<table>
<thead>
<tr>
<th><strong>Introduction</strong></th>
<th>Causes and effects are very important to science. In this lesson, students will examine the causes and effects of natural acts and human activity on the environment. This lesson is a suggested follow-up to the River as a Classroom program.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level</strong></td>
<td>Grades 5-8</td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td>45 minutes</td>
</tr>
<tr>
<td><strong>Background Information</strong></td>
<td>Students should be familiar with basic water quality tests such as temperature, pH, dissolved oxygen, and turbidity, and what the test results indicate for the organisms that live in that water.</td>
</tr>
<tr>
<td><strong>Anticipated Student Preconceptions/ Misconceptions</strong></td>
<td>Many students might not realize that the different parameters we measure during the water quality tests are interrelated, and have an effect on one another.</td>
</tr>
</tbody>
</table>
| **Vocabulary** | **Erosion** is the act in which earth is worn away, often by water, wind, or ice (glaciers). The process of erosion moves bits of rock or soil from one place to another. Moving water is the major agent of erosion.*  
**Sediment** is solid material that is moved and deposited in a new location. Sediment can consist of rocks and minerals, as well as the remains of plants and animals. It can be as small as a grain of sand or as large as a boulder. Sediment moves from one place to another through the process of erosion.*  
**Temperature** is the degree of hotness or coldness of an object. The temperature of an object, usually measured in degrees-Fahrenheit or degrees-Celsius, tells us how much heat, or energy, the object has.*  
**Dissolved Oxygen** Although water [H2O] molecules contain an oxygen atom this oxygen is not what is needed by aquatic organisms living in natural waters. A small amount of oxygen, up to about ten molecules of oxygen per million of water, is actually dissolved in water. Oxygen enters a stream mainly from the atmosphere and, in areas where groundwater discharge into streams is a large portion of streamflow, from groundwater discharge. This dissolved oxygen is breathed by fish and zooplankton and is needed by them to survive. Rapidly moving water, such as in a mountain stream or large river, tends to contain a lot of dissolved oxygen, whereas stagnant water contains less. Cold water can hold more dissolved oxygen than warm water. In winter and early spring, when the water temperature is low, the dissolved-oxygen concentration is high. In summer and fall, when the water temperature is high, the dissolved-oxygen concentration is low.^  
**pH** is a measure of how acidic or basic water is. The range goes from 0 - 14, with 7 being neutral. pH of less than 7 indicates acidity, whereas a pH of greater than 7 indicates a base. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water.^ |

^ Tsongas Industrial History Center, Lowell, MA. 2016
**Turbidity** is the measure of relative clarity of a liquid. It is an optical characteristic of water and is an expression of the amount of light that is scattered by material in the water when a light is shined through the water sample. The higher the intensity of scattered light, the higher the turbidity. Material that causes water to be turbid includes clay, silt, finely divided inorganic and organic matter, algae, soluble colored organic compounds, and plankton and other microscopic organisms.\(^\text{1}\)

Definitions are courtesy of National Geographic Society\(^*\) and the United States Geological Service\(^\text{2}\).

<table>
<thead>
<tr>
<th>Frameworks</th>
<th>Massachusetts Science Frameworks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grade 5</strong></td>
<td>5-ESS3-1: Obtain and combine information about ways communities reduce the impact on the Earth’s resources and environment by changing an agricultural, industrial, or community practice or process. [Clarification Statement: Examples of changed practices or processes include treating sewage, reducing the amounts of materials used, capturing polluting emissions from factories or power plants, and preventing runoff from agricultural activities.]</td>
</tr>
<tr>
<td><strong>Grade 7</strong></td>
<td>MS-ESS3-4: Construct an argument supported by evidence that human activities and technologies can be engineered to mitigate the negative impact of increases in human population and per capita consumption of natural resources on the environment. [Clarification Statement: Arguments should be based on examining historical data such as population graphs, natural resource distribution maps, and water quality studies over time. Examples of negative impacts can include changes to the amount and quality of natural resources such as water, mineral, and energy supplies.]</td>
</tr>
<tr>
<td><strong>New Hampshire Science Frameworks</strong></td>
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<tr>
<td><strong>Grade 5-6</strong></td>
<td>S:ESS1:6:5.1 Recognize that things change in steady, repetitive, or irregular ways, or sometimes in more than one-way at the same time</td>
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<tr>
<td></td>
<td>S:ESS1:6:7.2 Explain that water quality has a direct effect on Earth’s life forms.</td>
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</table>
### Materials Needed

For each pair of students:
1. One *Student Event Sheet*
2. One *Student Statement Sheet*
3. Glue stick
4. Pair of Scissors

### Preparation

Photocopy *Student Event Sheet* and *Student Statement Sheet*. Gather materials.

### Guiding Question

Why would a scientist want to know the cause of an observed condition in a body of water and what possible effects that cause might have on a water’s quality?

### Objective

Students will be able to:
- Discuss the causes and effects of natural events and human-caused activity on the ecosystem.
- Articulate the importance of observed conditions to a river’s water quality.

### Activity

1. Review the field trip data sheets with students. Discuss the meaning behind the results.
2. The teacher should demonstrate creating one if-then statement as an example. Students work in pairs to cut out events from *Student Events Sheet* and discuss which causes can be paired with which effects. There are multiple copies of the same phrases, as all phrases are reusable.
3. Students complete activity by gluing correct statements onto *Student Statement Sheet*.
4. To conclude the activity, ask students to share their if/then statements from their sheet. Refer back to the Guiding Questions for discussion.

### Assessment

Using the answer key, 8-12 correct answers is an excellent grasp of the content; 4-7 is a fair grasp of the content; and 0-3 is a poor grasp of the content.

### Adapting the Activity for Other Grades

For younger students: Help the students sort out the positive, neutral, and negative causes and effects before they begin to glue them into statements.
For advanced students: Challenge students to brainstorm the events themselves, rather than distributing the *Student Events Sheet*. 
<table>
<thead>
<tr>
<th>Positive Events</th>
<th>(Often) Neutral Events</th>
<th>Negative Events</th>
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</tr>
</thead>
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<td>Dissolved oxygen increases</td>
<td>land is steeply sloped</td>
<td>Humans build a dam</td>
<td>humans clear land of plants</td>
<td>sewage is dumped</td>
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<td>Dissolved oxygen increases</td>
<td>sediment is carried</td>
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<td>humans clear land of plants</td>
<td>sewage is dumped</td>
</tr>
<tr>
<td>Dissolved oxygen increases</td>
<td>sediment is carried</td>
<td>acid rain falls</td>
<td>humans clear land of plants</td>
<td>temperature increases</td>
</tr>
<tr>
<td>Dissolved oxygen increases</td>
<td>sediment is carried</td>
<td>algae overgrow</td>
<td>land is paved over</td>
<td>temperature increases</td>
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<tr>
<td>Dissolved oxygen increases</td>
<td>some sediment deposits</td>
<td>algae overgrow</td>
<td>land is paved over</td>
<td>temperature increases</td>
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<tr>
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<td>Dissolved oxygen increases</td>
<td>water moves swiftly</td>
<td>bacteria overgrow</td>
<td>pH decreases (acidity increases)</td>
<td>turbidity increases</td>
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<td>water slows down</td>
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<td>power plants give off sulfur/nitrogen compounds</td>
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<td>Dissolved oxygen increases</td>
<td>water tumbles over rapids</td>
<td>fish reproduction suffers</td>
<td>sediment washes into rivers</td>
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<td>Hurricane-force rain</td>
<td>fish/invertebrates can’t breathe well</td>
<td>sewage is dumped</td>
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<tr>
<td>Dissolved oxygen increases</td>
<td>Snow storm</td>
<td>fish/invertebrates can’t breathe well</td>
<td>sewage is dumped</td>
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</tbody>
</table>
1. Create six IF/Then Statements – three positive and three negative

<table>
<thead>
<tr>
<th>IF</th>
<th>THEN</th>
<th>Positive or Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: Dissolved Oxygen decreases</td>
<td>Fish die.</td>
<td>Negative</td>
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2. Choose one of the negative statements above and write about the impact of the “then” statement. What are the ramifications of that effect? What can be done to prevent it?
If/Then Answer Key

IF water moves swiftly THEN sediment is carried
IF water slows down THEN Dissolved Oxygen increases
IF water slows down THEN some sediment deposits
IF sediment washes into rivers THEN turbidity increases
IF runoff increases THEN fertilizers enter rivers
IF pH decreases (acidity increases) THEN fish reproduction suffers
IF temperature decreases THEN Dissolved Oxygen increases
IF sewage is dumped THEN bacteria overgrow
IF temperature increases THEN Dissolved Oxygen decreases
IF plant life dies THEN Dissolved Oxygen decreases
IF fertilizers enter rivers THEN algae overgrow
IF DO decreases THEN fish/invertebrates can’t breathe well
IF power plants give off sulfur/nitrogen compounds THEN pH decreases (acidity increases) (through acid rain)
IF humans clear land THEN sediment washes into rivers
IF humans clear land THEN runoff increases
IF land is paved over THEN runoff increases
IF a dam is built THEN water slows down
IF water moves swiftly THEN Dissolved Oxygen increases
IF turbidity increases THEN temperature increases
IF turbidity increases THEN plant life dies
IF algae overgrow THEN bacteria overgrow
IF plant life dies THEN runoff increases
IF bacteria overgrow THEN Dissolved Oxygen decreases
IF Dissolved Oxygen increases THEN fish thrive
IF runoff increases THEN sediment washes into rivers
IF temperature decreases, THEN Dissolved Oxygen increases (maybe)
IF temperature decreases, THEN fish thrive
IF turbidity decreases, THEN fish thrive
IF turbidity increases, THEN fish reproduction suffers (smothers eggs)
IF turbidity increases, THEN fish/invertebrates can’t breathe well (coats gills)
IF turbidity increases, THEN temperature increases (absorbs heat)
IF turbidity increases, THEN plant life dies (less photosynthesis)
IF water moves swiftly, THEN Dissolved Oxygen increases (more churning)
IF water moves swiftly, THEN sediment is carried
IF water slows down, THEN Dissolved Oxygen decreases
IF water slows down, THEN some sediment deposits
IF water slows down, THEN sediment is carried