PASSAGE TWO

Zebra Mussels and the Hudson River

A team of scientists at the Cary Institute of Ecosystem Studies has been researching the Hudson River ecosystem since 1986. Many changes have occurred along the river during this time, from economic development to the arrival of new species. Scientists have investigated how these changes affect the river and its aquatic life. Their research makes the Hudson River one of the most analyzed rivers in the world.

Zebra mussels arrived in the U.S. hitching a ride in the bottom compartments of cargo ships traveling from Europe to the Great Lakes. Waterways connect the Hudson River to the Great Lakes, so the Cary Institute scientists knew it was just a matter of time before zebra mussels would show up in the Hudson River. And since they had already begun collecting data on the river, they were in a unique position to understand the impact of the invasion. (Scientists don't usually have data about a lake or river until after the new species appears.) Their approach was to study the whole Hudson River ecosystem — both biotic (living) and abiotic (non-living) factors and the interactions between them.

See the chart on page 3 to learn more about biotic and abiotic factors in the river.

LOOK CLOSELY

A scuba diver collected this rock from the bottom of the Hudson River. It's covered with zebra mussels! How many do you think there are?

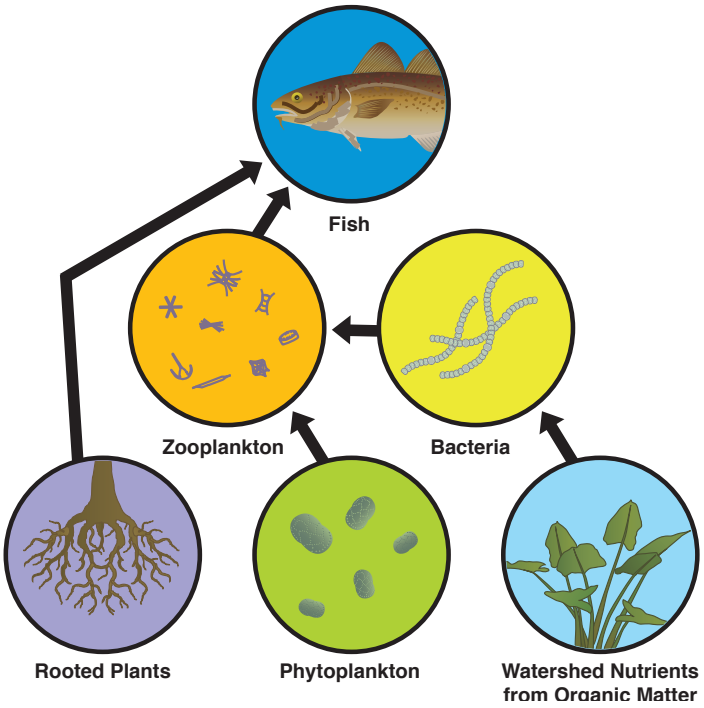
POWERED BY THE SUN

Photosynthesis is the chemical process in which green plants (and blue-green algae called cyanobacteria) make food from carbon dioxide and water using sunlight or light as an energy source.

CONTINUED: ZEBRA MUSSELS AND THE HUDSON RIVER

Making Predictions

Based on the Hudson's water chemistry, its river bottom, and other conditions, scientists predicted zebra mussels would thrive in the river. But the bigger question was: How would these zebra mussels affect the food web? Based on previous studies, scientists estimated how much plankton the zebra mussels could filter out of the water. (Phytoplankton and zooplankton are microscopic organisms that are two critical components of the river's food web.) The numbers suggested the impact of zebra mussels on the river could be huge.



HUDSON RIVER ECOSYSTEM FOOD WEB

This web shows how closely organisms in the Hudson River ecosystem interact with one another. Anything that happens to part of the web has an effect on the whole ecosystem.

Monitoring the River

Scientists have combined two approaches to studying the river's ecosystem:

- ***A spatial approach***, in which water samples are taken from many, closely spaced locations (called "transects") along the river. This data helps scientists analyze how changes relate to geography.

- ***A temporal approach***, in which samples are taken from the same six locations 4-6 times from May through October. (This is the "growing season" when organisms are most active.) Data is also collected from one location during winter months. By collecting data from the same locations for over 20 years, scientists can study changes over time.

CONTINUED: ZEBRA MUSSELS AND THE HUDSON RIVER

BIOTIC FACTORS

phytoplankton

These tiny driting organisms use photosynthesis to make food. They form the base of the ecosystem's food web. Like other producers, phytoplankton use chlorophyll for photosynthesis. To determine the amount of phytoplankton, scientists filter plankton from the water and measure the amount of chlorophyll they contain.

zooplankton

These tiny animals drift in open water, feeding on phytoplankton. Scientists measure their abundance by filtering river water through mesh nets. Different mesh sizes are used to sample small and large zooplankton.

watershed nutrients from organic matter

Organic particles from soil, dead leaves, and other materials wash into the river from the watershed (the surrounding land). This organic matter feeds many organisms, especially bacteria.

fish

Fish are the top predators of the river's food web. Fish eat zooplankton, invertebrates, or other fish. Scientists divide fish into two groups: pelagic fish, which live in open, deeper water; and littoral fish, which live in shallow water with plants.

plants

Some plants grow where water is shallow and clear enough for sunlight to reach the bottom. (Most of the river is too deep and turbid.) Scientists have found grasslike plants called water celery in 6 percent of the Hudson. They produce organic matter for the food web.

zebra mussels

Scuba divers collect rocks from hard areas of the river bottom. In the lab, zebra mussels are removed from the rocks, counted, and their shells measured. In "soft-bottom" areas, scientists use a device called a benthic grab to collect material. They count the mussels they find in these samples too. They combine data from both areas to estimate the total number of mussels in the river.

ABIOTIC FACTORS

water temperature

Temperature affects an organism's metabolism — the internal chemical reactions that affect its health and growth. Air and water temperatures vary with changes in weather, season, and the global climate. Scientists have found that the life cycle stages of many organisms change with the season.

dissolved oxygen

Oxygen is dissolved in water, but water doesn't hold as much oxygen as air in the atmosphere. Dissolved oxygen refers to molecules of oxygen gas (O_2) —which is different from the oxygen in a water molecule (H_2O). Even though aquatic animals can survive on lower concentrations of oxygen (O_2), they are threatened when O_2 levels are too low. Both producers and consumers (like zebra mussels) take up oxygen during respiration, causing oxygen levels to drop. Zebra mussels also reduce oxygen levels by eating producers (like phytoplankton) that release O_2 during photosynthesis.

suspended solids

The solid particles suspended in water affect its clarity and quality. These particles — measured as total suspended solids (TSS) — can be both biotic (like phytoplankton) and abiotic (like silt and clay). Scientists measure water's TSS by pouring a sample through a filter. The suspended solids are any particles that are too large to pass through. Zebra mussels consume huge amounts of suspended solids, clearing large bodies of water. Since suspended solids block sunlight in the water, lower TTS means more light for producers.

CONTINUED: ZEBRA MUSSELS AND THE HUDSON RIVER

The team gathers data from a small motorboat. They lower probes into the river to measure abiotic (chemical or physical) factors such as the water's temperature, oxygen and pH levels, current, speed, and cloudiness of the water (called turbidity). They also collect water and zebra mussels to test back in the lab. There, they measure the amount of sediment in the water as well as biotic factors — the living organisms in the water. Along the Hudson, the key biotic factors are phytoplankton, zooplankton, bacteria, crabs, fish, and, of course, the zebra mussels.

SCIENTISTS AT WORK

These scientists are collecting samples of tiny zooplankton from the river using long, fine mesh nets. They also collect data about each location using probes that measure temperature, oxygen, and other important factors.

STOP AND THINK

1. **What kinds of data are scientists collecting in the Hudson River? How does this compare to your answer in Passage 1? (Be sure to review the chart on page 3.)**
2. **What types of tools and techniques did the scientists use to gather, analyze, and interpret data?**
3. **How could this data help the scientists assess the impact of the zebra mussel invasion on the food web?**

EXPLORE MORE AT
amnh.org/education/hudsonriver