AQUATIC INVASIVE SPECIES

Model of Lake Michigan-Illinois River Zebra Mussel Metapopulation: Evaluating Possible Control Strategies

Final Report

Objectives
Identify the factors responsible for variable mortality and growth of Dreissena larvae in the Illinois River and Hudson River Estuary. Model the interaction of flow with growth and mortality to predict the spatial and temporal patters of settlement across systems. Determine how larval dynamics contribute to spatial and temporal patterns of settlement in the field.

Progress
Identified developmental bottleneck in laboratory studies. Currently assessing the role of food and starvation in bottleneck. Correlated larval abundance and settlement in Hudson River. Settlement is spatially variable, and related to local weather conditions as a result of the interaction of rainfall and storage of larvae in side embayments in the river.

Narrative Report
We have completed 1 full field season on the Hudson River and a number of laboratory experiments on larval mortality. First, we have successfully reared zebra mussel larvae in the laboratory, and established reliable techniques for studying aspects of larval biology. We have established our larval rearing laboratory as a resource for other researchers as well, who have used our facilities for their own studies on larval biology. Secondly, we have shown that zebra mussel larvae go through a developmental bottleneck in the laboratory around the time of the transition from D-stage to umbonal or veliconch larvae. During this transition, mortality increases substantially, from around 10%/d to around 30%/d. This bottleneck occurs consistently in laboratory studies at the same developmental stage as the increased mortality observed in the field during our previous study of the Illinois River. During this transition period, zebra mussel larvae may be particularly vulnerable to adverse environmental conditions such as low food or dissolved oxygen. We are currently investigating the reasons for this bottleneck, including food limitation and developmental constraints.

We have also studied the patterns of larval supply and settlement in the Hudson River Estuary. We have found a strong correlation between the number of large veligers in the plankton (> 200 æm) and settlement density, suggesting that larval supply is one of the primary determinants of local population size in river ecosystems. Thus, it is critical to understand factors affecting larval supply, such as mortality and water circulation patterns, to understand population dynamics of the zebra mussel.

The water flow and hydrodynamics affecting larval transport in the Hudson River Estuary are complex, and under investigation in a companion Illinois/Indiana Sea Grant project (C. Rehmann, PI). We have been using a combination of modeling and dye studies to assess the role of water flow in affecting larval transport and retention. One surprising factor affecting settlement rates that our field studies revealed was the potential importance of local rainfall. Intense, localized storms can flush nearby embayments and move trapped larvae into the main channel, and affect larval settlement rates. We found a highly significant correlation ($P < 0.001$) between daily rainfall and zebra mussel settlement rates for a main channel site in the Hudson River (Mills Norrie State Park) where we conducted our dye study, just downstream of a side embayment (Fig. 4). Rainfall accounted for 80% of the variance in our data on settlement at this site. At another site, Marist

College, there are no nearby embayments, and we found no correlation between local rainfall and settlement. Thus, depending on local environmental conditions and the timing of these short-term local events, side embayments could act as sources or sinks of larvae to river or estuarine systems.

Summary

We are evaluating the possibility of controlling the zebra mussel by concentrating efforts on the larval phase of the life cycle. This phase is responsible for dispersal of the mussel to new habitats and the maintenance of populations. River ecosystems, where larvae disperse downstream may be particular suitable for implementing control. We are investigating stages in the larval phase that may be most vulnerable to control efforts. In addition, we are documenting the role of dispersal and settlement of larvae in maintaining adult populations in the Hudson and Illinois Rivers. By combining models of water transport and larval biology, we hope to evaluate the potential for controlling the mussel in rivers with different flow characteristics. Evaluates the potential for controlling zebra mussels in flowing water systems by manipulating larval dispersal and abundance. Defines the environmental conditions where such a control scheme will be effective. Evaluates the role of critical periods in life cycle of zebra mussels when sensitivity to control may be greatest.

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