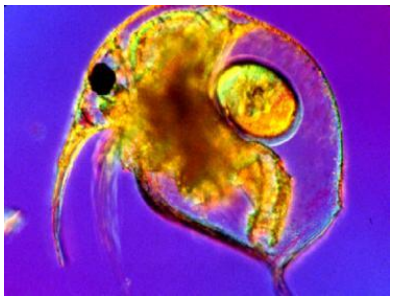
Level 2: Zebra Mussels & Other Organisms

❖ **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 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 have caused direct economic damage by attaching to hard substrates like drinking water intake pipes and power plant equipment. In addition, zebra mussels have significantly affected the living parts of the Hudson River ecosystem. They filter 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.



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

The zebra mussel invasion decreased both dissolved oxygen and suspended sediment levels in the Hudson. These changes can have variable effects on different species, which you can learn more about through the additional resources at the end of this document. Some organisms, such as deepwater fish, declined after the zebra mussel invasion, but others benefited from the zebra mussels. For example, redbreasted sunfish, which live in the vegetated shallows of the river, have experienced population growth that seems to be facilitated by zebra mussels.

As you analyze this dataset, you will learn about other organisms in the Hudson River and think about how they are connected to zebra mussels. This dataset documents changes in the populations of phytoplankton, zooplankton, and three different native pearly mussel (Unionidae) species. 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.
- ➢ **Average unionid mussel density** (#/m^2) – the average number of native mussels from the Unionidae family collected per square meter of river bottom sampled. This number includes all three species that were sampled from the Unionidae family.
- ➢ **Unionidae (native) mussel species:** *Elliptio complanata* – the average number of this particular pearly mussel species collected per square meter of river bottom sampled.
- ➢ **Unionidae (native) mussel species:** *Anodonta implicata* – the average number of this particular pearly mussel species collected per square meter of river bottom sampled.
- ➢ **Unionidae (native) mussel species:** *Leptodea ochracea* – the average number of this particular pearly mussel species collected per square meter of river bottom sampled.

Elliptio complanata
(Common name: Eastern Elliptio)
Source: Alan Cressler, www.discoverlife.org

Leptodea ochracea
(Common name: Tidewater Mucket)
Source: Art Bogan, www.discoverlife.org

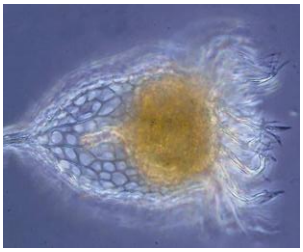
Anodonta implicata
(Common name: Alewife Floater)
Source: www.ct.gov/deep

- ➢ Phytoplankton biomass (µg/L) – the amount of Chlorophyll a in a sample of water is used to indirectly measure the amount of photosynthetic plankton.
- ➢ Zooplankton: copepods – the average number of copepods (microscopic aquatic crustaceans) counted per liter of Hudson River water sampled.
- ➢ Zooplankton: rotifers – the average number of rotifers counted per liter of Hudson River water sampled.
- ➢ Zooplankton: cladocerans – the average number of cladocerans (water fleas) counted per liter of Hudson River water sampled.
- ➢ Zooplankton: ciliates – the average number of tintinnid ciliates counted per liter of Hudson River water sampled.

Copepod

Rotifer

Cladoceran



Tintinnid Ciliate
Source: John Dolan

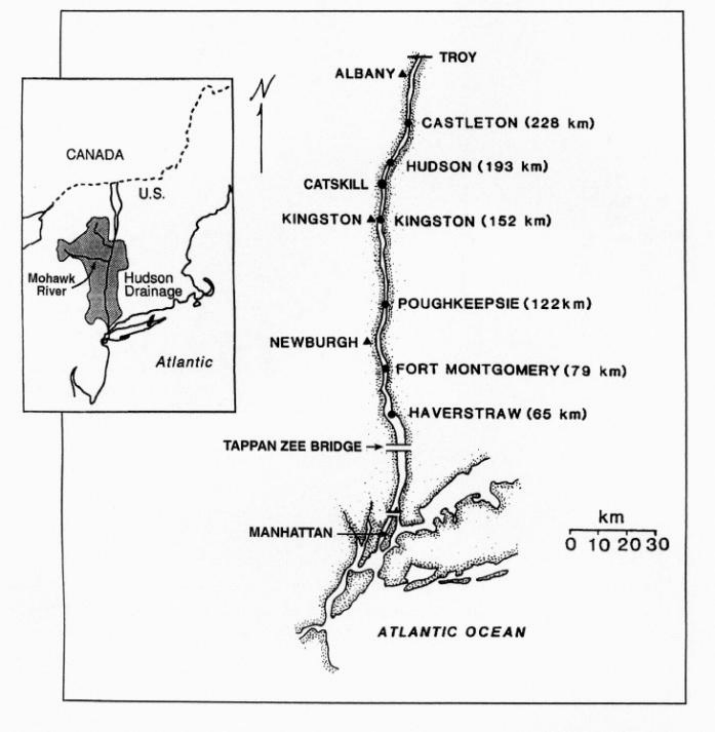
- **Dataset Timeframe:**
  - These data were collected between 1987 and 2014.
  - Zebra mussels were sampled twice per year at each site. Samples were collected in June and in August. The numbers you see in the dataset are the annual averages of the June and August collection points.
  - Pearly mussels were sampled once per year at each site, sometime between June and August.
  - Phytoplankton and zooplankton were sampled every two weeks during the growing season from May 1 through September 30.The numbers you see in the dataset are the annual averages of these collection points.

- **Data Collection Methods:**
  - Zebra mussel 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.

  - Native pearly mussels (Unionids) live in soft sediments, rather than attached to rocks, and were sampled through a different method called a PONAR grab (see photo). The PONAR scoops up sediments, which researchers are then able to sift through to find mussels. Researchers visited each site once per year and pulled 20 samples from each site. Mussels were then counted in the lab.
  - Phytoplankton density was estimated by using a chemical process to measure the amount of Chlorophyll a in water samples. Zooplankton were collected using a water pump and a mesh plankton net, which filters out water and concentrates the zooplankton sample. Zooplankton were brought back to the lab and counted under a microscope.

❖ **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. All sites were averaged together in this dataset.
- ➢ Pearly mussels were sampled each year at 11 sites along the Hudson River. The sites span the freshwater tidal portion of the Hudson River from Newburgh to the Troy Dam. Each site was sampled once per year, sometime between June and August. All sites were averaged together in this dataset.
- ➢ This dataset only includes the annual phytoplankton and zooplankton averages from the **Kingston** survey station (River kilometer 144-149). While phytoplankton and zooplankton densities vary along the river, Kingston values tend to be representative of the zebra mussel-invaded portion of the river, so this average should be sufficient for understanding mussel and plankton dynamics in your project.



❖ **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 did phytoplankton density change in the river after the zebra mussel introduction?
- ➢ How did zooplankton density change in the river after the zebra mussel introduction?
- ➢ Did different kinds of organisms respond in different ways to the zebra mussel introduction?

❖ More Information

- Although there are about 300 species of unionid mussels found only in Eastern North America, freshwater unionid (or pearly) mussels are considered by some scientists to be the most imperiled group of animals in North America (Strayer et al. 2004). Unionid mussels are filter feeders, and can control the movement of sediments and sediment-bound substances like toxins. They can be highly sensitive to pollution, and are considered an indicator of environmental quality.
- Pearly mussels have an unusual reproductive mechanism. Males release sperm into the water column, which is then uptaken through water filtration by female mussels. The fertilized eggs develop into larvae inside the female's gills for several weeks or months, and are then released into the water. The larvae cannot live independently in the water column, and must attach onto a fish host's fins or gills while they develop and disperse. For an extended look at pearly mussels, see *The Pearly Mussels of New York State* by David Strayer and Kurt Jirka.
- 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).
- 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 Changing Hudson project on the Cary Institute "For Educators" page: http://www.caryinstitute.org/educators/teaching-materials/changing-hudson-project
- 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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