

Can you swim in the Hudson?

Time: 1-2 class periods

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, 3, 4, 5, 6, 7

Objective: Students will know how the sewage levels in the Hudson River have changed over time, and be able to explain the consequences of these changes.

Lesson Outline:

1. Students discuss their ideas about the cleanliness of the Hudson River, and whether they could swim in it.
2. Students use historic data to determine whether the Hudson is swimmable.
3. Students create graphs and discuss results.

Materials:

- Copies of the handout: either with the graphs already created, the data for students to make the graphs by hand, or with instructions for using Excel to make the graphs
- Computers with Microsoft Office Excel or graph paper

Engagement: Ask students if they think it's safe to swim in the Hudson. Ask: what was the Hudson like 20 years ago, 50 years ago, or 100 years ago? Students should have some ideas about the changes that have taken place if they completed any of the lessons in the land use change module. As a class, graph the population data of the mid and lower Hudson River basin and the effluent rate. A good way to do this is to give each student (or group of students) a slip of paper with data points and ask them to add it to a pre-made graph (with labeled axes) on the board. You may want to make two graphs, one for population and one for effluent. Effluent flow refers to the amount of wastewater released from sewage treatment plants. This shows how much more wastewater is being released into the river now than in the beginning of the century.

	population	effluent m ³ /sec
1900	3418471	17.94
1910	4668274	24.59
1920	5535541	29.19
1960	9343582	53.34
1970	10660574	64.29
1980	9846458	78.84
1999	8501530	70.13

Ask: Based on this information, what do you predict about the overall health of the Hudson River from 1900-2000? What kind of information would you like to know to determine if you are correct? Students will probably respond that they think the Hudson is dirtier now than it was in the past.

Exploration: Before beginning the graphing activity, ask students to write down their predictions to the above questions and create a chart on the board of things they ‘would like to know’ in order to decide if the Hudson River’s health has improved or not.

Students will use the data set titled “Dissolved Oxygen and Fecal Coliform”. For the graphing, if possible, each student should be allowed to work individually. If they are proficient at graphing, they should be able to complete the first graph in class and then complete the remainder of the exercise for homework. This can be done using the worksheet and asking students to graph by hand, or downloading the data set into Excel and printing out the graphs when completed. You can also use the version of the worksheet which has the graphs pre-made.

Explanation: Surface DO is usually higher due to circulation with the air from wind or waves. The water at the bottom of a water body usually has little contact with the atmosphere, and this reduces the amount of dissolved oxygen that reaches the water. Generally, this is due to poor vertical mixing from stratification, which happens either due to temperature or salinity. Additionally, oxygen in the bottom waters declines due to decomposition of organic matter. Overall, the DO levels have increased in the Hudson, both in the surface waters and in the bottom waters. This indicates that the health of the river has improved, as higher DO levels are important for aquatic organisms. The last time fecal coliform levels went above the primary level was in 1991, and the secondary level in 1987. The health of the Hudson has improved because fecal coliform levels have gone down over time. Improvements to local sewage systems and treatment plants can explain much of this change. However, since we don’t have data for the entire Hudson River, it is difficult to state with confidence what has taken place in the rest of the river. We also don’t have daily or even weekly measurements, which might take into account sewage spills or overflow events from storms.

Extend: Students could investigate the reasons why changes have taken place in the quality of the river. Primary water treatment plants were constructed in 1924 at Passaic Valley, New Jersey and in Yonkers, and an additional three were added by 1938. There were seven total primary treatment plants by 1952. After the 1972 Clean Water Act, upgrades were made to the plants and additional secondary treatment procedures were added. For more on this topic, please read: “ Hudson River Sewage Inputs and Impacts” by Brosnan, Stoddard and Hetling in The Hudson River Estuary, edited by Levinton and Waldman, Cambridge Univ. Press 2006.

Evaluate: Use the graphs and student answers to evaluate their understanding.

Note to teachers: If you are using the Excel data set, you can find the finished graph on the second 'sheet'. Students can complete two separate graphs or one that shows all the variables.

- Graph 1 Answers:
1. highest: 1967, lowest: 1927
 2. Surface DO is usually higher due to circulation with the air from wind or waves. The water at the bottom of a water body usually does not mix with the atmosphere very much, due to thermal or saline stratification. Based on student knowledge, they may or may not know whether the rest of the Hudson should behave similarly (it should, except for the shallow reaches of the headwaters).
 3. Overall, the DO levels have increased in the Hudson, both in the surface waters and in the bottom waters. This indicates that the health of the river has improved, as higher DO levels are important for aquatic organisms.
 4. Students should realize that they only know about this area of the Hudson, near Manhattan. They should want to know more about the health of the river in other parts of the estuary.

- Graph 2 Answers:
1. The overall levels of fecal coliform bacteria have decreased.
 2. The last time fecal coliform levels went above the primary level was in 1991, and the secondary level in 1987. Events that might affect coliform levels include large storms that caused a combined sewer overflow event, or a problem with one of the sewage treatment plants.
 3. The health of the Hudson has improved because fecal coliform levels have gone down over time. Improvements to local sewage systems and treatment plants can explain much of this change.
 4. Depends on the location, and the time of year. Swimming after a large storm is not advisable due to stormwater runoff and combined sewage overflows.
 5. As sewage levels decrease, dissolved oxygen levels generally increase. Sewage encourages the growth of bacteria who feed on the waste product. As the bacteria thrive, they use up the dissolved oxygen, decreasing the amount remaining for other organisms.

Comments: