Zebra Mussels
and Fire Control Equipment

Fact Sheet

by

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1999 (Rev. 2002)

Figure 1. Typical Zebra mussel

The Problem

Zebra and quagga mussels, Dreissena spp., collectively known as "zebra mussels" for the purposes of this paper, are small (2-inch and smaller), clam-like mollusks with elongated shells typically marked by alternating light and dark bands, ranging from nearly all light to nearly all dark but most often with a herringbone or striped pattern (Fig. 1). Zebra mussels are native to the Black, Caspian and Aral Sea basins of Eastern Europe and Western Asia. It is believed that the mussels were introduced into North America in freshwater ballast dumped into the Great Lakes by ships originating from mussel infested freshwater ports in Europe and the former Soviet Union.

Zebra mussel larvae, called *veligers*, are spread by wind driven water currents, by flow through rivers and canals, in water in the live wells in anglers' boats, and in anglers' bait bucket water. Adult mussels spread by attaching to ship, barge and recreational boat hulls, on recreational boats trailered between water bodies, and by attaching to organisms such as crayfish and turtles. Since the discovery of zebra mussels in Lake St. Clair in June 1988, they have spread throughout all five of the Great Lakes and their connecting waterways; the Erie Canal; the Finger Lakes; the Allegheny, Arkansas, Cumberland, Genesee, Hudson, Illinois, Mississippi, Mohawk, Monongahela, Ohio, Oswego, Ottawa, St. Lawrence, and Tennessee Rivers; the Kawartha chain of lakes in the Canadian Province of Ontario and several hundred inland lakes in CT, IL, IN, MI, NY, OH, PA, VT and WI. Zebra mussels are now found in 20 states and two Canadian provinces (Fig. 2). It is believed that the mussels will eventually infest most environmentally susceptible waters of North America from coast to coast, south of central Canada to the Florida Panhandle.

Zebra mussel spawning begins when water temperatures reach about 54°F (12°C), peaks at about 63°F (17°C), and continues until waters cool back down below 54°F (12°C). Spawning takes place when the adult mussels' gametes are released outside their bodies in the water column and results in planktonic veligers approximately 40 microns in length. These veligers can be transported by water currents considerable distances from the parent colony. Within 2 to 5 weeks of hatching, the veligers become too large and heavy to remain planktonic and settle out of the water column. At this point, they must attach to a hard surface. Zebra mussels reach sexual

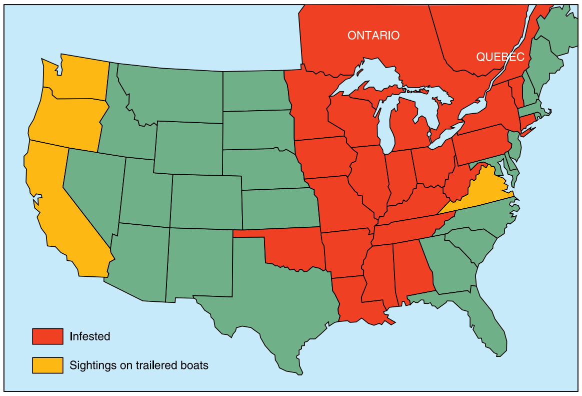

Figure 2. Map of the USA showing the spread of the Zebra mussel as of January 2002.

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maturity by the end of their first year at a shell length of approximately one half inch (1.25 cm) and may live up to 5 years, reaching lengths of up to about 2 inches (5 cm).

Zebra mussels secrete durable strands called byssal threads, with an extremely sticky "glue" at the end, by which they attach securely to nearly any solid surface, including stone, wood, rooted aquatic vegetation, and such manmade materials as iron, steel, concrete, and plastic. A major impact of zebra mussels is the fouling of raw water intakes and distribution lines at drinking water, electric generation and industrial facilities, and irrigation systems. There have also been reports of untreated fire hydrant distribution systems becoming clogged with zebra mussels. Such colonization can lead to the loss of pumping head, obstruction of valves, and blockage of screens, strainers, and fire suppression sprinkler heads.

Why Fire Departments Should Be Concerned With Zebra Mussels

When fire truck water tanks are filled from an infested water source during the zebra mussel spawning season, veligers can be drawn into those tanks. It is also possible that unattached juvenile and adult mussels could be drawn into hoses and tanks during any time of the year. If water tanks, including aerial water tanks used for forest fire suppression, which contain live zebra mussels are purged where the water could flow into uninfested surface waters without first being sprayed or dumped onto a fire, those receiving waters could also become infested.

It is also possible that some mussels could attach and grow inside water tanks. Such growth will be limited by the amount of oxygen and food in the water. There is little likelihood of mussel colonization within a tank if the dissolved oxygen content drops below 6 parts per million. The longer water remains in a closed environment like a fire truck tank without fresh water being added, the less dissolved oxygen there will remain in the water. If the water becomes anoxic (no oxygen) or hypoxic (very low oxygen), mussel survival and growth become unlikely.

Very few zebra mussels will attach to bright copper or brass, due to an irritating layer of metal ions formed at the metal/water interface. Therefore, new copper or brass hydrant and pump components should be relatively free of mussel attachment. The inside of copper pipes, however, oxidizes rather quickly, cutting off that ion layer and allowing mussel attachment. Because zebra mussels do not attach to substrates at water velocities above 3 to 5 feet (1.0 to 1.5 meters) per second, it is very unlikely that zebra mussels will attach inside draft hoses during use. Clumps of live or dead zebra mussels or mussel shells drawn into draft hoses may, however, cause increased wear on pumping equipment.

A final fire fighting setting of concern is dry hydrant systems which draw untreated water directly from surface water sources. Zebra mussels can attach to and grow within the mouths of intake pipes which provide water to dry hydrants in infested waterways. A mussel-clogged dry hydrant in the Province of Ontario, Canada, has been blamed for a lack of water during the suppression of a rural structure fire. Zebra mussels should not pose any problems in pressurized "wet" hydrant systems using filtered, disinfected (chlorinated) municipal water.

Control of Zebra Mussels in Fire Suppression Equipment

Fire companies in zebra mussel-infested areas can protect against zebra mussel impacts on their equipment and minimize the possibility that the mussels will be transported from infested waters to uninfested waters as a result of fire fighting activities. Preventing zebra mussels of any life stage from entering hoses, pumping systems, and tanks would be the best way of ensuring that the mussels would neither impact fire fighting equipment nor be transported by fire equipment from infested to uninfested waters. Unfortunately, while "typical" draft hose strainers have 0.25 to 0.5 inch (0.64 - 1.27 cm) or larger holes, zebra mussel veligers ready to attach to a hard surface may be as small as 250 microns (about 0.01 inch or 0.025 cm). This makes filtering them from water being drawn into a draft hose impractical as any filter capable of removing veligers would be prone to clogging by silt, algae, and organic detritus.

Fire Truck and Aerial Water Tanks:

Ideally, fire truck tanks should be filled from hydrants using treated (filtered, chlorinated) municipal water and not with untreated water drawn from a zebra mussel infested water source. Since this isn't always possible and trucks often must be refilled in the field, tanks on fire trucks or aerial tankers that have been filled from an infested surface water source should not be purged where the water might flow into uninfested surface waters.

Aerial water tanks that were filled with water that could possibly contain zebra mussels but which were not dumped on fires should either be purged on field or forest land where the water will percolate into the ground without any chance of flowing into an uninfested stream or waterbody, or should be dumped back into the infested water source which was used to fill the tanks.

One environmentally sound method of ensuring that no live zebra mussels get transported by fire suppression equipment to uninfested waters would be to allow potentially infested water in fire truck tanks to become stagnant (anoxic), killing the mussels by lack of oxygen. In warm water situations (59°F or 15°C and above), most mussels in anoxic water will die within 50 to 80 hours. In cold weather, mussels may survive in anoxic water for up to two weeks. A faster method of killing zebra mussels without damaging the environment would be to heat the water to a temperature high enough to kill zebra mussels (about 98°F, 37°C).

If neither of these alternatives is practical, infested tanks could be chemically treated to kill mussels of any life stage that may have been drawn into the tanks. The most readily available and least expensive chemical for such treatment is plain household chlorine bleach. The concentration required to kill zebra mussels will vary with the turbidity of the water. To achieve a residual chlorine level of about 2 parts per million in "typical" stream water, tanks could be dosed at the rate of 1 oz. household bleach per 180 gallons water. Very turbid water could be dosed at a rate of 1 oz. bleach per 140 gallons to achieve a residual chlorine level of about 2 parts per million.

Environmental Caution: Fire company personnel should exercise caution not to allow raw bleach to be discharged into streams or into storm sewers that empty into streams as this could result in a fish kill or other negative environmental impacts. Care should be taken not to allow chlorine-treated water from tanks to be discharged into streams or storm sewers immediately after mixing while the chlorine level is still high. Personnel should avoid direct contact with chlorine liquid or fumes.

Hoses and Pumping Systems:

Zebra mussels cannot survive long periods of exposure to air. An effective, environmentally sound treatment for hoses is to allow them to dry in the sun, in a heated environment, or at freezing temperatures. Mussel survival times drop with increased temperature. Zebra mussels can survive for about 485 hours at 41°F (5°C) and 75% humidity — this drops to about 211 hours at 59°F (15°C), 90 hours at 77°F (25°C), and 28 hours at 95°F (35°C). Individual zebra mussels will die within about 15 hours when exposed to temperatures of 29°F (-1.5°C) and within 12 hours at 26°F (-3°C). Clustered mussels can survive freezing longer than individual mussels, surviving more than 48 hours at 29°F (-1.5°C), but only 24 hours at 26°F (-3°C).

Dry Hydrants:

Protection of dry hydrants is more problematic. The main impact here is mussel growth around and in the mouth of a hydrant's intake in an infested water source. The material with which the hydrant is constructed will play a role in zebra mussel fouling. Mussels will attach readily to ductile iron and plastic pipes. Little attachment will take place on bright copper or brass, or on galvanized steel. However, copper or brass pipe oxidizes quite rapidly under water, reducing the mussel-proofing quality of the metal. Mussel attachment will be minimized for a longer period of time in galvanized pipe. Mussel growth into the pipe will be limited by the amount of food and oxygen available in the pipe between uses, with mussel survival

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decreasing with distance from the intake mouth. Screens or grates over the mouth of dry hydrants (with typical 1/2 inch or 1.27 cm holes), designed to keep out large pieces of organic and inorganic substances, are ineffectual as a mussel control and can, themselves, become fouled by attached mussels.

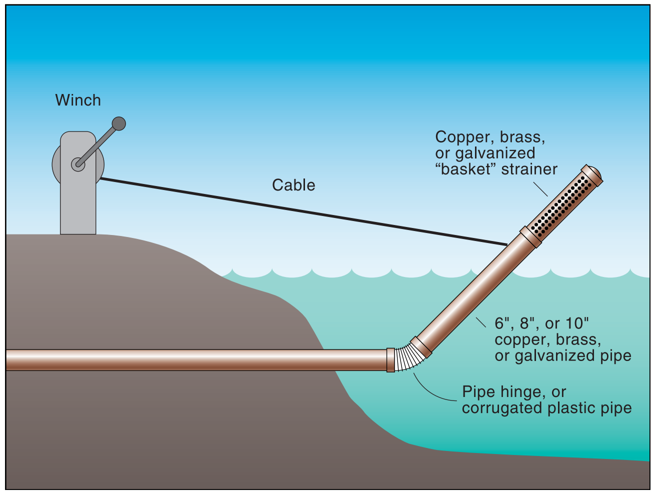

Figure3. "Dry" Hydrant

New dry hydrants and strainers should be made of materials (such as copper or galvanized steel) least likely to become fouled by zebra mussels. The intake end of the pipe could be coated with an antifoulant coating such as cuprous oxide paint. The use of such paints may, however, have negative environmental consequences and should not be undertaken without consultation with local environmental officials. Another alternative would be to galvanize the intakes.

The intake ends of dry hydrants could be retrofitted to allow them to be raised out of the water when not in use during the zebra mussel spawning season. Although dropping the pipes back into the water would be an additional step that must be taken before use of the hydrant in the event of a fire, it would not be as problematic as sending a firefighter into the water to unscrew a cap. This could be done with a pipe hinge or through use of a section of corrugated plastic pipe (Fig. 3).

Periodic maintenance of dry hydrants (inspection, mechanical removal of mussels, backflushing under pressure) on a routine basis would be an environmentally acceptable mussel control which, although an ongoing burden upon fire company resources, would provide usable hydrants without the need for time-consuming actions when called into emergency service.

Additional information on zebra mussels is available from:

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This paper ia a result of research funded by the National Oceanic and Atmospheric Administration grant to the Research Foundation of the State University of New York of the New York Sea Grant Institute. The U. S. Government is authorized to produce and distribute reprints for governmental purposes notwithstanding any copyright notation that may appear hereon. The views expressed herein are those of the authors and do not necessarily reflect the views of NOAA or any of its sub-agencies.

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