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# In spite of *Dreissena r. bugensis* dominance, *D. polymorpha* retains a strong potential to invade from the Great Lakes

## INTRODUCTION

The Great Lakes experience high levels of recreational boating, a major means of spread for dreissenids, and have therefore been a major source for zebra and quagga mussel invasions of other waterbodies in North America. In the recent years, *Dreissena r. bugensis* (quagga mussel) has been observed to dominate the lower Great Lakes in terms of biomass, size, and density, comprising over 95% of the dreissenid populations in lakes Erie and Ontario by 2002-2003 (Fig. 1). This suggests that these lakes are no longer a source of *D. polymorpha* (zebra mussel) secondary spread to other waterbodies, mostly while attached to boat hulls. Nevertheless, since that time, *D. polymorpha* rate of spread is still much higher than that of *D. r. bugensis* (Fig. 2). Considering that recreational boating is the main vector of the dreissenids spread throughout the United States, we examined the abundances and sizes of the two species on boats in 2009. We found that *D. polymorpha* attained similar or higher densities and larger sizes on boats from lakes Erie and Ontario. In light of the results of this preliminary study, we conducted a more extensive survey, encompassing a wider range of surveyed substrates and a larger number of sampled marinas and boats, on both lakes Erie and Ontario.

## METHODS

Boats were examined for dreissenids in 6 marinas, including the Buffalo Yacht Club, Sturgeon Point Marina, and Olson Marina on Lake Erie, and Sunset and Newfane Marinas on Lake Ontario. Samples were also taken of dreissenids attached to permanent (ie: submerged year-round) and temporary substrates. For the boats found to contain attached live dreissenids and samples from the other two substrate types, the mussels were identified by species, counted, and measured in length to the nearest 0.1 mm. Size-frequency distributions were then made for the dreissenid species at each of the 3 substrate types for marinas on lakes Erie and Ontario. A total of 208 boats, 17 permanent substrates, and 15 temporary substrates were examined.

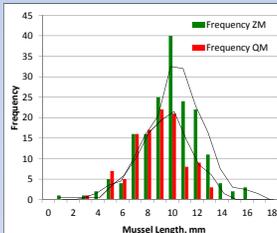


Figure 4. Dreissenids attached to boats at Sturgeon Point Marina, Lake Erie.

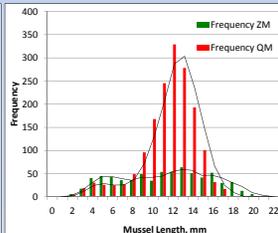


Figure 5. Dreissenids attached to boats at Olson Marina, Lake Erie.

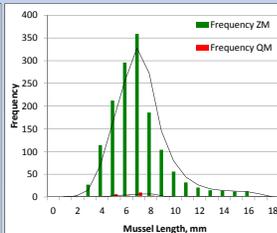


Figure 6. Dreissenids attached to boats from two marinas on Lake Ontario.

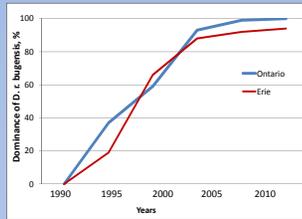


Figure 1. Relative abundance of *D. r. bugensis* in the Lower Great Lakes.

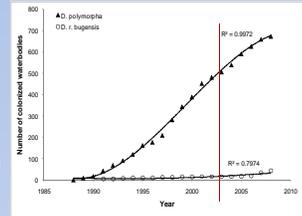


Figure 2. Spread of *D. polymorpha* and *D. r. bugensis* in North America, 1988-2008. (Karatayev et al. in review). Year 2003 is marked.

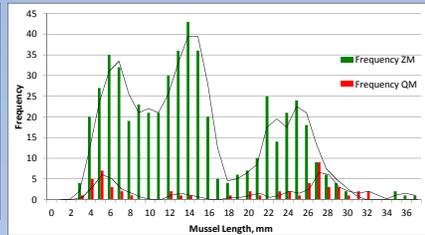


Figure 7. Dreissenids attached to permanent substrates in Newfane marina, Lake Ontario.

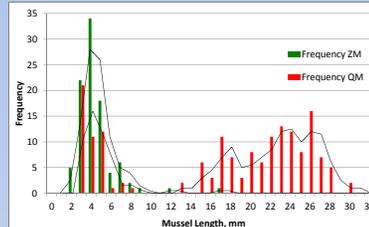


Figure 8. Dreissenids attached to permanent substrates in Sunset marina, Lake Ontario.

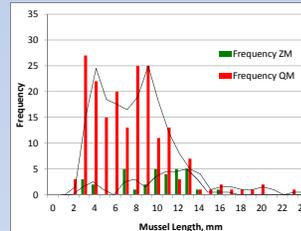


Figure 9. Dreissenids attached to rocks in the littoral zone of Lake Erie in Buffalo, NY.

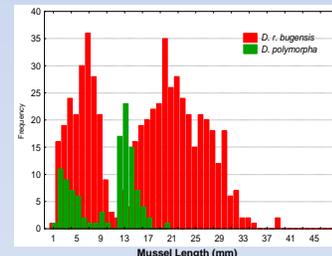


Figure 3. Size-frequency distribution of dreissenids in samples from a lake-wide benthic survey in Lake Erie, June 2009.

## RESULTS AND DISCUSSION

- Of the 208 examined boats, a total of 98 (47%) were fouled by *Dreissena*, including 84 fouled by both species, 12 by zebra mussels only, and 2 by quagga mussels only.
- Examined power boats and sail boats were 16-40 feet in length.
- Of the 30 sampled sail boats, dreissenids were found on only 5 of them (17%), suggesting that, as opposed to motor boats which have outboard motors and irregular bows, providing the *Dreissenids* shelter from waves while the boat is moving (Fig.10), sail boat hulls are much less suitable to the attachment of either species due to their smooth, streamlined hulls.
- Infestation rates were not uniform across marinas, with 13% of boats at the Buffalo Yacht Club infested, 32% at Sturgeon Point Marina, 44% at Sunset Marina, and 53% at Newfane Marina.
- In contrast to the results of surveys of Lake Erie's benthic environment, where quagga mussels formed over 95% of the total dreissenid density (Figures 1, 3), and in contrast to our littoral samples shown in Figure 9, *D. polymorpha* attained relatively similar densities and mean size on boats sampled at Sturgeon Point and Olson Marinas on Lake Erie (Fig. 4, 5).
- In the two sampled marinas on Lake Ontario, *D. polymorpha* made up the vast majority of dreissenids found on boats in marinas on Lake Ontario (Fig. 6). However, this is most likely due to the 2 surveyed marinas being situated on the mouths of creeks, which were apparently sources of a large number of *D. polymorpha* larvae.
- In all marinas, *D. polymorpha* attained a higher species proportion on boats than it did on permanent substrates in the same marinas.
- Despite apparently high numbers of *D. polymorpha* larvae in the Sunset and Newfane Marinas, on permanent substrates, *D. bugensis* attained a higher mean size at both marinas and higher densities at Sunset Marina (Fig. 7, 8), indicating that it has a higher growth rate and an advantage on substrates which experience lower wave intensity.
- We hypothesize that *D. polymorpha* is disproportionately abundant on boats compared to bottom substrates because it has a flat shell bottom and produces more byssal threads for attachment, thus allowing it to attach with much greater strength to hard, flat substrates (Peyer et al. 2009; Mills et al. 1996), and is less affected by intense water flow (ie: when a boat is moving).

## CONCLUSIONS

- Presence and distribution of dreissenids in the Lower Great Lakes are not representative of the same factors in the marinas situated on the lake, and thus the dominance of a dreissenid species in a lake may not determine the dominant species on boats. Therefore, dominance of a dreissenid species in a lake may not determine the dreissenid species most likely to spread from that waterbody.
- Despite strong *D. bugensis* dominance in the lakes themselves, some marinas on lakes Erie and Ontario are still important sources for *D. polymorpha*'s secondary spread in North America.
- D. polymorpha* can often attain larger sizes on boats than *D. bugensis*. However, *D. bugensis* attained higher mean size on permanent substrates.
- On temporary and permanent substrates, *D. r. bugensis* attained a higher mean size and relative abundance than on boats.

## REFERENCES

- Karatayev, A.Y., Burlakova L.E., Masitsky S.E., Padilla D.K., and Mills E.L. 2010. Invasion paradox: who is the better invader – *Dreissena rostriformis bugensis* or *Dreissena polymorpha*? In review.
- Patterson, M.W.R., Ciborowski, J.J.H., and Barton, D.R. 2005. The distribution and abundance of *Dreissena* species (Dreissenidae) in Lake Erie, 2002. J. Great Lakes Res. 31(Supplement 2): 223-237.
- Watkins, J.M., Dermott, R., Lozano, S.J., Mills, E.L., Rudstam, L.G., and Scharold, J.V. 2007. Evidence for remote effects of dreissenid mussels on the amphipod *Diporeia*: analysis of Lake Ontario benthic surveys, 1997-2003. J. Great Lakes Res. 33(3): 642-657.
- Peyer, S.M., McCarthy, A.J., and Lee, C.E. 2009. Zebra mussels anchor byssal threads faster and tighter than quagga mussels in flow. J. Experiment. Biol. 212(1): 2027-2036.
- Mills, E.L., Rosenberg, G., Spidle, A.P., Ludyanskiy, M., and Pligin, Y. 1996. A review of the biology and ecology of the quagga mussel (*Dreissena bugensis*), a second species of freshwater dreissenid introduced to North America. Am. Zool. 36(3): 271-286.

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