Turbid Vision

Adapted from: An original Creek Connections activity.
Creek Connections, Box 10, Allegheny College, Meadville, Pennsylvania 16335.

Grade Level: all

Duration: 15 minutes

Setting: Classroom or Outside (a large **grassy** open area)

Summary: Students participate in a simulation that demonstrates the difficulties aquatic organisms face living in turbid surroundings.

Objectives: Students will learn about the consequences of turbidity on aquatic life.

Related Module Resources:
- "Measuring Turbidity with Filters"
- "A 'Soily' N and P"
- HANDBOOK: p.99-104
- FIELD MANUAL: p.52-55
- Turbidity Fact/Info. Sheets
- Secchi disk [A-3]
- Turbidity tube [A-4]

Vocabulary: turbidity, inorganic matter, organic matter, fine particulate organic matter, light penetration, sedimentation

Materials (Included in Module):
- Poker chips [B-3-envlp]
- Green and Blue Colored Paper Scraps [B-3-envlp]
- Turbidity glasses [B-3-envlp]

Additional Materials (NOT Included in Module):
- None

ACADEMIC STANDARDS: (ENVIRONMENT AND ECOLOGY)

7th Grade
4.3.7.B Describe how human actions affect the health of the environment.
- Identify land use practices and their relation to environmental health

4.6.7.A Explain the flows of energy and matter from organism to organism within an ecosystem.
- Demonstrate the dependency of living components in the ecosystem on the nonliving components
- Identify the relationship of abiotic and biotic components and explain their interaction in an ecosystem

10th Grade
4.1.10.C Describe the physical characteristics of a stream and determine the types of organisms found in aquatic environments.
- Describe and explain the physical factors that affect a stream and the organisms living there

4.3.10.B Explain how multiple variables determine the effects of pollution on environmental health, natural processes and human practices.
- Explain how human practices affect the quality of the water and soil

12th Grade
4.6.12.A Analyze the interdependence of an ecosystem.
- Analyze the positive and negative impacts of outside influences on an ecosystem.

4.6.12.C Analyze how human action and natural changes affect the balance within an ecosystem.
- Analyze effects of human action on an ecosystem

BACKGROUND:

Turbidity measures the cloudiness of water: the higher the turbidity, the cloudier the water. The numerical measurement is usually given in Jackson Turbidity Units (JTUs) or Nephelometric Turbidity Units (NTU); both are equal.

Turbidity is caused by suspended **inorganic matter** (minerals and elements not composed of living or dead plant or animal matter) and **organic matter** (composed of living or once living material, containing carbon). These are the materials that you can see in the water; they are not dissolved. Commonly, clay (very small) and silt (a little bigger) sized particles are suspended in water flow. Phytoplankton (algae, some protists, and cyanobacteria), **fine particulate organic matter** (FPOM, small pieces of dead plant and animal parts), and animal waste can also contribute to turbidity levels. There are natural levels of turbidity in all waterways because of normal stream processes, but human disturbance of land can increase turbidity levels.

Soil erosion is the biggest contributor to turbidity levels. Erosion is prone to occur on land that has been disturbed by human activity (deforestation, farming, construction, dirt roads). Removal of streamside vegetation accelerates soil erosion and the cutting away of stream banks. There are no roots to anchor the soil in place or intercept soil washing downhill toward a waterway. Sewage and industrial discharges into a waterway can also increase turbidity levels.

Cloudy water further complicates the lives of aquatic organisms. When soil mixes with water, it changes the physical characteristics of the water. Suspended solids in water can reduce **light penetration** (the distance that light can reach into the water) which may have an effect on aquatic life that need light. High turbidity possibly blocks out the sun needed for algae and plant growth on the bottom of the stream. In turbid water, algae in the water column might only survive closer to the surface and rooted bottom plants may only survive in shallower water near shorelines. Photosynthesis rates may decline, reducing the amount of oxygen provided to streams.

High turbidity levels reduce visibility for aquatic life, making it difficult for predators (such as fish) to find their food (the insect on the stream bottom or the fisherman's bait). Fish that feed mostly by sight, such a pike, need clear water. Fish that constantly live in murky or muddy water can rely on other senses to survive, depending on taste and touch or even on electrical fields to sense surroundings and find food. For example, catfish and carp use their barbels near their mouth to help feel and taste for food and are comfortable living in silty water with limited visibility. Ironically, abundant bottom feeding fish like carp usually disturb settled sediments as they search for food, increasing the cloudiness of the water even more.

Suspended sediments can also harm aquatic life by clogging fish and insect gills, causing breathing difficulties. The lower oxygen levels caused by the warming of turbid water further exaggerate this difficulty. Clear water is also preferred by filter feeding organisms (such as freshwater mussels) that siphon water through body parts to obtain food.

As the motion of the water slows or stops, suspended solids settle out of the water in a process called **sedimentation**. The smallest, lightest soil particles stay suspended in the water the longest, and the largest, heaviest settle first. These settling sediments can fill in the spaces between rocks where insects are supposed to live. The diversity and abundance of species associated with riffles, pools, and runs can change significantly as accumulations of fine sediments on stream bottoms reduce the distinction between these specific habitats. Settling sediments from turbid waters can also smother insect and fish eggs. Turbidity further hinders reproduction for some fish species, making hard to find a mate, see eggs that need to be fertilized or protected, or distinguish a good location for deposited eggs.

Cloudy water can frustrate another animal – humans. We find clear bodies of water more aesthetically pleasing for recreation, vacationing, and wildlife viewing. People who

fish definitely prefer clear water so they can spot the fish, casting that bait to the exact spot where the fish can clearly see it and strike at it.

OVERVIEW: Students participate in a simulation that demonstrates the difficulties aquatic organisms face living in turbid surroundings. Students will perform simple timed tasks and repeat the process wearing "turbidity glasses" to determine if life is more difficult in turbid conditions.

PROCEDURE:
This activity can be conducted indoors or outdoors depending on teacher preference. Procedures for both activities are provided below.

Outdoor Activity

1. Gather the turbidity glasses but DO NOT distribute them to the students yet. If more are needed than are included in the module, you can make more following the instructions for "How to Make Turbidity Glasses" page at the end of this activity.

2. Scatter all of the red and blue poker chips in the grass. Scatter a few of the white poker chips in the grass as well.

3. Instruct the students to gather around the playing area with their back to it.

4. Tell the students they will have five or ten seconds to gather food (poker chips) once they turn around. They can pretend that they are fish searching for invertebrates (such as mayflies) or that they are dragonflies preying upon smaller invertebrates (like midge larvae).

5. Once five seconds have passed, make the students stop collecting chips. Have them count how much food they were able to catch. This trial represents clear water, a trout's ideal habitat condition. Just like the students, the trout has no problems foraging for food in clear water.

6. Collect the chips from the students and pass out the turbidity glasses. Instruct the students to put their backs to the playing area and put the glasses on.

7. Scatter the poker chips that were collected from the students. *Note that white chips are much easier to see with the turbidity glasses on. Blue and red are very hard to see against the background of the grass.*

8. Give the students five seconds to collect chips after you tell them to turn around. How many chips did they get this time?

9. Play more rounds as time allows. Alter the rules slightly with each round. Some options are below:
   - Have the white chips be the least nutritionally valuable or that they are not food at all.

- Set a certain number of chips that each student must catch to survive. How many students are able to live in clear versus turbid water?
- Only scatter the red and blue chips when the water is turbid because the white chips were organisms that died when sediment blocked their gills.
- Put out an even number of blue, red and white chips. After doing a round with the glasses discuss the impact that turbid water had on the prey populations. (*The white prey will be devastated which will disrupt the balance in the ecosystem*.)

Indoor Activity

1. Gather the turbidity glasses but DO NOT distribute them to the students yet. If more are needed than are included in the module, you can make more following the instructions for "How to Make Turbidity Glasses" at the end of this activity.

2. Once a general introduction has been given, each student / group should receive a handful of blue and green pieces of paper to spread out on a desk or table.

3. Indicate that the students are playing the role of fish searching for invertebrates (such as mayflies) or dragonflies preying upon smaller invertebrates (like midge larvae). The colored pieces of paper represent the prey (aquatic macroinvertebrates or bugs). The blue bugs are highly nutritious and worth 10 calories of energy to the fish. The green bugs are not as nutritious and only worth 5 calories of energy. To maximize energy gain, the fish (your students) should pursue the **blue** bugs.

4. Tell the students they will have five or ten seconds to gather as much food (blue paper scraps) as possible. They should only resort to green bugs when no more blue bugs exist. This trial represents clear water, a trout's ideal habitat condition. Just like the students, the trout has no problems foraging for food in clear water.

5. Have students indicate or record the number of blue insects they were able obtain in the clear water round. Replace all paper scraps to the spread out pile.

6. Now, hand out the turbidity glasses. Instruct your students to repeat the same process as the last round with the glasses on – as many blue bugs in five or ten seconds They should notice it is much harder to determine which bugs are nutritious (blue) and which are not. Every green bug they accidentally pick up represents energy they have wasted.

DISCUSSION:

Talk to the students about their experience with the turbidity glasses. Discuss how the difficulties they faced are comparable to those of organisms that live in water that has become turbid.

How might organisms that are adapted to turbid water cope with the difficulties the students faced? *They would not be visually oriented. They might have a keen sense of smell. Some fish have barbels around their faces and can orient themselves with their sense of touch.* Make sure that the students recognize that turbidity is sometimes from natural processes and some creatures have mechanisms to cope with the cloudiness.

Discuss with the students some reasons that water might become turbid naturally and unnaturally. *See the Background section of this activity*. It is important for them to recognize that humans often are responsible for increased turbidity and can make efforts to decrease their impact.

EVALUATION:

- Describe how turbidity affects visually oriented predators.
- Explain why organisms that are not adapted to an altered or human impacted environment have a hard time surviving.
- Other than visual difficulty, what are other negative impacts of turbidity on aquatic creatures.

EXTENSIONS AND MODIFICATIONS:

- Play the game with the students as prey. Have all students come to one edge of the playing field and turn their backs. Scatter the chips, this time representing predators. The students now have to walk across the field without stepping on any chips. Now repeat the activity with the turbidity glasses. The teacher or some "helper" students will have to call students out as they step on chips as they might not even know they did.
- Have the students design other ways to catch prey when the water is turbid. They should come up with "adaptations" that might help organisms to survive.
- Add other hindrances to the activity that would simulate other negative effects that turbidity has on aquatic organisms. Students must hold their breath when collecting the chips/squares because their gills have been clogged. Have students be creative.

NOTES (PLEASE WRITE ANY SUGGESTIONS YOU HAVE FOR TEACHERS USING THIS ACTIVITY IN THE FUTURE):

Activity Version: October 2001

HOW TO MAKE TURBIDITY GLASSES

MATERIALS NEEDED:

1. Cardstock
2. Brown or yellow cellophane – ideally the type they put over fruit baskets or wrap decorative flowers with (available in craft stores)
3. Scissors
4. Clear tape
5. Stapler

INSTRUCTIONS:

1. Photocopy the template (see next page) onto the cardstock.

2. Cut along the lines, discarding portions that are crosshatched (but leaving the dark nose section for now).

3. Measure the cellophane to fit the size of the frames. Tape the cellophane over the tops and bottoms of the frames. Depending on the thickness of the cellophane, you may need to put more than one layer. (Creek Connections glasses have two layers.) Experiment until you find a good number of sheets to use.

4. Cut out the dark nose section, including the cellophane in this section.

5. Tape the cellophane to the frames where the nose has been cut out.

6. Staple the sides to the corner of the glasses and bend the joint.