TETRA TECH

HANDOUT #1

Recommendations for ERA Endpoint

Tetra Tech ecologists have considered multiple species for inclusion as an ideal biological endpoint for the ERA of microplastics in the Potomac River, with implications for the broader Chesapeake Bay. Our first consideration was whether to include a semi-aquatic or aquatic species endpoint. While there are several good candidates for a semi-aquatic species, more aquatic species are covered by the 2014 Chesapeake Bay Agreement. In addition, of the few studies carried out in the Chesapeake Bay watershed looking into microplastic occurrence, almost all have assessed the aquatic component. For these reasons, we recommend an aquatic species as the ERA endpoint.

Several fish and shellfish species have been discussed as candidate endpoints, and strong cases can be made for many of these.

1. Blue crabs (*Callinectes sapidus*) are an iconic species for the Bay and evoke a strong interest by the general public. In addition, they are a very well-studied species in the Bay and elsewhere. Lastly, the 2014 Agreement established restoration outcomes for blue crabs and thus they should be considered.
2. In addition to blue crabs, the team also considered American Shad (*Alosa sapidissima*). Shad are an abundant group that are regular components of the Potomac River estuary and the state fish of the District of Columbia. A major drawback of using shad (or other Alosines) is the nature of their life cycle-- while Alosines are important in the ecosystem, they are transient. Adults enter the system from the ocean to spawn and then leave again. The young-of-year remain in the estuary, but eventually depart for life primarily in the ocean.
3. Forage fish (e.g. anchovies, silversides, etc) are an integral part of the coastal ecosystem, feeding on zooplankton while serving as primary food for Striped Bass, Bluefish, and other piscivores. The 2014 Agreement identified the importance of forage fish and recommended further research to better understand their abundance. Research in other parts of the world have demonstrated ingestion of microplastics by forage species. By definition, forage species occur lower on the food chain and therefore might artificially represent a truncated pathway for microplastics.
4. We also considered the American Eel (*Anguilla rostrata*) as it is a major component of estuarine and non-tidal ecosystems. However, the American Eel has a very complex life cycle that will make it very difficult to develop a strong risk assessment model. Eels reproduce in the Sargasso Sea, then migrate along the east coast of North America before entering estuaries and continuing into non-tidal waters where they develop into mature adults. Eels then migrate out of the streams and rivers into the estuaries, followed by a long migration back to the Sargasso Sea to spawn and die. This species is not ideal for the current risk assessment because of their extensive movement between different habitats and geographical locations.
5. Striped Bass (*Morone saxatilis*) are one of the top-level piscivores found in the Chesapeake Bay and tributaries. The Chesapeake Bay is also a major center of

reproduction along the western Atlantic. The species has been recognized as a major success story in terms of aggressive multi-jurisdictional management, when the population crashed in the late 1980's. The species recovered after a fishing moratorium was imposed for several years and is highly managed today. Striped Bass, as one of the highest trophic-level organisms in the Bay, provide a very good model endpoint as they will naturally include blue crabs and forage fish (both having specific outcomes in the 2014 agreement). In addition, there is considerable literature on the trophic dynamics of striped bass (Fay et al. 1983, Hartman and Brandt 1995, Cooper et al. 1998, Secor 2000) along the east coast, including the Chesapeake Bay. While striped bass are also migratory, they tend to remain in the estuary the first several years of their life (Fay et al. 1983), thereby providing an organism that can reflect the potential impact of microplastics in a specific location.

Recommendation

We recommend using Striped Bass as the biological endpoint for a risk assessment model for microplastics because it is an apex predator that feeds on several important recreational and commercial fishery species in the Chesapeake Bay, which also have goals under the 2014 Chesapeake Bay watershed agreement. By addressing Striped Bass, we can potentially assess ecological risk to a myriad of species of interest, including blue crabs, forage fish, and oysters

Recommendations for ERA Microplastic of Interest

Microplastics refer to pieces of plastic <5mm in length, either deliberately produced as small pieces (primary microplastics) or as degradation products of larger plastics (secondary microplastics). Primary microplastics include beads used as exfoliants in personal care products, cleaners, and air blasting materials. Secondary microplastics include large plastic items including cups, plastic bags, bottles, etc., broken down by biological, chemical, and physical processes. Common plastic polymers that result as microplastics in aquatic environments include polyethylene, polystyrene, polypropylene, polyvinyl chloride (PVC), polyethylene terephthalate (PET), and polycarbonate (EPA 2016).

It is not possible to exhaustively consider all microplastic sizes and materials in the current effort because microplastics encompass a diverse group of materials with different physical/chemical properties along with fate, transport, and bioavailability characteristics. In order to keep the ERA focused, we recommend considering one category of microplastics for the initial assessment. The following types were considered based on expected prevalence or initial suggestions for the Potomac River and larger Chesapeake Bay:

- **Fibers**—Microplastics from washing machine effluents produced as a result of washing synthetic clothing (ex. Polyester, nylon, acrylics, etc.)

- **Fragments**—Microplastics made by environmental degradation of various types of larger plastics including cups, bags, and bottles.
- **Particles ≤ 150um**—Microplastics, including the upper size limit of microplastics thought to be biologically active.

A recent report of microplastic abundance in submerged aquatic vegetation in the Anacostia River showed that almost 75% of the identified particles were fibers, followed by a smaller percentage of fragments, and beads (Figure 1) (Murphy 2019).

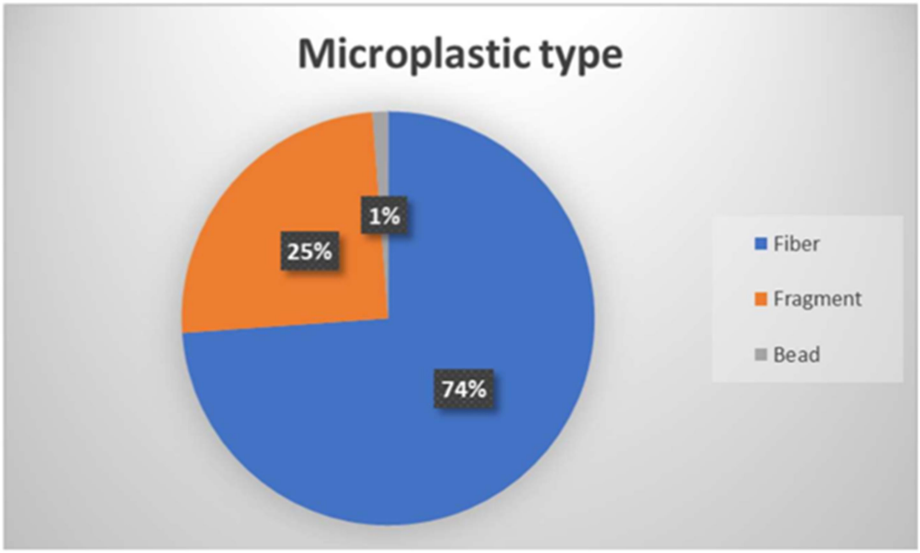

Figure 1. Abundance of microplastic particles in the Anacostia River (Murphy 2020).

Another recent study (Bikker et al. 2020) identified morphology of plastic particles from water samples around the Chesapeake Bay and showed that the greatest abundance of particles were fragments, followed by film, and fibers.

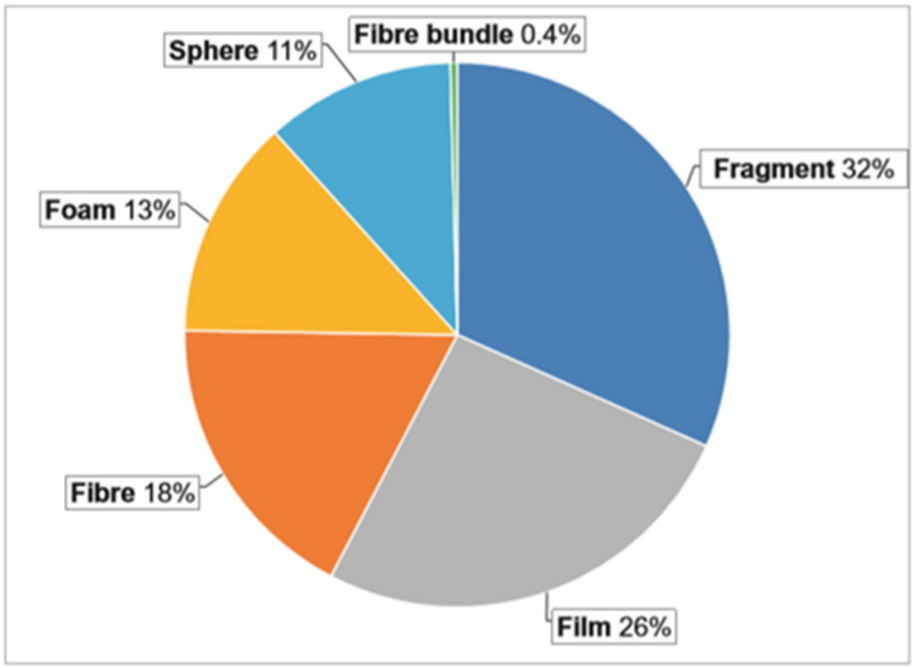

Figure 2. Morphology of particles from thirty surface water samples (after blank correction) in the Chesapeake Bay (from Bikker et al., 2020).

It is noteworthy that the proportion of abundances in Bikker et al. (2020) were different than those found by Murphy (2020), however the physical and chemical characteristics of plastics govern where they are found in the water column and how far they travel from their source. Currently, little is known about the quantitative transport of different types of plastic between the Potomac River and larger Chesapeake Bay.

While other types of microplastics might be more prevalent in the main portion of the Chesapeake Bay, preliminary evidence suggests that fibers could be more abundant in river systems. Additionally, field studies evaluating incidental microplastic consumption suggested that the majority of ingested microplastics were fibers (Desforges et al. 2015, Peters et al. 2017, Sun et al. 2019). Given the abundance of fibers found in the Anacostia, a major tributary of the Potomac, and evidence that fibers are the most ingested particles, we recommend fibers as the primary focus for the current ERA.

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Questions for the Committee

1) Fibers were most prevalent in a study of the Anacostia River, but other types of plastic were more abundant in the main portion of the Chesapeake Bay. Given the evidence in the Anacostia River and data regarding ingestion of fibers, is the selection of fibers a reasonable starting point for this assessment?

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