Mussels as a Bioindicator of Microplastic Pollution in Mission Bay

Julia Humphrey
Dr. Steven Searcy, Environmental and Ocean Sciences
University of San Diego

Introduction

- Microplastics, plastics less than 5 mm in size, pose a threat to the marine environment due to their ubiquity and various consequences[1, 3, 4, 10]
- Microplastics are commonly found in the form of synthetic fibers (Fig 1A) and fragments (Fig 1B)

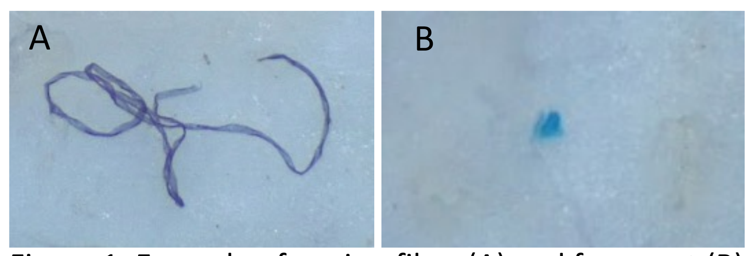

Figure 1: Example of a microfiber (A) and fragment (B)

- Understanding spatial trends of microplastics is critical as studies have found they may cause harm to marine organisms including but not limited to:
  - Negatively impacting growth, reproduction, and energy allocation[6, 8]
  - Causing inflammatory responses[8]
  - Reducing filtering rates[10]
- One mussel can filter through about 50 mL of seawater per minute, retaining undigested microplastics in their stomachs and tissues[2]

Objectives and Hypotheses

1. Determine whether mussels serve as an effective bioindicator of microplastics in Mission Bay
   H_1: Microplastics will be found in mussels throughout Mission Bay
2. Identify any spatial trends in Mission Bay
   H_2: Fewer microplastics will be found at the mouth than the back
   H_3: Microplastic color will vary among sampling sites
3. Determine potential negative impacts of microplastics on mussels
   H_4: Mussels with more microplastics will report a lower condition (plumpness index)

Methods

- Collected mussels from four sites around Mission Bay (Fig 2).
- Measured length, width, and wet weights (WW)
- Digested tissues with 30% hydrogen peroxide at 55ºC for 48 hours
- Vacuum filtered digestate onto glass fiber filters

Figure 2: Site map

- Filters examined under microscope and microplastics identified
- Mussel condition was calculated using Fulton's K Index[7]:

$$\text{Fulton's K} = \frac{WW}{length^3} * 10^6$$

Graphs , regressions, and statistical tests were conducted using RStudio Version 1.4.1103

Results

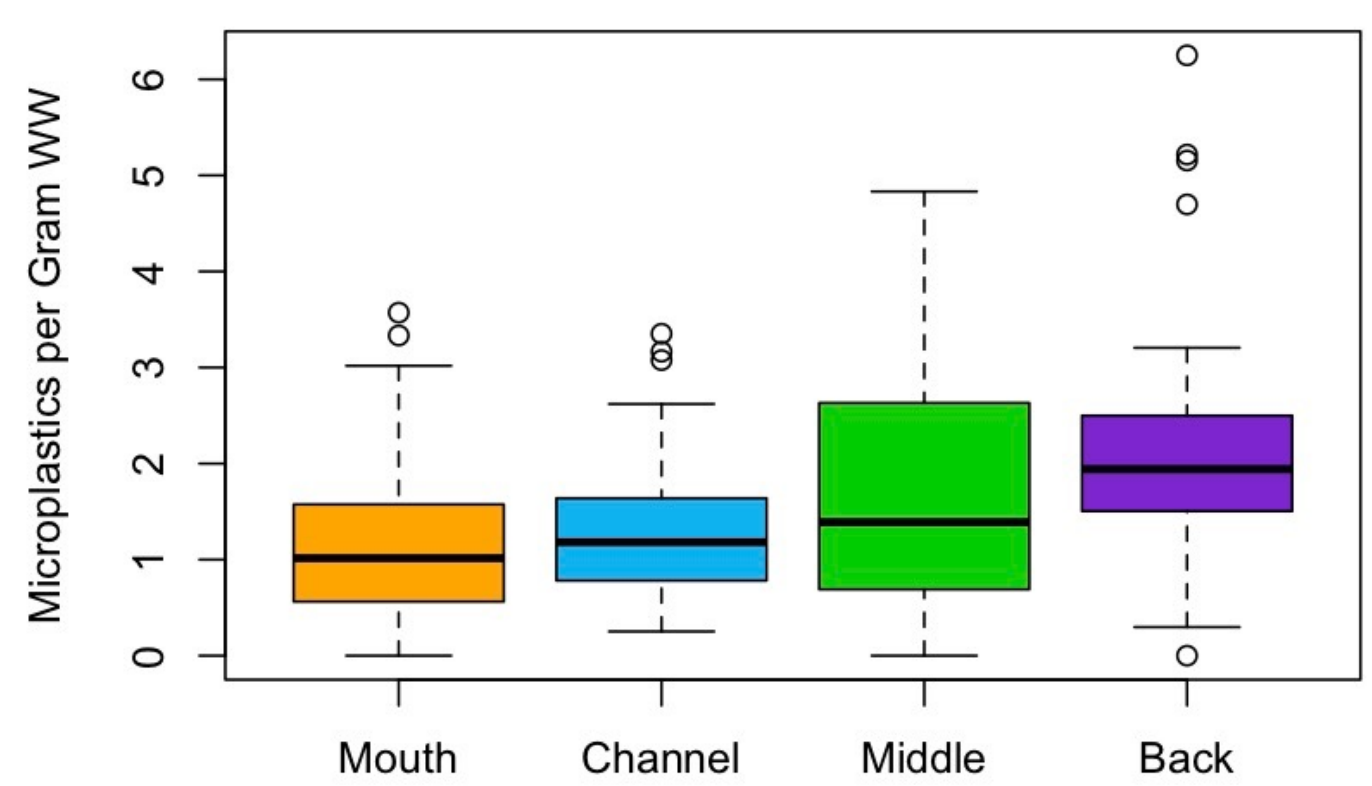

Figure 3: Boxplots comparing median microplastic amount per gram wet weight of mussel tissue at each site.

Figure 4: Microplastic color distribution throughout the bay

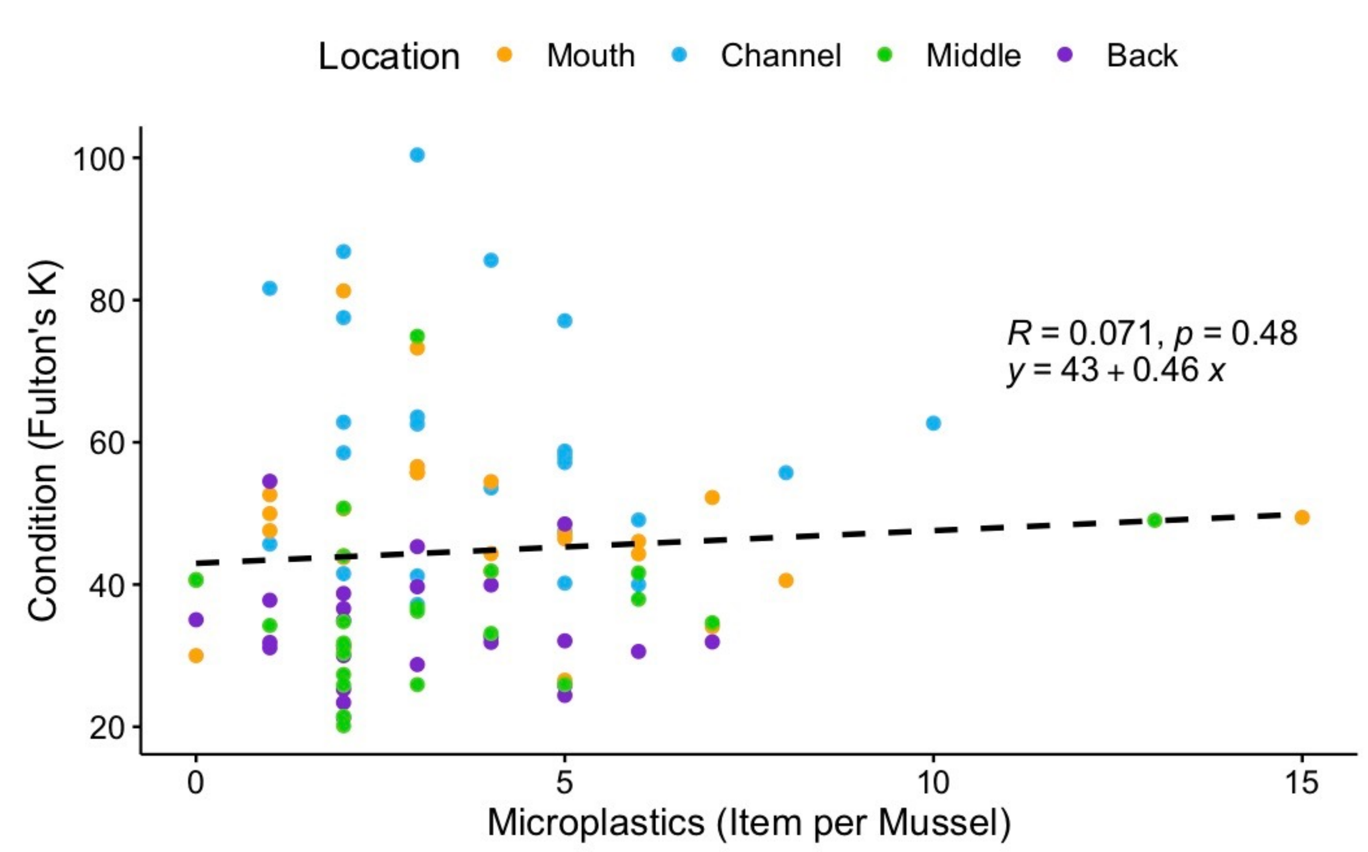

Figure 5: Scatterplot of microplastics per mussel versus mussel condition as quantified by Fulton's K Index value. Dotted line indicates a linear regression.

Discussion

- Mussels are an effective bioindicator of microplastics and metals
- General trend of higher microplastics in the back of the bay than the mouth, although, no significant difference (Kruskal Wallace; p=0.222)
  - Back has more storm drains, higher freshwater input, and longer flushing intervals that can lead to higher contribution and longer retention of microplastics[3]
  - May be more significant difference after a large rain that could input microplastics
- Little variation in color distributions
  - Indicates microplastics are ubiquitous in the environment
  - Another study has also found that blue colored microplastics were predominant[1]
- No mussels with high microplastics reported a high condition
  - Lower condition could be due to reduced filtering rates, stunted growth, and impaired energy allocation [6, 8, 10]
  - Wide range of conditions with low microplastics may be due to another parameter (ex. copper)

Future Studies

- Microplastic samples can be identified by compound using Fourier-transform infrared spectroscopy (FTIR)
- Biomonitoring efforts should expand spatially and temporally. A long-term microplastic monitoring program may be established

Acknowledgements

Funding was made possible by USD's SURE program. I would like to thank Dr. Steven Searcy for his support, guidance, and mentorship.

References:

1. *Chinfak et al. Science of the Total Environment 781:146700. (2021)*
2. *Beyer et al. Marine Environmental Research 130: 338-365. (2017) 3. Largier et al. Estuarine, Coastal and Shelf Science 45(6):789-97. (1997)*
3. *Largier et al. Estuarine, Coastal and Shelf Science 45: 789-797. (1997)*
4. *Li et al. Environmental Pollution 244:522-33. (2019)*
5. *Li et al. Environ Pollution 207:190-5. (2015)*
6. *Sussarellu et al. Proceedings of the National Academy of Sciences 113(9):2430-5. (2016)*
7. *Tsakiris et al. Aquatic Conservation and Freshwater Ecosystems 27: 1240-1250. (2017)*
8. *von Moos et al. Environmental Science & Technology 46(20):11327-35. (2012)*
9. *Wegner et al. Environmental Toxicology and Chemistry 31(11):2490-7. (2012)*
10. *Wright et al. Environmental Pollution 178:483-92. (2013)*