The Zebra Mussel Connection: Harmful Algal Blooms and the ECOHAB Project

INTRODUCTION

Nuisance blooms of the potentially toxic blue-green alga *Microcystis* have returned to Lake Huron's Saginaw Bay and Lake Erie. Saginaw Bay has experienced blooms most summers since 1992. Lake Erie has also experienced blooms during many summers. One bloom, resembling a thick slick of grass-green paint, extended over the entire surface of the western basin during September 1995 (Figure 1) was documented in a satellite image.. Blooms of *Microcystis* and other blue-greens have not occurred since the 1970's and early 1980's when phosphorus controls began to reduce phosphorus inputs to the Great Lakes. Excessive phosphorus is the usual culprit for nuisance blooms, but now other causes must be considered.

These recent blooms occurred a few years after the invasion of zebra mussels and their cousins the quagga mussels in the Great Lakes. The prodigious filtering by these mussels makes the water clear by removing particles. Even in years when blooms have occurred, zebra mussel filtering caused the water to be very clear during spring and early summer before the blooms took off. A similar pattern of *Microcystis* or other blue-green blooms is now being seen in some small lakes that have been invaded by mussels.

Blooms are of concern because *Microcystis* is poor food for the aquatic food chain and because it contains a potent toxin called microcystin that is harmful to the aquatic food chain, including fishes, and to waterfowl or other animals that might drink untreated water. The Lake Erie and Saginaw Bay strains of *Microcystis* are toxic; however, there has to be a high concentration of *Microcystis*, such as that found in a thick surface scum, to be dangerous to wildlife or pets drinking the water. Such conditions can occur when *Microcystis* floats up to the surface under calm conditions and is concentrated by winds or currents in areas near shore.

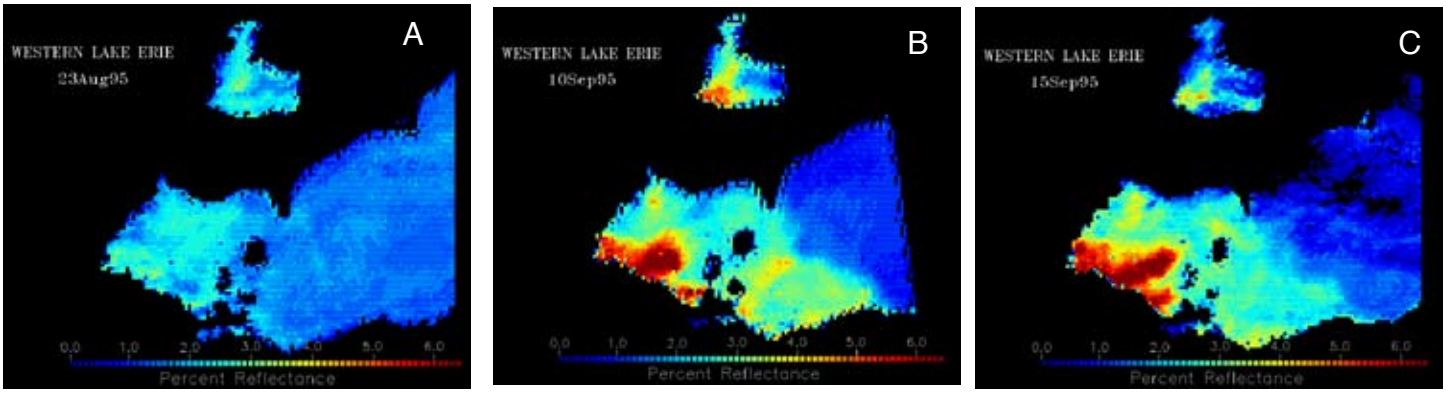

Figure 1. NOAA CoastWatch satellite images of western Lake Erie showing development of the Microcystis *bloom as measured by percent reflectance, which is a measure of concentration of particles—in this case* Microcystis*—in the water. Little reflectance was seen on (A) 23 Aug 95, before the bloom got underway. Concentration of* Microcystis *started to increase in the southwestern part of the western basin (B) (10 Sep 95) and continued until much of the whole basin was covered (C) (15 Sep 95). The water body near the figure captions is Lake St. Clair.*

WHAT GLERL IS DOING

An extensive monitoring and experimental program of NOAA's Great Lakes Environmental Research Laboratory (GLERL) on Saginaw Bay provided early hypotheses and some answers to explain the zebra mussel-*Microcystis* connection. In particular, experiments at GLERL with water from Saginaw Bay and Lake Erie have shown that zebra mussels selectively filter and reject phytoplankton so as to promote and maintain *Microcystis* blooms as follows. Using special video equipment, GLERL showed that mussels filter the water whether or not *Microcystis* is present, but they spit *Microcystis* back into the water, while at the same time they eat other algae (Figure 2). Thus, the competitors of *Microcystis* are removed. This probably explains why *Microcystis* has been Saginaw Bay's dominant alga in many summers. At the same time this selective feeding process is occurring, the mussels are excreting nutrients (phosphate and ammonia) derived from the phytoplankton they eat as part of digestion and metabolic processes. These nutrients, in turn, serve to fertilize further growth of *Microcystis*.

Zebra mussel.

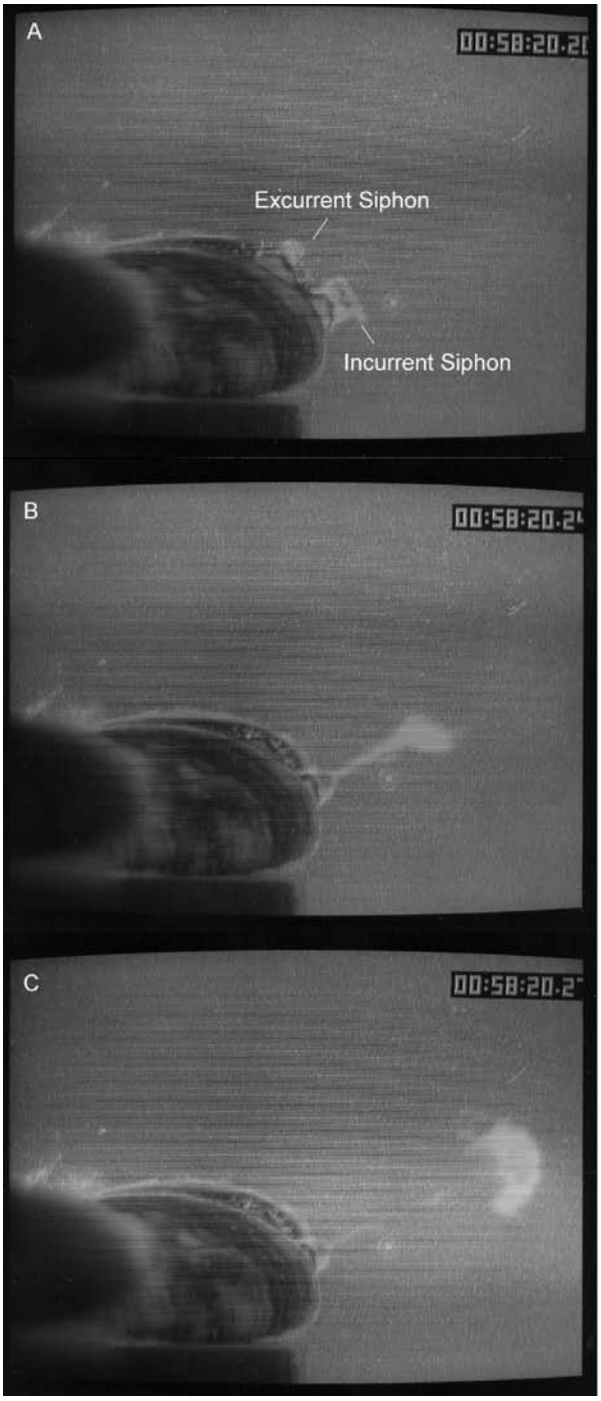

Figure 2. Zebra mussel expelling Microcystis *as pseudofeces. (A) Mussel filtering with siphons in normal position. (B) Excurrent siphon retracted and incurrent siphon starting to expel the* Microcystis *as pseudofeces. (C) Pseudofeces ejected.*

UNDERSTANDING CAUSES OF BLOOMS - THE ECOHAB PROJECT

A major question about the zebra mussel connection is that zebra mussels appear to primarily promote blooms in lakes having a moderate level of nutrients as now occur in some Great Lakes, but not in lakes of high or low nutrient levels. GLERL has been participating in a large project with colleagues from Michigan State University as part of the NSF, EPA, and NOAA's Ecology of Harmful Algal Blooms (ECOHAB) Program to understand the influence of nutrients on the *Microcystis*-mussel interaction. To get at this question, we are doing experiments in mesocosms, large plastic cylinders (Figure 3), in which we manipulate the abundance of both mussels and nutrient concentrations in the different mesocosms. The mesocosms were initially filled with lake water containing the ambient concentrations of phytoplankton and zooplankton before we added mussels and nutrients. By monitoring the populations of different phytoplankton and *Microcystis* in the different mesocosms, we can tell what combination of nutrients and mussels promote blooms. At the same time, we determine feeding rates and nutrient excretion rates of the mussels in the mesocosms so we know their effect. Experiments like these are more controlled and cost effective than working in several different lakes.

Figure 3. Floating dock holding the large (2-m wide × 11-m deep) plastic cylinders called mesocosms. Each of these mesocosms may be thought of as a miniature lake.

Microcystis *bloom.*

PARTNERS

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