Microplastics in NELHA Waters

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Organization: NELHA
Microplastics

- Plastic particles between 0.3 mm – 5 mm
- Microplastic particles are ubiquitous in ocean waters
Harmful Effects to Organisms

- Microplastics can be ingested by organisms.
- Ingestion of microplastic can cause a variety of negative effects:
  - Intestinal damage
  - Liver damage
  - Impaired reproduction
  - Reduced immune function
  - Oxidative stress
  - Other negative health effects that result in increased mortality
Chemicals within Plastic

- Plastics have chemical additives.
- Microplastics absorb hydrophobic and toxic chemicals from the water and concentrate them.
- Chemicals leach to organisms when particles are ingested.
NELHA

- NELHA is a supplier of deep and surface ocean water.
- Some of their clients bottle desalinated drinking water from the deepsea.
- Sampling the deepsea and surface pipelines.
- Also sampling coastal surface waters.
- **Goal:** determine microplastic concentrations in the pipelines and surface waters.

[Article Link](https://www.beveragedaily.com/Article/2016/02/16/Kona-Deep-brings-desalinated-deep-ocean-water-to-the-US-market)
Locations for Sampling

- Sea surface
- 80 feet
- 2000 feet
- 3000 feet
Sample Collection - Pipelines

- Designed and constructed a water filtration system
- Installed flowmeters to calculated water volume
- Ran water through 0.333 mm nets
Sample Collection - Ocean

- Used manta trawl net with flowmeter
- Floats on sea surface
- Went along six transects branching out from the main facility
Lab Procedure

• Lab procedure from NOAA (National Oceanic and Atmospheric Administration).
• Recently released as an intended standard for microplastic concentration analysis to create comparable data.
Sieving and Drying

- Samples were sieved using 5mm and 0.333 mm sieves
- Dried at 90° C in a drying oven
- Mass of total solids taken

Surface Sample

Deep Sea Sample
Wet Peroxide Oxidation (WPO)

- Natural organic matter oxidized
- Used 30% hydrogen peroxide
- FeSO4 as a catalyst
- Heated to 75° C
WPO - Success
WPO - Red Precipitate

- Two samples produced red precipitates
- Natural organic matter remained
- Process was repeated
Wet Peroxide Oxidation - Foaming

- Larger amount of organics
- Thick foam lifts solids out of mixture
- Return beaker to stir/hot plate
Density Separation

- NaCl solution, density 1.2 g/mL
- Most plastics density less than 1.2 g/mL

| Density range of most common polymers of environmental relevance: Density (g/cm³) |
|-------------------------------|---------------|
| Distilled water               | 1             |
| Sea water                     | 1.025         |
| Polyethylene (PE)             | 0.93-0.98     |
| Polypropylene (PP)            | 0.89-0.91     |
| Polystyrene (PS)              | 1.04-1.11     |
| Polyvinylchloride (PVC)       | 1.20-1.45     |
| Polyamide (PA)                | 1.13-1.5      |
| Polyethylene terephthalate (PET)| 1.38-1.39    |
| Polyvinyl Alcohol (PVA)       | 1.19-1.35     |
Final Steps

• Sieved
• Air dried
• Microscope Examination
• Gravimetric Analysis
### Microplastics in the Pipelines

<table>
<thead>
<tr>
<th>Location and Sample #</th>
<th>Mass Total Solids (mg)</th>
<th>Mass Microplastic (mg)</th>
<th>Water Volume (m³)</th>
<th>Concentration (mg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 ft Deep Point (1)</td>
<td>277.3</td>
<td>2.5</td>
<td>541.844</td>
<td>0.0046</td>
</tr>
<tr>
<td>2000 ft Deep Point (2)</td>
<td>307.7</td>
<td>0.2</td>
<td>702.648</td>
<td>0.0003</td>
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<tr>
<td>80 ft Deep Point (1)</td>
<td>974.2</td>
<td>1.1</td>
<td>599.761</td>
<td>0.0018</td>
</tr>
<tr>
<td>80 ft Deep Point (2)</td>
<td>386.3</td>
<td>0.5</td>
<td>719.039</td>
<td>0.0007</td>
</tr>
<tr>
<td>3000 ft Deep (1)</td>
<td>93.9</td>
<td>2.2</td>
<td>722.862</td>
<td>0.0030</td>
</tr>
<tr>
<td>3000 ft Deep (2)</td>
<td>254.5</td>
<td>1.1</td>
<td>351.324</td>
<td>0.0031</td>
</tr>
<tr>
<td>80 ft Deep (1)</td>
<td>424.4</td>
<td>1.4</td>
<td>920.877</td>
<td>0.0015</td>
</tr>
<tr>
<td>80 ft Deep (2)</td>
<td>--</td>
<td>1.3</td>
<td>279.098</td>
<td>0.0047</td>
</tr>
<tr>
<td>Surface Trawl (1)</td>
<td>30511.9</td>
<td>1206.9</td>
<td>3,010</td>
<td>0.4010</td>
</tr>
<tr>
<td>Surface Trawl (2)</td>
<td>11202.5</td>
<td>2056.2</td>
<td>2,660</td>
<td>0.773</td>
</tr>
<tr>
<td>Pipeline</td>
<td>Concentration (mg m&lt;sup&gt;-3&lt;/sup&gt;)</td>
<td>Concentration (mg m&lt;sup&gt;-3&lt;/sup&gt;)</td>
<td>Concentration (particles m&lt;sup&gt;-3&lt;/sup&gt;)</td>
<td>Location</td>
</tr>
<tr>
<td>--------------</td>
<td>----------------------------------</td>
<td>----------------------------------</td>
<td>------------------------------------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>2000 ft Point</td>
<td>0.0046</td>
<td></td>
<td>0.017</td>
<td>North Pacific central gyre, sampling at 100 m</td>
</tr>
<tr>
<td>2000 ft Point</td>
<td>0.0003</td>
<td>0.010.02</td>
<td>0.2 to 0.4</td>
<td>Santa Monica Bay, California (offshore); range</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>represents before and after storm conditions</td>
</tr>
<tr>
<td>80 ft Point</td>
<td>0.0018</td>
<td>0.010.13</td>
<td>1 to 11</td>
<td>Santa Monica Bay, California (nearshore); before</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and after storm conditions</td>
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<tr>
<td>80 ft Point</td>
<td>0.0007</td>
<td>0.120.25</td>
<td>1.56</td>
<td>Santa Monica Bay, California (offshore); before and after</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>storm conditions (Epibenthic)</td>
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<tr>
<td>3000 ft</td>
<td>0.0030</td>
<td></td>
<td>8 to 9180</td>
<td>Northeastern Pacific/coastal British Columbia.</td>
</tr>
<tr>
<td>3000 ft</td>
<td>0.0031</td>
<td></td>
<td>1.69</td>
<td>North Atlantic subtropical gyre to a depth of 5 m</td>
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<tr>
<td>80 ft</td>
<td>0.0015</td>
<td></td>
<td>2.46</td>
<td>North Atlantic, Celtic Sea to a depth of 3 m</td>
</tr>
<tr>
<td>80 ft</td>
<td>0.0047</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# A World Comparison (Surface)

<table>
<thead>
<tr>
<th>Surface Trawls</th>
<th>Concentration (mg/m³)</th>
<th>Concentration (mg·m⁻³)</th>
<th>Concentration (particles m⁻³)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>0.4010</td>
<td>0.02-0.04</td>
<td>0.2-1.0</td>
<td>Santa Monica Bay, California (offshore); before/after storm conditions</td>
</tr>
<tr>
<td>Two</td>
<td>0.773</td>
<td>0.0022.4</td>
<td>0.518.5</td>
<td>Santa Monica Bay, California (nearshore); before/after storm conditions</td>
</tr>
</tbody>
</table>
Conclusion

• Designed and constructed a filtration system to test the pipeline water
• Tested and refined the NOAA lab procedure for NELHA
• Successfully determined microplastic concentrations for the pipelines and the surface waters
  • The pipelines have a very low concentration
  • The surface waters have a much higher concentration
Future Steps and Recommendations

• Determine a mass solids/ hydrogen peroxide solution ratio
• Use a different catalyst such as activated carbon
• Use a different density separation solution to capture heavier microplastics
• Use several solutions of different density to characterize plastic types
• Do a longer term study to determine concentration trends over time
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