Name_______________________________

Hudson River Food Webs

During this activity, you will learn about food webs in the Hudson River, and how the base of the food web might change depending on changes in the consumer population.

Part 1: Identifying food chains from a Hudson River food web.
Go to the following web site: http://www.ecostudies.org/chp_river_visuals.html and click on "Food Chains".
Choose one of the four Hudson River habitat types.

What habitat did you choose? ____

Using the food web shown, construct **two** different food chains where one of the consumer organisms occupies two different trophic (feeding) levels. Be sure to use different producers and consumers in each food chain (except the one consumer in both food chains).

Producer	→	Primary Consumer	→	Secondary Consumer	→	Tertiary Consumer
1st Trophic Level		2nd TL		3rd TL		4th TL

Looking at the producer that you chose, list the other consumers that eat the producer (**consumers you didn't use in your food chains):**

____

____

Finally, look for the zebra mussel in the fresh water channel food web.
What do zebra mussels eat? ____
What eats the zebra mussels? ____

Part 2: Plankton identification

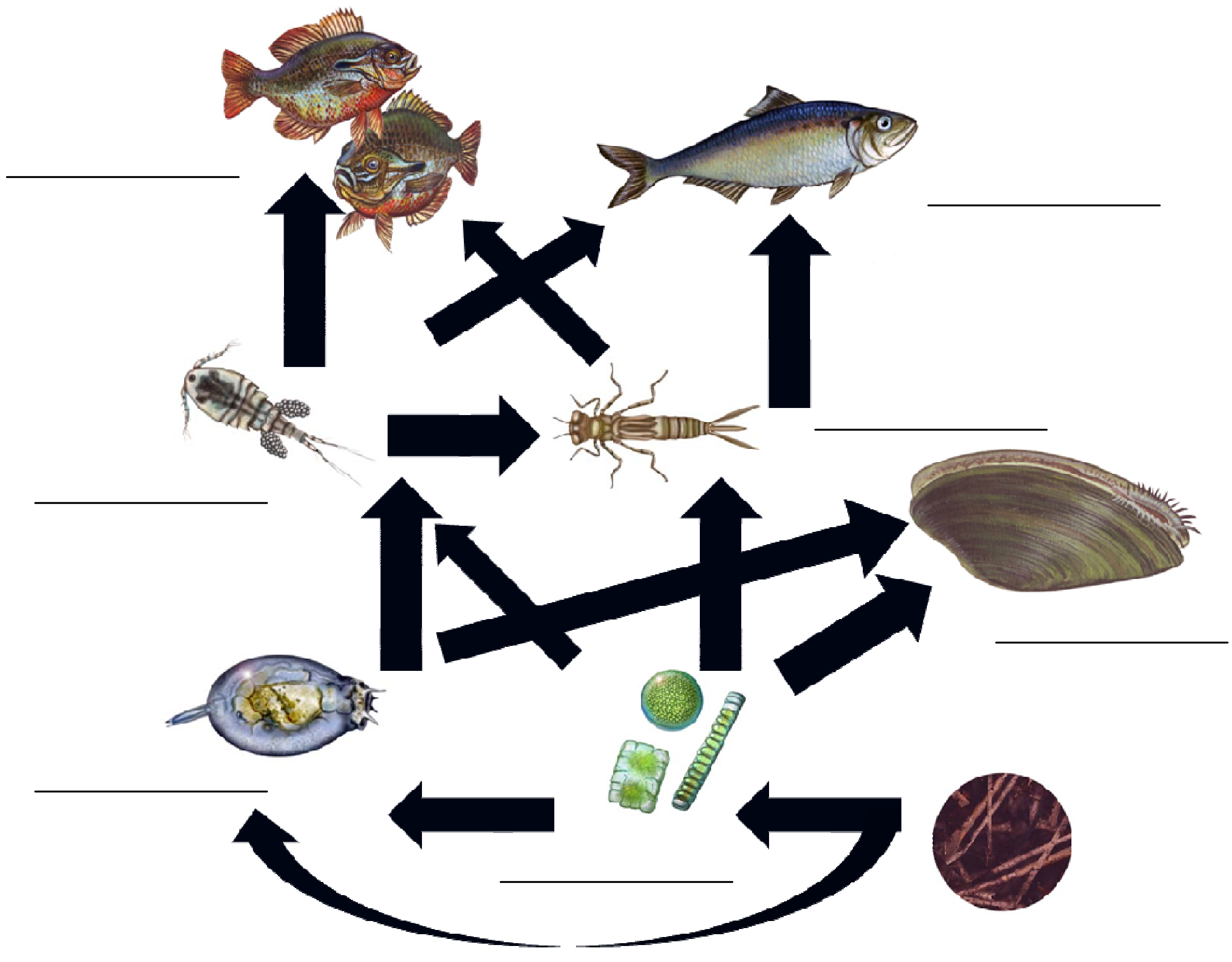
There are several stations set up around the room. Using the space below, draw what you see at each station. If you need more room, use another sheet of paper.

Station 1: ______________________

Station 2: __________________________

Station 3: ________________________

Station 4: ___________________________



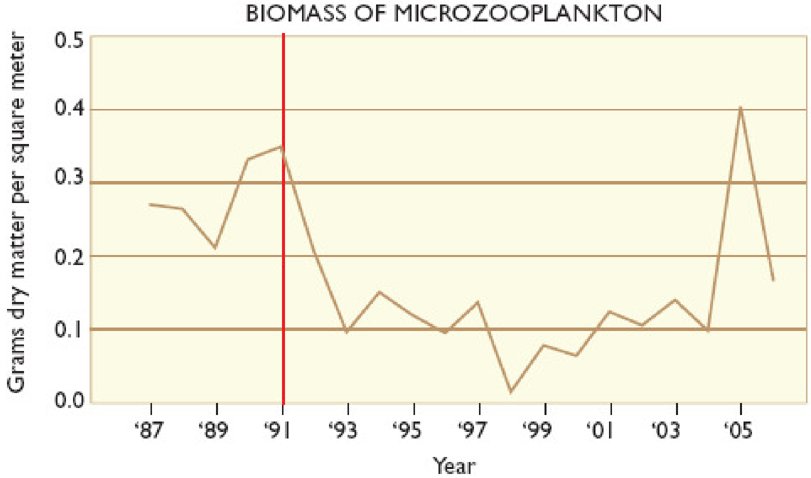
Label the organisms on this sample Hudson River food web, prior to the zebra mussel invasion. Use the reading provided by your teacher or the online food webs to help you.

Use the space below to answer the following question:

If another mollusk was introduced to this food web, how do you think it would change? Explain your answer. Could there be additional consequences that are not depicted in the food web above?

Part 3: Hudson River Changes

Using the graph below, answer the following questions.



This figure shows total microzooplankton biomass (dry weight of organism), which includes rotifers, copepod nauplii (immature copepods), and tintinnids (see the reading for more information) from 1987 to 2006. The solid line indicates the point at which zebra mussels became abundant.

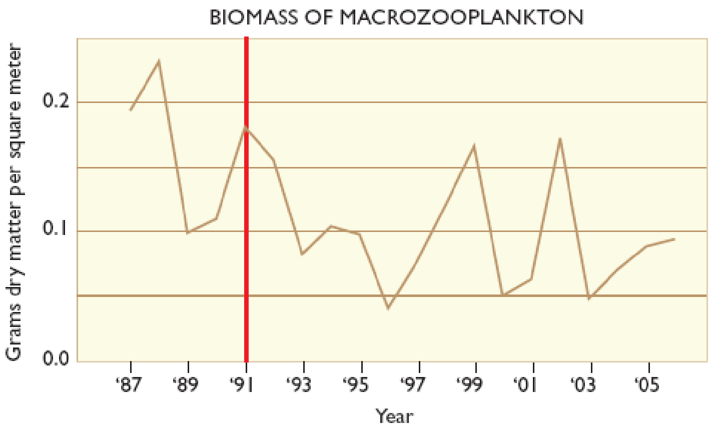
1. Looking at the numbers of the pre- and post-invasion, find the average biomass (in grams) of microzooplankton. For example, looking at the line to the left of the zebra mussel arrival time, you can estimate that before zebra mussels, there was an average of 0.28g of microzooplankton in the river. What do you think the average was after the invasion? ____________ . After completing this handout, you will be asked to fill in a chart with the estimates of pre and post-invasion numbers **for all of the major organisms in the Hudson River**.

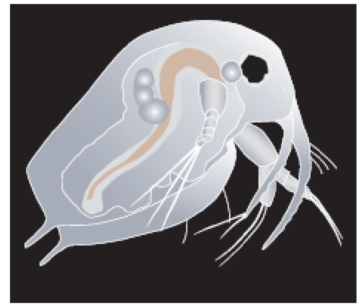
2. Explain what you think happened to the microzooplankton. What might be the reason for the large change in the last two years of data collection? What do you think might happen when the 2007 data is finalized?

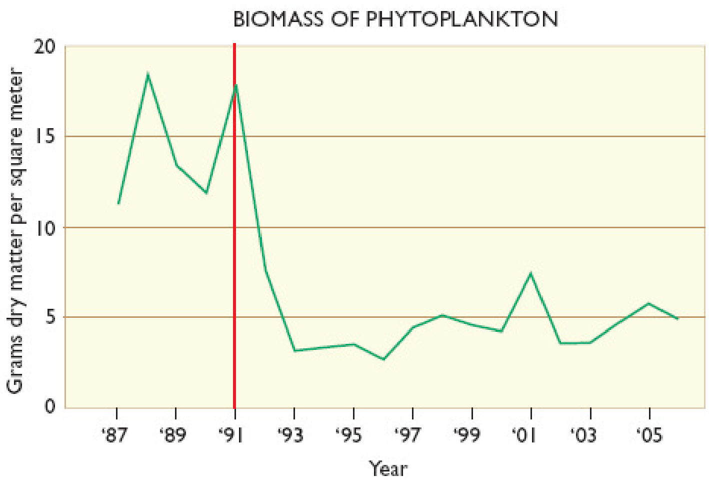
____
____
____
____

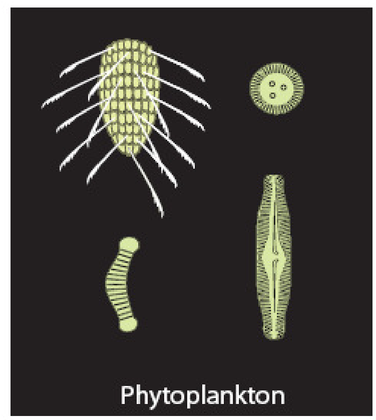
3. Based on this graph, how do you think the food web in the Hudson might have changed?

____
____
____
____
____
____





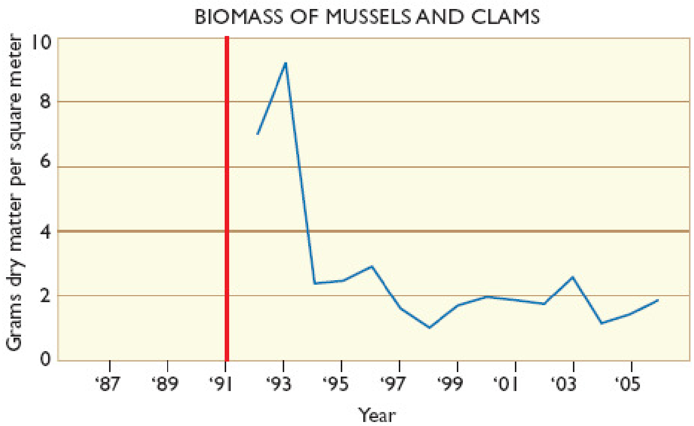


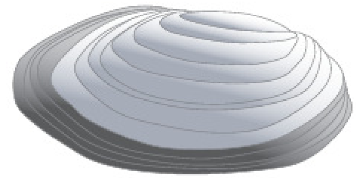


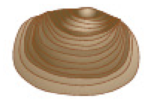
Macrozooplankton for this study include the meso-zooplankton (copepods and cladocerans; mostly Bosmina). Researchers sampled plankton every two weeks from April to December, taking three samples at a site near Kingston, NY. Phytoplankton biomass was measured through chlorophyll a, since all plants contain the pigment. Again, the dashed line shows the arrival of the zebra mussels.

4. Based on these graphs, what can you conclude about the macrozooplankton community after the arrival of the zebra mussels? What about the phytoplankton community? How might these two graphs be related?

____
____
____
____







This graph shows biomass of native bivalves: the freshwater mussels (unionids) and pea clams (sphaeriids). Although we don't have pre-invasion data, remember that freshwater mussels live a relatively long time, anywhere from 5-100 years. Scientists estimate that pre-invasion biomass of native mussels was 8g/m^2. To get this data, scientists took five replicate samples using a bottom-grab during June-August at each of eighty-nine stations along the Hudson from Albany to Newburgh. See the reading for more information about each of these groups of animals. For comparison, zebra mussel biomass was averaged at 21 grams (21,000 mg) dry matter per square meter several years after the invasion. Keep in mind that this is an average, because populations fluctuate a lot!

5. How did scientists collect this data?

____

____

6. What can you conclude about the native clam & mussel populations after the arrival of the zebra mussels? Why do you think this happened? What other factors could be at work besides predation?

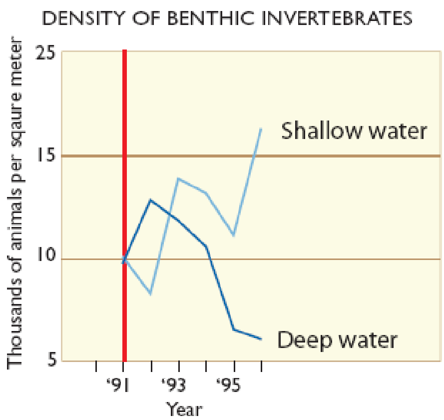
____

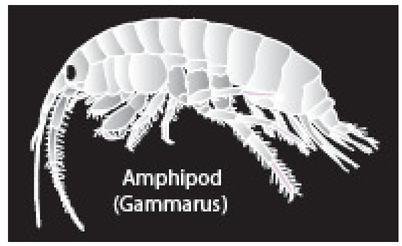
____

____

____

7. Use both the graph and the text below to answer questions a, b & c.





The change in the amount of benthic invertebrates at the time of and after the invasion is shown above. The graph shows invertebrates (such as amphipods) that live in shallow water, and those that live in deep water.

a. What happened to the population of invertebrates that live in shallow water? In deep water? ____

____

____

There are two main groups of fish in the Hudson: pelagic and littoral.

1) Pelagic fish, which include American shad, blueback herring, alewife, white perch, and striped bass, live in open water, and feed mainly on zooplankton, along with some deep water invertebrates.

28%

97%

2) Littoral fish live in vegetated shallows, where they eat mainly benthic (bottom dwelling) invertebrates that live in the vegetated shallows along the shores of the Hudson River. Examples of littoral species are the redbreast sunfish, smallmouth bass, pumpkinseed, tessellated darter, common carp, and spottail shiner.

Fish that live in the shallow water (littoral) eat the shallow water invertebrates, while those that live in the open water (pelagic) eat the deep water invertebrates. In a 2004 study, Strayer and his collaborators found that the abundance of open-water species had decreased by 28% since 1991, while the abundance of littoral species increased by 97%.

b. Why do you think the population of littoral species increased so much?

____

____

____

In a separate but related study, Caraco and her collaborators found that the decline in plankton increased water transparency, which allows more vegetation along the shoreline to grow. It was estimated that submerged aquatic plants, which generally live along the shoreline, increased by 38%. Scientists think this is because of the increase in water transparency, which has gone up 45%.

c. Use this space to draw what happened to submerged aquatic plants. Think of a flow chart: start with the decline in plankton, and finish with the increase in submerged aquatic plants.

d. Could the increase in water transparency, along with submerged aquatic plants, affect the population of fish and invertebrates? How?

8. According to what you have learned, what group of organisms in the Hudson River changed the most?

9. Based on the information you have learned about the different parts of the Hudson food web, what do you think is the most important part of the food web? Why?

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.

Pace, M.L., S.G. Findlay, and D. Fischer. 1998. Effects of an invasive bivalve on the zooplankton community of the Hudson River. *Freshwater Biology*, 39:103-116.

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.