Slide Notes for Power Point Presentation:
Consequences of Zebra Mussel Invasion in the Hudson

Slide number	Notes	Additional Notes
1	Now that you know about the invasion of zebra mussels in the Hudson River, let's take a more detailed look at the consequences for native species.	
2	You can use this chart to summarize or review your students' findings from the Jigsaw activity completed in this lesson.	
3	Zebra mussels cover large areas of the benthic environment, crowding out native (and threatened) bivalves, sometimes growing on top of them.	
4	Our native pearly mussels, part of the unionid family, are amazing organisms that are seriously threatened. While they might not be as cute as other threatened organisms, they have really interesting symbiotic relationships with fish (see next slide).	
5	Pearly mussels have an amazing relationship with fish; they release their larvae (glochidia) into the water, where they latch onto the gills of a host fish. This is a "parasitic" relationship, although we're unsure of whether the larvae actually harm the fish or not. Each pearly mussel has its own fish host species. The snuffbox on the lower right hand side actually captures its host fish, the log perch, between its shell, and then releases the larvae. The other images are examples of lures that the mussels use to encourage fish to come closer and investigate a possible meal, at which point the mussel releases the glochidia.	
6	Images in this slide demonstrate the economic importance of pearly mussels. Before plastics, mussel shells were used to make buttons. *Follow the link to a video of freshwater mussel behavior in the streams of Missouri. These mussels' flesh looks and moves like small fish.	

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7	Zebra mussels filter a lot of the Hudson River every day; even in times of low population levels, they still filter 30-40% of the river every day. The cyclic nature of zebra mussel population is evident in the fluctuations in filtration rate. There is wide variation in the filtration rate, but the overall trend is down since the invasion in 1992-1993.	
8	Results from Cary Institute research- early years of ZM invasion: Submerged aquatic plants grow in the shallows. Water transparency has increased due to ZM filtering large volumes of water. Aquatic plants get more sunlight so their growth has increased.	
9	How to read this diagram: Red- decreased in concentration (abiotic) or population size (biotic) Blue- increased " " Example: Littoral fish (found along the shore) such as pumpkinseed increased in population size as water clarity increased.	
10	In comparison, open water fish that rely on plankton for food experienced population declines because the zebra mussels were eating a lot of their food. Dissolved oxygen also decreased because A) ZM respiration and B) declines in phytoplankton (which oxygenate the water through photosynthesis). Image left: Shad, Imagine right: pumpkin seed fish	
11	Here is another way to visualize the changes that have taken place in the Hudson River as a result of the ZM invasion.	
12	Changing trends- The smaller zebra mussels consume phytoplankton and bacteria (zooplankton are too big for them to eat). Since 2005, most of the zebra mussels have been small and medium, so phytoplankton is being eaten at high rates and can't recover. The largest zebra mussels eat phytoplankton and micro-zooplankton. Since 2005, very few zebra mussels live through their first year to become adults. Therefore, there is much less predation on the micro-zooplankton and their populations have	

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	started to recover.	
13	The first full year of the invasion was 1993. The early invasion was 1993-2004. The later invasion, sometimes referred to as the "recovery" began in 2005. The zebra mussel population goes up and down, being limited by light, food, and freshwater flow. In 2007, there were nearly 4,000 in a square meter!	
14	Summary of conditions later in the invasion: -Native bivalves, deepwater invertebrates, and zooplankton are starting to come back. -Phytoplankton remains down – the mystery remains – how is this possible? What else are zooplankton eating that allows them to be successful w/o the phytoplankton? -Studying this system long term has helped us to track changes in this dynamic system.	
15	Adult male blue crabs migrate upriver in the late summer, and have been observed eating zebra mussels. There aren't more blue crabs in the river, however, so we might assume that they have learned how to eat the mussels over time. Another organism in the river that has learned to eat the mussels is the pumpkinseed fish, which has a pharyngeal tooth (instead of actual teeth, these fish have one tooth further down in their throats). The pumpkinseed is a type of sunfish. In observational studies done at the Cary Institute of Ecosystem Studies, scientists observed pumpkinseed fish from the Hudson River eating zebra mussels. The same species of fish, however, that was taken from a river were there were no zebra mussels, did not eat the zebra mussels, even after being starved for several days. The question remains – did the fish learn how to eat the zebra mussels in the Hudson? Or were pumpkinseed with larger or stronger pharyngeal teeth selected for over the course of the invasion?	