COASTAL OCEAN RESEARCH

R/CZ-31PD: 3.15.1998–5.01.2001

Calcium Requirements and the Spread of Zebra Mussels

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Background

Zebra mussels (*Dreissena polymorpha*) are pistachio-sized freshwater bivalves native to the regions around the Black and Caspian seas. Since their discovery in Lake St. Clair, Michigan, in the late 1980s, they have spread distressingly fast through the Great Lakes and Mississippi River basin, as well as to other lakes and rivers in the eastern United States and Canada.

Zebra mussels are considered a nuisance species because of their tremendous abundance (they can grow on top of each other in great mounds) and habit of colonizing the interior of any pipe carrying fresh water. They also encrust docks and boats and can literally carpet beaches with their small, sharp shells. From an ecological perspective, they can alter the natural food chain by filtering huge amounts of algae.

Zebra mussels are 2- to 3-centimeter-long freshwater bivalves. Their shells have alternating dark and light stripes, hence their name. Photo: S. van Mechelen, University of Amsterdam, The Netherlands

Worker removing zebra mussels from water intake pipes. Photo: Ron Peplowski, Detroit Edison—Monroe, Michigan Power Station

Governments and businesses have spent many millions of dollars unclogging water lines, scraping water in-take screens, boat hulls and boat engines and developing public education programs to slow their spread. There is no ecologically friendly way to eradicate zebra mussels.

Despite their highly invasive nature, zebra mussels have not spread west of the Rocky Mountains. There are no established populations in California. This is encouraging since the mussel, if established, might easily menace the region's elaborate aqueduct, which transports much-needed water to desert cities and farms.

Project

One component of a successful strategy for keeping California free of zebra mussels is identifying those environmental conditions that favor its proliferation. One such parameter is dissolved calcium. Mussels need calcium to build their shells and for gamete production. For this reason, scientists have hypothesized that dissolved calcium concentrations might limit the potential distribution of mussels, with mussels thriving only in calcium-rich waters.

Sea Grant and the U.S. Department of Energy's National Energy Technology Laboratory funded Andrew Cohen of the San Francisco Estuary Institute to review the existing body of scientific literature on the calcium requirements of the mussel and to compare this information to the known distribution of zebra mussels across the United States. His collaborator on the project was Anna Weinstein, also with the San Francisco Estuary Institute.

Based on their review, Cohen and Weinstein believe many lakes

Lake Powell in southern Utah and northern Arizona has between 2 and 3 million visitors a year, many of whom bring their own boats. The lake's popularity and its calcium concentrations, salinity, temperature and acidity make it the most likely point of entry for a zebra mussel infestation in the Colorado River system. Photo: Mark Anderson, Glen Canyon National Recreation Area, National Park Service

and rivers are less vulnerable to infestation than previously thought. Calcium levels do indeed limit the zebra mussel's potential range, they report. However, "Previous studies that assumed the mussels can reproduce throughout the United States have misrepresented their potential range," Cohen said. "The number of vulnerable sites in North America is probably lower than we thought."

More specifically, Cohen and Weinstein found that:

• Zebra mussels are unlikely to become established in waters with calcium concentrations below 20 milligrams per liter (mg/l) unless there is an upstream source of larvae from waters with higher calcium levels. This is significant because past studies have assumed a 15 mg/l or even an 8 mg/l threshold.

• If the 20 mg/l threshold is true, studies of the mussel's potential distribution in America have overestimated the number of vulnerable waterways between 20 and 200 percent, they report. North Carolina and Connecticut are two areas where relatively calcium-poor waterways may prevent infestations.

• Cohen believes future studies should focus on understanding the mussel's ability to complete reproduction and development in calcium concentrations between about 12 mg/l and 28 mg/l. Calcium levels in the California aqueduct and many of the state's waterways fall squarely in this range, he added.

Impacts and Collaborations

The California Department of Water Resources is incorporating the scientists' findings into its current risk assessment report.

Cohen is working with the Center for Applied Aquatic Ecology at North Carolina State University to continue fieldwork needed to understand the zebra mussel's true calcium requirements.

The study's findings are based on an analysis of many sources of data. However, the two primary sources were the Environmental Protection Agency, which maintains a database on the chemistry of the nation's waters, and the U.S. Geological Survey, which maintains information on the zebra mussel's distribution. Since the project's completion, zebra mussels have shown up in a waterway in northwestern Connecticut, where the calcium levels are the highest in the state at 25 mg/l.

Publications

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May 2004

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This work is sponsored in part by a grant from the National Sea Grant College Program, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, under grant number NA04OAR4170038, Project number A/P-1. The views expressed herein are those of the author and do not necessarily reflect the views of NOAA or any of its sub-agencies. The U.S. Government is authorized to reproduce and distribute for governmental purposes.

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