

# **Report on Interview with Dr. G. Mackie, University of Guelph On Zebra Mussels at Four Mile Lake**

*by Jim Russell, P.Eng.  
Oct. 2005*

**Background** - Dr. Mackie is a recognized expert on "Ecology and pollution biology of freshwater invertebrates" - i.e.: Zebra Mussels. I met with **Dr. Gerald Mackie**, Professor Emeritus, Department of Zoology, University of Guelph on Friday, October 7, 2005. Dr. Mackie is perhaps, one of the world's foremost experts on Zebra Mussels. His expertise and feedback on Zebra Mussels will be of great help to our understanding of Zebra Mussels in our local environment. He has clearly generated a most impressive doctorate of knowledge on Zebra Mussels – one that we can all be most grateful for!



**Fig. 1 - Dr. Gerald Mackie, Department of Zoology, University of Guelph**

**Objectives:** The objectives of my interview with Dr. Mackie were to document a generalized knowledge of Zebra Mussels that could help lakefront property owners understand their local exposure and effects.

Specifically, I wished to: 1) gain sufficient zoological knowledge about Zebra Mussels to answer environmental and safety related questions from Four Mile Lake residents; 2) identify the most up-to-date technical information on the prevention of Zebra Mussels from entering water systems for the purpose of advising members on the advantages & disadvantages; and 3) gain advice regarding “what should we do” to live with Zebra Mussels on Four Mile Lake and other water bodies in Kawartha Lakes region?

I was able to obtain excellent counsel from several of our Four Mile Lake Association directors and Lake Stewards to build a good list of questions for the meeting with Dr. Mackie. Thanks to all of you that helped put our information together, as it made the discussions meaningful and the results very beneficial.

**Summary: (the “Punch Line”):** Dr. Mackie was able to quickly dispel Zebra Mussels myths, and clarify common issues regarding Zebra Mussels. I am sure that it is more complex than a few summary comments, but for those that just can't wait for the 'punch line', here goes...

- 1) Four Mile Lake is likely to have seen its first Zebra Mussels in 2000 or 2001, brought to the lake by a bait bucket or in the live-well of a visiting fishing boat.
- 2) After introduction to a new lake (such as Four Mile Lake) Zebra Mussels population will reach its peak in about 4-5 years.
- 3) The life cycle of an individual, Zebra Mussel averages 2 years, but can be as much as 4 years, and they grow approximately 1 cm per year.

- 4) The Zebra Mussels population will NOT subside or eventually decline....evidence is that in 5 years, the stabilized “peak” level is reached, and the environment (including residents) learns to “live with them.” Different parts of Four Mile Lake may see varying ° of problems from Zebra Mussels, due to the local environment.
- 5) There is no “silver bullet” to help us get rid of zebra mussels...there is no known effective eradication treatment. Zebra Mussels can be annoying and even dangerous as they are very sharp edges and can cause painful cuts on hands and feet.
- 6) Zebra Mussels can clog the foot valve of water intake pipes, but are not likely to damage water pumps, water heaters, washing machines or dishwashers. Dr. Mackie suggests observing your own local Zebra Mussels situation to assess whether a *water intake filter* is necessary or beneficial.
- 7) Zebra Mussels will NOT hurt people if swallowed.



**Figure 2- The Zebra Mussel [*Dreissena polymorpha*]**

### **Discussions:**

- 1) Four Mile Lake background - I provided a background description of Four Mile Lake environment in the Kawartha Lakes region of Ontario, as it relates to Zebra Mussels. (Ph=8.0, can drop to 6 at inflow creeks after rain; water temperature = 32°F (winter) to 80°F (June); calcium = unknown; lake straddles boundary between Canadian Shield and Carden (limestone) Plain; most of the lake is in limestone). Four Mile Lake has progressed from 2 sightings of Zebra Mussels in 2003 to a total infestation along all shores in 2005.
- 2) Why such a rapid change in Zebra Mussels infestation? The growth of Zebra Mussels in Four Mile Lake is typical of the evolution in Ontario’s Great Lakes. The Zebra Mussels are brought to the lake, usually in bait buckets, or live wells of fishing boats. If the (4) requirements for their sustenance are present in the environment (calcium, water temperature, water ph level and food) then they will begin to grow. Their growth cycle depends on each of the basic environmental requirements, however usually sees them grow by approximately 1 cm per year, to an average maturity of 2 cm (2 years old), but as much as 4cm (4 years old). The cycle usually takes 1 year for introduction (not likely to be seen or reported), 2<sup>nd</sup> year for first growth and reproduction (may have isolated sightings), reaching full maturity in 3<sup>rd</sup> year, and maximum population in 4-5 years. Zebra Mussels usually reach maximum

population in about 5 years. At this point, there are layers of Zebra Mussels on the lake bottom, on rocks, in mud and weeds, and on appendages (like docks and water pipes). Prevailing wind and waves will bring the Zebra Mussels to all exposed parts of the lake, even those areas that are not particularly attractive to their flourishing growth.

This is precisely the development observations that we have seen on Four Mile Lake. So we can conclude from our observed development, that Zebra Mussels were first introduced to Four Mile Lake in about 2000-2001 – and that they are likely here to stay.



**Figure 3 – Zebra Mussels will latch on to limestone rocks or areas of high water flow**

- 3) Environmental conditions - Zebra Mussels like a pH level of greater than 7.8 (Four Mile Lake's pH is 8.0). They will not survive in pH levels less than 7.5. They will become dormant (not die) as water temperature falls below 4°C. If water freezes, they will die. Zebra Mussels will become active when the temperature rises above 4°C and begin laying eggs when  $T > 12^{\circ}\text{C}$ . As temperature increases, they thrive. Zebra Mussels like calcium levels  $> 7\text{mg/litre}$ . We don't know what Four Mile Lake's calcium level is currently, however with the limestone structures covering much of the area, we are most certainly above this threshold (in strong limestone structured areas of the lake, calcium levels could be  $20\text{mg/litre}$ ). Zebra Mussels feed on algae (Four Mile Lake is plentiful with algae). The easiest way for them to feed is to locate where food-plentiful water flows by them, providing a constantly replenishing nourishment. So, stream inlet/outlets, water pipe inlets, etc. are common points of accumulation.

The portions of Four Mile Lake that are predominantly granite rock based may see locally lower pH levels (even below 7.5). In these areas, while evidencing some Zebra Mussels due to wind and waves, they may be less invasive. It is possible that in the granite-based areas of Four Mile Lake, the Zebra Mussels will live to 1-2 years only, (due to lower Ca levels) and may not thrive to the same population as other (more limestone based) areas will. *This will remain to be seen over next few years...if waves and wind are sufficient to maintain a constant movement of water, the Ca level of all parts of Four Mile Lake may remain homogeneous, promoting a more even infestation of Zebra Mussels throughout all areas of the lake...*

- 4) Zebra Mussels Life Cycle - The life cycle of Zebra Mussels is approximately 2 years, starting as larvae from eggs in early May, when the water temperature rises to above 4°C. The Zebra Mussels will mature (to an egg layer) in the course of one

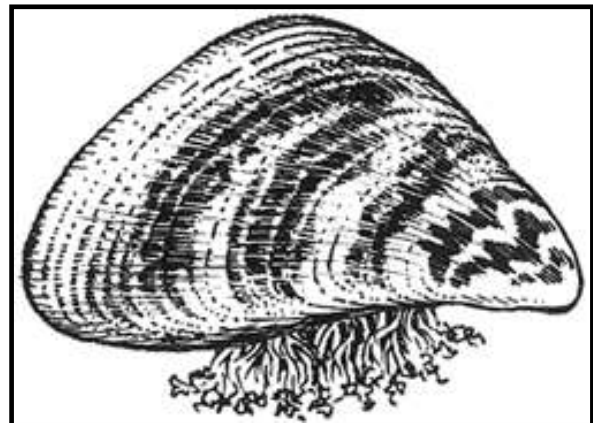
summer, and can lay eggs as the water temperature reaches 12°C. As they feed on algae and grow, they “flutter” throughout the water. As they develop their “shells” and “foot” - usually in 2-4 weeks, they become too heavy for water suspension, and ultimately “settle” to the lake bottom. They will then attach themselves with their foot and secretions; to whatever they happen to land on. They then stay attached to their new “home”, growing and laying more eggs.



**Figure 4 Zebra Mussel adult shell length can range from approximately 6 to 45 mm**

As the population continues to expand, there are more Zebra Mussels “floating” throughout the lake water, moving about as the waves take them to all shores. Eventually, new Zebra Mussels will “settle” on top of more mature ones, forming “layers” of “aggregate” – those on the bottom die, those in the middle are growing, and those on top are maturing. This is why we see, over the course of 4-5 years, a build-up of Zebra Mussels at the attractive “living” locations. *The population of Zebra Mussels is not likely to decline, but rather “stabilize” after 5-6 years. Other Ontario Great Lakes studies have shown that the environment simply “learns” to live with the Zebra Mussels...and, thus, so must we, as residents.*

As the cycle reaches it’s stabilized “peak”, the most heavily populated areas of the lake will experience Zebra Mussels shells on rocks, shores and even sandy beaches – so gloves and shoes are best worn while swimming or playing on the beach and when handling rocks, docks or any water-submerged items.



**Figure 5 – the Zebra Mussel anchors itself to hard objects using its foot and byssal threads**

- 5) Is there a way to get rid of Zebra Mussels from Four Mile Lake? – No! At least not yet...and not in the foreseeable future, either. Methods of Control Researchers are faced with the challenge of trying to find a way to eradicate zebra mussels while at the same time leaving native species unharmed. Methods such as chlorination, chemical treatment, ozone, heat, ultraviolet radiation, electrical shock, anti-fouling paints, and sonic vibrations have been under experimentation during the past 15 years. Dr. Mackie has been a major contributor to research activities. The use of biological agents, including toxic microorganisms, parasites, and spawning inhibitors

has also been investigated. Although some treatments have proven effective, completely eliminating zebra mussels is not probable.

*The result of past 2 decades of research has been that the environment, including its human residents, are merely learning to live with Zebra Mussels.*

6) So, what should we do? Dr. Mackie recommends that residents observe closely, their exposed appendages for infestation or damage by Zebra Mussels. Since the Zebra Mussels will most heavily populate the most “attractive” living conditions, there may be more serious exposure in some areas than in other areas. *“Take action when it is observed to be necessary.”* Here are some Zebra Mussels “survival” facts that can help us evaluate and protect our own local areas around Four Mile Lake.

- a. Zebra Mussels (alive or dead) have VERY sharp shells, that can cut like a knife – so be very careful once you have located them.
- b. Zebra Mussels (in any form) will not hurt people if swallowed.
- c. Zebra Mussels like moving water (like a water intake pipe/foot-valve), but when the water is moving too fast, they cannot “settle” on the surface.
- d. Water system intake pipes and foot valves are the most vulnerable items to “damage” by Zebra Mussels attaching themselves. Smaller intake pipes are better, as they will generate higher water intake velocities, preventing Zebra Mussels from attaching themselves to the inside of the water pipe (if  $V > 1.5$  m/sec).
- e. Zebra Mussels are not likely to damage water pumps, washing machines or dishwashers, since the water velocity inside your pump is too fast for the Zebra Mussels to attach itself, and the motion is found to destroy the Zebra Mussels in most cases.



**Figure 6 – Zebra Mussels can clog a water intake (foot valve) if you don’t clean it off regularly**

- f. Zebra Mussels cannot survive in your hot water tank (temperature  $> 40^{\circ}\text{C}$ ), so damage to the HWT is unlikely.
- g. Zebra Mussels will not usually damage the water pipes inside your home/cottage, as these distribution pipes are usually sufficiently small so that water velocities are too high to allow Zebra Mussels to “settle” or attach themselves.

- h. Water systems that are not used allot (e.g.: left quiet for weeks at a time) can be more susceptible to Zebra Mussels “settling” (attaching), so using the system frequently can help protect it.
- i. Zebra Mussels REALLY do not like copper; also, stainless steel deters them somewhat; bronze is somewhat annoying to them (due to Cu). Zebra Mussels will like most other metals (like aluminium, steel, etc.), plastics, wood and other hard surfaces.

7) What can I do to protect my water intake pipe and foot valve? There are mechanical filters available that will keep Zebra Mussels away from attaching to your intake pipe, preventing clogging of the foot valve. These filters are readily available from the several distributors or retail outlets. We have listed available locations on the FMLA website (<http://www.fourmilelake.ca/zebra1.html>) Most of the devices have filters that will have to be replaced, the frequency of replacement depending on the population of Zebra Mussels at your location and the type of filter you install.

*Dr. Mackie’s research, and testing of the various filter systems available, have shown that most all of them work pretty well – even the less expensive ones. Dr. Mackie’s advise is to observe your own local Zebra Mussels situation (inspect your water pipe & foot valve) to determine if a filter is warranted.*

8) What should I do in the winter - with my water system, intake pipe and foot valve?  
*Well, it depends....*

- a. *If your water intake pipe is left in the lake for the winter? If it is sufficiently deep that the water around it does not freeze, then the Zebra Mussels will be dormant, but will not be killed. If your pipe or foot valve is within the frozen ice, then any Zebra Mussels attached will be killed.*
- b. *If your water intake pipe is pulled out of the lake for the winter? Then all Zebra Mussels will be exposed to freezing temperatures, and will be killed.*
- c. *If my Cottage plumbing system is drained in the winter? Zebra Mussels are not likely to settle or damage a water system past the pump – but if your system is drained in the winter, and sees freezing temperatures, then all Zebra Mussels will be killed, nevertheless.*
- d. *What if my plumbing system is NOT drained in winter? Zebra Mussels are not likely to settle or damage a water system past the pump – but if your system is exposed to freezing temperatures, then all Zebra Mussels will be killed – if your system temperature remains above 1°C, then you should carefully inspect for Zebra Mussels (but remember that the Zebra Mussels will show up first at the water pipe intake and foot valve). You may need to install a filter to protect your water inlet and foot-valve.*

- 9) What is a Quagga Mussel? *This is another (completely distinct) mussel from the Zebra Mussels that are so far, only observed in the Great Lakes. They are similar in size and shape, and behaviour, except that they are more temperature resistant – they can remain dormant (but not dead) at temperatures LESS than 4°C. Quagga Mussels are most easily identified by their shape – the shells have no “bottom” and so will “fall over” when set on a flat surface. Zebra Mussels have distinctive “stripes” on their shell, have a “flat spot” on the bottom of their shell, and will stay “upright” when set on a table.*
- 

by Jim Russell, P.Eng.  
Director, Four Mile Lake Association  
October 2005

Copyright© 2005 by Jim Russell  
All rights reserved.

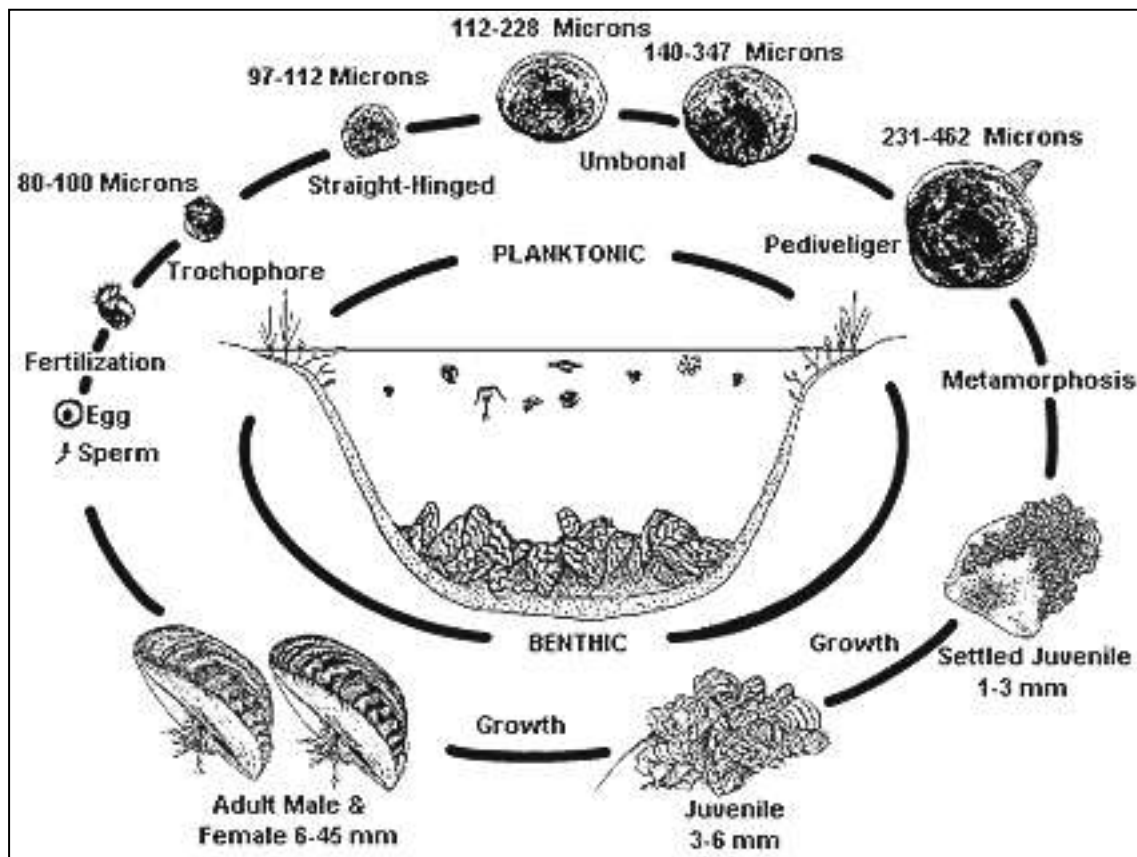
*No part of this report may be reproduced, transmitted, transcribed or translated into any language, in any form or by any means without the prior written permission of Jim Russell. Information in this report is subject to change without notice and does not represent a commitment on the part of Jim Russell or Four Mile Lake Association.*

**Appendix – Life Cycle and Anatomy of the Zebra Mussel**

[Ref: Danielle M. Crosier and Daniel P. Molloy, New York State Museum, Cambridge, New York 12816]

Life Cycle

There are three main periods in the zebra mussel life cycle: the larval, juvenile, and adult stages. The larvae are planktonic (float in water column) during their initial three life stages: trochophore, straight-hinged veliger, and umbonal veliger. Larvae eventually settle on a substrate during their pediveliger stage, and move only by crawling during their plantigrade stage. The pediveliger is considered by some to be the final larval form, with the plantigrade as a stage between larval and juvenile stages (Ackerman et al. 1994). These stages are identified primarily on morphology and behavior and are somewhat variable and overlapping in physical dimensions. The amount of time required for a fertilized gamete to develop into a fully developed juvenile is longer at colder water temperatures and thus can range from 8 to 240 days (Nichols 1996).



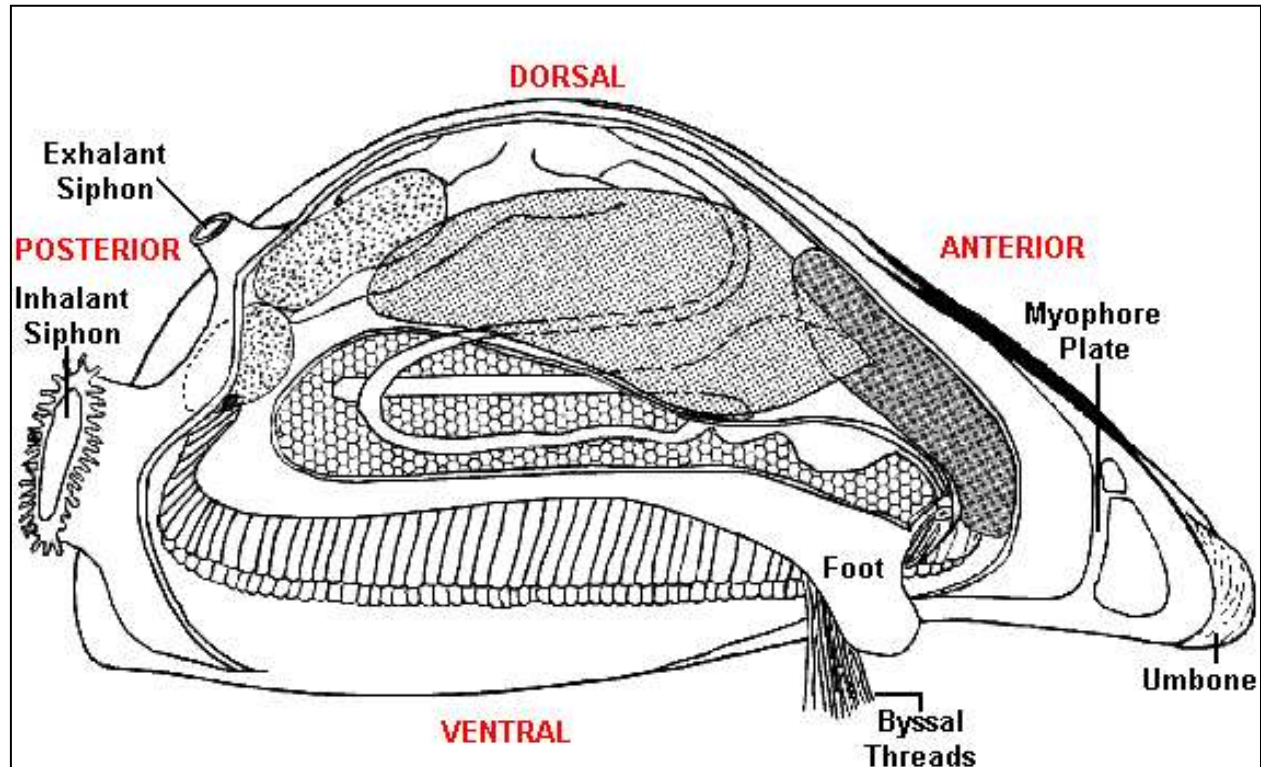
**Figure 7 – The main periods in the zebra mussel life cycle: the larval, juvenile, and adult stages**

The zebra mussel's clam-like shape throughout much of its larval stage is replaced by a more triangular or mussel-like shape as it enters the juvenile stage. Mussels are



considered adults when they become sexually mature. Adult mussels range from approximately 6 to 45 mm and generally live to be 2-3 years old in temperate climates.

### Anatomy and Physiology



**Figure 8 Zebra Mussel Gross Morphological Features**

Copyright© 2005 by Jim Russell & Four Mile Lake Association  
All rights reserved.

*No part of this report may be reproduced, transmitted, transcribed or translated into any language, in any form or by any means without the prior written permission of Four Mile Lake Association or Jim Russell. Information in this report is subject to change without notice and does not represent a commitment on the part of Jim Russell or Four Mile Lake Association.*