Biomass, Condition of Western Lake Erie Dreissenids

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Overview

The introduction and expansion of dreissenid mussels (Zebra and Quagga mussel) has led to large-scale changes in nutrient dynamics and food webs in the Great Lakes. This project will examine the physiological condition of dreissenids in western Lake Erie and compare results to the condition of mussel populations in Lake Michigan. This project will…

- examine trends over time and
- assess the relative physiological condition and abundance of dreissenids populations to predict rates of population change

Proposed Work

This is a joint project with the University of Windsor and the GLSC-USGS.

- Analyze length-weight relationships, glycogen content, carbon, and nitrogen content from 2007 dreissenid collections
- Write manuscript analyzing sampling data

Sample processing and analysis at the Great Lakes Environmental Research Laboratory

Accomplishments

Models to determine the impact of dreissenids on the western Lake Erie ecosystem are dependent upon accurate estimates of dreissenid biomass but there are no current, accurate estimates of biomass in this portion of the lake. Biomass is calculated from abundances, size-frequencies, and length-weights. The goal of this project is to determine these three variables for the population in the western basin and work completed to date includes:

- Established 60 sites throughout the western basin for sampling
- Spring 2004: 30 sites sampled by GLSC-USGS, 30 sites sampled by GLERL-NOAA
- Dreissenids collected in spring (May), summer (July), and fall (October) for determination of relative physiological condition at five sites Detroit River plume
    - Maumee River plume
    - Deep mid-lake
    - Shallow eastern islands
    - South mixed plume
- Zebra and Quagga mussel variables measured at each site to assess physiological condition as compared to dreissenids collected in Lake Michigan length-weight to determine biomass
    - lipid content
    - glycogen
    - C:N ratio
- All dreissenids collected at the 30 sites in western Lake Erie were counted, identified (Zebra or Quagga), and their sizes determined in 2004 and 2005

Dreissenid sample processing and analysis at the Great Lakes Environmental Research Laboratory

Scientific Rationale

Measures of physiological condition provide insight into the relative condition of populations. As populations expand, environmental conditions such as food availability become limiting, and the population will either stabilize or decline. Abundances can be highly variable, and sometimes are not accurate on a local scale.

Physiological conditions, however, combine all environmental variables and can be useful in predicting trends in populations. An accurate measure of physiological condition in dreissenids is the shell length-tissue weight relationship. Tissue weight per unit length is high in healthy populations, but severely depressed in populations that are stressed. Differences in weight per length can be 4-fold between the two extremes. Measuring length-weight, abundance, and size-frequency are essential to determine population biomass. Metabolic processes such as filtering and excretion are defined in biomass units, and ecosystem impacts can only be truly assessed if population biomass estimates are accurate.

Governmental/Societal Relevance

Accurate estimates of dreissenids population biomass in Lake Erie are necessary to examine causes for recent changes in lake phosphorous levels. After the initiation of phosphorus abatement programs in the 1970s, there were improvements in water quality of Lake Erie. Recently, progress has been reversed and some theories indicate dreissenid mussels as the cause for this reversal. This theory cannot be proven without accurate measures of dreissenid populations throughout the lake.

Relevance to Ecosystem Forecasting

Most significant ecological changes occurring in the Great Lakes over the past few decades have been the result of the introduction and spread of invasive species, particularly dreissenid mussels. Ecosystem models must now incorporate the activities of dreissenids to evaluate present and predict future lake ecosystem scenarios.

Biomass measures are most relevant when defining dreissenid rate processing. Most large mussels have lower rates per unit biomass than smaller mussels; however a few large mussels in a system may have filtering and excretion rates that are greater in magnitude than several hundred smaller mussels.

A key component of ecological prediction is making accurate assessments of population growth patterns. Knowing whether dreissenid populations are stressed/stagnant or healthy/functional is essential when predicting population direction. The indicators of physiological well-being measured in this project provide an assessment of present population health and therefore the potential for future population growth.