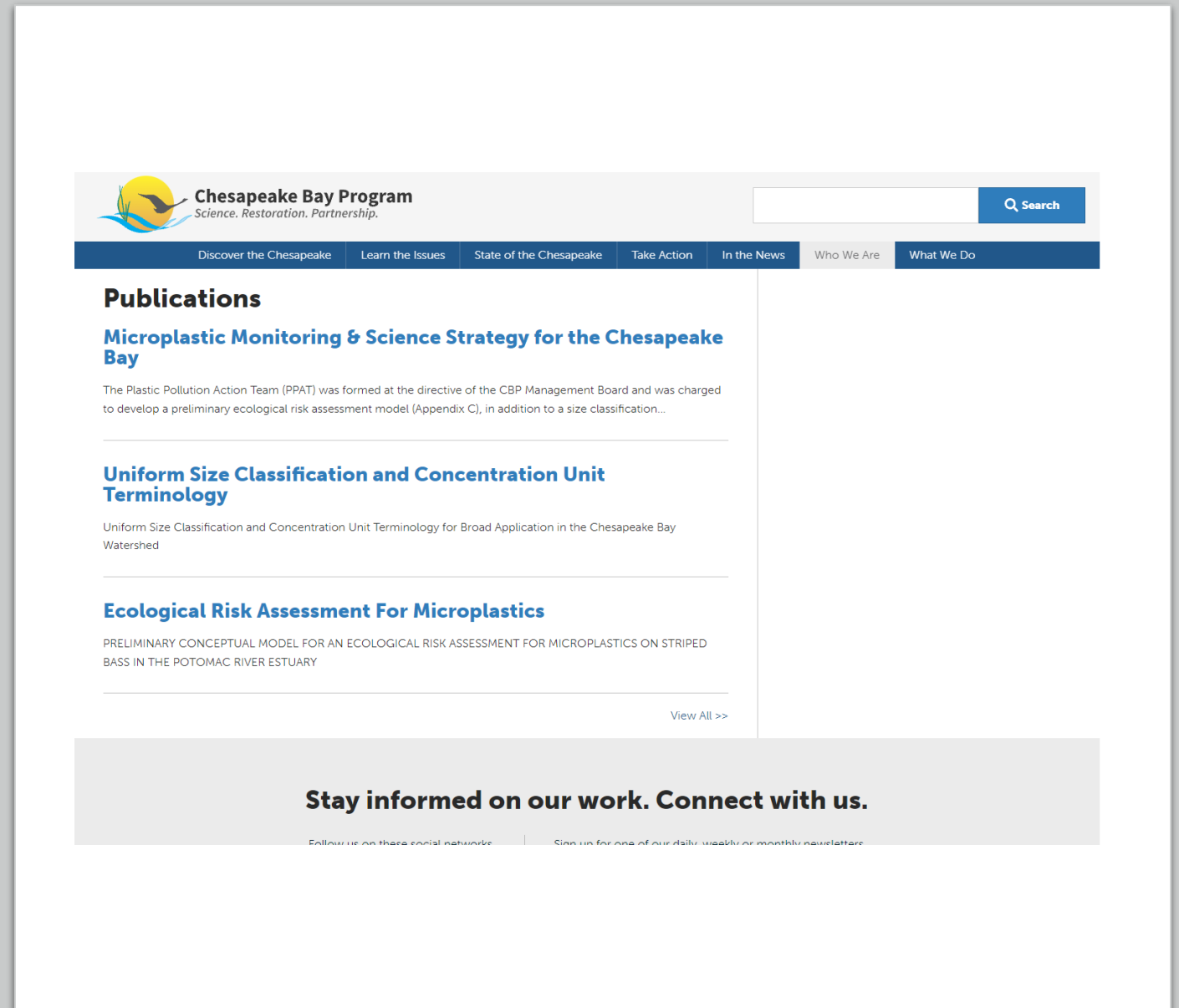
- Continue to work with the Plastic Pollution Action Team to update and refine the preliminary conceptual ecological risk assessment as new information gets published

Future:

- Explore opportunities to integrate microplastics into existing monitoring networks
- Develop a source reduction strategy
- Provide policy recommendations to Chesapeake Bay decision makers to reduce plastic contamination loads

Reports Available Online

- https://www.chesapeakebay.net/who/group/plastic_pollution_action_team



The screenshot displays the Chesapeake Bay Program website. At the top, the logo features a bird in flight over water, with the text "Chesapeake Bay Program" and the tagline "Science. Restoration. Partnership." to its right. A search bar with a magnifying glass icon and the word "Search" is positioned on the far right. Below the header is a dark blue navigation bar with white text links: "Discover the Chesapeake", "Learn the Issues", "State of the Chesapeake", "Take Action", "In the News", "Who We Are", and "What We Do".

The main content area is titled "Publications" in bold. It lists three publications, each with a title in blue and a brief description in black text:

- Microplastic Monitoring & Science Strategy for the Chesapeake Bay**
The Plastic Pollution Action Team (PPAT) was formed at the directive of the CBP Management Board and was charged to develop a preliminary ecological risk assessment model (Appendix C), in addition to a size classification...
- Uniform Size Classification and Concentration Unit Terminology**
Uniform Size Classification and Concentration Unit Terminology for Broad Application in the Chesapeake Bay Watershed
- Ecological Risk Assessment For Microplastics**
PRELIMINARY CONCEPTUAL MODEL FOR AN ECOLOGICAL RISK ASSESSMENT FOR MICROPLASTICS ON STRIPED BASS IN THE POTOMAC RIVER ESTUARY

A "View All >>" link is located at the bottom right of the publications list. Below the list is a light gray footer box with the text "Stay informed on our work. Connect with us." and two links: "Follow us on these social networks" and "Sign up for one of our daily, weekly or monthly newsletters".

Region 3: Drinking Water Literature Review

- Region 3's drinking water direct implementation program received a small FY21 allotment to further support its drinking water systems in addressing contaminants of emerging concern.
- Washington Aqueduct indicated that an examination of microplastics occurrence would be beneficial.
- R3 tasked its contractor, The Cadmus Group, to conduct a literature review to summarize the occurrence of microplastics in drinking water.
- Report discusses removal efficiency in the conventional drinking water treatment process; sampling, analytical, and identification methods; health effects; and future research needs.
- Report is currently under review.

Thank you!

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https://www.bayjournal.com/news/pollution/picture-of-chesapeake-microplastics-grows-clearer/article_87bd3606-c3e1-11eb-bdc4-4f1a3864c6f9.html#comments