

Hudson Food Webs

Time: 3-5 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, 4, 5, 6, 7

Objective: Students will know how an invasive species has changed the Hudson River food web and be able to explain the impact of the introduction of the zebra mussel on the food web.

- Lesson Outline:**
1. Students brainstorm a list of organisms that live in the Hudson.
 2. Students use online food web visuals to learn about different communities that live in the Hudson River.
 3. Using stations, students view different species of plankton with microscopes (either prepared slides or live samples).
 4. Students draw the main plankton species
 5. Using the provided Hudson River food web drawings and reading, as well as the data in the lab sheet, students determine the changes that have taken place in the river food web since the arrival of zebra mussels.
 6. Students create pre and post-invasion food webs.

Materials:

- prepared slides or live specimens of **phytoplankton:** diatoms, chlorophyceae (often called green algae), cyanobacteria; and **zooplankton:** rotifers, cladocerans (if you can get more than one species of cladoceran, that would be great; the most abundant in the Hudson is *Bosmina freyi*), copepods (the major forms are *Cyclops* and copepod nauplii- these are juvenile or young forms).
- microscopes
- Computers with internet access (this can be assigned as homework the night before)
- copies of the food web reading, worksheet, and images-optional (these can be laminated and cut out to reduce student work time)

Preparation: Prepare slides with students or ahead of time. Preparing live slides takes some time, although students can help if you have dissecting and compound microscopes. A product such as 'Protoslo' helps calm the organisms down, and is available for around \$6 from any scientific supply company. A great option for collecting plankton is using a plankton tow, which can be easily made from household items. A great company that provides "demoslides" of live organisms is Connecticut Valley Biological Supply; each demoslide costs around \$2.

Engage: Ask students to draw, in pairs, a representative food chain for the Hudson River. Discuss what students have created, and create a class-wide food web on the board. Point out which parts of the created web are strong, and which parts may be missing organisms. Allow students to go online to view the four different food webs of the Hudson River, and have them fill out the first portion of the worksheet. Review answers with students.

Explore: In groups, students will move around the room to view different examples of phytoplankton and zooplankton, taking notes and drawing each specimen. Allow 5-10 minutes per station. When students are finished, they should use the reading titled “Hudson Food Webs” as a reference to devise a possible food web of their own.

Ask students to use the data from the Hudson to explain the ways in which the food web has changed since the arrival of the zebra mussels. This can be done in class or given as homework. Finally, students use a chart to calculate the percent change of major groups of organisms in response to the zebra mussel invasion. Students should be able to explain the complex interaction between various groups within the food web.

Explain: In the Hudson, the majority of the phytoplankton community is made up of diatoms, followed by chlorophyceae and cyanobacteria (green algae and blue-green algae, respectively). The abundance of phytoplankton in the Hudson is not limited by nitrogen or phosphorous; instead, due to its turbid nature, the limiting factor is light. The planktonic community of the Hudson is dominated by freshwater species, although there are a number of estuarine species (that can tolerate salt water) as well. It might be helpful for students to think about the overall size of the different zooplankton when trying to develop a possible food web. The smallest groups they have seen include the rotifers, copepod nauplii, and smaller cladocerans and copepods (these are between 20-200 μm). There is a group which is smaller than the microzooplankton, which are called ‘nano’ (2-20 μm in diameter), and include the flagellates and some smaller ciliates. The class size above the microzooplankton is called the meso-zooplankton, which includes mostly crustaceans that are past the nauplii stage (these animals are 200-2000 μm and this class includes includes the cladoceran, *Daphnia*). The largest size group (more than 2000 μm) is the macrozooplankton, which includes predatory zooplankton such as ctenophores, *Leptodora*, and mysids.

The Hudson River’s food web has been dramatically altered since the arrival of the zebra mussel (*Dreissena polymorpha*). Plankton populations, specifically microzooplankton, have been reduced by 54%. In addition, the clarity of the water has increased because mussels also remove the silt particles which limit light penetration. This increase in light has allowed aquatic plants that grown at the bottom of the river to increase. These changes, in turn, have affected benthic animal communities leading to declines in the native bivalves and impacts on the littoral and pelagic fish community structure. Littoral fish have flourished, while open-water (pelagic) fish have suffered due to a lack of food for their larvae.

Recently, zebra mussel numbers have declined substantially. Although this data is not presented in the lesson, you could discuss with students the possibility of future changes in the food web of the Hudson River. For a more in-depth analysis of the changes in different population groups in the Hudson, use the lesson called “Graphing Zebra Mussel Data” in the Invasive Species module of the Changing Hudson Project curriculum.

Extend: Students could collect their own water samples and learn how to prepare slides of these plankton for viewing. You can also extend this lesson by completing the macroinvertebrate

sampling lesson, and then asking students to complete a local food web based on what they discovered.

Evaluate: Students should present the results of their work to the class, and submit the completed worksheet.

References:

- Caraco, N.F., J.J. Cole, S. Findlay, D. Fischer, G. Lampman, M. Pace, and D. Strayer. 2000. Dissolved Oxygen Declines in the Hudson River Associated with the Invasion of the Zebra Mussel (*Dreissena polymorpha*). *Environmental Science Technology*, 34:1204-1210.
- Fernald, S.H., N.F. Caraco, and J.J. Cole. 2007. Changes in Cyanobacterial Dominance Following the Invasion of the Zebra Mussel: Long-term Results from the Hudson River Estuary. *Estuaries and Coasts*, 30(1), p163-170.
- Pace, M.L. and D.J. Lonsdale. 2006. Ecology of the Hudson River Zooplankton Community. The Hudson River Estuary, J. Levinton and J. Waldman, editors.
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- Strayer, D.L., N.F. Caraco, J.J. Cole, S. Findlay, and M. Pace. 1999. Transformation of Freshwater Ecosystems by Bivalves. *BioScience*, 49: 19-27.
- Strayer, D.L., and L.C. Smith. 1996. Relationships between zebra mussels and unionid clams during the early stages of the zebra mussel invasion of the Hudson River. *Freshwater Biology*, 36:771-779.
- Strayer, D.L., K.A. Hattala, and A.W. Kahnle. 2004. Effects of an invasive bivalve on fish in the Hudson River estuary. *Canadian Journal of Fisheries and Aquatic Sciences*, 61:924-941.