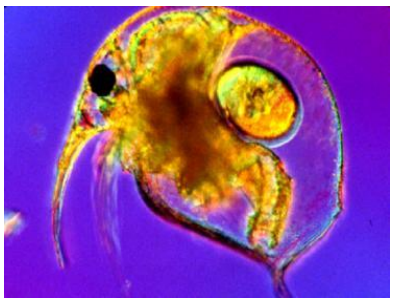
Level 1: Zebra Mussel Abundance

❖ **Background Information:**

Cary Institute scientists with the Hudson River Ecosystem Study first discovered invasive zebra mussels in the Hudson in 1991, and they have been closely monitoring their population ever since. Because the group began intensive study of the Hudson several years before zebra mussels appeared, they coincidentally were fortunate enough to be able to document the large and far-reaching impacts of the zebra mussel invasion on the Hudson River ecosystem.

Zebra mussels, which are European natives, first arrived in ship ballast and canals, and rapidly spread through the Eastern United States. Since September 1992, zebra mussels have dominated the freshwater tidal Hudson. They make up more than half of the non-producer biomass, and filter a volume of water equal to all of the water in the estuary every 1-4 days during the summer. Zebra mussels feed on phytoplankton, which are microscopic photosynthetic organisms that float in the water column. Phytoplankton are major producers in the Hudson River food web and are a food source for zooplankton, which are typically microscopic and cannot photosynthesize.

As you study this dataset, you may want to learn about other organisms in the Hudson River and think about how zebra mussels affected them. For instance, native pearly mussels of the Hudson, which formerly numbered more than one billion, appeared to be on the verge of disappearing from the river shortly after the zebra mussel introduction. This is largely because they were out-competed by the zebra mussels. In addition, after the zebra mussel invasion, dissolved oxygen and suspended sediment levels decreased. These changes can have different effects on different species, which you can learn more about through the additional resources and references at the end of this document. Surprisingly, some organisms have benefited from the arrival of zebra mussels, such as the fish that live in the vegetated shallows of the river, like the redbreasted sunfish.



Top: Photosynthetic phytoplankton called diatoms; **Bottom:** *Bosmina freyi*, a common zooplankton species of the freshwater Hudson River.

In addition to indirect effects from ecological changes, zebra mussels have caused direct economic damage by attaching to hard substrates like drinking water intake pipes and power plant equipment. The zebra mussel invasion had large effects on many parts of the Hudson's ecosystem, and was one of the largest changes that humans have caused to the Hudson (Strayer et al. 1999).

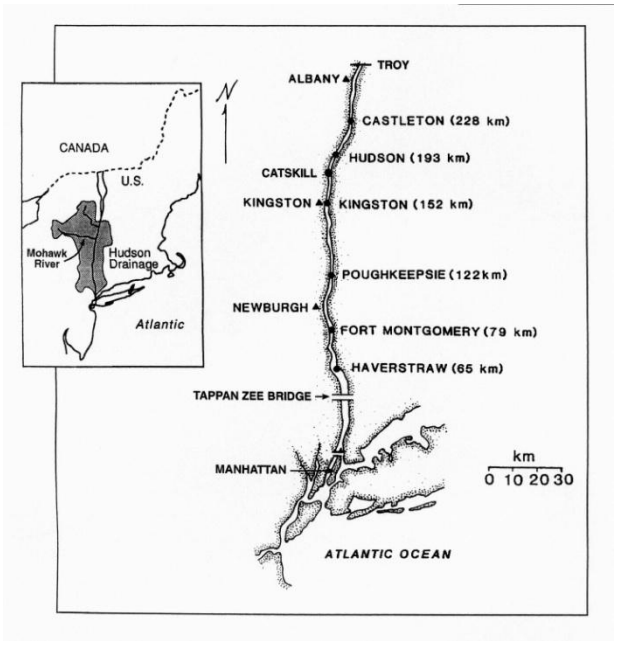
- **Dataset Variables:**
  - Year – the year the samples were collected.
  - Zebra mussel density (#/m^2) – the average number of zebra mussels collected per square meter of river bottom rocks sampled.

- **Dataset Timeframe:**
  - These data were collected between 1987 and 2014. Zebra mussels were sampled twice per year at each site. Samples were collected in June and in August. The numbers you see in the dataset are the yearly averages of the June and August collection points.

- **Data Collection Methods:**

  - Samples were collected by professional divers working with Hudson River Ecosystem Study staff.
  - At each site, divers picked up 10 river bottom rocks between 15 and 40 cm in maximum dimension and brought them to the surface.
  - Samples were brought back to the lab, where all zebra mussels > 2mm long were removed from the rocks and counted. Zebra mussels < 2 mm long were not counted because they are not considered established on the rock, and can still migrate between rocks.

- **Information About Sites**
  - Zebra mussels were sampled at 7 sites in the freshwater tidal Hudson River including Albany, Castleton, Stuyvesant, Coxsackie, Stockport, Port Ewen, and Poughkeepsie. Zebra mussels cannot live in salt water, which is why all sites are north of the typical Hudson River salt front.



- **Source of Dataset:**
  - Hudson River Ecosystem Study: http://www.caryinstitute.org/science-program/research-projects/hudson-river-ecosystem-study/hudson-river-ecosystem-study-data
  - If you have specific questions about this research that you would like to ask the scientists, please email caryeducation@caryinstitute.org and we will be happy to contact the scientists on your behalf.

❖ Inquiry Idea Starters

Here are some sample questions you could ask using these data. These are just suggestions, and we hope you'll come up with many interesting questions of your own!

- ➢ How has zebra mussel density changed in the river?
- ➢ Does zebra mussel density seem to follow any regular patterns or cycles?

❖ More Information

- ➢ In recent years, scientists have found that other Hudson River species, such as blue crabs and bluegill are now preying on zebra mussels, and that some native mussel populations are beginning to stabilize and even recover (Strayer & Malcom 2007).
- ➢ These zebra mussel data were collected by Cary Institute scientists from the Hudson River Ecosystem Study group. Founded in 1983, the Cary Institute of Ecosystem Studies is one of the world's leading independent environmental research organizations. Areas of expertise include disease ecology, forest and freshwater health, climate change, urban ecology, and invasive species.

- ➢ For three decades, Hudson River Ecosystem Study scientists have researched the Hudson River ecosystem– from the way shoreline development impacts water quality to how invasive species influence resident plants and animals. As a result, the Hudson is the most scientifically scrutinized river in the world, and the Hudson River research team is working to inform sound river management.
- ➢ Because ecosystems are dynamic, long-term studies are essential to understanding how complex ecosystems operate. Due to costs and time commitment, however, they rarely happen. By treating the Hudson River as an integrated system—with research sites spanning 200 kilometers from Troy, NY, to the Tappan Zee Bridge—the Hudson River Ecosystem Study has gained an unprecedented understanding of the river's ecosystem.
- ➢ Researchers currently involved in this study include:

David Fischer, Manager of Hudson River Studies

Dr. David Strayer, Freshwater Ecologist

Heather Malcom, Senior Research Specialist

Dr. Stuart Findlay, Aquatic Ecologist

❖ Additional Resources

- Search the large collection of Hudson River lessons (including several on zebra mussels) that are available through the Hudson River Ecology section of the Cary Institute "Teaching Materials" page: http://www.caryinstitute.org/educators/teaching-materials/hudson-river-ecology
- An excellent 8-minute video from the American Museum of Natural History about zebra mussels and the scientists who study them: https://www.youtube.com/watch?v=MtUnVMGpTFs
- This website from the American Museum of Natural History includes an interactive Hudson River data graphing tool that allows students to manipulate both time and location to examine abiotic and biotic factors such as dissolved oxygen and bacterial abundance: http://www.amnh.org/education/resources/rfl/web/riverecology/explore.html

❖ References

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Strayer, D. L., and Malcom, H. M. (2007). **Effects of zebra mussels (Dreissena polymorpha) on native bivalves: the beginning of the end or the end of the beginning?.** *Journal of the North American Benthological Society*, *26*(1), 111-122.

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Cary Institute researchers Heather Malcom and David Fischer monitoring the Hudson River