PASSAGE THREE

The Short-Term Impact of the Zebra Mussel Invasion

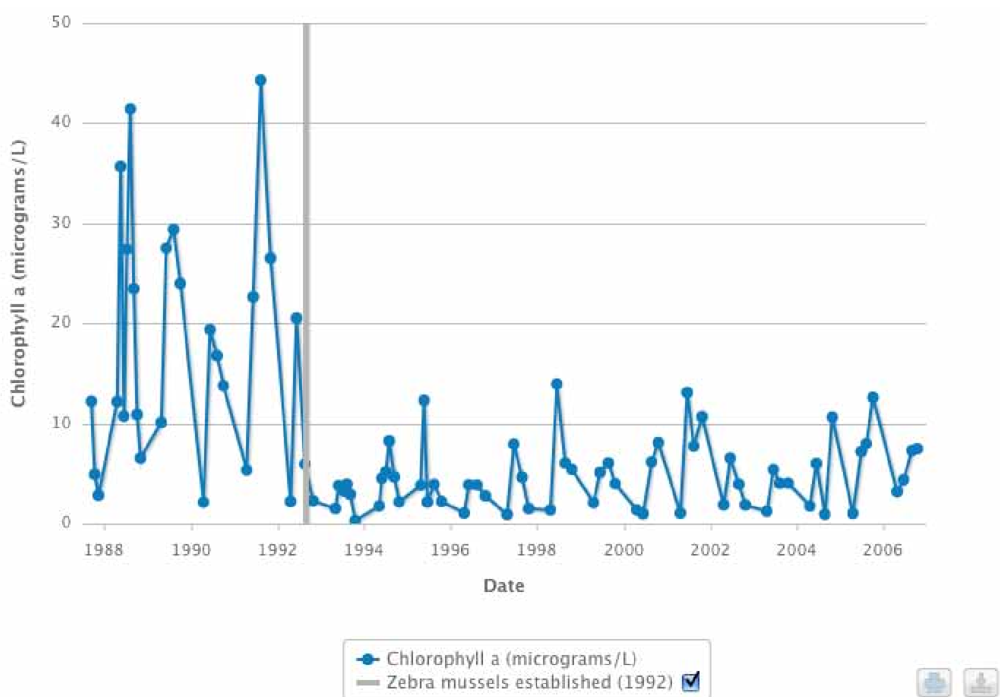
Zebra mussels first appeared in the Hudson River in May 1991. By 1992, scientists estimated that they numbered about 500 billion. This accounted for half of the heterotrophic biomass of the river. In other words, if you had a huge balance and put zebra mussels on one side, they would outweigh all the other consumers: native fish, native zooplankton, worms that live in the river bottom, all the shellfish, and all the bacteria.

Phytoplankton and Zooplankton Populations Drop Sharply

Before the invasion, the Cary Institute scientists had created computer models that predicted the effect of the zebra mussels on phytoplankton. The predictions were dire. Even so, the scientists were surprised by the consequences for the food web. By 1992 zebra mussels were so abundant that scientists estimate they were filtering a volume of water equal to all of the water in the estuary every 1-4 days during the summer. In the years immediately following the invasion, phytoplankton biomass fell by 80%. The overall population of zooplankton, which eat phytoplankton, declined by half, and populations of the smallest zooplankton (micro-zooplankton) fell by about 90%.

In 1994, two years into the zebra mussel invasion, Cary Institute scientists hypothesized that zebra mussels were causing phytoplankton populations to decline, resulting in a shortage of food for the zooplankton and reductions in their numbers. So competition was taking place and the zebra mussels were winning.

The scientists submitted a manuscript to several peer-reviewed scientific journals, but reviewers requested more sampling and experimentation in order to support the hypothesis. While the declines did coincide with the zebra mussel's arrival, no supporting experiments established that the zebra mussels were in fact causing the algae to decline, nor that this decline was responsible for the drop in zooplankton. Perhaps other processes were behind the fluctuations. Perhaps other simultaneous events had negatively impacted zooplankton, such as a release of pollution or major changes in rainfall patterns. Perhaps zebra mussels were in



This graph shows the change in concentration of Chrolophyll a (representing phytoplankton biomass) between 1988 and 2006 at the Kingston station. The gray line indicates the date that zebra mussels first became established in the river.

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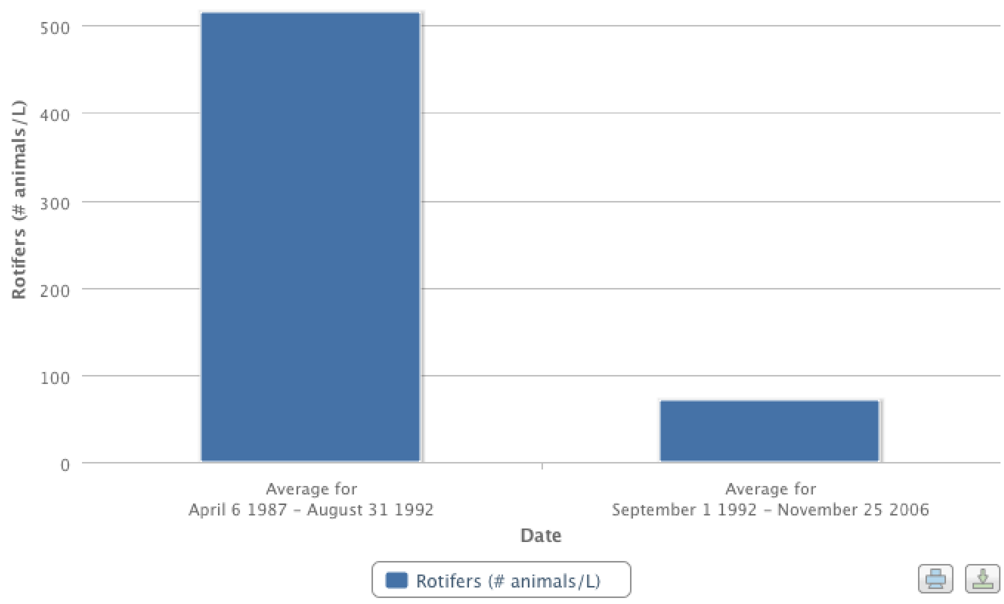
fact causing the declines but not by competing with zooplankton for phytoplankton. A different process altogether might be responsible. Reviewers also suggested the scientists collect more years of monitoring data.

The Food Web Changes

In the years that followed, the Cary Institute data remained consistent with these earlier findings, and these were published in peer-reviewed scientific journals. Scientists also made additional findings. They observed that the initial impact on phytoplankton and zooplankton rippled throughout the food web. With less food available, the fish that live in the open river such as shad, herring, and striped bass, declined in number or grew more slowly. Scientists found that native pearly mussels, which also eat plankton and formerly numbered more than one billion, appeared on the verge of disappearing.



This bar graph shows the change in the average number of rotifers per liter (micro-zooplankton) at the Kingston station before and after zebra mussels became established in 1992.

Scientists also observed a significant change in the turbidity of the river. With far less phytoplankton, the water got clearer and sunlight reached deeper. During the summertime, instead of being limited to three to five feet, visibility extended between four and eight feet. Scientists found that the rate of growth of rooted aquatic plants such as water celery increased by as much as 40 percent. This benefited fish that live in these shallow weed beds, such as sunfish and largemouth and smallmouth bass. Scientists measured an increase in these populations, and observed that they moved further upriver than before the zebra mussel invasion.

Other results were unexpected, even surprising. After the invasion, scientists observed that dissolved oxygen in the river fell by about 15 percent. Too small a drop to endanger any river-dwelling animals, it was nevertheless a huge amount of oxygen. Scientists think the enormous zebra mussel populations were consuming oxygen at large rates. The simultaneous removal of phytoplankton, single-cell plants that produce oxygen, might also have contributed to the drop.

Questions About the Long-Term Impact

Once an invasive species is established in an ecosystem, many things can happen. For example, the invader's population could adapt to the new environment, making it more able to efficiently use the resources of its new home.. Alternatively, native species might adapt to be more tolerant of, or to even feed on, the invader. Once Cary Institute scientists had a clear picture of the invasion's immediate impact, they started to wonder more about these long-term consequences.

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Stop and Think

1. What evidence did the scientists use to assess the impact of the zebra mussel invasion?
2. Two years into the zebra mussel invasion, reviewers chose not to publish this research. Do you think their decision was justified? If you were a reviewer, what additional evidence would you have wanted to see, if any? What do you think ultimately tipped the balance in favor of publication?
3. Over time, did the scientists adequately answer their original question about how the zebra mussels might affect the Hudson River ecosystem?
4. Why do the scientists continue to collect data about the ecology of the Hudson River 20 years after the invasion of the zebra mussels?
5. What additional questions might they investigate? What might some of the long-term impacts of the invasion be?