Effects of Tributaries in the Transport of Microplastics in the Hudson Valley Watershed

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Microplastics

- Entering our waterway through a number of ways
  - Personal Care products
  - Fragmentation
  - Laundry
- Do not break down in the water
- Chemical additives such as antioxidants, processing chemicals, colorants and pigments and absorb hydrophobic contaminants from the surroundings

- 2 Sub-categories
  - Microbeads
  - Microfibers
Research Goal

- Study and evaluate the contribution that tributaries play in the transport of microplastics into the Hudson River
  - Studies have already been done showing microplastics in major rivers
    - Rhine River - One of Europe’s largest rivers\(^1\) (Thomas Mani)
      - 892,777 particles km\(^{-2}\) on average\(^1\)
  - How are these microplastics entering the waterways?
  - What characteristics of the waterways and surrounding communities affect microplastic content?
  - It's hypothesized that a large amount of the microplastics will enter through tributaries with low water quality or positioned in a highly populated area

Stream Drift Net

- Stainless steel frame
- 45 cm wide by 25 cm in height
- 100 cm in length
- 333μm net
- 2 piece PVC detachable cod ends with 333 μm mesh
- Free flushing design for quantitative analysis
Tributaries

- Fallkill Creek, Capserkill Creek, Rondout Creek, Fishkill Creek
- All tributaries drain into the Hudson River
- Tributaries were chosen because of varying location and varying characteristics
  - Surrounding community
  - DEC reported water quality
  - Usage: swimming, fishing, tubing, etc.
  - State Pollutant Discharge Elimination System sites upstream
Material was sieved through a stacked arrangement of different sized sieves, rinsing with DI water periodically
- 5.0mm and larger sizing did not go through the rest of the analysis
- Separated samples were dried for 24 hours, cooled, then dried again for 1-2 hours
- After drying and cooling the mass of the samples were recorded prior to analysis (weight of total microdebris)
Transfer of all the dried, solid material to a 500ml beaker

Addition of 20ml of aqueous 0.05M Fe(II) and 20ml of 30% hydrogen peroxide

- Mixture was incubated for 5 minutes on the lab bench
- Stirring rod and watch-glass was added and mixture was heated to 75°C
- Heating process was to be repeated until no organic material is visible in the beaker
Microplastics Content in Different Tributaries

- Each sample was weighed and separated into three smaller samples prior to Wet Peroxide Oxidation (WPO).
- After WPO (all naturally occurring material should have been destroyed) samples were viewed under a microscope and plastic was separated.
- After all plastic in the sample was visually found the plastic from the sample was weighed.
- The weight of the found plastic was divided by the weight of the microdebris (any debris that was smaller than 5mm) and multiplied by 100 to get what percent of each sample was plastic.
Infrared Spectroscopy

- Nicolett iS5 - iD7 ATR (Thermo Scientific)
- Used to confirm the structural make-up of any material unidentifiable by visual analysis
  - Provides a percent match of the unknown to known stored in a library
- Acceptable match level was set at 70% and up
  - Chosen because of degradation occurring during Wet Peroxide Oxidation and other aspects that could change the structural make-up
Infrared Spectroscopy

- Types of plastics found included the following:
  - Polyethylene - most common plastic, bags, bottles, films
  - Poly(methyl methacrylate) - shatter resistant alternative to glass
  - Poly(propylene), atactic - ropes, carpets, reusable containers
  - Poly(phthalamide) - automotive and electrical use
  - Nylon - fibers, flooring, films
  - Poly(vinylidene fluoride) - sheets, filiming, tubes, plates
  - Poly(ethylacrylate:st:acrylamide) - used as a soil conditioner
  - Poly(vinyl chloride) - PVC, pipes
Infrared Spectroscopy
Percent Microplastic

Fallkill Creek Microdebris
- Plastic: 19%
- Debris: 81%

Fishkill Creek Microdebris
- Plastic: 13%
- Debris: 87%

Casperkill Creek Microdebris
- Plastic: 5%
- Debris: 95%

Rondout Creek Microdebris
- Plastic: 7%
- Debris: 93%

Plastic in all sample!
Highest: 20.58%
Lowest: 3.76%
Statistical Analysis

- Results from each sample were run through statistical analysis to compare the four tributaries and the three samples
- IBM SPSS Statistics version 23
- Means were compared using a one-way analysis of variances (ANOVA)
- Determined at a $p \leq 0.05$ probability level using multiple comparison test; Student-Newman-Keuls (SNK)
Percent Microplastic

<table>
<thead>
<tr>
<th>Location</th>
<th>Average % Microplastic</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fallkill</td>
<td>18.92%</td>
<td>6.747</td>
</tr>
<tr>
<td>Casperkill</td>
<td>4.82%</td>
<td>2.618</td>
</tr>
<tr>
<td>Fishkill</td>
<td>13.34%</td>
<td>8.185</td>
</tr>
<tr>
<td>Rondout</td>
<td>7.07%</td>
<td>4.447</td>
</tr>
</tbody>
</table>

![Graph showing the average % microplastic content for different locations with error bars indicating standard deviation.](chart.png)
Geographic Information Systems (GIS)

- Esri ArcGIS 10.4
- Used to examine aspects of the surrounding communities to the tributaries
  - Population density
  - Land use types
  - Number of hospitals and SPDES sites upstream sampling site
  - Roads in the surrounding 2000ft radius
<table>
<thead>
<tr>
<th>Name of Tributary</th>
<th>Land Use Type</th>
<th>Population Density of Surrounding Town (persons/mi²)</th>
<th>Visual Pollution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fallkill Creek</td>
<td>Commercial/Industrial</td>
<td>5743.50</td>
<td>High</td>
</tr>
<tr>
<td>Casperkill Creek</td>
<td>Residential</td>
<td>1385.76</td>
<td>Low</td>
</tr>
<tr>
<td>Rondout Creek</td>
<td>Commercial</td>
<td>293.10</td>
<td>Low</td>
</tr>
<tr>
<td>Fishkill Creek</td>
<td>Preserved/Commercial</td>
<td>689.79</td>
<td>Medium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name of Tributaries</th>
<th>^1Risks (2000ft Radius)</th>
<th>Number of Hospitals</th>
<th>Number of Malls</th>
<th>^2SPDES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fallkill Creek</td>
<td>141</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Casperkill Creek</td>
<td>84</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Fishkill Creek</td>
<td>41</td>
<td>0</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Rondout Creek</td>
<td>59</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
</tbody>
</table>
GIS for Fallkill and Casperkill Creeks

Fallkill Creek

Casperkill Creek

Microplastic Content (Total)
Total MP Density
- 6.36
- 7.07
- 13.34
- 18.86

Hudson River Estuary

MP Collection Sites
Discharge affecting Casperkill
Malls

Microplastic Content (Total)
Total MP Density
- 6.36
- 7.07
- 13.34
- 18.86

Hudson River Estuary
GIS for Fishkill and Rondout Creek

Fishkill Creek

- Treated Water to Fishkill
- Treated Water to Fishkill
- MP Collection Sites
- Treated Water to Casperkill
- Malia

Microplastic Content (Total)
Total MP Density
- 5.36
- 7.07
- 13.34
- 18.86
- Hudson River Estuary

Rondout Creek

- Treated Water to Rondout
- MP Collection Sites
- Hospitals
- Malia

Microplastic Content (Total)
Total MP Density
- 5.36
- 7.07
- 13.34
- 18.86
- UlsterCoRoads2000ftbuf
- DutchessCoRoads2000ftbuf
- Hudson River Estuary
Conclusions

- Based on GIS we would expect Fallkill Creek to have the highest microplastic content
  - Study show Fallkill Creek is the highest
- Based on the same aspect we would expect Rondout or Casperkill to have the lowest microplastic content
  - Study shows Casperkill is the lowest, Rondout is the second lowest
Microplastics exist in all tributaries, found in all samples taken on various dates and times.

Water quality, location, pollution and surrounding community aspects are likely to effect the amount of microplastics in each tributary.

The type of plastic varies depending upon the tributary sampled.

In all tributaries the most abundant category of microplastics was fibers, the least abundant was microbeads and fragments fell in between the two.

Immediate attention needs to be given to the tributaries and surrounding communities as they are playing a significant role in transport of microplastics through watersheds and to major rivers.
Future Research

- Further studies of more tributaries running into the Hudson and there community aspects
  - Environmental Injustice
- Toxicological affects of microplastics and their effects on a native aquatic species
  - Histology based
A special thanks to everyone whose helped me over the course of the project!

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