Watershed Detectives

Summary

In this lesson, students will analyze water samples from different fictional watersheds. Students are given a description of each watershed, including their unique land uses, along with spiked water samples. Students test the water samples for turbidity, pH, and nitrates. Information about the temperature and dissolved oxygen levels are given. Students interpret the water quality data and land use clues to match the water samples to the watersheds. They also discuss approaches to improving or protecting water quality in different settings.

Materials

- Watershed sketches/clues
  6 plastic jugs (e.g. rinsed gallon milk bottles) for water samples
  Modeling clay or fine silt/soil
  Vinegar or lemon juice
  *Sodium nitrite (or fish tank water)
  *Turbidity tubes
  *pH strips
  *Nitrate kits
  Water Quality Sampling Data Sheet (pdf, word) 1 per student or group
- Utah's Requirements Sheet
  (1 per group)
- Turbidity Conversion Chart
  (1 per group)
  Pencils

* View the Utah State University Equipment Purchasing List

Background for Teachers

A watershed is an area of land from which all the water drains to the same location, such as the land that all drains to a stream, pond, lake, river, wetland or estuary. A watershed can be quite large, such as the Colorado River drainage basin, or very small, such as a small horse pasture that drains to a farm pond. Watersheds are "nested", with many small watersheds containing larger watersheds. Watersheds are comprised of upland areas, riparian areas (the strips of water loving vegetation near streams, lakes and other water bodies), and the streams, lakes and wetlands that collect and transport the water and anything carried by the water.
The natural conditions of a watershed, such as its elevation, annual precipitation and temperature, native geology and plant communities will all determine the quality of the water leaving that watershed. " Point sources" of pollution are discharges from industries or waste water treatment plants and may be significant in some areas. In many watersheds, however, streams and lakes are more affected by " nonpoint souce pollution" which enters primarily from rain and snowmelt runoff over the land surfaces. The amount and types of pollutants are determined by the land uses and activities in a watershed. Different types of land uses and activities, such as roads and urban development, mining, timber harvesting, recreation, and agricultural activities, may result in quite different mixes and amounts of pollutants. Nonpoint source pollution is associated with rainfall and snowmelt runoff moving over and through the ground, carrying natural and human made pollutants into water sources. Examples of nonpoint source pollutants are fertilizers, pesticides, sediment, gas, and oil. Pollutants such as nutrients, pesticides, oil and gas products, salts, sediment and bacteria can drastically alter the state of the stream or lake's ecosystem. If we can determine the type of

pollutant and its source, we can take preventative measures to reduce any further contamination. Students will make the following measurements on each water sample:

Turbidity is a measure of suspended material (such as sediment or microorganisms) in the water. Suspended sediment eventually settles out in a stream and fills in the spaces between the rocks and gravel on a stream bottom. This can suffocate the tiny aquatic animals living between the rocks or the fish eggs laid on stream bottoms. Turbidity can also prevent sunlight from reaching aquatic plants and may also affect the ability of fish and aquatic invertebrates to see and capture their prey. Turbidity increases naturally when flows increase, but also increases from uncontrolled runoff from agricultural fields, roads and trails or construction sites. Also, nutrients can increase turbidity. How to measure turbidity.

Nitrate (NO3) is the most common form of inorganic nitrogen in unpolluted waters. It is an essential nutrient for plant and animal growth. However, increased amounts of nitrate can lead to excessive plant growth which can decrease the aesthetic value of water bodies (by making it murky, smelly or creating a slimy bottom). The decomposition of this extra plant material also uses up oxygen in streams and lakes, resulting in fish kills. Sources of nitrate include fertilizers, animal waste and failing septic systems. How to measure nitrate.

pH a measurement of how acidic or basic something is. pH is measured on a scale from 0 to 14 with 7 being neutral. The lower numbers on the scale are more acidic, while the higher numbers are more basic. The pH scale is logarithmic, which means each unit change (e.g., from 7 to 8) in pH represents a 10-fold change in the acidity. How to measure pH.

Students will also be given information on other measurements that are more difficult to modify in a classroom setting. These include:

Dissolved Oxygen: This is not the bubbles in water, or the oxygen part of the H20 water molecule. It is a separate oxygen molecule that is dissolved into water. It gets into the water either by oxygen from the atmosphere mixing into a river where there is turbulence, or by aquatic plants realeasing oxygen during photosynthesis. Fish and aquatic macroinvertebrates require a certain level of dissolved oxygen in order to survive.

Temperature: The temperature of water is the amount of heat energy it contains. Temperature can be measured in Fahrenheit or Celsius. Since state requirements are usually in Celsius, that is the preferred scale for testing water samples.

Preparing Water Samples

These measurements are for 1 gallon water samples. Measurements are estimates and may vary due to differences in tap water.

Gold Creek

High Turbidity: Add a pinch of silt/soil or a small dash of modeling clay until the disc at the bottom of the turbidity tube can be seen between 25 and 30cm.

Low Nitrates: No addition needed.

Low pH: Add vinegar or lemon juice until pH reaches 4 - 5 (approximately 1T of vinegar).

Straight Shot Stream

High Turbidity: Add a pinch of silt/soil or a small dash of modeling clay until the disc at the bottom of the turbidity tube can be seen between 25 and 30cm

High Nitrates: Add sodium nitrate until the concentration is between 1.5 and 2mg/liter (approximately 20 grains).

Neutral pH: Add baking soda until pH is 7 (approximately 1/4T).

Red Ribbon River

High Turbidity: Add a pinch of silt/soil or a small dash of modeling clay until the disc at the bottom of the turbidity tube can be seen between 25 and 30cm.

High Nitrates: Add sodium nitrate until the concentration is about 5mg/liter (approximately 40 grains).

Neutral pH: Add baking soda until pH is 7 (approximately 1/4T).

Capital Creek
Medium Turbidity: Add slightly less than a pinch of silt/soil or a very small dash of modeling clay until the disc at the bottom of the turbidity tube can be seen between 35 and 40cm.
Low Nitrates: No addition needed.
Neutral pH: Add baking soda until pH is 7 (approximately 1/4T).
Off Road Dream Stream
High Turbidity: Add a pinch of silt/soil or a small dash of modeling clay until the disc at the bottom of the turbidity tube can be seen between 25 and 30cm.
Low Nitrates: No addition needed.
Neutral pH: No addition needed.
Mayfly River
Low Turbidity: No addition needed.
Low Nitrates: No addition needed.
Low-Neutral pH: Add vinegar or lemon juice until pH is between 6 and 6.5 (approximately 1/2T vinegar).

Instructional Procedures

Discuss with your students what a watershed is and the different types of land uses that can occur in a watershed. (Be sure you cover each land use shown in the watershed sketches). Explain to your students that each of these land uses impact the quality of the water in various ways and that during this lesson they will be learning about those impacts.
Show students the watershed sketches and talk about the land uses in each watershed. Have them speculate what type of impacts each use might have on the quality of the water.
Explain to your students how turbidity, nitrates, pH, dissolved oxygen and temperature are affected by different land uses and natural and human activities. As you go through each one, demonstrate how to do the measurement. Sampling instructions: turbidity, nitrates, and pH (dissolved oxygen and temperature are given).

a. Discuss natural and human activities that will raise or lower water temperature.
   Examples: Natural - elevation, riparian vegetation, and source. Human - loss of riparian vegetation, climate change, discharge from industrial and urban areas.
b. Discuss natural and human activities that will change turbidity.
   Examples: natural - geology (a good example is the difference between a stream in the Uintas (where the geology is primarily granite and other material that does not erode easily) and the Colorado River (where the geology is primarily sandstone and other material that does erode easily). Human - phytoplankton, agricultural runoff, runoff from construction areas, stormwater runoff.
c. Discuss the pH scale.
   Discuss natural and human activities that will alter pH. Examples: Natural -- geology, acid rain, pine forests. Human - mine drainage. Mention that most streams in Utah are basic (limestone, calcium carbonate in bedrock buffers acid snow melt).
d. Discuss natural and human activities that are a source of nitrates.
   Example: Human - fertilizers (agriculture, urban lawns and gardens), animal waste (livestock and pets).
   Discuss dissolved oxygen and the natural and human activities that influence the amount of dissolved oxygen. Discuss what will influence the amount of dissolved oxygen in a water body (temperature, turbulence, and salinity).

Show the students the water samples and explain that they will measure turbidity, pH and nitrates for each sample. Dissolved oxygen and temperature will be given to them. They will then use that information to determine which watershed each sample came from.

Divide the students into groups and give each group a water sample and the sampling equipment.
Have each group report their results and the watershed they think their samples came from. Write the results for all groups on a whiteboard. Discuss which watershed each sample came from and have the students tell you why. Discuss the land use activities that changed each chemical measurement (see Table 1). Have the students compare the parameters of each watershed with the Utah's Requirements Sheet. Review with the class each watershed, the land uses occurring there and reveal which samples came from which watershed. Also, see discussion questions for some leading questions to help guide discussions.

Extensions

Follow up STEM Activities:

- Use your data to create graphs and comparisons. You can view examples of some graphed data here.
- Have students learn about the " beneficial use designations" of streams. Discuss whether or not each water sample would meet each beneficial use.
- Compare your results with results collected from actual rivers and lakes.
  - Get outside and take water samples from a lake or stream near you.
  - Go to Utah Water Watch's online database to find results from Citizen Monitors
  - Other online databases are available at: Bear River Watershed Information System or iUtah's online database
  - Contact USU Water Quality Extension (waterquality@usu.edu or 435-797-2580435-797-2580) for help accessing other water quality data
- Research best management practices (BMP's) that could reduce pollution in each of the fictional watersheds.
- Have students interpret maps with water quality data. These maps were created by teachers involved in CMaP. Students could also monitor water quality data and use GPS to create their own maps.

Watershed Connections:

If you live in one of the following watersheds, click on the link to find sampling locations, sample data sets, and other information about that watershed.

- Bear River Watershed

Bibliography

This lesson plan is part of the Utah State University Extension's Stream Side Science program.

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