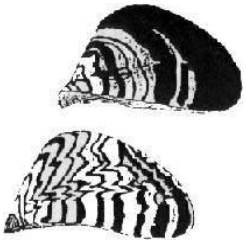
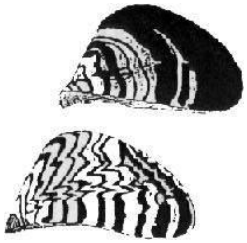



Chapter 9

Zebra Mussel Monitoring

- Introduction to Volunteer Water Quality Monitoring Training Notebook -

How Stream Teams can help thwart the latest threat to Missouri's streams and lakes

Exotic Species

When you hear the word "exotic", it usually brings to mind something unique, rare, beautiful or unusual. However, the primary meaning refers to something that has come from another place, something that is not native. A successful non-native species usually has great physiological flexibility by gaining nourishment from many sources and being able to adapt to a broad range of conditions.

For millions of years, the distribution of the world's biota has been restricted by oceans and other natural barriers. However, over the last 100 years, human activities, especially international travel and trade, have circumvented these barriers. Nearly 4,500 plants and animals have been introduced into North America alone. The negative effects of exotic species may not be immediately apparent. This is especially important in aquatic environments where the introduction may go unnoticed until the exotic species is established and a problem has occurred.

There are many threats to aquatic ecosystems: changes in land use, decline in water quality, habitat loss, and the introduction of exotic species. While the first three may be correctable, exotic organisms often become permanent residents and can profoundly affect biodiversity. The combined effects of habitat degradation and introduced species have contributed to the decline of native freshwater species in North America. A single introduced species may alter the physical environment in addition to causing numerous extinctions. Introduced species have been implicated as a causal factor in 68% of the 40 fish species extinctions and the second most cited cause of extinctions in North America behind habitat loss. This is important because 20% of North American fishes have been categorized as extinct or imperiled. Although the majority of concern has been directed toward fish, freshwater invertebrates may be even more threatened. Approximately 70% of mussels and 50% of crayfish are considered vulnerable/threatened, imperiled, critically imperiled or presumed extinct.

Oftentimes the first organism that pops into people's minds when discussing aquatic introduced species is the zebra mussel.

Zebra Mussel Biology

Zebra mussels get their name from the alternating light and dark stripes on their shells. The mussel is also flattened on one side, where it attaches to firm substrates by strong elastic byssal threads.

The life cycle of a zebra mussel is simple, and is much different from native unionid mussels. Females can produce over 40,000 eggs in a reproductive cycle and approximately one million in a spawning season. Fertilization occurs outside the body. Upon hatching, the larval zebra mussel, known as a "veliger," swims to the bottom of the lake or stream. There they move along the bottom until they find a suitable substrate. They attach to the substrate with strong elastic byssal threads and remain there until they are disturbed or die.

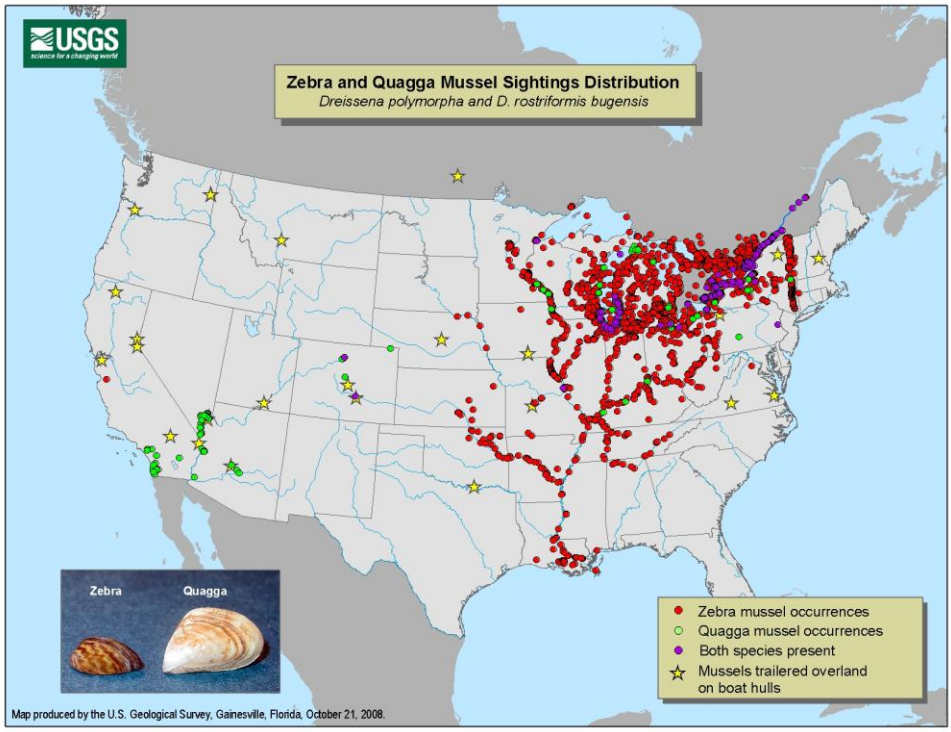
If left undisturbed, zebra mussels will often form large colonies. Zebra mussels can attach to almost any surface, although they prefer hard substrates like rock, metal or other mussel shells. They can grow to a length of one-half inch at the end of their first year and can reach two inches in length in four or five years, which is their maximum life expectancy.

Zebra Mussel Distribution

Where did zebra mussels come from? They are native to the Black, Caspian and Aral Seas in Europe and Asia. During the mid-to late-1980's, it is believed that these organisms were introduced by ballast water into Lake St. Clair near Detroit, Michigan. Since that time, this introduced species has spread very quickly. Dots in the Great Lakes area illustrate their distribution in 1988.

Zebra mussels were first discovered in Missouri in the Mississippi River in 1991. They spread to the mouth of the Mississippi River in less than 10 years. Currently, zebra mussels inhabit a number of interior U.S. lakes and almost every major tributary to the

Mississippi River. In 2000, adult zebra mussels were found on a trailered boat at Lake of the Ozarks prior to its being launched into the lake, thanks to the watchful eyes of marina personnel. Zebra mussels have not yet colonized the Missouri River to the same extent as other Mississippi tributaries. The "Big Muddy," or Missouri River, may be an ecological barrier because it is too swift and has too soft a substrate for these organisms to colonize. However, note the spots along the Missouri River on the 2008 Distribution Map. For basic purposes, it should be assumed that all waters are infested with larval zebra mussels, just to be on the safe side. That being said, as of January 2008, the following water bodies have known infestations of adult zebra mussels:



- Mississippi River
- The lower mile of the Meramec River
- Lake of the Ozarks
- Lake Taneycomo
- Bull Shoals Lake
- The Osage River

Additionally, other water bodies such as the Chariton River and the lower few miles of tributaries to water bodies with known infestations should be considered to be most likely infested, but this has not been confirmed.

For more information regarding zebra mussel distribution in Missouri and prevention measures, check out this website http://www.mdc.mo.gov/nathis/exotic/zebra/.

Zebra mussels could eventually infest most susceptible waters of North America from coast to coast, and south of central Canada to the Florida panhandle. The most concerning

waters in Missouri are our major rivers and reservoirs due to high boat traffic and heavy fishing pressure. If infested, Missouri's major reservoirs and rivers could then serve as seed populations and unfortunately help the westward spread of zebra mussels, in effect serving as "stepping stones."

Zebra Mussel Impacts

Ecological

Zebra mussels impact the environment they invade in several ways. They can kill native mussel species, many of which are threatened and endangered. Not only do zebra mussels compete with native mussels for food and habitat, they can attach to any hard surface, including native mussels. When attached to native mussels, zebra mussels prevent the natives from siphoning water, essentially preventing them from feeding and breathing. Zebra mussels also colonize on rock and gravel substrates. This impairs the reproduction of fish that spawn on rock-bottomed habitat.

Zebra mussels can become habitat for themselves. As they grow to adults, they can form huge colonies that support up to 70,000 individuals. This equates to about six inches deep in one square meter. These colonies grow rapidly when oxygen and particulate food are available and water currents are not too swift.

There are other ways in which zebra mussels impact the ecology of their new surroundings. They alter the food chain because they are filter feeders. This filtering of particles from the water has increased the water clarity in many areas in which these organisms have invaded. Sounds good, doesn't it? Not necessarily! In some lakes, increased water transparency has resulted in increased rooted aquatic vegetation, including nuisance species such as Eurasian water milfoil. Additionally, clearer water may reduce the ability of larval fish to avoid predation and encourage adult fish to relocate to deeper, darker water. This, coupled with the reductions in spawning habitats and food availability for young fish, has actually changed fisheries in many northern lakes.

"Each adult [zebra mussel] is capable of filtering a liter of water per day, removing almost every microscopic aquatic plant (phytoplankton or algae) and animal (zooplankton). Zebra mussel colonies in Lake Erie have reached astounding densities of 70,000 per square meter, and **experts estimate that Lake Erie's zebra mussel population filters the entire volume of the lake's western basin once a week**. The mussel has increased Lake Erie's

water clarity up to 600 percent and reduced some forms of phytoplankton, the basis of the lake food web, by as much as 80 percent. The increased water clarity has allowed light to penetrate deeper into the water column, allowing rooted aquatic vegetation to increase greatly in density. Bottom-dwelling (benthic) forms of algae appear to be increasing, as do several forms of insect-like benthic organisms. Researchers have also found that zebra mussels even colonize the shells of freshwater clams and have almost totally eliminated some native species in certain areas." – *excerpt from Sea Grant Great Lakes website.*

A second problem exists as a result of the zebra mussel's filter feeding. Usually when waste passes through the digestive tracts of aquatic organisms, the feces easily break down into smaller elements and are recycled back into the ecosystem. Waste passing through the digestive tracts of zebra mussels is not easily broken down. Instead, they are bound up with mucous into loose pellets called pseudofeces. The pseudofeces accumulate on the stream bottom creating a foul environment as they slowly decompose, using up dissolved oxygen and dropping the pH of the water around them.

Socioeconomic

Zebra mussels have multi-billion dollar impacts on our society. The problem is already costing power companies in the Great Lakes region billions of dollars annually to clean mussel colonies from their water intakes. While chlorine and other chemicals that are typically used in cleaning operations are effective in zebra mussel control, they are also toxic to other desirable aquatic organisms.

Zebra mussels attach themselves to boat hulls, causing an increase in drag, reduced speed and increased fuel consumption. They can clog a boat engine's cooling water intake, leading to overheating and damage.

Zebra mussels can negatively affect recreational fishing because their shells can cut line and result in lost catches. Huge numbers of zebra mussels can wash up on shore after a storm, littering beaches and cutting sunbathers' feet. This also creates a terrible stench from rotting zebra mussel flesh.

Zebra Mussel Control

Natural

Zebra mussels have very few known natural predators. Diving ducks have been effective temporarily reducing zebra mussel numbers in Europe, with some ducks actually changing their migration patterns to feed on mussel beds. Unfortunately, this is not a permanent solution because zebra mussels quickly replenish their populations each summer. In North America, the duck species that would most likely prey on mussel beds (scaup, canvasbacks and old squaws) have low population numbers. Additionally, the migratory feeding would only occur during northward and southward migrations and along migratory routes.

Fish (e.g., freshwater drum, sunfish and catfish) and other organisms (e.g., crayfish, turtles) feed on zebra mussels but can not significantly control their exponential growth. In addition, toxins concentrated by zebra mussels in their bodies may be passed up the food chain to predators feeding on them, and on up the food chain from there.

Human

Chlorination is the most effective control used to date against zebra mussels. Water is often chlorinated prior to entering intake pipes. Unfortunately, chlorination not only impacts the zebra mussels surrounding intake pipes, but the entire ecosystem in the area. The same is true when water is heated as a control strategy prior to pipe intake. The resulting thermal pollution affects more than the target organism. Other mechanisms such as ozone, potassium permanganate injection and sand bed filtration have also been used. However, all are expensive and do not prevent recolonization from occurring in the future.

There is currently no practical control of these animals once they become established in an area, which only adds to their success as an aquatic invader. However, there have been some promising developments in the use of a simple freshwater bacterium called pseudomonas fluorescens strain CLO145. The bacterium contains a toxin that destroys the mussel's digestive system by giving it something akin to a fatal bleeding ulcer. It does not harm other aquatic life. It is not practical for treating large lakes or reservoirs because of the large quantity of the toxin needed; but it could be an effective treatment in smaller areas, such as swimming beaches.

Additional research has been conducted to possibly disrupt the reproductive process of these animals. Zebra mussel eggs are fertilized externally so males and females must release gametes simultaneously. The sperm are only viable for a short time, perhaps only a few minutes, providing the potential to interrupt this process.

Educating citizens about the issue is the most effective means of halting the spread of zebra mussels. Keeping a vigilant watch on our streams, rivers and lakes will serve as an early warning system.

Zebra Mussel Monitoring

State and federal agencies are poised to institute programs to slow the spread of zebra mussels once their presence is reported. The earlier the mussel is detected, the sooner we can institute defense mechanisms. When adults are found, they are removed and procedures are implemented to ensure that boat, motor and other stream and river equipment are cleaned. By doing so, zebra mussel numbers may be effectively kept to a tolerable minimum. However, all these measures will not be effective if an unidentified upstream source exists that will continue to spread zebra mussels.

The key is to find them—that's where Stream Teams fit in. Simply put, agencies need volunteers all over the state watching for zebra mussels. We need Stream Teams to volunteer to monitor for the mussel and give the Missouri Department of Conservation (MDC) an immediate call when one is found (see contact information on report form at chapter's end). Department biologists also need to know where the mussels are *not* being found, so we need Stream Teams, or any individuals, who are committed to assisting in this monitoring effort. Knowing where zebra mussels are not is just as important as knowing where they are.

Zebra Mussel Sampling Protocol

Stream Teams can be the primary line of defense against the zebra mussel invasion by looking for them. By using the following sampling protocol, you can help—and it's easy! Basically, zebra mussel monitors need to look for the mussel at their chosen monitoring sites and send in a monthly report on whether or not any were found.

Equipment

The primary means of monitoring for zebra mussels will be using your eyes. By visually examining the bottoms, edges and shorelines of streams or lakes, Stream Teams can detect either living adult zebra mussels or their empty shells (the presence of which would indicate they're living somewhere nearby). Also, look at rocks, crevices, woody debris, docks and vegetation in the water for living adults. If you are looking for an excuse to do some snorkeling (and you are reasonably sure the water quality is safe enough for swimming), a mask and fins are great for inspecting your site.

You can also add a substrate upon which zebra mussels can attach, and check it periodically. This is especially useful for deeper water. The substrate of choice is a concrete block. Concrete blocks are ideal surfaces for zebra mussel attachment. The blocks are heavy, readily available, and inexpensive.

Simply tie a rope (½-inch diameter or greater) to the block. The length of the rope will depend on the depth of the water. Secure the other end to something stationary on the bank (e.g., a tree). Submerge the block three to eight feet deep. Two or three blocks placed in the upstream, middle, and downstream ends of your pool should provide a good sample.

Can I Monitor My Adopted Stream for Zebra Mussels?

We need information from all over the state on the presence and absence of zebra mussels, but especially in areas of high recreational use. If you have adopted a stream and wish to incorporate zebra mussel monitoring into your other activities, please do so. But, additionally, we need information from all of our popular float and fishing streams and all large reservoirs. Accurately recording location-related information on the *Zebra Mussel Report Form* (see last page in this chapter) will help biologists interpret your report. If you would like suggestions on where to look for zebra mussels, please contact the MDC's Stream Unit and we'll help you find a convenient monitoring location.

Where Do I Look?

Looking for zebra mussels at your water quality monitoring site is a good start. Generally, the best areas in a stream to look are in and along the edges of runs and pools with

slow current. Check any hard surface if you are looking around rather than using a concrete block. Zebra mussels prefer dark places and are commonly found in crevices and on the underside of rocks and other objects. If you use concrete blocks, remember to submerge them in water three to eight feet deep. Place them in inconspicuous spots away from heavily used areas to avoid both tampering and the possibility of interfering with recreational activities. Locations downstream of boat ramps or canoe accesses are ideal, since these sites are potential areas of zebra mussel introduction.

Remember, zebra mussels attach to hard substrates. They will be fastened tightly to rocks and other hard items. If you find mussels that are loose or buried in the sand or silt, they probably aren't zebra mussels.

How Long Do I Look?

Zebra mussel monitoring should be done during the warmer months, generally April through October. If you are visually examining a site rather than just checking a concrete block, spend as much time as it takes to examine all hard-surfaced objects and record the amount of time you spent looking on your report form. A monthly sampling trip is ideal, but looking for zebra mussels every two or three months is okay, too. If you are using concrete blocks, remove them from the water and inspect for zebra mussels monthly. Record the number of blocks you are using on the report form.

What If I Find A Zebra Mussel?

Even if you aren't a regular zebra mussel monitor, **if you think you've found a zebra mussel, report it immediately, preferably by phone (1-800-781-1989).** Leave a message on the voice mail that includes your name, telephone number, what time is best to reach you at that number and a brief description of where you found the mussel. A Conservation Department biologist will contact you to get more details and make arrangements to have the identity of the specimens you collected confirmed. So be sure to put a few of the suspected zebra mussels in a jar with isopropyl alcohol (rubbing alcohol, commonly found in supermarkets and pharmacies). If you are a zebra mussel monitor, don't wait for the biologist to contact you before you go ahead and send in a copy of your completed *Zebra Mussel Monitoring Report Form* (see last page of this chapter). Making a note on the form stating that you left a message on the 1-800 voice mail and list the date you

called would be very helpful. Also, be sure to make a copy of the completed form to keep for your own records before mailing off the original. You can fax the form to the Stream Unit (FAX: (573) 526-0990) or mail it to us:

Stream Unit
Missouri Department of Conservation
PO Box 180
Jefferson City, MO 65102-0180

Submitting an online *Zebra Mussel Monitoring Report Form* is great too! These are available on the Missouri Stream Team website: **www.mostreamteam.org**.

If you run out of forms, let us know and we'll send you more. If you don't have a form, go ahead and send us your name, telephone number, **date and location of the sighting.** You can also email that information to the Stream Team general email address: **streamteam@mdc.mo.gov**.

Remember, early detection and action can help slow the spread of this mussel. Report all monitoring, but report positive sightings as quickly as possible.

Zebra Mussel Monitoring Report Forms

In order to determine the origins of any zebra mussel infestation and to track the rates at which zebra mussels spread, we need regular reports from Stream Team monitors. Monitors will be given a supply of *Zebra Mussel Monitoring Report Forms* and self-addressed, postage-paid envelopes. Please complete and mail a report form each time you look for zebra mussels, whether you find any or not. Additional forms and envelopes can be requested by calling 1-800-781-1989. You can also submit your report form online using the Missouri Stream Team Home Page: **www.mostreamteam.org.**

If We Find Zebra Mussels, Can We Do Anything?

There are a number of things that can be done to slow the spread of these mussels. When you are finished floating or boating for the day, thoroughly inspect your boat or canoe hull. Run your hand along the hull. If you feel a sandpaper-gritty feel, you may have veligers attached to your boat. Remove all water weeds hanging from the boat or trailer. Clean your boat, live well, bait bucket, bilge water, rope and other equipment. Zebra mussels

should be removed and discarded in the trash, **not** thrown back in the water. Throw leftover bait in the trash at the boat launch site. Do not release unused bait to the wild—this runs the risk of introducing a foreign species to a natural system. When you get home, thoroughly flush the hull, motor, live wells, bilge, trailer, bait buckets, etc. using a hard spray from a garden hose. You can also use high pressure hot water at a do-it-yourself car wash. Dry the equipment thoroughly in the sun for three to five days. Since cleaners and bleach are very toxic to aquatic life, do not use anything with chlorine in the ingredients if there is a chance that the rinse water could runoff into area streams or lakes. Finally, spread the word. Tell your neighbors, friends, and family how they too can help prevent the spread of zebra mussels.

For More Information

Want more information about zebra mussels? Check out one of these websites for more information:

http://nas.er.usgs.gov/taxgroup/mollusks/zebramussel
http://www.nmnh.si.edu/iz/alienspecies.htm
http://www.mdc.mo.gov/nathis/exotic/zebra
http://www.100thmeridian.org/
http://www.des.state.nh.us/factsheets/bb/bb-17.htm
http://www.sgnis.org/www/zebra.htm
http://sun.science.wayne.edu/~jram/zmussel.htm
http://www.sg.ohio-state.edu/
http://unionid.missouristate.edu/
http://unionid.missouristate.edu/gallery/links.htm
http://unionid.missouristate.edu/gallery/good_bad_ugly/bad_ugly.htm

By getting on your computer's internet search engine, typing in "zebra mussels" in the topic line and doing a search, you will generate a wealth of websites to explore this topic!

Thanks for Your Help!

Preventing the Spread of Aquatic Nuisance Species

Stream Team Volunteer Water Quality Monitoring Program

Aquatic nuisance species (ANS) are defined as non-native species which threaten the diversity or abundance of native aquatic species, the ecological stability of infected waters, or the commercial, agricultural, aquacultural, or recreational activities dependent on such waters. In the United States, ANS have caused major economic and ecological damage, making it important to prevent them from reaching Missouri's waters and containing their spread when they arrive. Specifically, as part of the Stream Team Volunteer Water Quality Monitoring (VWQM) program, we need to take some simple precautions to make sure our activities do not facilitate the spread of any ANS.

Currently, there are seven ANS impacting Missouri's rivers and streams. Additionally, there are 12 more ANS that may establish populations in Missouri if precautions are not taken to limit accidental transportation of these species. These 19 species are listed below. In many cases international ANS are introduced to the Great Lakes region as a result of global shipping. These species then use the Illinois River as a transport corridor from the great lakes to the Mississippi and Missouri rivers. From the rivers these species either migrate to stream systems or are transported from one basin to the next when boats, canoes, and other equipment are not properly cleaned before being used in multiple aquatic systems. For a detailed description of the Missouri Department of Conservation's management plan for aquatic nuisance species visit:

mdc4.mdc.mo.gov/applications/MDCLibrary/Library.aspx?ArtID=16342

ANS Currently Impacting Missouri Rivers and Streams

Zebra mussel
Asian clam
Grass Carp
Common carp
Bighead carp
Silver carp
White perch

ANS with the Potential to Spread to Missouri

Water hyacinth
Hydrilla
Eurasian milfoil
New Zealand mudsnail
Rusty crayfish
Quagga mussel
Northern snakehead
Black carp
Ruffe
Round goby
Didymo
Whirling disease
Viral Hemorrhagic Septicemia

As part of the VWQM program several pieces of your monitoring equipment have the potential to transport ANS (Table 1). Special attention should be given to your protective footwear.

There are two methods to treat this equipment in order to successfully prevent the transport of any ANS (Table 2). The first is a short term chemical bath using a straight vinegar or diluted chlorine (bleach) solution. Alternatively, these solutions can be applied to the nets or equipment with a spray bottle. **This method should be used if you are planning on sampling more than one stream within the span of 1-3 days**, and if possible, should be done at home in your bathtub or shower.

The long-term alternatives are to thoroughly dry, freeze, or bathe the equipment in a salt bath. Adequate drying time is the best option given the minor safety issues associated with the chemical treatment options. For most of your equipment, it should be sufficient to allow it to dry thoroughly for at least 3 to 5 days between uses.

Aquatic nuisance species are a threat to Missouri's unique aquatic resources and their spread will be both economically and ecologically expensive. Your monitoring efforts are important to protecting our aquatic resources but we must make sure that we do not do anything detrimental to the streams we are trying to protect. Taking these simple precautions takes a little extra time but will ensure that the chances of spreading ANS are minimized.

Table 1. Volunteer Water Quality Monitoring equipment that should be treated to avoid potential spread of Aquatic Nuisance Species.

<u>Biological Monitoring Equipment</u>
Nets (3' x 3' kick net or long-handled D-frame net)
Sorting pan/ice cube trays
Forceps
Squirt bottle
Protective footwear
<u>Stream Discharge Equipment</u>
Float – wiffle golf ball
Tape measure
Rope
<u>Chemical Monitoring Equipment</u>
All sample bottles and glassware used in chemical kits
Thermometer
Turbidity Tube
<u>Sediment Monitoring Equipment</u>
Cubitainer
DSS Sampler
Milk Jugs
Funnel

Table 2. Methods for treating Volunteer Water Quality Monitoring equipment to avoid potential spread of Aquatic Nuisance Species

Technique	Duration	Concentration	Solution (per gallon)	Comments
Short Term				
Vinegar	20 min	100%	1 gallon of vinegar, no water	Safety glasses and gloves should be worn. Vinegar and bleach are corrosive to metal and toxic to fish.
Chlorine	10 min	200 ppm	5 oz or 15 ml of bleach and 1 gallon of water	Before re-use rinse with water but don't let the solution runoff directly to the stream.
Long Term				
Air Drying	3 - 5 days	N/A	N/A	Equipment must dry completely.
Freezing < 32° F	24 hrs	N/A	N/A	Must be below freezing for duration of contact time.
Salt Bath	24 hrs	1%	1/8 cup and 1 gallon of water	Equipment must be completely submerged.

STREAM TEAM PROGRAM
ZEBRA MUSSEL MONITORING REPORT FORM

Name:_____

Stream Team No.:_____

Address:_____

City, State, Zip:_____

Daytime phone:_____ **Evening phone:**_____

Name(s) of monitor(s): _____

_____

Date of sample:_____ **County:**_____

Stream name:_____

Location of Monitoring Site [Please be specific; give legal description (Section, Township, Range) or describe proximity to roads/highways/towns (e.g., where Hwy. H crosses Spring Creek in southwest Mussel County)]:_____

_____

_____

_____

Sampling Method (please check):

☐ **Visual observation** ☐ **Concrete block** **No. of blocks used**_____

Sampling Results (please check):

☐ **No zebra mussels found** ☐ **Zebra mussels present**

If zebra mussels present, how many did you observe in total (all blocks combined)?

☐**One** ☐ **2-10** ☐ **11-50** ☐ **51-100** ☐ **>100**

Were the mussels: ☐ **Alive?** ☐ **Dead?** ☐ **Both alive and dead?**

Did you preserve any specimens in isopropyl (rubbing) alcohol? ☐ **Yes** ☐ **No**

Other Comments:_____

_____

_____

_____

<u>Please submit form to</u>:
Stream Unit
Missouri Department of Conservation
PO Box 180
Jefferson City, MO 65102-0180
Phone: (573) 522-4115 ext. 3169 **Voice Mail: 1-800-781-1989**
Fax: (573) 526-0990 **Email: streamteam@mdc.mo.gov**
Or submit this form online at: <u>www.mostreamteam.org</u>