

## If/Then

Introduction	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.
Level	Grades 5-8
Time	45 minutes
Background Information	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.
Anticipated Student Preconceptions/ Misconceptions	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.
Vocabulary	<p><b>Erosion</b> 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.*</p> <p><b>Sediment</b> 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.*</p> <p><b>Temperature</b> 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.*</p> <p><b>Dissolved Oxygen</b> Although water [H<sub>2</sub>O] 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.^</p> <p><b>pH</b> 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.^</p>

**If/Then**

	<p><b>Turbidity</b> 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.<sup>^</sup></p> <p>Definitions are courtesy of National Geographic Society* and the United States Geological Service<sup>^</sup>.</p>
Frameworks	<p><b>Massachusetts Science Frameworks</b></p> <p><b>Grade 5</b></p> <p><b>5-ESS3-1:</b> 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.]</p> <p><b>Grade 7</b></p> <p><b>MS-ESS3-4:</b> 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.]</p> <p><b>MS-LS2-4.</b> Analyze data to provide evidence that disruptions (natural or human-made) to any physical or biological component of an ecosystem can lead to shifts in all its populations. [Clarification Statement: Focus should be on ecosystems characteristics varying over time, including disruptions such as hurricanes, floods, wildfires, oil spills, and construction.]</p> <p><b>MS-LS2-5.</b> Evaluate competing design solutions for protecting an ecosystem. Discuss benefits and limitations of each design.* [Clarification Statement: Examples of design solutions could include water, land, and species protection, and the prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]</p> <p><b>New Hampshire Science Frameworks</b></p> <p><b>Grade 5- 6:</b></p> <p><b>S:ESS1:6:5.1</b> Recognize that things change in steady, repetitive, or irregular ways, or sometimes in more than one-way at the same time</p> <p><b>S:ESS1:6:7.2</b> Explain that water quality has a direct effect on Earth's life forms.</p>

**If/Then**

Materials Needed	For each pair of students: 1. One <i>Student Event Sheet</i> 2. One <i>Student Statement Sheet</i> 3. Glue stick 4. Pair of Scissors
Preparation	Photocopy <i>Student Event Sheet</i> and <i>Student Statement Sheet</i> . 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: <ul style="list-style-type: none"><li>• Discuss the causes and effects of natural events and human-caused activity on the ecosystem.</li><li>• Articulate the importance of observed conditions to a river's water quality.</li></ul>
Activity	<ol style="list-style-type: none"><li>1. Review the field trip data sheets with students. Discuss the meaning behind the results.</li><li>2. The teacher should demonstrate creating one if-then statement as an example. Students work in pairs to cut out events from <i>Student Events Sheet</i> and discuss which causes can be paired with which effects. There are multiple copies of the same phrases, as all phrases are reusable.</li><li>3. Students complete activity by gluing correct statements onto <i>Student Statement Sheet</i>.</li><li>4. To conclude the activity, ask students to share their if/then statements from their sheet. Refer back to the Guiding Questions for discussion.</li></ol>
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 <i>Student Events Sheet</i> .

Positive Events	(Often) Neutral Events	Negative Events	Negative Events	Negative Events
Dissolved oxygen increases	land is steeply sloped sediment is carried	Humans build a dam Humans build a dam acid rain falls algae overgrow algae overgrow algae overgrow	humans clear land of plants humans clear land of plants humans clear land of plants land is paved over land is paved over land is paved over	sewage is dumped sewage is dumped temperature increases temperature increases turbidity increases turbidity increases
Dissolved oxygen increases	sediment is carried			
Dissolved oxygen increases	sediment is carried			
fish thrive	some sediment deposits			
fish thrive	some sediment deposits			
fish thrive	some sediment deposits			
pH is near neutral	water moves swiftly	bacteria overgrow bacteria overgrow bacteria overgrow	pH decreases (acidity increases) pH decreases (acidity increases) pH decreases (acidity increases)	turbidity increases aquatic plant life dies aquatic plant life dies
plants thrive	water moves swiftly	Dissolved oxygen decreases	power plants give off sulfur/nitrogen compounds	aquatic plant life dies
plants thrive	water moves swiftly	Dissolved oxygen decreases	power plants give off sulfur/nitrogen compounds	
plants thrive	water slows down	fertilizers enter rivers	runoff increases	
temperature decreases	water slows down	fertilizers enter rivers	runoff increases	
temperature decreases	water slows down	fertilizers enter rivers	runoff increases	
	water tumbles over rapids	fish reproduction suffers	sediment washes into rivers	
	Hurricane-force rain	fish reproduction suffers	sediment washes into rivers	
	Snow storm	fish/invertebrates can't breathe well	sediment washes into rivers	
		fish/invertebrates can't breathe well	sewage is dumped	
		fish/invertebrates can't breathe well		

## If/Then Student Statement Sheet

1. Create six If/Then Statements – three positive and three negative

IF	THEN	Positive or Negative
Example: Dissolved Oxygen decreases	Fish die.	Negative

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