Fate of Microplastics at the Mouth of an Urban Coastal Watershed

Theresa Sinicrope Talley[1], Rachel Whelan[2], Nina Venuti[1]

[1]California Sea Grant, Scripps Institution of Oceanography; [2]Environmental and Ocean Sciences, University of San Diego

Introduction

Plastics are pervasive in urban watersheds (Fig. 1) and have high potential for chemical adsorption, transport, ingestion (1), and leaching of constituent semi-volatile organic compounds (SVOCs), which bind to fats and sediments (2). Little is known, however, about the incorporation of these contaminants into coastal food webs.

Our project **goal** was, therefore, to determine the extent to which wetland fish living at the mouth of an urban coastal watershed are contaminated with microplastics and SVOCs.

We tested the following **hypotheses**:

1. Microplastics in fish will reflect the composition and abundance in sediments (i.e. fish will display non-selective consumption)
2. SVOC contamination of fish tissue will be common in all species

Fig. 1. Study site at flood tide

Methods

- In June 2015, we sampled a 250 m-long reach of intertidal Chollas Creek, located about 1 km upstream of the mouth (X, Fig. 2).
- Wetland resident fish were collected using baited traps (Fig. 3) for gut content and SVOC analysis.
- Sediment (10 cm diam. x 5 cm depth cores) was collected for microplastics classification and enumeration.
- Fish diet preference was explored using Manly's alpha (3).

Fig. 2. Chollas Creek sub-watershed

Fig. 3. Collecting fish from trap at Lower Chollas Creek

Results & Discussion

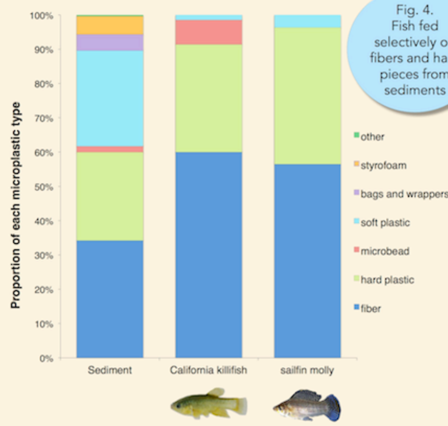

Fig. 4. Fish fed selectively on fibers and hard pieces from sediments

Sediment

- All sediments contained microplastics with an average (±1SE) of 9,638±1,636 pieces per m^2
  - synthetic fibers and hard and soft plastic pieces made of 90% of microplastics (Fig. 4)

Fish

- ~25% of fish ate microplastics (12% of 61 California killifish, 32% of 74 sailfin molly, 0% of 4 longjaw mudsucker)
- Of the 39 types of sediment plastics, killifish and molly consumed a subset (Fig. 4) of 10-11 types
  - 7-8 types of plastic were preferentially eaten, including blue, yellow, orange, and red hard pieces, fibers of any color, and microbeads (killifish);
  - Preferred plastics often resembled prey items such as snails, fish eggs, filamentous algae, nematodes, and worms (Fig. 5)

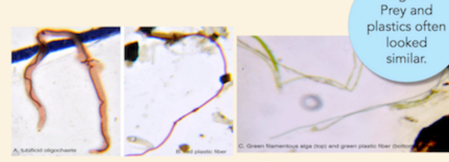

Fig. 5. Prey and plastics often looked similar.

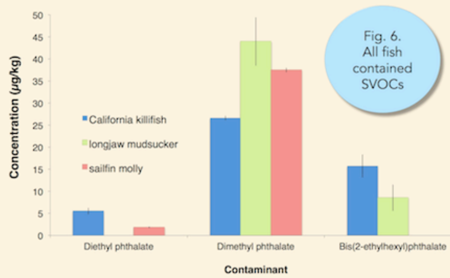

Fig. 6. All fish contained SVOCs

- Size and sex influenced plastics ingestion: larger than average California killifish, and sailfin molly females were more likely to consume plastics
- All of the 7 fish tested for SVOCs contained two or three phthalates, or plasticizers (Fig. 6), with highest concentrations of SVOCs being those with a high capacity for sediment accumulation.
- SVOCs are known endocrine disruptors in wildlife and humans (4).

Takeaways

- Plastics pollution has ecosystem-level impacts through incorporation into the foodweb
- Species natural history, including differences in behavior and requirements among species, ontogeny and sex, can affect rates of plastic ingestion
- Some fish selectively ingest plastic items that resemble their prey
- Plastics entering coastal watersheds will likely be incorporated into foodwebs; the most effective solution is to stop initial entry through (a) reduced use of plastics in production of goods; (b) encouraging reduced use and recycling of plastics by consumers; and (c) improving enforcement of illegal dumping, trash management, street cleaning, and stormwater filtration strategies.

Acknowledgments

This project was supported by the California Sea Grant Extension Program (TST, NV), National Science Foundation (TST), University of San Diego Summer Undergraduate Research Experience Program (RW), and the University of San Diego-Mater Dei Science Partnership Program (AM). Thank you to A. Malunes for extensive field and lab work help; E. Cathcart and Enviromatrix Analytical, Inc. for help with SVOC analyses; D. Talley for use of lab space and resources; Ocean Discovery Institute for information from a complimentary macroplastics study; and S. Searcy and E. Cathcart for poster critiques.

References

1. Rochman, C. 2013. Plastics and priority pollutants: A multiple stressor in aquatic habitats. Environ. Sci. Technol. 47: 2439–2440.
2. Teuten, E.L., et al. 2009.. Transport and release of chemicals from plastics to the environment and to wildlife. Philos. Trans. R. Soc. B: Biol. Sci. 364(1526): 2027–2045.
3. Chipps, S., J. Garvey. 2007. Assessments of diets and feeding patterns. In: Guy, C.S., Brown, M.L., eds. Analysis and Interpretation of Freshwater Fisheries Data. Bethesda, MD: American Fisheries Society. p. 473-514.
4. Gore, A.C., et al. 2015. Executive Summary to EDC-2: The Endocrine Society's Second Scientific Statement on Endocrine-Disrupting Chemicals. Endocrine Reviews 36(6): 593-602.