Biomanipulation of Aquatic Trophic Interactions

Time: One class period for pre-lab and setup; one to two weeks of observation.
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 be able to explain how zooplankton grazing affects the food web of an aquatic system.

Lesson Outline:

1. Students set up experiments to measure the reduction of algae in an aquatic system.
2. Students monitor their experiments over a two-week time period.
3. Students report on their results.

Materials: Natural algal populations or cultures such as *Chlorella*; zooplankton cultures such as *Daphnia*, *Bosmina*, *Cyclops*; predators such as snails, mussels, or larger fish; containers (mason jars, fishbowls, small aquaria, or midsized aquaria).

Preparation: Algal populations may need to be allowed to grow over 1 to 2 weeks to produce a high enough concentration to be visible to the eye before adding grazers. Additions of phosphate or phosphate and nitrate-nitrogen (about 5 ppm each) can be used to stimulate algal growth.

Engagement: Show students pictures of different aquatic ecosystems, with different levels of water clarity. Ask: what causes the difference between these water bodies? Why is the Hudson such a cloudy, "dirty" river? What could cause this? Students should be able to remember the tides, and the amount of sediment that washes down from the watershed, as contributing factors to the turbidity of the system. Another factor is the number of predators. What predators in the Hudson River might feed on plankton? If students have completed the Hudson River Food Webs lesson, they should know about zebra mussels and native filter feeders.
Exploration: Give students access to the equipment, and allow them one class period to develop hypotheses and set up their experiments with teacher verification. Some containers should be controls; various zooplankton or larger predator species could be introduced into different aquaria. Students should measure changes in transparency

(turbidity) during a one week to two week period. The most efficient way to do this is with a probe; however if you do not have a probe, you can also measure algal populations by using a microscope and counting phytoplankton and/or observing the color of the water. A good way to do this is to pass a known amount of water through a filter and then compare the colors, creating a range of 'green-ness'.

Explanation: Some species of zooplankton are more efficient at grazing than others, and therefore will improve water clarity. The "quality" of algae as food also matters; small green algae are easier to ingest than large, filamentous green algae or cyanobacteria ("blue-green" algae). This lesson works well as a follow-up to "Hudson Food Webs", since you can then talk about the effect of zebra mussels on the river.

Before the invasion of the zebra mussel, the Hudson River was filtered through the native unionid mussels every 2-4 months. Now, every drop of water moves through a zebra mussel every 1-4 days. However, the zebra mussel population also fluctuates, which will allow plankton population sizes to change as well.

Make sure students understand that "clear" water doesn't mean "clean" water. High water clarity can mean that the aquatic ecosystem doesn't have enough productivity to support much life.

Extension: If a mid-sized aquarium is used, add planktivorous fish (e.g. minnows or darters) and see the effect on transparency of increased predation on the grazers. What characteristic do planktivorous fish key upon to choose zooplankton as food items? What change might be expected of transparency if the aquarium was large enough to add piscivorous fish to the system? What other trophic relationships would add complexity to this simplified food chain?

Evaluation: Students should be able to determine the more efficient grazers and understand the main trophic interactions that affect water transparency. Students should complete their lab reports.

Comments: This lesson was written and compiled by Bill Doolittle, Oakwood Friends School, Poughkeepsie, NY.