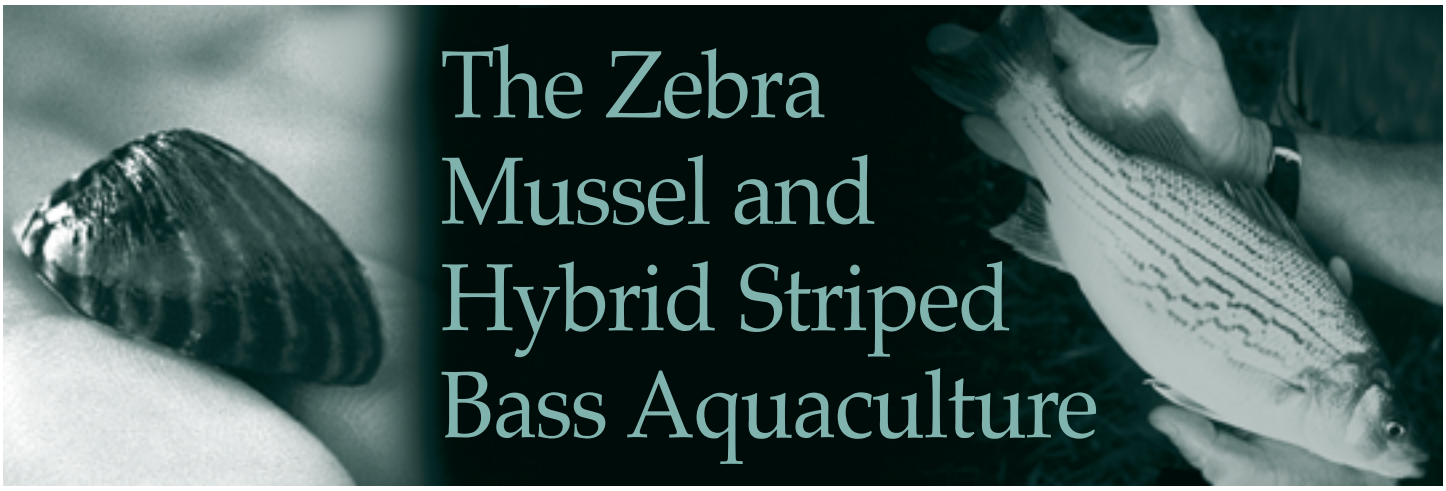

# The Zebra Mussel and Hybrid Striped Bass Aquaculture

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The zebra mussel, an exotic mollusc native to the temperate waters of the Black, Caspian and Aral Seas in southwestern Russia and Ukraine, has spread by natural and artificial dispersal throughout most of Europe and has now entered North America. Since first appearing in the Great Lakes in 1988, zebra mussels have spread rapidly through the Mississippi River basin to southern waters in the U.S. Their presence in the region represents a potential problem to the warm water aquaculture industry.

Their tremendous fecundity (ability to reproduce) and planktonic larval phase give them unmatched ability to disperse through natural and artificial habitats. Zebra mussels are prolific spawners, producing as many as 1 million eggs per year. Fertilized eggs hatch into semibuoyant planktonic larvae, which are easily dispersed and/or transported while in suspension. Upon metamorphosis, larvae settle out of the water column, attaching to whatever hard surfaces they encounter. Once mussels attach themselves to barges, boats or other movable objects, they can be passively transported to new areas. These factors give them an almost limitless potential for colonization of new habitats.

Because they have few natural predators, multiply rapidly, feed on phytoplankton and encrust most hard surfaces, zebra mussels may impact hybrid striped bass producers in a variety of ways, such as obstructing supply and drain pipes, encrusting aerators and reducing their buoyancy, and clogging water supply valves and filtration systems. They may also reduce natural striped bass productivity and adversely affect oxygen dynamics in nursery, fingerling, and production ponds as a result of intensive filter feeding. Finally, zebra mussels frequently harbor life stages of fish-infecting trematode parasites in European waters, and could possibly do so in North America.

## The Zebra Mussel and Hybrid Striped Bass Profitability

Annual production of hybrid striped bass in the U.S. has grown steadily, reaching approximately 7 million pounds by the mid-1990s. Although this growth has been accompanied by fairly consistent profitability, production of hybrid striped bass is often complicated by cash flow constraints. Zebra mussel infestation and subsequent control programs can create economic problems for small hybrid bass producers in the same manner as competition from wild-caught stripers, crop failures, and high fuel and feed costs.

## What is the ZM/CCP Program?

The Zebra Mussel /Critical Control Point (ZM/CCP) program is a proactive, common sense approach to address potential impacts of zebra mussels on warm water aquaculture. This goal can be achieved for specific production systems by following these guidelines:

(1) Identify Critical Control Points (CCPs), that is, areas where zebra mussels could inadvertently enter production facilities.

(2) Determine appropriate measures to avoid infestation and establish monitoring procedures based on the identified problem areas.

(3) Formulate control actions and/or remediation in the event an infestation does occur.

(4) Establish a record keeping system to facilitate these activities.

### Identify Critical Control Points in Hybrid Striped Bass Aquaculture

Given the zebra mussel's record for dispersal and infestation as well as its widespread presence in southern waters, it may only be a matter of time before the zebra mussel appears in hybrid striped bass operations. Hybrid striped bass producers should be especially aware of these Critical Control Points (CCPs):

(1) Contaminated surface water sources. Zebra mussel populations are already well established in the Mississippi, Atchafalaya, Tennessee, and Arkansas rivers, and could potentially exist in any tributaries of these waterways. Introductions of zebra mussel larvae, juveniles, or adults into surface waters by recreational boaters is possible throughout the traditional range of this pond-based industry.

(2) Brood stock from contaminated sources. Collection and shipment of wild brood stock from zebra mussel-contaminated waters could inadvertently result in introduction of planktonic larvae, or vegetation carrying juvenile or even adult zebra mussels. This is a particular problem in the traditional method of fry production. Some hatchery facilities regularly use broodstock from infested watersheds, and, on occasion, from Lake Erie.

(3) Water and equipment from contaminated facilities. Hauling tank water can harbor microscopic larvae and newly-settled juveniles. Nets, baskets, boots, gloves and other equipment can transport inconspicuous juveniles and subadults, attached directly or on bits and pieces of vegetation.

### Determine Monitoring and Vertification Procedures for CCPs

Monitoring for zebra mussels is the most effective way to verify the presence of all the zebra mussel life stages that can potentially be introduced via each CCP. The monitoring process for each life stage is different. Adults are recognizable by their dark, zebra-like rays; very young zebra mussels, though barely visible, feel grainy to the touch, whereas the veligers (planktonic larval stage) are visible only under a microscope.

The process necessary to detect the planktonic larval (veliger) stage probably requires the most tedious procedures. Veligers must be collected using a plankton net. A dissecting microscope with a cross-polarized light system is often necessary to detect larval zebra mussels, especially in samples contaminated with other planktonic forms.

Monitoring surfaces for the settling life stages of the zebra mussel is far more practical. Although this type of monitoring is an indicator of infestation after the fact, it is useful because zebra mussels are vulnerable to a number of control treatments at all stages of development. This type of monitoring should include deployment and regular inspection of small samples of the same hard surface materials currently being used at your facility, such as polyvinyl chloride (PVC) pipe. These samples or test plates will provide a suitable surface for attracting mussels as they settle out of the water column. Other materials can be used. Plastic mesh pot scrubbers are inexpensive alternatives that can sometimes capture all sizes of zebra mussels. These "plates" should be deployed at strategic locations (at least 6 inches under the surface where water flow is slow, oxygen and phytoplankton available, water temperature between 32-86°F or 0-30°C) throughout your facility.

Adult zebra mussels typically have small, thumb sized D-shaped shells with zebra-like bands, but some may be solid brown or black. They usually colonize in clusters. Zebra mussels are easily recognized by a simple shell test. When placed ventral side down, zebra mussel shells remain upright. Stand pipes, screens, spawning mats, boat hulls, submerged equipment such as aerators and their anchoring stakes or any other hard surfaces are good places to look for adult and subadult zebra mussels. They can also be found frequently on aquatic weeds such as naiad, coontail, milfoil, hydrilla and water hyacinth.

Zebra mussels have extremely fragile shells. Even when adult mussels are not noticeable, shells or shell fragments may be evident in various locations. Since zebra mussels will die if deprived of oxygen, they may also be detected by foul smelling odors coming from outflowing waters associated with supply lines or drains that may have been left with stagnant water for several days or weeks.

Since predicting which type of sampling will produce the first evidence of zebra mussels is impossible, a combination of plankton sampling, placement of settlement devices and regular examination of surfaces for settled adults should be used. These inspections should be made at least every two weeks, or more frequently if you suspect water or equipment from a contaminated source may have entered your facility.

Positive verification of zebra mussels should be made before any remedial action is taken. Identification assistance, including wallet-sized, free, identification cards, are available from your nearest state Sea Grant office (Alabama 334/438-5690; Louisiana 504/388-6349; Mississippi 601/388-4710). Verification is available from most US Fish and Wildlife Service offices or Sea Grant Marine Extension Offices. Samples may also be sent directly to Dr. Bruce Thompson, Coastal Fisheries Institute, Louisiana State University, Baton Rouge, LA 70803-7507 (504/388-6337). Be sure to enclose your name, phone number and pertinent collection data (your location, water source, water temperature, pH, date of sample). Samples at all stages can be most easily verified if they are kept alive. Placed in a cooler with the water in which they are living after collection. If samples must be preserved to transport them for verification, use a 70% ethanol or isopropyl alcohol solution.

For more information on zebra mussel monitoring and identification, refer to the booklet: Standard Protocols for Monitoring and Sampling Zebra Mussels by J. Ellen Marsden, Illinois Natural History Survey, Biological Notes 138, April 1992. It is a comprehensive guide to monitoring all stages of the zebra mussel and is available from the Illinois Natural History Survey, Natural Resources Building, 607 East Peabody Dr., Champaign, IL 61820 (217/333-6880).

### Formulate Action: Preventive Measures

Prevention is the best approach to avoiding a zebra mussel infestation, but preventive treatments are not the same as preventing entry. Treatments when the presence of zebra mussels has not been confirmed can be expensive, expose fish to needless risks and are potentially harmful to the environment. No chemical treatment has proven 100% effective against all stages of the zebra mussel without harming other aquatic life forms, including fish. Therefore, careful surveillance and monitoring coupled with a regular procedure to prevent entry is the preferred approach.

To reduce the possibility of zebra mussels entering your facility, follow these guidelines:

(1) Use only fry and fingerlings from zebra mussel-free suppliers, and insist they be

hauled in well water with a 1% salt treatment whenever possible.

(2) Inspect seining nets, traps, spawning mats and other equipment before allowing them into your ponds.

(3) Steam clean or immerse in hot water (140°F or 60°C) all contaminated or possibly-contaminated equipment, or use a pressure washer if you suspect newly-attached juveniles may be present.

(4) Quarantine or dispose of all incoming plant material.

(5) Use ground water wherever practical or thoroughly filter all incoming surface water.

Filtration is probably the most efficient and economical preventive method for operations that must use surface waters. Backwashable sand filters and submerged infiltration beds are presently available that will eliminate veligers and juvenile mussels from intake waters.

### Formulate Action if Zebra Mussels Present: Control Measures

Besides monitoring the CCPs, hybrid striped bass producers should check tanks, pipes, screens and aerators regularly for adult zebra mussel colonies and shell fragments. The known feeding habits of hybrid stripers suggest that they are unlikely to feed directly on settled zebra mussels. This could allow infestation problems to develop in ponds or tanks over a very short period of time. If zebra mussels are found through monitoring or periodic equipment checks, several courses of action to eliminate them are available:

Treatment with hot water/steam. Contaminated equipment like hauling-tanks or vats should be steam cleaned or immersed in hot water (140°F or 60°C) for 23 minutes.

Desiccation. Seines, nets, aerators, floats, and other contaminated equipment should be allowed to air dry at least one week in humid climates. Infested ponds should be drained and allowed to dry thoroughly for at least two weeks, preferably during very cold or very hot weather.

Salt. This is a particularly promising control measure for hybrid striped bass producers with access to saline or brackish ground water because hybrid stripers generally benefit from intermediate concentrations of chlorides. A 1% treatment of sodium chloride (24 hours) will kill all larval stages of the zebra mussel and most newly settled juveniles. Whenever possible, similar concentrations should be used when transporting fish to or from other facilities.

Disinfection. Traditional aquaculture disinfectants, calcium hypochlorite and iodine, do not appear to effectively eliminate zebra mussels from tanks and equipment. Benzalkonium chloride is effective against all stages of the zebra mussel at 100 mg/L for three hours and at 250 mg/L for 15 minutes. It can be used to disinfect hauling-tanks, stainless steel troughs, vats, nets and other equipment suspected of harboring zebra mussels. This compound is commercially available as ROCCAL™. Note that benzalkonium chloride is highly toxic to most fish species and should be used with extreme care. Thorough rinsing and proper disposal of runoff is essential to avoid impacts to fish stocks within and outside the facility.

Treatment with traditional fisheries chemicals. Rotenone™ (15 mg/L for 24 hours) or chelated copper (2 mg/L for 48 hours) have been shown to kill zebra mussels when applied for other control purposes in infested ponds. These compounds are not, however, labeled specifically for zebra mussel control in aquaculture settings. Note that Rotenone™ is classified as a restricted use pesticide, and can be purchased and applied only by a certified pesticide applicator.

One fishery chemical with some promise for zebra mussel control is potassium chloride. Research suggests that exposure to KCl concentrations as low as 100-200 mg/L for 24 hours should kill roughly 50% of all zebra mussel life stages. Although the FDA has issued LRP (Low Regulatory Priority) guidelines for up to 2000 mg/L of potassium chloride to provide for stress reduction and osmoregulatory enhancement, these levels may not eliminate all veligers/juveniles, even over a 24 hour period, and could result in significant stress for any fish present.

Hydrated lime (CaOH). Addition of calcium hydroxide (hydrated lime) to newly drained ponds at 1000-2000 lb/acre will kill all stages of the zebra mussel as well as other unwanted organisms.

Molluscicides/toxic compounds. No compounds have been approved specifically for zebra mussel control in aquaculture facilities. Although a number of molluscicides have been investigated or permitted for use in eradicating zebra mussel infestations at public and private utilities and industries throughout the Great Lakes and Mississippi valley, regulatory agencies are understandably concerned with potential environmental impacts to adjacent aquatic habitats whenever these types of compounds are applied. The use of any of these chemicals requires specific permission from state and federal agencies. Be sure to contact your state environmental agency as well as your local EPA and/or FDA office to determine the latest regulations and options pertaining to toxic chemical or molluscicide treatments.
8) Natural predators. Although triploid snail carp (or black carp) have been proposed as an environmentally safe approach to controlling infestations once they occur, European experiences with this solution have not been promising.

### Some Vendors for Zebra Mussel Monitoring, Prevention and Control

Because research on zebra mussels control measures continues, no list of vendors, including this one, can be complete. New vendors are entering the marketplace every day. The following list includes vendors who have notified Sea Grant that they have provided consultation, products, or other services relative to zebra mussel monitoring and control in various parts of the U.S. This list does not represent an endorsement or any type of judgment by the authors or their programs of any individual, corporation, or product associated with these vendors, nor does it guarantee the accuracy of these business addresses or telephone numbers after date of publication.

Acres International
140 John James Audubon Pkwy
Amherst, NY 14228-1180
716/689-3737
Products: Monitoring programs for zebra mussel identification

Aim Trading Co.
21 Bishops Rd
St. Catharines, Ontario, Canada L2M 1T8
416/934-0830
Products: Self cleaning filter systems

Alex Milne Associates Ltd
3700 Weston Rd
New York, Ontario, Canada M9L 2Z4
416/742-4911
Products: Sand filters and backflush systems

Aquacenter
166 Seven Oaks Rd
Leland, MS 38756
800/748-8921
Products: Rotenone™, chelated copper and other chemicals

Argent Chemical Laboratories
8702 152nd Ave NE
Redmond, WA 98052
800/426-6258
Products: Benzalkonium chloride, chelated copper, Rotenone™ and other chemicals

Filtomat
40 N. Van Brunt St
Englewood, NJ 07631
201/568-3311
Products: Automatic self cleaning water filter systems

Fuji America, Inc.
Dept. T
4044 Yancey Rd
Charlotte, NC 28217
704/527-3854
Products: Automatic backflushing systems

Lakos Plum Creek
1911 North Helm Ave
Fresno, CA 93727
209/255-1601
Products: Self cleaning pump intake screens

Ronningen Petter
9151 Shaver Rd
P.O. 188
Portage, MI 49081
616/323-1313
Products: Automatic backflushing systems

S.P. Kinney Engineers, Inc.
P.O. Box 445
Carnegie, PA 15106
412/276-4600
Products: Automatic self cleaning strainers

University of Wisconsin
Sea Grant Advisory Service
Philip Keillor, Coastal Engineer
1800 University Ave.
Madison, WI 53705
608/263-5133
Products: Sand filters and buried infiltration systems

**Sample Record Keeping for ZMCCP**

An example of suggested information that should be included on a ZMCCP Report:

**ZMCCP REPORT**

Discovery Date _____
Name of Operation _____ Owners Name_____
County _____Town/City _____State_____
Phone Number ( ) _____

**COLLECTION SITE LOCATION**

Water Source _____
Where Found: (Circle)
Standpipe Screen Aerator Float Floating plants Filter Equipment Boat/Trailer Ponds Vats Tanks Other_____
Type Substrate: (Circle)
Concrete Metal PVC Plant Wood Plastic
Possible source of introduction (For previous 6 to12 months):_____
_____
Possible introductions to other ponds/facilities:
_____
_____
Collected By _____
Identified By _____

Comments, Notes or Map:

**FOR MORE INFORMATION**

Mississippi State University
Coastal Research and Extension Center
2710 Beach Blvd., Suite 1E
Biloxi, MS 39531
601/388-4710
Publications: What Every Fish Farmer Should Know about the Zebra Mussel; The Zebra Mussel and Aquaculture

Louisiana State University
Cooperative Extension Service
P.O. Box 25100
Baton Rouge, LA 70894
504/388-2152
and
Louisiana Sea Grant College Program
Louisiana State University
Baton Rouge, LA 70803-7507
504/388-6349
Publications: Invasion of the Zebra Mussels; Lower Mississippi River Valley Zebra Mussel Newsletter, Southern Region Zebra Mussel Newsletter

Auburn University
Marine Extension and Research Center
4170 Commanders Drive
Mobile, AL
334/438-5670
Publications: Boaters: Beware of Zebra Mussels