Microplastic Contamination of Texas Waters and Potential Impacts on Fish

COLLEEN PETERS
Microplastic

- Plastic ranging in size from 50 μm to 5 mm
- Two types:
  - 1. Primary microplastics: plastics manufactured at a microscopic scale (i.e. <5 mm) and used in products such as facial cleansers, boat cleaners, and as vectors for drugs
  - 2. Secondary microplastics: form from the prolonged mechanical, photolytic, or chemical degradation of primary macroplastics, resulting in fragmented pieces or fibers
Wildlife and Plastic

- Ingestion by sea birds first noted in 1960’s
- An estimated 1 million birds and 100,000 marine mammals die each year due to plastic
- Ingested plastics, such as bottles, six-pack rings, and large fragments have been consumed by wildlife
Plastic Hazards

- Obstruct feeding appendages
- Limit food intake
- Leach toxins
- Accumulate pollutants
Reports of Microplastic Ingestion

- Amphipods, Lugworms, Mussels, Crustaceans
- Fish
  - Marine studies:
    - Ingestion rates of 12% to 36%
  - Freshwater studies:
    - Ingestion rate of 12%
My Research

Goals:
- Determine whether or not sunfish are ingesting microplastics
- Examine effects of urbanization
- Investigate causation behind microplastic ingestion
Study Area

- Brazos River Basin
  - 3 major tributaries: Salt Fork, Double Mountain Fork, Clear Fork
  - Drainage area: 109,000km²
  - Fish from every major trophic guild
  - Species of conservation concern
- 14 geographic locations
  - Representing upstream, downstream, and urban areas (5)
Species

- Bluegill Sunfish (*Lepomis macrochirus*) and Longear Sunfish (*Lepomis megalotis*)
  - Reside within stream, ponds, and reservoirs
  - Omnivores
  - Utilize feeding methods such as suction feeding
Sample Collection

- March 2014 to July 2014
- 436 sunfish samples (318 bluegill, 118 longear)
- Captured using hook and line and cast net
- Size Class Variations
  - Fish separated into 3 length categories
  - $\leq 10$ cm (n=91),
  - 10.1 to 13.9 cm (n=203),
  - $\geq 14.0$ cm (n=142)

Baylor Marina
Laboratory Analysis

- Stomach removed
- 1000 µm, 243 µm, 118 µm, and 53 µm
- Resultant stomach contents were examined, separated, and categorized
  - Organic (e.g. biological)
  - Inorganic (e.g. anthropogenic)
    - Underwent further microscopic analysis
      - Number microplastics found within each stomach
      - Form of contaminate
      - Color of contaminate
      - Specific to thread form, determined to be intact for frayed
Results

- 436 fish analyzed
- Bluegill greater in mean length and weight (13.33cm and 54.24g) than longear (10.46cm and 28.13g)
- 196 fish stomachs (45% of the total) contained ingested microplastics
Microplastic Characteristics

- 349 anthropogenic items sampled
  - 4% macro-debris
  - 96% in the form of microplastic threads
  - 37% of microplastics displayed body fray
Overall Rates of Microplastic Ingestion

Figure 4. Frequency of ingested microplastics by sunfish sample at each site
Effect of the Urban Zone

Figure 5. Mean number of ingested microplastics per sunfish by size class and sample site distribution.

<table>
<thead>
<tr>
<th>Sunfish Size Class</th>
<th>Upstream-Urban</th>
<th>Downstream-Urban</th>
<th>Upstream-Downstream</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤10 cm</td>
<td>z=-1.76, p=0.078</td>
<td>Z=-1.37, p=0.170</td>
<td>z=-0.326, p=0.745</td>
</tr>
<tr>
<td>10.1 cm to 13.9</td>
<td>z=-4.69, p=0.000</td>
<td>z=-0.378, p=0.706</td>
<td>z=-2.08, p=0.037</td>
</tr>
<tr>
<td>≥14 cm</td>
<td>z=-3.95, p=0.000</td>
<td>No comparison</td>
<td>No comparison</td>
</tr>
</tbody>
</table>
Microplastic Characteristics and the Urban Zone

- Gray and blue most common microplastic colors (79.1%)
- Color distribution associated with sample site ($X^2=23.93$, $p=0.021$)
  - Urban sites had the greatest color diversity, followed by upstream and downstream sites
- Presence of fray was associated with urban locales ($p=0.044$)
- Microplastics from urban locales had the lowest percentage of body fray (33%) in comparison to upstream (41%) and downstream sites (51%)

Distribution of microplastic color compared to the total of all samples analyzed.
Cluster analysis of the sunfish ingested items. Data was clustered based on group average of ranked Whittakers Indices.

Pearson analyses using the Decorana Axes to correlate microplastic ingestion frequency versus location of sunfish ingested items within the water column.

<table>
<thead>
<tr>
<th>Number of Microplastics</th>
<th>Surface to Benthos</th>
<th>Land to Water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pearson Correlation</td>
<td>-0.081</td>
</tr>
<tr>
<td></td>
<td>Sig</td>
<td>0.095</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>425</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.775</td>
</tr>
<tr>
<td></td>
<td></td>
<td>425</td>
</tr>
</tbody>
</table>
Conclusions

- Sunfish ingest microplastics at significant levels
- Human development, in the form of major roads and urbanization, influence microplastic ingestion
- Roadways act as vectors for non-point source pollution
- Consistent color and form suggests microplastics originate from similar source
- Microplastic ingestion occurs incidentally during normal feeding habits
Implications

- Further research needed to:
- Determine adverse effects of microplastic ingestion
- Residence time of microplastics within the stomach and gut
- Potential of food web transfer
- Better sampling methods need to be developed
- Sources need to be determined
2015 Study

- **Purpose:** Determine frequency of microplastic ingestion within marine species
- **Location:** Texas Coast
- **Species**
  - Pinfish
  - Croaker
  - Spadefish
  - Grunt
  - Sand Trout

<table>
<thead>
<tr>
<th>Species</th>
<th>Avg. Length (cm)</th>
<th>Max. Frequency per site</th>
<th>Overall mean frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunfish</td>
<td>12.6</td>
<td>75%</td>
<td>45%</td>
</tr>
<tr>
<td>Pinfish</td>
<td>14.9</td>
<td>77%</td>
<td>47%</td>
</tr>
<tr>
<td>Whiting</td>
<td>20.2</td>
<td>34%</td>
<td>34%</td>
</tr>
<tr>
<td>Croaker</td>
<td>17.7</td>
<td>83%</td>
<td>46%</td>
</tr>
<tr>
<td>Spadefish</td>
<td>13.3</td>
<td>59%</td>
<td>53%</td>
</tr>
<tr>
<td>Trout</td>
<td>21.3</td>
<td>72%</td>
<td>52%</td>
</tr>
<tr>
<td>Grunt</td>
<td>17.1</td>
<td>67%</td>
<td>26%</td>
</tr>
</tbody>
</table>
Acknowledgements

- Baylor University
- Environmental Science Department
- Susan Bratton
- University Research Committee
- C. Gus Glasscock Endowed Fund