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The Mashpee River: Water Quality Index & Macroinvertebrates

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THE MASHPEE RIVER
Water Quality Index & Macroinvertebrates

MASHPEE HIGH SCHOOL
Environmental Science
The Mashpee River is a short tidal river which flows south five miles before draining into Popponesset Bay on the Nantucket Sound.
<table>
<thead>
<tr>
<th><strong>MASHPEE &amp; WAKEBY PONDS</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AREA</strong></td>
<td>729 ACRES</td>
</tr>
<tr>
<td><strong>MAX DEPTH</strong></td>
<td>87 FEET</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>MASHPEE RIVER</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LENGTH</strong></td>
<td>5 MILES</td>
</tr>
<tr>
<td><strong>STREAM FLOW</strong></td>
<td>11 CUBIC FEET/SECOND</td>
</tr>
</tbody>
</table>
Though oxygen is not very soluble in water, what little gets into solution is vital to aquatic life, making it a consistent tool in determining water quality. Most oxygen in rivers, lakes, and oceans gets there by contact with the atmosphere or by photosynthetic plants. If the DO levels are too low, fish can drown. A low DO level is a sign of pollution.

As dissolved oxygen levels in water drop below 5.0 mg/L, aquatic life is put under stress. Oxygen levels that remain below 2 mg/l for a few hours can result in large fish kills.

**MASHPEE RIVER**

**SITE 1 (HEADWATER)**

| D.O. | 11.6 mg/L |

**SITE 2 (CONSERVATION AREA)**

| D.O. | 9.75 mg/L |
pH

- pH is the measure of the acidity or alkalinity of a solution
- The pH scale measures how acidic or basic a substance is
- Ranges from 0 to 14
- pH of 7 is neutral
- pH less than 7 is acidic
- pH greater than 7 is basic
- Most fish can tolerate pH values of about 5 to 9
- In a lake or pond: water’s pH is effected by its age and the chemicals discharged by communities and industries.
- Most lakes are basic (alkaline) when they are first formed and become more acidic with time due to the build-up of organic materials.
Mashpee River pH

- 1\textsuperscript{st} Test: Headwaters March 13 6.2 pH
- 2\textsuperscript{nd} Test: Conservation Area March 24 6.7 pH
pH pictures!
Temperature Change

• Water temperature controls the rate of metabolic activities and reproductive activities, which speed up life cycles. Most aquatic organisms are cold-blooded; they cannot regulate their own body temperature, so their bodies are vulnerable to seemingly insignificant changes in temperature. The optimal temperature ranges for most aquatic life fall between 5°C and 25°C.

Headwaters: 11.5°C
Conservation Area: 9.5°C
Temperature Change: -2°C

Our water temperature dropped, so there was no thermal pollution.
5 Day Biological Oxygen Demand

- The amount of oxygen used by microorganisms that oxidize organic matter.
- Gives an approximation of the level of biodegradable waste in the water.
- Water with high BOD usually contains high levels of bacteria.

Mashpee River
Headwater – 6.7 mg/L
Conservation Area – 4.2 mg/L

Water Quality
1 - 2 Very Good: There will not be much organic waste present in the water supply.
3 - 5 Fair/Moderately Clean
6 - 9 Poor/ Somewhat Polluted: indicates organic matter/bacteria are present.
100 or greater Very Poor/ Very Polluted: Contains organic waste.
Nitrates In Action
Nitrates

• Nitrates are crucial in aquatic environments for synthesis of amino acids and proteins
• Nitrates can enter waterways from point source solutions such municipal and industrial wastewaters, septic tanks, and feed lot discharges.
• Nitrates can also come from farm-site fertilizer and animal wastes, lawn fertilizer, leachate from disposal in dumps or sanitary landfills, or atmospheric fallout.
• There are several methods to measure nitrate levels. One method is a test kit to determine the nitrate concentration or use an electronic sensor
Nitrates as a Problem

• Nitrates only become toxic only under conditions where they are reduced into nitrites. Nitrites are harmful to humans and fish.
• Nitrates can cause eutrophication, a high level of nutrients.
• Nitrate pollution affects groundwater and surface water.
• Nitrates are the primary cause of dead zones in the Gulf of Mexico, the Chesapeake Bay, and Long Island Sound.
Our Nitrates Results

- 0 to 1 mg/L as Good,
- From 1 to 10 mg/L as Fair
- Over 10 mg/L as Poor.

- Total for Headwater Sample: 1.7 mg/L
- Total for Conservation Sample: 1.7 mg/L
Phosphates

• Phosphates are another essential nutrient for aquatic plants, but only in very low concentrations.

• Excessive amounts of phosphorus build up easily, and small amounts can contaminate large volumes of water.

• Total phosphorus concentrations in excess of 100 µg/L P may interfere with coagulation in water treatment plants.
Phosphates Continued

• Phosphorus gets into water from many sources, such as fertilizer, sewage and detergents.

\[
\begin{align*}
\text{Downstream} & \quad 0.3 \text{ mg/L} \\
\text{Upstream} & \quad 0.3 \text{ mg/L}
\end{align*}
\]
Phosphate Fun!

Temperature: 95°C

Group

Phosphates

D.O. = 9.75 mg/L

pH a. 6.7

Nitrate

Group a. 1.8 mg/L

b. 1.0 mg/L

c.

Group a. b. c.

b. c. by BOD.
Turbidity

- Turbidity is the measure of how particles scatter light as it passes through the water, affecting the clarity. The higher the turbidity the murkier the water.
- Turbidity is caused by soil particles that can enter the water through natural or human induced erosion of the river and surrounding land.
- Also turbidity can cause higher water temperatures that reduce the concentration of dissolved oxygen, basically the turbidity reduces light penetrating the water which decreases photosynthesis.
- High Turbidity can clog fish gills, lower growth rates, reduce resistance to disease, effect egg and larva development and can fill in nesting sites.
Turbidity (continued)

- Turbidity can be a useful indicator of the effects of runoff from construction, agriculture, logging, and industrial discharges.
- The turbidity for drinking water should be no higher the 5 NTU, but ideally below 1 NTU.
- Since it is not healthy for fish to live in high turbidity water, anything above or at 50 NTU is at risk.
- For the Mashpee river the Turbidity measured at 7.6 NTU in our first sample taken from the headwaters. The Turbidity was at 6.7 NTU at the second site. Though both site had good turbidity the second site, conservation area, had better.

  NTU = Scale from 0-1000
  (0 being the best, 1000 being the worst)
What is the Water Quality Index?

- A water quality index provides a single number that expresses overall water quality at a certain location and time based on several water quality parameters.
- The objective of an index is to turn complex water quality data into information that is understandable and useable by the public.
- This type of index is similar to the index developed for air quality that shows if it’s a red or blue air quality day.
Factors in Water Quality

- Dissolved Oxygen
- pH
- Temperature Change
- Fecal Coliform
- Biological Oxygen Demand
- Nitrate
- Total Phosphates
- Total Dissolved Solids
- Total Suspended Solids
<table>
<thead>
<tr>
<th>Test</th>
<th>Test Results</th>
<th>Q-Value</th>
<th>Q-Value</th>
<th>Weight Factor</th>
<th>Total</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissolved Oxygen</td>
<td>% Saturation</td>
<td>93</td>
<td>93</td>
<td>0.17</td>
<td>15.81</td>
<td>15.81</td>
</tr>
<tr>
<td>pH</td>
<td>Units</td>
<td>60</td>
<td>80</td>
<td>0.11</td>
<td>6.6</td>
<td>8.8</td>
</tr>
<tr>
<td>Temperature Change</td>
<td>°C</td>
<td>90</td>
<td>-</td>
<td>0.1</td>
<td>0.9</td>
<td>-</td>
</tr>
<tr>
<td>Biological Oxygen Demand</td>
<td>mg/L</td>
<td>45</td>
<td>60</td>
<td>0.11</td>
<td>4.95</td>
<td>6.6</td>
</tr>
<tr>
<td>Nitrate</td>
<td>mg/L</td>
<td>97</td>
<td>97</td>
<td>0.1</td>
<td>9.7</td>
<td>9.7</td>
</tr>
<tr>
<td>Total Phosphates</td>
<td>mg/L</td>
<td>85</td>
<td>85</td>
<td>0.1</td>
<td>8.5</td>
<td>8.5</td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>feet or NTU's</td>
<td>95</td>
<td>84</td>
<td>0.08</td>
<td>7.6</td>
<td>6.7</td>
</tr>
</tbody>
</table>

Q-Values represent conversions of raw data that are reported in a variety of units and then are converted on the same scale of measurement.
## Water Quality Rating

<table>
<thead>
<tr>
<th>WQI Value</th>
<th>Water Quality Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>91-100</td>
<td>Excellent Water</td>
</tr>
<tr>
<td>71-90</td>
<td>Good Water</td>
</tr>
<tr>
<td>51-70</td>
<td>Average Water</td>
</tr>
<tr>
<td>26-50</td>
<td>Fair Water</td>
</tr>
<tr>
<td>0-25</td>
<td>Poor Water</td>
</tr>
</tbody>
</table>

- **70.21 First Water Quality Rating - Headwaters**: 91-100, Excellent Water
- **83.75 Second Water Quality Rating - Conservation Area**: 71-90, Good Water
- Headwaters have an “Average” water quality, while the Conservation Area has a “Good” water quality.
Phosphates: 0.7

pH:
- a. 6.7
- b. 6.4
- c. 6.7

5 day BOD: start 3/25 7.8

Turbidity:
Freshwater Invertebrates

What are invertebrates?

-- Invertebrates are all of the animals that do not have an internal skeleton of cartilage or bone. There is a vast array of invertebrates, many of which can only be seen under a microscope with very high magnification.

Why study freshwater invertebrates?

-- A very compelling reason for studying freshwater invertebrates is that they are important. Invertebrates account for 70% of all known species of living organisms—microbes, plants, and animals. They play important roles in the community and ecosystems. Their best known role is serving as food for other organisms, especially fish, amphibians, and water birds.
Represents information about macroinvertebrates tolerance levels to pollution in different locations of the river.
Mayflies - Ephemeroptera
Stoneflies - Plecoptera
Caddisflies - Tricoptera

These macroinvertebrates are particularly sensitive to pollution, and you are better off having a high amount of these organisms than a low amount.
Both pie charts show that there are more intolerant families than tolerant families to water pollution.

This high level of animals that are intolerant to pollution is particularly striking at the downstream site where 85% of macroinvertebrates found were families that do not do well with any pollution.
Things We Learned From Macroinvertebrates

- The EPT richness shows us that the water quality is good. 11 families are represented, which is in the healthy range.

- The Family Biotic Index for the river overall is very good. The low numbers tell us that there is little pollution, especially at the downstream site.

- There is a better ratio of tolerant to intolerant families downstream than upstream. The presence of intolerant species tells us that the water quality is exceptional in order for them to survive.
Conclusions

• In consideration of the Water Quality Index and the structure of the Macroinvertebrate Community:
  – the water quality within the Mashpee River is good and appears safe for all the organisms to live…for now.

• Thanks to all those that helped and for this opportunity to share our findings.