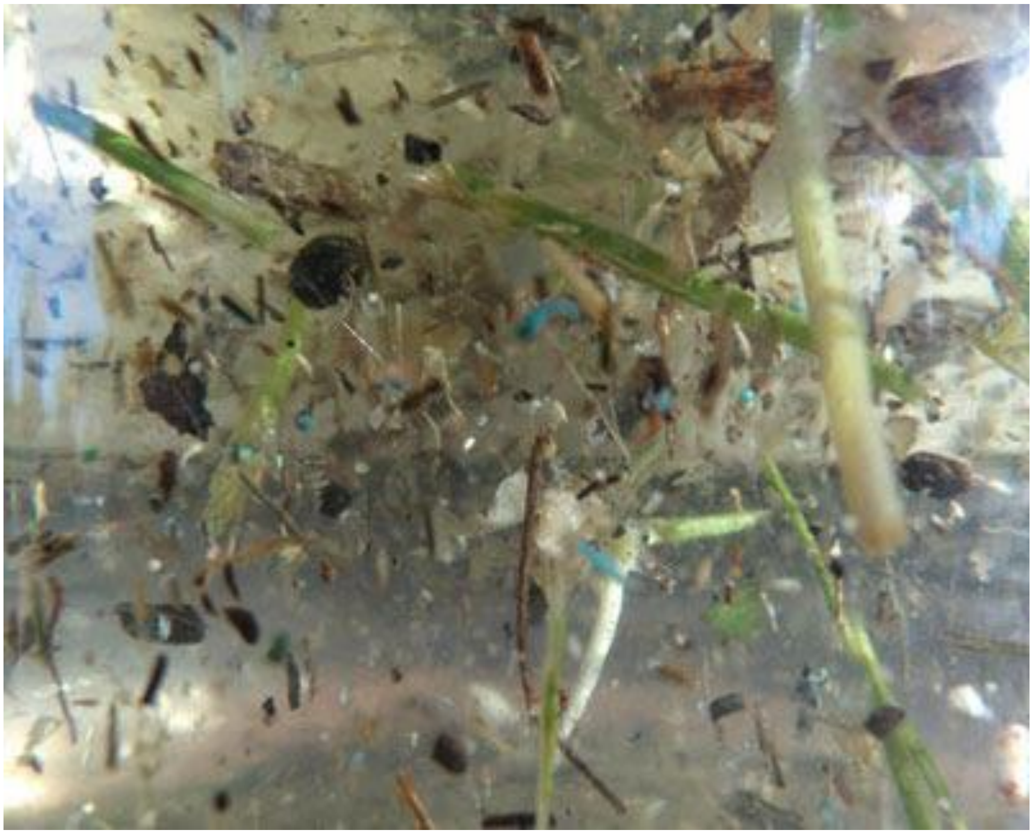
STAC Merit Review of PPAT Product: Phase II Ecological Risk Assessment Conceptual Model for Striped Bass Exposure to Microplastics



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About the Scientific and Technical Advisory Committee

The Scientific and Technical Advisory Committee (STAC) provides scientific and technical guidance to the Chesapeake Bay Program (CBP) on measures to restore and protect the Chesapeake Bay. Since its creation in December 1984, STAC has worked to enhance scientific communication and outreach throughout the Chesapeake Bay Watershed and beyond. STAC provides scientific and technical advice in various ways, including (1) technical reports and papers, (2) discussion groups, (3) assistance in organizing merit reviews of CBP programs and projects, (4) technical workshops, and (5) interaction between STAC members and the CBP. Through professional and academic contacts and organizational networks of its members, STAC ensures close cooperation among and between the various research institutions and management agencies represented in the Watershed. For additional information about STAC, please visit the STAC website at www.chesapeake.org/stac.

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The enclosed material represents the professional recommendations and expert opinion of individuals undertaking a workshop, review, forum, conference, or other activity on a topic or theme that STAC considered an important issue to the goals of the CBP. The content therefore reflects the views of the experts convened through the STAC-sponsored or co-sponsored activity.

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Background

The Chesapeake Bay Program Plastic Pollution Action Team (PPAT) was tasked by the Chesapeake Bay Partnership Management Board with overseeing the development of ecological risk assessments looking at the effects of microplastics on Chesapeake Bay resources. The PPAT requested input from the Chesapeake Bay Scientific and Technical Advisory Committee on their Phase II Ecological Risk Assessment conceptual model for striped bass exposure to microplastics. The PPAT provided specific questions requesting STAC input within a two week timeframe.

STAC convened a panel on November 11, 2020 to conduct a Rapid Response Technical Review. By design, these Rapid Response Technical Review advisories involve a limited number of individuals, occur in relatively short time frames, and generate concise and focused reports.

The panel reviewed the following documents provided by the PPAT:

- Phase II: Preliminary Ecological Risk Assessment Conceptual Model for Striped Bass Exposure to Microplastics. Tetra Tech.
- Microplastics Ecological Risk Assessment: Phase II Model. Powerpoint presentation by Bob Murphy and Jennifer Flippin (Tetra Tech Center for Ecological Studies) and Ryan Woodland, University of Maryland, Chesapeake Biological Laboratory.
- Developing a Preliminary Conceptual Ecological Risk Assessment Model and Science Strategy for Microplastics in the Potomac River. Quality Assurance Project Plan prepared for US Environmental Protection Agency. Tetra Tech July 10, 2020.
- Chesapeake Bay Program Plastic Pollution Action Team (PPAT). Charge questions for STAC review.

Executive Summary

The analysis has assembled critical information that can now be used to advance the understanding of the potential risk factors posed by microplastics to striped bass and other fishes. However, the panel found it difficult to assess the appropriateness of the conceptual model without knowing the end product e.g. is it a qualitative or quantitative assessment of ecological risk? The panel felt the report would benefit greatly from more detail on the process for literature selection and model development. The panel acknowledged that they conducted the review with the material provided and may not have had access to more detailed information but suggest that it will be important for the report to convey a detailed vision of the ultimate product and to provide details on the methods employed. Providing more detail (metadata) in the report will impart transparency and accountability for the final product. The panel believes the model is transferable but cautioned against utilization of the model beyond the Potomac River unless appropriate information is carried with the models.

Responses

1. **As previously stated, the food web models were constructed from highly relevant, albeit limited, information on the dietary habits of juvenile Striped Bass. Was the process utilized to compile the information at an appropriately comprehensive extent to support model construction, given the potential use of this model?**

Insufficient details on the methodology and synthesized findings from the literature review were provided in the report for the panel to assess the appropriateness of completeness of the approach used for model constructions.

<u>Specific comments:</u>

- Reviewers felt that details on the methodology, synthesized findings from the literature review, and description of the R model were lacking.
- Statements in the report suggest the literature review is incomplete (bottom page 2) "Prey trophic linkages will continue to be refined through the ongoing literature review to ensure the network structure is robust."
- Detailed results on the literature review were lacking such as:
  - The criteria for inclusion of some studies versus others in conceptual food webs.
  - The commonalities/differences in prey items reported in the studies.
  - The variation in primary prey for each life stage of striped bass.
- Only a single study (Boynton et al. 1981) was used to develop the semi-quantitative food webs for YOY striped bass. There was no explanation why other studies were excluded. The Boynton paper is 30 year old and some discussion of the potential of food web shifts with changing fishing patterns, nutrient management during this timeframe, and possible climate forcing should be provided.
- Citations for microplastic occurrence in aquatic insects are missing from Table 2.

<u>Additional references that may be pertinent to YOY and juvenile striped bass include:</u>

Hartman, K.J. 2000a. The influence of size on striped bass foraging. Marine Ecology Progress Series 194: 263-268.

Hartman, K.J. 2000b. Variability in daily ration estimates of Age0 striped bass in the Chesapeake Bay. Transactions of the American Fisheries Society 129(5): 1181-1186.

Hartman, K.J and S. Brandt. 1995. Canadian Journal of Fisheries and Aquatic Sciences 52(8):1667-1687.

Markle, D.F. and G.C. Grant. 1970. The summer food habits of young-of-the year striped bass in three Virginia rivers. Chesapeake Science 11(1): 50-54.

Martino, E.J. and E.D. Houde. 2012. Density-dependent regulation of year-class strength in age-0 juvenile striped bass (*Morone saxatilis*). Canadian Journal of Fisheries and Aquatic Sciences 69(3): 430-446.

Nemerson, D.M. and K.W. Able. 2003. Spatial and temporal patterns in the distribution and feeding habits of *Morone saxatilis* in marsh creeks of Delaware Bay, USA. Fisheries Management and Ecology 10(5): 337-348

2. Tetra Tech's analysis was conducted in collaboration with experts in trophic ecology from the Chesapeake Biological Laboratory. Do the methods utilized to formulate Phase II of the conceptual model seem appropriate and/or sufficient?

It is difficult to assess the appropriateness of the conceptual model without knowing the end product e.g. is it a qualitative or quantitative assessment of ecological risk? The study would benefit from a pause and, given the information gathered, some forward-looking planning. What is the hoped for final product and outcome? If the idea is to stop with some conceptual models, that would be disappointing. The outcome will be "plastics COULD be important."

If the end product is qualitative, the approach builds on previous network analysis work in the Chesapeake Bay and summarizing the diet information is a good step.

If the end product is quantitative, additional documentation is necessary as provided in the specific comments below.

<u>Specific comments:</u>

- There are quantitative models available that predict juvenile striped bass recruitment on daily time steps with detailed feeding, even for the Potomac River and that look at contaminant effects
- Semi-quantitative estimates of the extent of microplastic (of each type) concentrations in the tissues of the prey species would be valuable. Those estimates do not have to be exact, but estimates of relative concentrations could at least identify the most critical risks to striped bass, their life histories, and the potential of human consumption, and thus form the basis of further study.
- Information on juvenile striped bass diets is relatively well known. If only Potomac River studies are valid, then the data is more limited. However, striped bass diets are quite consistent across many estuarine systems.
- A key is what resolution is needed in the prey types. For the levels shown in the conceptual modeling, the information on diets is quite robust. Striped bass are opportunistic. A key question is how will this opportunism be captured in subsequent analyses of risk?
- Prey switching with different encounter rates will be critical but is not discussed as part of predicting diets. The authors may want to also consider using size as covariate in diet analyses to inform future modeling.
- Food web models (Figures 6-7) for Ages 1-2 do not coincide with the Aggregate table of prey items (Table 1). An explanation of why select prey items were not listed in the table should be included. Though conceptually included in Figure 2, the aggregated prey list appears to be lacking some potentially important groups such as:
    - Annelids (see Kellogg, L.M., P.G. Ross, M.W. Luckenbach, J.C. Dreyer, M. Pant, A. Birch, S. Fate, E. Smith and K. Paynter. 2016. Integrated assessment of oyster reef ecosystem

services – Fish utilization and trophic linkages. Final Report, Virginia Institute of Marine Science, 20p.

    - Other crustaceans such as Blue Crab juveniles) Walter and Austin, 2003).
    - Small bivalves (See Kellogg et al. 2016).

- How were the diet compositions of the various sources indicated combined? i.e. were they weighted and, if so, what criteria was utilized?
- No details on methods or even the conceptual approach of the food web model already applied to the diet study performed in R.

<u>Additional references to be considered:</u>

Monaco, M. 1995. Comparative Analysis of Estuarine Bio-Physical Characteristics and Trophic Structure Defining Ecosystem Function to Fishes. University of Maryland dissertation.

Monaco, M.E. and R.E. Ulanowicz. 1997. Comparative ecosystem trophic structure of three U.S. mid Atlantic estuaries. Marine Ecological Progress Series. 161:239-254.

Rose, K.A. and Cowan Jr, J.H., 1993. Individual-based model of young-of-the-year striped bass population dynamics. I. Model description and baseline simulations. *Transactions of the American Fisheries Society*, *122*(3), pp.415-438

3. **What are the potential barriers in applying this conceptual model to other tributaries in the Chesapeake Bay? Which elements of the model may not be scalable/transferable to other tributaries?**

The conceptual model is easily transported to other systems if the appropriate information is carried with the models. Encounter rates with different prey types will vary across systems but, with some clever analyses and the use of field data, can be approximated so the conceptual model becomes more predictive as it is moved from system to system. Striped bass diets are likely quite robust across systems if certain auxiliary information is incorporated into the conceptual models.

The various tributaries of the Chesapeake Bay vary substantially in depth, flow, tidal influence, habitat, and salinity, and the interaction of all these factors together warrants caution in the interpretation of the Potomac River model when applied elsewhere.

<u>Specific comments:</u>

Potential barriers that may limit transferability include:

- Lack of comparative data on microplastic concentrations in prey items in different systems.
- Lack of data on individual or population level effects on microplastics ingestion/bioaccumulation on striped bass.
- Lack of validated models depicting microplastic concentration and distribution in Chesapeake Bay.
- The proportion of a specific prey consumed may differ in other tributaries due to differences in water quality (e.g. low dissolved oxygen) and habitat availability for both prey and striped bass.

- In general, the elements may be scalable but may not represent the same predator prey interactions and volume consumed given variable environmental conditions (e.g. changes in salinity regimes).

4. **To what extent does this model inform the question of the risk posed by microplastics to the restoration effort? What are major gaps in the representation of potential risk?**

The analysis has assembled critical information that can now be used to advance the understanding of the potential risk factors posed by microplastics to striped bass and other fishes. However, the analysis is qualitative and is therefore only appropriate for a screening type model, for example one which results in the assessment that "plastics COULD be important." In order to truly inform risk, the analysis would have to proceed to a quantitative one, as discussed above.

One approach is to simulate different levels over a possible range and see at what levels approach ecologically-relevant effects in striped bass and compare those levels to the levels in other systems to determine if there is any chance the Chesapeake Bay would get to levels that trigger effects.

Specific comments:

- While the model captures the significant environmental pools of microplastics through the various prey pathways (Figure 1), inclusion of variable estuarine landscape setting would provide a relative representation of potential risk which will be spatially variable. For example, urban areas may have higher or concentrated inputs of microplastics compared to forested environments.
- A major gap is understanding microplastic transport dynamics. This is a key step to define areas of high risk for striped bass ingestion of microplastics.
- It is not clear what is meant by "the restoration effort". This needs clarification to address this question. Currently, the description of the intended work/approach does not explicitly address this aspect.

5. **There is currently very little information on the presence, abundance, and effects of microplastics in Chesapeake Bay. Anecdotally, can you provide any relevant information that was omitted from their research looking at impacts of microplastics on juvenile Striped Bass and their prey, or on the effects of microplastics on juvenile Striped Bass and their prey in the Chesapeake Bay?**

Specific comments:

- Not specific to Chesapeake Bay, but a review article that includes references of prey (blue crab) that may be useful. Smith, M., Love, D.C., Rochman, C.M., and Neff, R.A. 2018. Microplastics in seafood and the implications for human health. Current environmental health reports, 5(3), pp. 375-386. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6132564/