

**Tides in the Hudson**

**Time:** 1 class period

**National Benchmarks:** Benchmarks 5A: Diversity of Life; 5D Interdependence of Life; 5E: Flow of Matter and Energy; 9B: Symbolic Relationships; 9D: Uncertainty; 12B: Computation and Estimation; 12D: Communication Skills; 12E: Critical-Response Skills.

**National Science Content Standards:** *Science as Inquiry: A; Life Science: C:* Biological Evolution; The Interdependence of Organisms; Matter, Energy, and Organization in Living Systems; *Science and Technology: E:* Abilities of Technological Design; Understandings about Science and Technology; *Science in Personal and Social Perspectives: F:* Population Growth; Natural Resources: Environmental Quality; Natural and Human-induced Hazards; Science and Technology in Local, National, and Global Challenges

**New York State Standards:** 1, 2, 4, 5, 6, 7

**Objective:** Students will know how tides affect the Hudson River and be able to create a graph showing a two day pattern of tides in the river.

**Lesson Outline:**

1. Teacher demonstration of salt and fresh water mixing and stratification
2. Students use Hudson river data to determine the impact of tides on salinity
3. Students discuss their graphs

**Materials:**

- For demonstration: 2 clear plastic containers, 2 siphons (or spoons if you want to do a smaller demonstration), clear fresh water, fresh water with drops of food coloring, clear salt water, salt water with drops of food coloring
- For student groups: computers with excel, copy of worksheet

**Preparation:** You should make the salt water ahead of time; use Kosher salt to eliminate the cloudiness. Mix 35 grams of Kosher salt to 1 liter of water for salt water that is 35 ppm. If you don't have a good balance, mix 1 gallon of water with 1 cup of deionized salt.

**Engage:** Show a picture of the Hudson River watershed, and ask students to identify the water bodies shown. Ask: What kind of water would you expect in the ocean? In the river? In between? Ask students what they think happens when fresh and salt water mix. Define estuary if necessary. Tell them that you have a large container of fresh water and that you are going to add a large amount of salt water. The salt water has been colored-if they don't believe you that it is salt or fresh, they can taste the water. Using the siphon, carefully add the colored salt water to the container of fresh water, keeping the siphon near the bottom. Ask the students to describe what they see happening, and whether this matched their predictions. Repeat the test with the fresh water containing the food coloring. Ask students why you have to repeat the test this way (to eliminate the

possibility of food coloring as a variable). Then, ask the students why the salt water stayed at the bottom of the container.

**Explore:** Students will now use data showing the salinity levels over a week-long period at West Point on the Hudson River to think about the tides. They should graph this data, using time on the x-axis and salinity along the y-axis. If students have access to Excel, they can use the data set titled “Salinity from West Point”. If students don’t have access or don’t know how to use Excel, they can use the attached worksheet and graph it by hand. When the students have finished with their graphs, they should compare with other students in the class. The class should see a four day period of salinity changes.

**Explain:** Ask: Why did the salinity change? If students are lacking information about the ocean, this might be a good time to explain that the salinity of the open ocean is around 35 ppm, or 35000 ppt. Ask: What is the level of salinity of fresh water? Students should be able to explain why the levels of salinity fluctuate throughout the course of a day, a week, and a month.

Tides are caused by the interaction between gravitational and centrifugal forces, with the strongest tides resulting from the pull of the moon. Water levels rise on the side of the earth nearest the moon and on the side opposite the moon, causing a ‘bulge’ of water around the earth. Since the moon circles the earth every 24 hours and 50 minutes, an observer standing at one point on Earth would see two high tides and two low tides during this period. These tides are called semidiurnal. The Hudson is open to the ocean, and semidiurnal tides travel up the Hudson all the way to the Troy dam. Tides make the water in the Hudson slosh back and forth, much as you would see in a bathtub. The river runs north for six hours and then runs south for six hours. However, freshwater from rivers can change the flow of the river and even prevent the tidal push during very heavy runoff. The salt front, which is the leading edge of the diluted sea water, is usually below the Tappan Zee Bridge, but it sometimes comes to Poughkeepsie or even further, depending on weather conditions. It is important for communities (especially those that obtain drinking water from the river) along the Hudson to monitor the location of the salt front, since salinity in the water could be dangerous for the public.

**Extend:** Depending on students’ understanding of tides and tidal cycles, it might be a good idea to complete an additional activity on tides, such as graphing the Salt Front Data which is available at [http://ny.water.usgs.gov/projects/dialer\\_plots/saltfront.html](http://ny.water.usgs.gov/projects/dialer_plots/saltfront.html) .

Students can also use the “Tides in the Hudson” reading to learn more details about the nature of tidal change in the Hudson. Students could also graph data from the annual “A Day in the Life of the Hudson River” event, found at this website: <http://www.ldeo.columbia.edu/edu/k12/snapshotday/2008.htm> .

**Evaluate:** Students should read “The Hudson River and Tides” and answer the questions.

Comments: