Author's Commentary: The Outstanding Zebra Mussel Papers

Sandra A. Nierzwicki-Bauer
Darrin Fresh Water Institute
Rensselaer Polytechnic Institute
Troy, NY 12180
nierzs@rpi.edu

Introduction

One cannot underestimate the potential impact of exotic aquatic species. In particular, the zebra mussel, a small, fingernail-sized freshwater mollusk that was unintentionally introduced to North America via ballast water from a transoceanic vessel, has caused havoc to say the least! Zebra mussels have significantly impacted electrical power generation stations, drinking water treatment plants, industrial facilities, navigation lock and dam structures, and recreational water bodies. In fact, zebra mussels cause an estimated $5 billion in economic damage annually, with this amount continuing to escalate. The zebra mussel problem is a national one, which impacts over half of the fifty states. In light of the ecologically devastating and costly consequences of zebra mussels, it is imperative that there is increased education, research, and science-based policy.

As revealed in this year's contest, the use of real data sets means working with numerous variables and sometimes incomplete information. Additionally, the facts that need to be considered when trying to address issues surrounding the success or failure of zebra mussels to spread and survive are complex. Many important and complex environmental problems lie at the interface of disciplines and therefore require interdisciplinary approaches to be addressed. Interdisciplinary training is more than learning and acquiring the ability to talk different languages across disciplinary boundaries. It is an approach that promotes teamwork, innovation, creativity, and "out-of-the-box" thinking for solving "real-world" issues and problems. The interdisciplinary problem contest plays a vital role in this experiential training bringing together

The UMAP Journal 22 (4) (2001) 421–425.

teams of students that are focused for four days on "solving" a complex problem. The breadth of approaches that were used by the teams this year was truly impressive.

Basis for Contest Question: Queen of the American Lakes, Lake George, NY

Until recently, it was thought that zebra mussels had not invaded Lake George, New York, the home of the Darrin Fresh Water Institute (DFWI). Since 1995, the DFWI had carried out a zebra mussel monitoring program in Lake George where zebra mussel larvae had been observed in only two of the years. In 1997, larval zebra mussel numbers at 1 of 11 locations were comparable to those observed in the Hudson River, an area of high zebra mussel colonization. Despite the presence of larvae, no adult zebra mussels or settled juveniles had been observed. In December of 1999, the situation changed when two divers from the Bateaux Below Inc., a nonprofit organization dedicated to underwater archaeology, found adult zebra mussels at the southern end of Lake George.

In response to the discovery of these mussels, the DFWI has been working intensively at the site to determine why adult zebra mussels were able to survive and reproduce, ways in which they could have been introduced to this location, and an appropriate action to eradicate them from this location.

The discovery of zebra mussels in Lake George was particularly surprising given the low calcium content and low pH of the lake; laboratory tank experiments had previously shown that zebra mussel larvae would not survive under these conditions. However, water chemistry analyses conducted at the site where the mussels were found revealed calcium and pH levels higher than that characteristic of the majority of Lake George. Further investigation revealed that water entering the lake from a nearby culvert was introducing stormwater runoff and groundwater into the lake with calcium levels four times higher than that characteristic of the rest of the lake. In addition, the site contains numerous concrete and rock aggregates that are likely sources of additional calcium. Finally, there is potential contribution of calcium from a concrete boardwalk that was built approximately a year before the discovery of zebra mussels at this location.

Introduction of zebra mussels may have occurred when boats contaminated from other lakes entered Lake George at the boat launch adjacent to the site. Introduction could also have occurred during the construction of the nearby boardwalk via contaminated equipment. The exact mechanism(s) by which they were introduced may never be known.

After discovering zebra mussels in Lake George, the DFWI and Bateaux Below SCUBA divers carried out an extensive survey of the location to determine the size of the affected area. The mussels were confined to a 15,000 square-foot area. After consultation with state and local agencies, it was agreed that

hand-harvesting of the relatively low-density mussels was the best solution. Diving at the site to remove all visible zebra mussels began and has been ongoing since April 2, 2000. This approach has been extremely labor intensive and, while hopefully effective, would not be feasible if multiple sites were found throughout Lake George.

Currently, a number of activities are being continued at Lake George, including monitoring and removal of any remaining zebra mussels at this site. Removal of any remaining zebra mussels is critical to reduce the likelihood of successful reproduction. In addition, mussels that are not removed may adapt to the lower calcium and pH conditions and spread into surrounding areas. Water samples are continuing to be checked for microscopic larvae and chemical parameters. This information will be used to evaluate success of removal efforts, determine whether to extend the monitoring area beyond the present site and better understand the local water chemistry.

As can be seen from the above "story," the questions asked in this year's contest—examining environmental factors that could influence the spread of zebra mussels and the potential impacts of human activities and policy issues—are real ones. I read with great interest the solutions provided by this year's teams. In fact, I plan to reread a number of them as we continue to work on these research questions.

Proactive vs. Reactive

There are many ways in which we can be proactive against the potential threat and spread of zebra mussels. Perhaps of primary importance is education of individuals, through which it is hoped that the spread of zebra mussels can be reduced. The primary mode by which zebra mussels are transported to new bodies of water or to new locations within single water bodies is by human activities: mussels attached to boat bottoms, or veligers hitching a ride in bait buckets or scuba gear, for example. Therefore education can be viewed as a preventive measure for the spread of zebra mussels.

A second critical activity is monitoring for the first appearance of zebra mussel larvae (veligers), young juvenile mussels and adult zebra mussels. Of course, the earlier the detection, the better the opportunity to minimize a widespread colonization. Thus, monitoring programs are paramount in being proactive about zebra mussel infestations.

Third, and to the point of the contest question, there is a need for development of mathematical models that can be made robust using the numerous data sets that already exist for water bodies that either have or lack zebra mussels. These models may then be used to predict possible new infestations within water bodies potentially in jeopardy of zebra mussel introductions. At the time of the contest only three such models had been published in the scientific literature. To have interdisciplinary student teams and worldwide focus on this important issue was a fantastic opportunity.

Another aspect of this year's question related to policy. Too often policy development is the result of being reactive. The most beneficial outcomes are likely to occur if we are proactive and policy decisions are put into place before, rather than after there is a serious and sometimes uncorrectable problem. In order to facilitate this scientists must accept the responsibility of effectively conveying scientific findings and results in "layman's" terms. It is only then that policy can be an informed decision influenced by the scientific fact finders.

Data Sets for Competition

Just as the students in the contest worked in teams, the collection of data for this year's problem was also an example of collaboration and teamwork. The sharing of scientific information is critical when working on complex problems, where the saying that "the whole is greater than the individual parts" is truly the case. Data were kindly provided for the contest by

- Cathi Eliopoulos of the Vermont Department of Environmental Conservation, for Lake A (Lake Champlain);
- Larry Eichler of the Darrin Fresh Water Institute, Rensselaer Polytechnic Institute, for Lake B (Lake George, NY); and
- Scott Kishbaugh of the New York Dept. of Environmental Conservation, for Lake C.

Zebra mussels were discovered in Lake Champlain in 1993 and have since continued to expand in their distribution throughout the lake. In 1999, adult zebra mussels were found for the first time at the southern end of Lake George. This remains the only location in that lake where they have been observed to date, although the search for additional colonies continues. No zebra mussels have been found in Lake C, and this is likely to remain the case unless there are significant increases in calcium concentrations within the lake.

Acknowledgment

I would like to thank Chris Arney and Gary Krahn for their invaluable contributions in brainstorming and the development of this year's problem.

About the Author

Sandra A. Nierzwicki-Bauer received a B.A. and a Ph.D. in Microbiology at the University of New Hampshire. After a two-year postdoc at the University of Chicago, she joined Rensselaer Polytechnic Institute in 1985 as Assistant Professor of Biology. She has served in a number of positions at RPI, including Chair of the Biology Department and most recently Interim Dean of the School of Science, and now Professor of Biology and Director of the Darrin Fresh Water Institute.

"Although my formal training was as a microbiologist, it did not take long for me to recognize the power of interdisciplinary research and education, as well as the national importance that the zebra mussel problem was taking on." In 1995, when zebra mussels began encroaching closer and closer to the beloved Adirondacks and Lake George, she began a new program that focused on research, education and outreach activities related to the pesky mollusk. Six years later, this exciting work continues. "Participating as a judge for this year's contest reminds me of one of the joys of working on interdisciplinary problems: having the best of both worlds . . . being a student and a teacher."