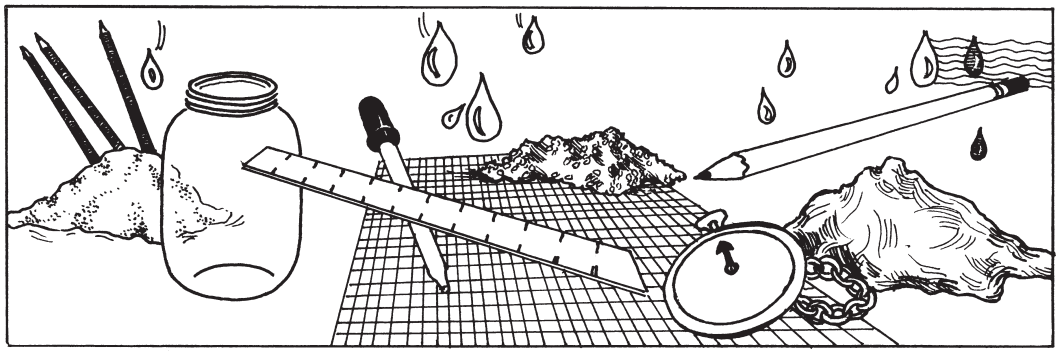


Activity #4: Settling Rates of Different Size Particles

Objectives:

To explain how and why the settling rate of particles varies with particle size.

Time:

One 55-minute class period

Background:

Turbidity (cloudiness caused by sediment in suspension in the water) is affected by the sedimentation rate of particles in a water column. Sediment may be put into suspension by disturbances such as waves, currents, or mechanical disturbances. After a disturbance, particles will again settle, but at different rates. The settling rate of a particle depends on its size, shape, and density as well as on the viscosity of the fluid through which it is settling. Turbidity can be measured by lowering an object into the water and noting at what depth the object disappears from view. The more turbid the water, the shallower the depth at which the object disappears.

The turbidity of a body of water has a direct affect on the organisms living in the water, particularly the plants. The more turbid the water, the more light is reflected and/or refracted in the water, causing less light to be available to the plants. As with soil particle size, the turbidity of water affects the species of plants that are able to survive in the area, and by extension the survivability of organisms that depend on the plants.

During this activity, students will calculate the amount of time it takes for a soil sample in water to settle after it has been disturbed, and they will graph the settling rate over time. The students should already have some understanding of the affect of grain size on estuarine processes from previous activities. This activity should increase that understanding and prepare the students for on organisms that live in the estuary.

Materials:

Students should work in pairs. Each pair will need a clear glass jar approximately 10 cm. high, enough soil to fill the jar 1/3 full, a paper clip, ruler, and stopwatch or clock.

Procedure:

Students will disturb (shake vigorously) the soil sample in the jar, and measure the settling rate with a paper clip. Students should continue to time the settling rate for at least 40 minutes or longer.

Answers to student questions:

1. The base of the food chain in most aquatic environments is made up of single-celled plants called phytoplankton. Predict how the turbidity of the water might affect the survival and growth of these plants.

   Students should understand that the more turbid the water, the less light can penetrate the surface of the water. Less light would decrease survival and growth of plants. However, water can also be turbid because of organic matter in the water, which would increase nutrients available to the plants and make survival and growth more likely.

2. What kinds of disturbances could increase the turbidity of the water in the Tijuana Estuary? Think of daily disturbances, seasonal disturbances, and random disturbances.

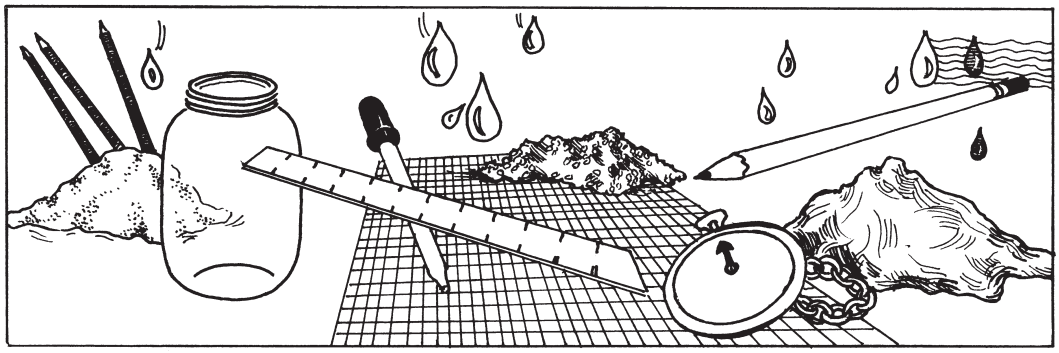
   Answers will vary, but might include tides, winds, animal life, storms, earth quakes, etc.

3. How might the turbidity of the water affect animal life in the Estuary? Include both positive effects and negative effects.

   Turbid water might make it harder to find prey, which could be both a negative or a positive effect depending on whether you view from the perspective of a predator or prey. Turbid water might decrease plant life leaving less food for herbivores and omnivores. It could also provide protection for nesting and for offspring.

4. During storms and floods, sediments become suspended in the water column and moved to other areas. This is called erosion and deposition. Describe how erosion and deposition would change the features of an estuary, such as stream beds, sand dunes, and marshes.

   Movement of sediments is the main reason that features of an estuary change over time. A middle marsh can transition to high marsh then upland habitat. Stream beds can fill up, new channels can be created, etc. Students should understand the reasons for these changes in an estuary.



Activity #4: Settling Rates of Different Size Particles

PURPOSE:

Explain how and why the settling rate of particles varies with particle size.

INTRODUCTION:

The settling rate of a particle depends on its size, shape, and density as well as on the viscosity of the fluid through which it is settling. In general, smaller particles have a larger surface area to mass ratio, so their settling rates are slowed more by frictional drag than are larger grains. Two grains of equal size may settle at different rates due to differences in density or shape. Flatter shapes will settle at a slower rate because of a larger surface area on which frictional drag will act.

Turbidity is cloudiness caused by sediment in suspension. Sediment may be put into suspension by disturbances such as waves, currents, or mechanical disturbances. After a disturbance, particles will again settle, but at different rates. Turbidity can be measured by lowering an object into the water and noting at what depth the object disappears from view. The more turbid the water, the shallower the depth at which the object disappears.

During this activity, you will calculate the amount of time it takes for a soil sample in water to settle after it has been disturbed, and you will graph the settling rate over time.

MATERIALS:

Each pair of students will need:

1. A clear glass jar that is at least 10 cm high.
2. A soil sample
3. A paper clip
4. A pencil and ruler

PROCEDURE:

1. Fill the jar 1/3 full with your soil sample. Add water until the jar is filled to the brim.

2. Bend the paper clip into an "L" shape.

3. With the lid on tightly, shake the jar vigorously.

4. Let the jar sit for 5 minutes. Note how much the water has cleared. Predict how long it would take for the soil to settle completely.

5. Shake the jar again, quickly set the jar down, and open the lid.

6. Make observations as follows:

   One person lowers the paper clip into the water to the level where it disappears from view as observed from the top, and holds it there. The paper clip must be lowered next to the side of the jar so it can be seen through the glass.

   The second person measures the depth beneath the water surface at which the paper clip disappears from view as observed from the top.

7. Record the observation on the table below.

8. Repeat every 2 minutes for the amount of time instructed by your teacher.

Time after shaking	Depth of disappearance

9. Plot the data points on a graph of depth vs. time and answer the following questions.

(1). Summarize your observation of how the rate of change in turbidity changes with time after shaking.

(2). Describe any layering of sediment sizes you observe in the jar.

(3). Explain the relation of grain size to settling rate.

(4). Explain the change in turbidity as a result of settling of different particle sizes.

(5). How long would it take for the paper clip to be visible on the surface of the sediments? How does this time compare to your predicted time?

QUESTIONS:

1. The base of the food chain in most aquatic environments is made up of single-celled plants called phytoplankton. Predict how the turbidity of the water might affect the survival and growth of these plants.

2. What kinds of disturbances could increase the turbidity of the water in the Tijuana Estuary? Think of daily disturbances, seasonal disturbances, and ran dom disturbances.

3. How might the turbidity of the water affect animal life in the Estuary? Include both positive effects and negative effects.

4. During storms and floods, sediments become suspended in the water column and moved to other areas. This is called erosion and deposition. Describe how erosion deposition would change the features of an estuary, such as stream beds, sand dunes, and marshes.