Turbidity and Sediment

Turbidity- an indication the presence of dirt and other particulate matter in water- is an important variable in the health of a stream. The biggest contributor to turbidity is erosion. High levels of turbidity negatively affect all living things in a stream.

For this activity the turbidity of stream water will be measured using a turbidity tube, also known as a transparency tube. This instrument is less expensive than an electronic turbidimeter. The variances that may occur with this instrument are discussed below.

Although the pre and post discussions are necessary to provide important information about each topic, it is the activity that is most vital to this unit. Be sure to allow plenty of time to complete the activity.

Pre-Activity Discussion (Answers can be found in the Background Information section below)

1) Look at the water in this stream. How would you describe it? Can you see the bottom? Is something affecting the clarity?
2) What is turbidity and how does it affect the quality of stream water? The plants and animals that live there?
3) What human activities might affect the turbidity of the water?

The Activity

Site Selection

Select a site from which water can be easily collected from the stream without stirring up the stream bottom. The site should be upstream from other activities such as benthic macroinvertebrates and stream speed that could stir up sediment and taint your sample. A bridge or culvert provides an ideal sampling location, but be careful about traffic. If sampling from the bank, pick a spot that is not obstructed by bushes and brush. Watch out for poison ivy, nettles, blackberries, etc. If sampling from within the stream, wear boots or waders to protect against sharp objects and face upstream when collecting water to avoid the mud that your feet will stir up.

Equipment

-A bucket with a weight on the lip. The weight is important. It will allow the bucket to tip easily and collect water. The bucket should be tied to a rope long enough to reach the water from a bridge or streamside collection site.
-Turbidity tube 120 cm in length and stand
-Funnel (to make it easier to pour water into the turbidity tube)
-Boots or waders (needed to protect against sharp objects)
-Data forms, pencils and clipboard
-Calculator
-Small table (convenient but not essential)
-Display board

Using the Turbidity Tube

With a turbidity tube one measures the length of a column of water at which one can first definitely see a black and white target at the bottom of the tube. This is a judgment call. It is good practice to set a standard for "definitely seeing the black and white target" to help reduce variances in the readings. This can be done with a practice round or during the first round of sampling by permitting all of the students to look through the same column of water at a target that can be considered definitely visible.

Procedure

1. Make sure that the tube and the black and white disk at the bottom of the tube are clean and that the tube is mounted on its stand in a vertical position. Close the white clamp on the small hose at the bottom of the tube. Work in a shady area if possible because direct sunlight interferes with the readings.

2. Collect the water sample in the weighted bucket from the main current, not an eddy or a pool. Carefully follow the instruction above under Site Selection to avoid tainting the sample with sediment stirred up from the bottom of the stream. NOTE: Some streams are quite clear offering little opportunity to discover how clarity can be affected by particulate matter. If this is the case, do some comparisons by sampling water in different areas of the stream or even downstream from other activities that might be in progress. Or pour a bucket of water on an exposed bank to simulate runoff and erosion and then take a sample from water affected by the runoff.

3. Vigorously shake or swirl the bucket so that the sediment is well mixed with the water. Quickly pour water from the bucket into the turbidity tube until it is filled to the top.

4. Open the white clamp on the hose so that the water is slowly draining out of the tube. Have one team member, the drainer, do this.

5. A second team member -the watcher- stands so that his body shades the tube from direct sunlight (if the tube is not in shade) and watches carefully- looking down from the top of the tube- as the water level in the tube falls. When the black and white disk at the bottom of the tube becomes definitely visible, the watcher calls out Stop! The drainer immediately stops the flow from the tube by tightly closing the white clamp on the hose tightly so there is no leaking.

6. Use the numbers on the tube to measure the length of the column of water to the nearest 0.2 centimeter (cm). For example, if the water level is at the third mark above 73, the length of the water column is 73.6 cm. **Note**: Students make a lot of mistakes reading this scale. Explain how it is read and **always** check their readings for errors. This length (73.6 cm in our example) is the transparency of the water: the greater the length, the clearer the water. Record the transparency on the Turbidity data sheet. Only then should you empty the turbidity tube.

Calculating Turbidity

1. Calculate the turbidity of the water using the following formula and record it on the data sheet. Remember, transparency is the length of the column of water in the tube.

$$\text{Turbidity} = \frac{100 \text{ cm/meter}}{\text{Transparency (cm)}}$$

The units of turbidity are "per meter", indicated as m^{-1}. In our example, the turbidity is equal to 100/73.6 = 1.36 m^{-1}.

2. Measure the transparency two more times and calculate the turbidities so you wind up with three values. Since the measurements that result from using a tube are, to a degree, subject to individual judgment, results might vary somewhat, perhaps ~ 5%. This is OK. Be sure and rotate tasks among the students to keep them all as involved as possible.

3. Calculate the average turbidity by adding the three turbidity values together and dividing by three. Record this on the data sheet.

Turbidity Scale

Turbidity	Water quality
< 1	Very good; water is quite clear
1-2	Pretty good
2-5	A bit muddy
5-10	Pretty muddy

Post-activity discussion questions:

1) How would you rate this water in terms of its turbidity? What do the measurements tell us about the health of this stream today?
2) What other things besides human activity could affect the measurements?
3) What can people do to reduce stream turbidity?

Background Information

A stream with high turbidity will have problems with sedimentation since the dirt will eventually settle out of the water and to the stream bottom. Sediment- ordinary mud- is THE biggest single water pollution problem we have in the U.S.

Sediment causes problems in many ways:

1) High sediment levels interfere with the operation of drinking and industrial water treatment plants, adding greatly to the cost of making the water fit for our use. The Huron River supplies approximately 85% of Ann Arbor's drinking water. When turbidity is high, the sand beds used

for filtering sediment out of the water must be cleaned much more frequently and the cost of treating the water goes up.
2. High sediment levels interfere with the survival of fish and other aquatic life by clogging their gills and preventing them from getting oxygen that is essential to life. High sediment levels also damage habitat for flora.
3. Predator fish and other aquatic organisms can't see to hunt in highly turbid water.
4. Sediment causes loss of habitat diversity. It fills the open spaces between the rocks and gravel in the stream bottom. These interstices are excellent habitat for small critters. They provide shelter from predators and protection from strong currents that might sweep them away. Gravel provides an excellent place for many fish to spawn. But these benefits are lost if the gravel is choked with mud. Fewer types of critters can survive in muddy streams than can survive in clear ones. As species disappear due to habitat loss the food web is disrupted.
5. Deposition of sediment in slow, quiet reaches of a stream raises the level of the streambed causing increased flooding.

Sediment levels as an indicator

1. High sediment levels often indicate stream bank sloughing erosion. Streamside property may be lost due to washing away.
2. High sediment levels may indicate the loss of valuable topsoil from farm fields in the watershed through erosion.

Some common sources of sediment:

1. Agricultural and lumbering practices leading to soil erosion from fields and forests
2. Over-grazing of pasturelands, an extremely serious problem in the western U.S
3. Exposure of bare soil to rains during building and road construction
4. Runoff from gravel roads during heavy rains
5. Damage and destruction of streamside vegetation buffer zones (riparian buffer zones). These buffer strips consist of trees, shrubs, grass, and other plants, and serve to filter sediment from surface runoff water before it gets to the stream. The roots, particularly woody roots, tend to armor the stream banks against erosion by the stream current.
6. Stream bank erosion caused by increased flash flooding as a result of a high percentage of impervious surfaces (concrete, asphalt, roofs, streets, parking lots, etc.) in the watershed. This causes a lot of the water from a storm to run directly and quickly into the stream rather than infiltrating into the ground and moving to the stream as groundwater much more slowly.

Reducing Turbidity

To reduce turbidity one must reduce erosion and runoff from surfaces that carry dirt into the waters of a watershed. Here are some ways to accomplish this: 1) Protect riparian zones: keep them well vegetated, planting trees and shrubs where needed; 2) Use retention ponds, diversions and rain barrels to prevent dirty runoff from parking lots, roads, rooftops, etc. from reaching streams and lakes; 3) Use farming practices that minimize runoff into streams and lakes; 4) Establish and enforce regulations for activities such as mining that cause runoff into lakes and streams.

For this and all other units, advanced level information is available if desired. Contact the HRWC and request an electronic version of the unabridged manual.

Turbidity Data Sheet

Turbidity indicates the amount of dirt in the water. Dirt, or sediment, hurts the river many ways. It makes it more expensive to clean our drinking water. It can coat the gills of small organisms. It can keep organisms from attaching to gravel or rocks, which may cause them to get swept away in fast water.

Transparency measurement	Turbidity Turbidity = 100 cm/meter / Transparency (cm)	Scale
1 _____cm 2 _____cm 3 _____cm	1 _____m^{-1} 2 _____m^{-1} 3 _____ m^{-1} _____m^{-1} Average turbidity (add the 3 measurements, divide the sum by 3)	A turbidity of 1.0 m^{-1} or less is quite good—very clear water. Between 1.0 and 2.0 is pretty good. From 2.0 to 5.0 is a bit muddy. From 5.0 to 10.0 is quite muddy. Greater than 10 means that the water is really bad.

1. How would you rate this water in terms of its turbidity?

2. What do the measurements tell us about the health of this stream today?

3. What conditions could cause the measurements to be different?

4. What are some results of high turbidity?

5. What can people do to reduce stream turbidity?

KEY Turbidity Data Sheet

1 How would you rate this water in terms of its turbidity?

Answers may vary

2 What do the measurements tell us about the health of this stream today?

Answers may vary

3. What conditions could cause the measurements to be different?

More or less water in the stream, construction upstream, recent storms, etc.

4. What are some results of high turbidity?

a. It interferes with the survival of fish and other aquatic life by clogging their gills and preventing them from getting oxygen that is essential to life.

b. Predator fish and other aquatic organisms can't see to hunt in highly turbid water.

c. Sediment causes loss of habitat diversity; it fills the open spaces between the rocks and gravel in the stream bottom. These interstices are excellent habitat for small critters; they provide shelter from predators and protection from strong currents that might sweep them away. Gravel provides an excellent place for many fish to spawn. But none of this can happen if the gravel is embedded--choked with mud. Imagine trying to live in your house if it were filled with mud to the ceiling! Fewer types of critters can survive in muddy streams than can survive in clear ones.

d. Deposition of sediment in slow, quiet reaches of a stream raises the level of the streambed, causing increased flooding.

e. High sediment levels interfere with the operation of drinking and industrial water treatment plants, adding greatly to the cost of making the water fit for our use.

f. High sediment levels often indicate stream bank sloughing erosion, resulting in damage to streamside property that is washed away.

g . High sediment levels may indicate the loss of valuable topsoil in the watershed through erosion.

5. What can people do to reduce stream turbidity?

Reduce run-off, put up construction barriers, don't cut streamside trees and shrubs, minimize bare soil, minimize impervious surfaces.

Turbidity Lesson Narrative

Intro. 5 – 8 minutes. The mission is to make these points: Turbidity tests the amount of dirt in the water. Dirt, or sediment, hurts the river many ways. It makes it more expensive to clean the drinking water. It can coat the gills of small organisms. It can keep organisms from attaching to gravel or rocks, which may cause them to get swept away in fast water. Sediments in the water can raise the temperature of the water. This can lower the amount of dissolved oxygen in the water.

1. 1. My name is _____ and I'm a volunteer with the Turbidity station. Please tell me your names. (Go around)
2. When you look at the river water, or the water in this stream, do you think it would be OK to drink it straight from the stream?
3. Why do you think that? What are you worried about? (Students may say it's yucky; there is bacteria or germs, it's dirty, there are chemicals or pollution in it, etc.)
4. Agree that they should not drink the water straight from the stream. You may want to note that in Ann Arbor, the drinking water comes from the Huron River, but it is cleaned up first.
5. Explain that the biggest source of pollution in the Huron River is dirt.

The Activity. 10 – 15 minutes. Explain the activity. Assign the roles. Run the test 3 times. If time permits, change a variable. Run the tests again.

6. Explain the activity, and that it is a way to get a sense of how much dirt is in the stream.
7. Assign the roles.
8. Run the test once. Record.
9. Repeat.
10. If time, gather water from a different part of the stream, or add a small amount of dirt or mud to your current sample. Repeat the tests.

The Wrap Up: 5 minutes. Gather the group back at the table/station. Discuss the key questions.

11. How would you rate this water in terms of its turbidity?
12. What do the measurements tell us about the health of this stream today?
13. What conditions could cause the measurements to be different?
14. Explain some results of high turbidity. (Higher water temperature, loss of species, higher expenses to clean the drinking water.)
15. Explain what people can do to reduce stream turbidity. (Limit erosion, reduce run-off, stabilize banks, etc.)
16. Thanks for visiting with me today. It's time for you to go to your next station _____.