

Project Description

Background

Plastic pollution in the ocean provides a wide range of concerns, including aesthetic “eyesores,” ingestion by marine life, and entanglement (Moore 2008). Plastics that range in size between 100 nm and 5 mm are known as microplastics and are of concern since they likely contaminate marine sediments, bioaccumulate in marine food webs, and serve as substrate for invasive species (Khalid et al 2021). They are also the most abundant plastic pollution in the open ocean (Cózar et al 2014). Bivalve molluscs are excellent candidate species for acting as bioindicators of microplastic pollution (Ding et al 2021). Bivalves are filter feeders and microplastics found in the water column will be present in bivalve tissue, which can then be extracted and analyzed (Rochman et al 2015, Cho et al 2019, Ding et al 2021). Of course, many bivalve species are food sources for humans, and therefore, there are potential concerns of the toxic nature of microplastics that are embedded in bivalve tissue that may be consumed by the general public (Smith et al 2018).

The North Atlantic Ocean is estimated to harbor between 1.0-6.7 kilotons of plastic debris in its surface waters (Cózar et al 2014). In Northeastern Pennsylvania, many bivalve species sold in local grocery stores are sourced from the North Atlantic (e.g., see Valley Seafood 2024 and Figure 1). While studies in Great Britain and South Korea have described the presence, abundance, and quality of microplastics found in wild and store-bought seafood (Li et al 2018, Cho et al 2019) there is, to our knowledge, no study that has explored the abundance and type of microplastics in seafood that is sold to residents of Northeastern Pennsylvania. Furthermore, the impact of processing may also introduce additional microplastics into seafood tissue, and it is worth investigating if the type and source of seafood varies in microplastic quantity and quality (Lusher and Covernton 2022). We have collected preliminary data (to test our methods) and found that live blue mussels (*Mytilus edulis*) sold in a Dallas, PA grocery store contain polyethylene terephthalate (PET) and polystyrene.

In addition to examining the presence, abundance, and type of plastics in bivalve mollusc seafood collected from grocery stores and seafood sellers in Northeastern Pennsylvania, we are also going to build a geovisual analytics tool to help stakeholders, including the public and seafood farmers, to understand where microplastics are found and where they come from. Geovisual analytics (GVA) is an emerging field in which spatial information (in this case, location of harvest and location of purchase) is explored using a visual interactive interface (Robinson 2017). GVA has been used in various fields including crisis management (Tomaszewski and MacEachren 2012), river ecology (Xu et al 2019), archaeology (Huisman et al 2009), among other fields. Across disciplines, the purpose of GVA is to give the user an opportunity to extract an “overview first, zoom and filter, then details on demand,” per the visual-seeking mantra of Shneiderman (1996). Thus, in our case, the user can see an overview of

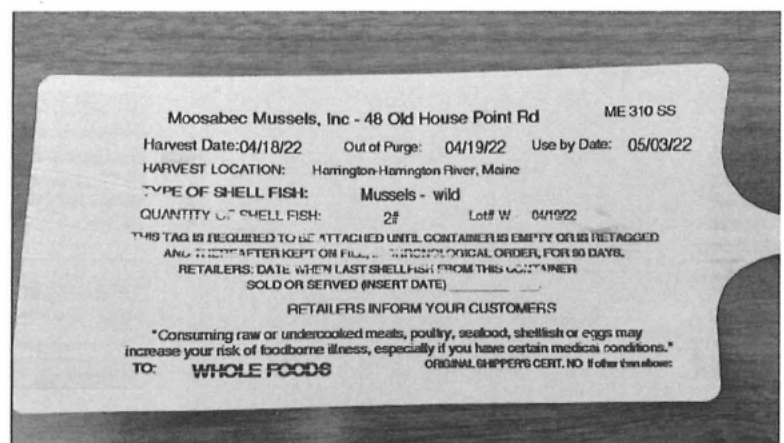


Figure 1: Tag attached to live mussels sold at Weis Markets, Dallas, PA. Note that these mussels were harvested from Harrington River, Maine.

where bivalve mollusc seafood is sourced, then they can filter by species, processing type, or plastic type, and gain more knowledge about cases from each category.

Therefore, the goals of the proposed research for this SURF application are: 1) To collect bivalve mollusc seafood from sellers across Northeastern Pennsylvania that have their source of harvest clearly indicated. Species may include mussels, clams, oysters, or scallops, 2) To digest the organic material for each sample and weigh the resultant plastic components, 3) In conjunction with Dr. [REDACTED] in Misericordia University's Chemistry Department, to identify the plastic types found in each sample, 4) To build a GVA tool that will show the locations of samples collected and allow a user to interact with the data for visualization and sensemaking.

We hope to answer the following questions as the result of our study:

- 1) Does plastic quality and quantity differ across species? Across processing method?
- 2) What spatial relationships exist between plastic type and abundance in species that are sold in Northeastern Pennsylvania?

Methods

Live, processed, and frozen mussels, clams, scallops, and oysters will be collected from grocery stores and seafood markets in Northeastern Pennsylvania. Each sample will consist of one entire bag or container of mollusc species from each location. (Previous experiments we have conducted showed that larger quantities of mussels than 1 at a time are necessary to accurately quantify and identify plastics.) All tools and glassware to be used will be washed using filtered distilled water before use. All specimens will be stored at -20°C for at minimum 24 hours. After this period, the specimens will be weighed and rinsed with filtered DI water before being immersed in 10% KOH solution at 3x tissue volume for digestion. This digestate will be incubated at 60°C for 48 hours to increase filtration capacity, then removed. Then the digestate will be neutralized with 1M citric acid solution until a neutral pH is achieved (this ratio is approximately 0.6 mL citric acid to every 1 mL KOH). The digest will be mixed, then filtered through a pre-weighed GF/C 1.6-micron glass fiber filter through vacuum filtration. Filtered samples will be dried at 60°C for 24 hours. These samples will then be given to Dr. John Morgan in Chemistry for analysis on the NMR to determine the quantity and type of plastic.

While the samples are processed by Chemistry, we will design and construct a GVA tool in either ArcGIS Insight, Shiny, or Tableau, depending on our overall design. Over the summer, we will use the data that we receive during this time period along with data from the literature to create a prototype. We will then design a usability and utility study to gauge the usefulness of the tool with an audience ranging from a breadth of backgrounds (student, faculty, shellfish farmer, etc. (to make sure the tool is useful). The deliverables for the summer will include the prototype tool and any results we receive from chemistry.

Proposed timeline

- May 28 – 31: Prepare and order reagents and work area, discuss goals in more detail, meet with chemistry
- Early June: Collect and digest samples for analysis
- Late June: Hand samples to chemistry
- July-August: Work on mapping skills and build a map tool using geographic data from samples collected. If samples return from chemistry by the end of July, add in data about plastics. Work on talk.

This research is part of [REDACTED] ongoing independent project that began in [REDACTED]. [REDACTED] completed a proposal for the work in our [REDACTED] BIO 300 (Junior Seminar) course and we are ready to expand the work so that we can potentially publish the work and the GVA tool, and [REDACTED] can complete ENV 400 (Capstone) and BIO 400 (Senior Seminar) for the BIO/ENV double-major.

Budget

Item	Quantity	Price
1.2 μ m Whatman GF/C borosilicate glass filters (100 pack)	2	\$69.05 each = 138.10
10% KOH, 500 mL bottle	3	\$59.27 each = 177.81
1M Citric acid, 1L bottle	1	\$57.91
Seafood	See note below*	\$357.32
NMR reagents	See note below **	\$500.00
Total		\$1,231.05

*Seafood

Mussels (live) = 8.00/bag of 30 (3 bags) = \$24.00

Mussels (frozen) = 4.00/lb (3 lbs) = \$12.00

Clams (live) = \$0.51 each (60 clams) = \$30.60

Clams (frozen) = 48.00/2 lbs (6 lbs) = \$144.00

Clams (canned) = \$2.59/can (6 cans) = \$15.54

Oysters (live) = \$0.89 each (30 oysters) = \$26.70

Oysters (frozen) = \$1.95 each (30 oysters) = \$58.50

Scallops (live) = \$22.99/lb (1 lb) = \$22.99

Scallops (frozen) = \$22.99/lb (1 lb) = \$22.99

**NMR reagents

Dimethylsulfoxide-d₆ = 60.00/10g bottle (2 bottles) = 120.00

Chloroform-d = 75.00/100g bottle (2 bottles) = 150.00

Trifluoroacetic acid – d = 85.00/10g ampoule (2 ampoules) = 170.00

Chemical shipping charges = \$60.00

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I would like to participate in SURF because I want to gain more experience working independently in the lab on a project other than the curriculum-based labs that are presented in class. I would like to gain more confidence in the lab when working on an independent project to become a better researcher and a better future scientist. It is also crucial, especially in times such as these, with the uncertainty that comes with continued scientific advancement and issues such as climate change, that scientists are able to properly communicate with each other and the public, and I anticipate that the required writing and presentation aspect of the SURF program will help me grow my communication skills.

I also am very interested in all areas of science and would greatly enjoy being able to learn more about the projects that my peers are doing and make lasting connections with faculty and students alike across the University. I believe that I have been prepared very well to meet the requirements of the SURF program through the multiple rigorous lab courses that I have taken as a biology/environmental studies double major that allowed me to practice and learn about a variety of lab techniques, and other courses such as biostatistics, GIS, and environmental research design that have taught me incredibly valuable information about which statistical tests should be performed on experimental data that are collected, how to present those data, and how to write about those data. I've also had experience as a lab assistant at Misericordia University, mixing solutions and carrying out experiments.