



ZEBRA MUSSELS

**Poster Child of
Biological Invasions**

by Dick Sternberg

Why the term “Poster Child of Biological Invasions”?

Zebra mussels represent one of the most important biological invasions into North America, having profoundly affected the science of Invasion Biology, public perception, and policy. -USGS

ZMs have all the qualities of the “Perfect” invader:

- Extremely difficult to keep out.
- Extremely difficult to detect until well-established.
- Reproduce and spread at an explosive rate.
- Cause major ecological and economic damage.
- Have few natural predators.
- Once they're in, you can't get rid of them.

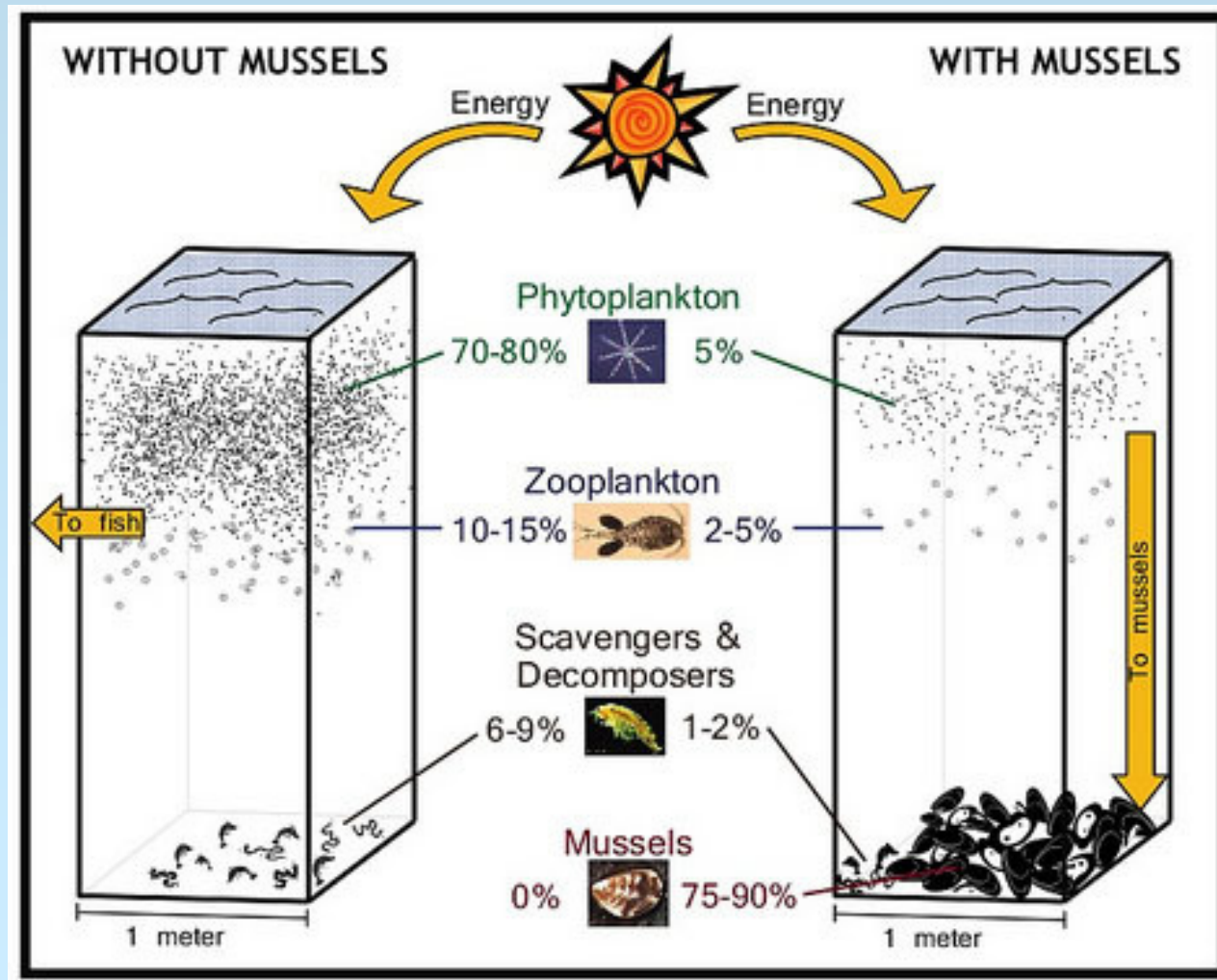
Zebra Mussel Basics

- Zebra mussels are small freshwater mollusks ($\frac{1}{4}$ to $1\frac{1}{2}$ inches long) named for the striped pattern of their shells
- Native to Black and Caspian sea drainages in Eurasia
- Brought to North America in the ballast waters of trans-Atlantic freighters in the late 1980s
- Attach to underwater objects with their byssal threads which secrete a strong adhesive substance



Most Damaging Property:

- They filter the water to remove plankton that would otherwise provide food for fish and other aquatic life



- May reach a density of 700,000/sq. meter
- They spread extremely rapidly; within 2 years of the first Great Lakes sighting, they found their way into all of the Great Lakes.
- As more and more waters become infested, the rate of spread will increase, as appears to be happening in Minnesota
- Once zebra mussels invade a body of water, there is no known method of control or containment
- The only solution:

**KEEP THEM
OUT!!!**

Quagga vs. Zebra Mussels



Quagga mussel

Zebra mussel

- Quaggas tend to be slightly larger with a broader shell
- Ridge on quagga's shell not as sharp as Zebra's and hinge area may lack stripes
- Quaggas can tolerate colder water and lower oxygen levels than zebras so they feed throughout the year and filter even more food organisms from the water.
- Quaggas are more tolerant of a soft, mucky bottom.

- Quaggas inhabit a greater range of depths. Found in water as deep as 500 feet; zebras rarely deeper than 75 feet.
- Quaggas found in MN waters of the Miss. River and in Duluth-Superior Harbor of L. Superior.
- They have displaced zebra mussels in L. Michigan and other areas of the Gr. Lakes, quickly becoming far more abundant than zebras ever were.

• "Quagga mussels are widely regarded as the most destructive invasive species to colonize the Great Lakes, surpassing even the ravenous sea lamprey." - Jeff Alexander, Muskegon Chronicle

• The quagga population in L. Michigan is now estimated at ~~330~~ 950 trillion.

• "Massive, ecosystem-wide changes" have occurred in lakes Michigan and Huron as a result of zebra and quagga mussels stripping the lakes of their life-supporting algae. "These are astounding changes, a tremendous shifting of the very base of the food web in those lakes into a state that has not been seen in the recorded history of the lakes."

- Mary Anne Evans, Univ. of Michigan researcher



Trawling for quagga mussels in L. Michigan.

Reproduction

- Extremely prolific - an adult female releases up to a million eggs in a year and has a life span of 2-5 years.
- The larval form, called veligers, are microscopic in size and enable the species to spread quickly by drifting downstream with the current or being **transported overland by trailered watercraft.**
- Veligers float freely for several weeks before settling onto underwater objects where they can grow and anchor themselves with their byssal threads.
- They may anchor themselves to adult zebra mussels, leading to the rapid formation of dense colonies.



Juvenile zebra mussels attached to adults

Impacts

Byssal threads secrete a powerful glue, enabling the mussels to form dense colonies on rocks, metal, plastic, concrete, pipes, ropes, boats, motors and practically any other submerged object.



Before zms



After zms



On boats and motors



*On dock wheel, Pelican
Lake (Ottertail Co.) Nov.
2010*



Scraped off dock and boat lift - Pelican Lake (Ottertail Co.), 2010



On inside of pipe



On stick



On remains of beer can



Quagga mussels on flip-flop - Lake Mead, NV



On lake bottom following a drawdown

- Zebra mussels attach themselves to living things, like turtles, crayfish and native clams. In some infested waters, native clams have been nearly eliminated by encrusting of their shells.



- Even larval insects, like these dragonfly nymphs, may fall victim to zebra mussels.



Zebra mussels also attach themselves to aquatic plants...



Which are often transported on **trailed** boats.



*EWM draped over boat trailer – Bailey's Harbor, Lake Michigan **NEXT STOP??***



Presque Isle State Park – Lake Erie

- Dead and dying zebra mussels wash up on beaches, sometimes creating windrows more than a foot deep.
- The decaying mussels emit a foul odor and the razor-sharp edges of their shells make footwear a must when walking the beach.



- Notorious for their biofouling capabilities, zebra mussels colonize water supply pipes and debris screens of power plants, public water treatment plants, and industrial facilities.
- They constrict water flow, thereby reducing the intake in heat exchangers, condensers, fire-fighting equipment, and air-conditioning and cooling systems.



Encrusted debris screen



Clogged water-supply pipes



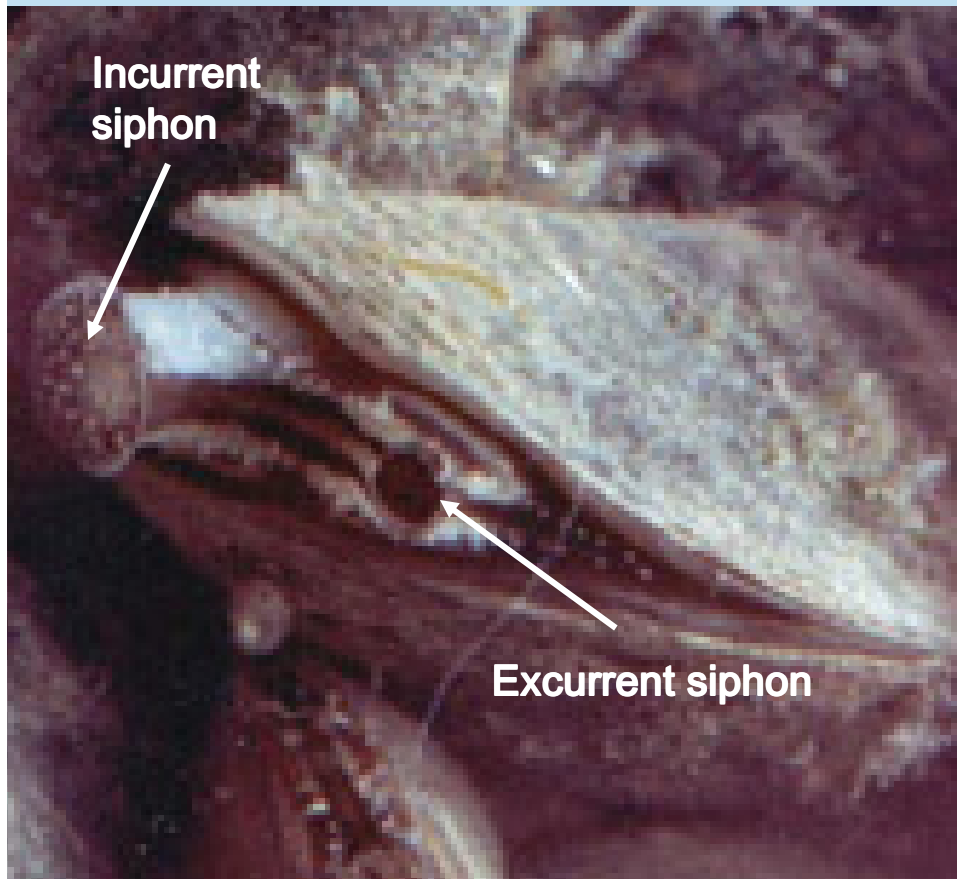
Zebra mussels scraped from Lock & Dam #7 near LaCrescent, Minnesota, 2001

- They also encrust docks, piers, pilings, buoys and locks & dams.
- Continued attachment of zebra mussels can cause deterioration of wooden, concrete and even steel objects, affecting their structural integrity, so periodic scraping or chemical treatment is necessary.



ZMs encrusting navigational buoy on Lake Le Homme Dieu, MN.

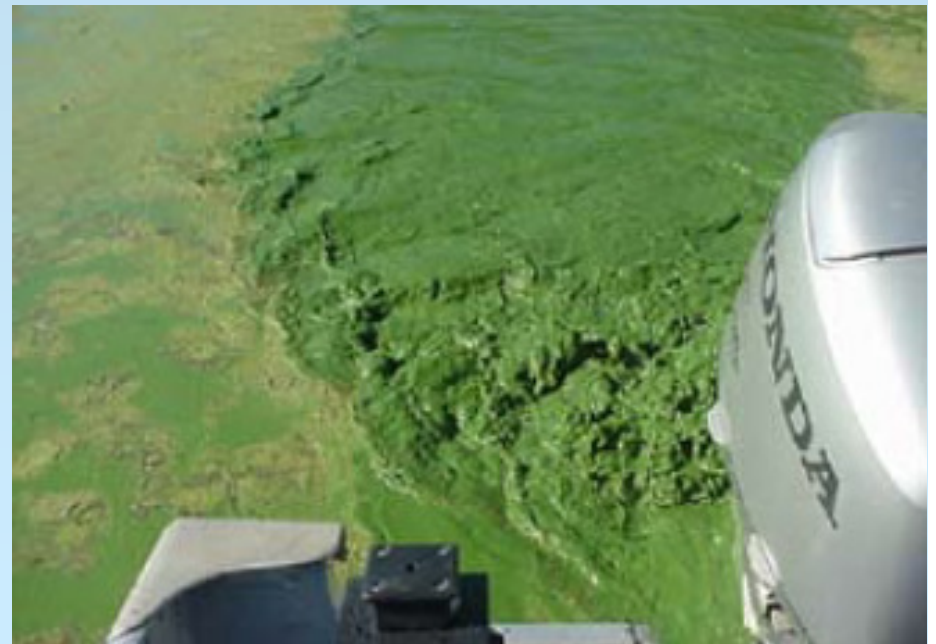
- Zebra mussels are filter feeders, sucking water in through the incurrent siphon, removing the digestible organic matter and then expelling much clearer water through the excurrent siphon.
- Ejected particles are bound with mucus, forming "pseudofeces" which encrusts the bottom and displaces native bottom fauna.



- Clearer water means deeper light penetration, promoting growth of aquatic plants and filamentous algae at greater depths.
- The plants and algae may break free, fouling shorelines and beaches. Dead ZMs tend to collect in the decaying vegetation, making a bad odor worse.
- Dense algae blooms may develop as a result of ZMs rejecting blue-green algae while consuming green algae and other "good" algae that feed on it. The blue-green algae can be toxic to wildlife and pets.



Cladophora mats along L. Michigan shoreline



Microcystis bloom

- Dead algae sinks to the bottom, promoting growth of a toxic strain of botulism.
- Baitfish consume the toxic algae, paralyzing them and making them an easy target for fish-eating birds, which themselves become paralyzed and drown.
- Since 1999, 75,000 fish-eating birds, including **9,000 loons**, have been killed by ZM-induced avian botulism in the Great Lakes area.
- Zebra mussels "bioaccumulate" pollutants in their tissues by as much as 300,000 times. The pollutants continue to biomagnify as they are passed up the food chain and eaten by higher-level predators including fish which may in turn be eaten by humans.
- Zebra mussels can increase acidity and reduce dissolved oxygen. They may be to blame for "dead zones" in the Great Lakes.



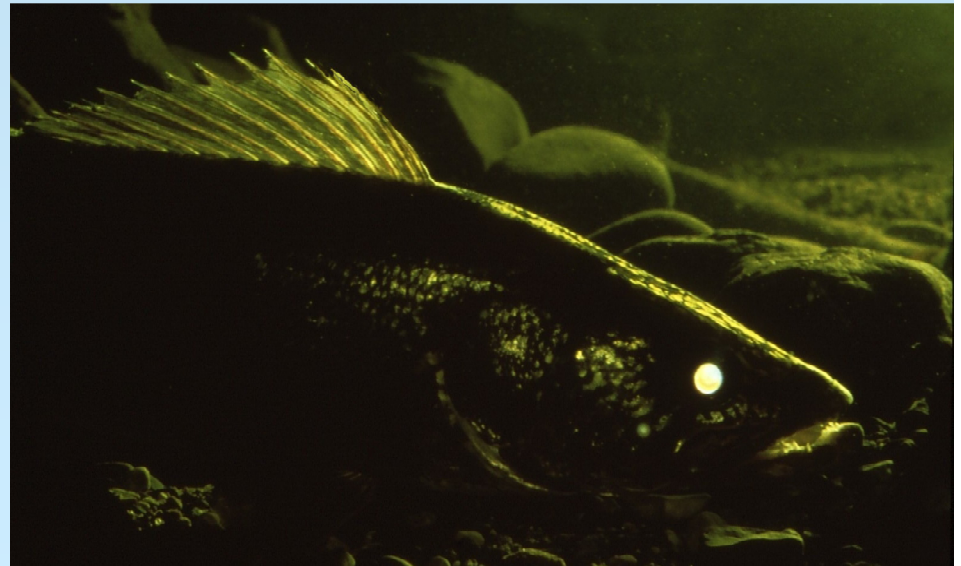
Michigan DNR wildlife biologist examining dead loons collected in the Great Lakes region.

Impacts on Fish & Fishing

- Zebra mussels filter out the plankton that baitfish, juvenile gamefish and some adult gamefish need for food.
- The water becomes clearer, but not cleaner.
- Because plankton are at the bottom of the food chain, overall fish productivity is reduced.
- Dim-light feeders like walleyes generally go deeper and do more of their feeding at night.
- Pelagic (open-water) feeders like salmon can spot lures at a greater distance, so angler catch rates may stay the same or even increase, masking a population decline.



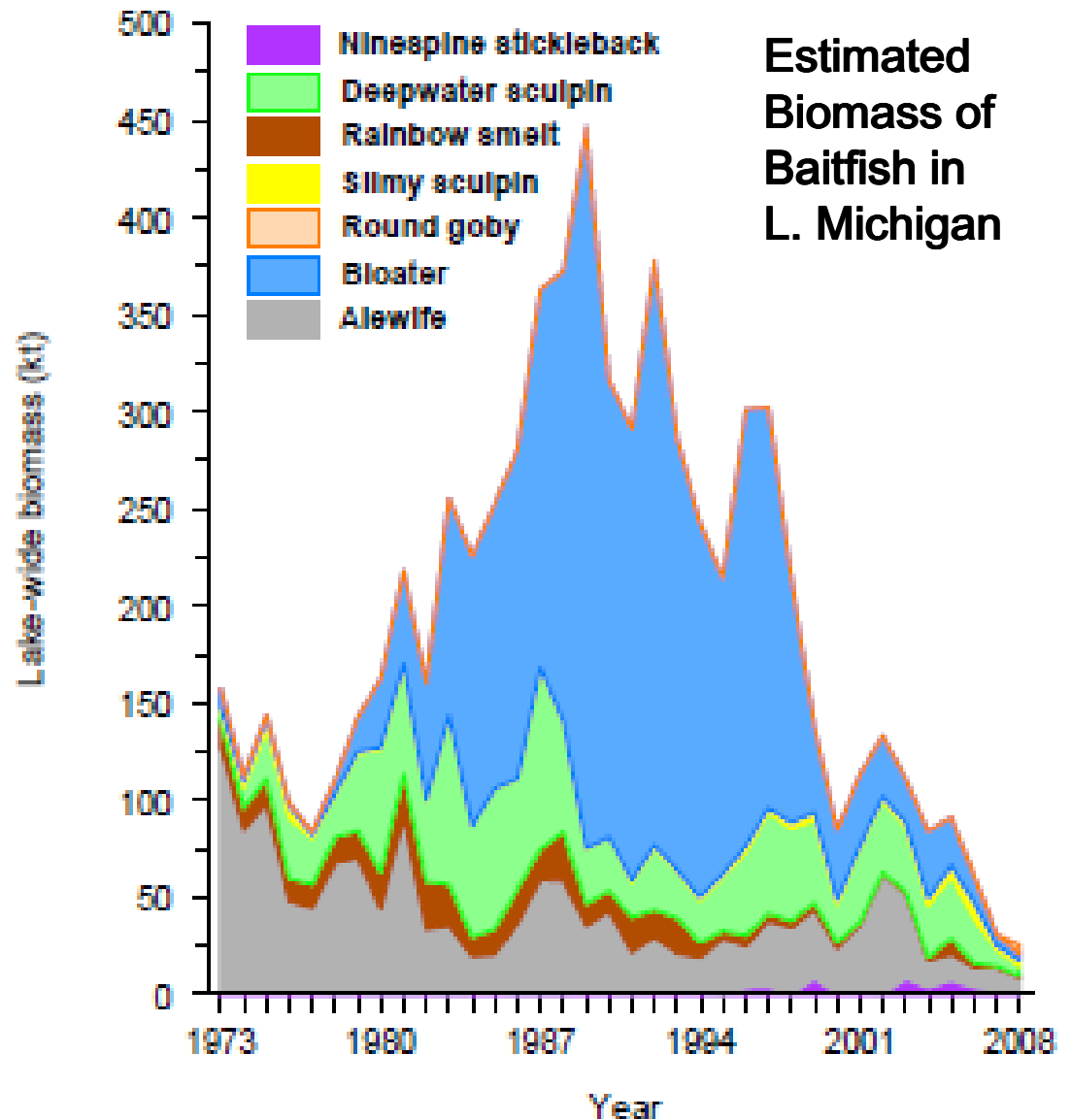
A blanket of zebra mussels on the bottom means clearer water but less food for fish



Walleyes have better dim-light vision than their prey, so they often feed after dark in clear waters

Lake Michigan Example:

- Total poundage of baitfish dropped from 450,000 tons in 1989 to 30,000 tons (a record low) in 2008.
- Alewives, the major food for salmon, declined from 140,000 tons in 1973 to 2,000 tons in 2008.



- Salmon stocking in L. Michigan has been reduced from 10 million (1999) to 3.2 million because of the food shortage, and the average weight of chinooks has dropped about 25%.

- Diporeia, tiny shrimplike amphipods that are the major food source for whitefish and many species of baitfish, declined by 95% from 1994 to 2005.

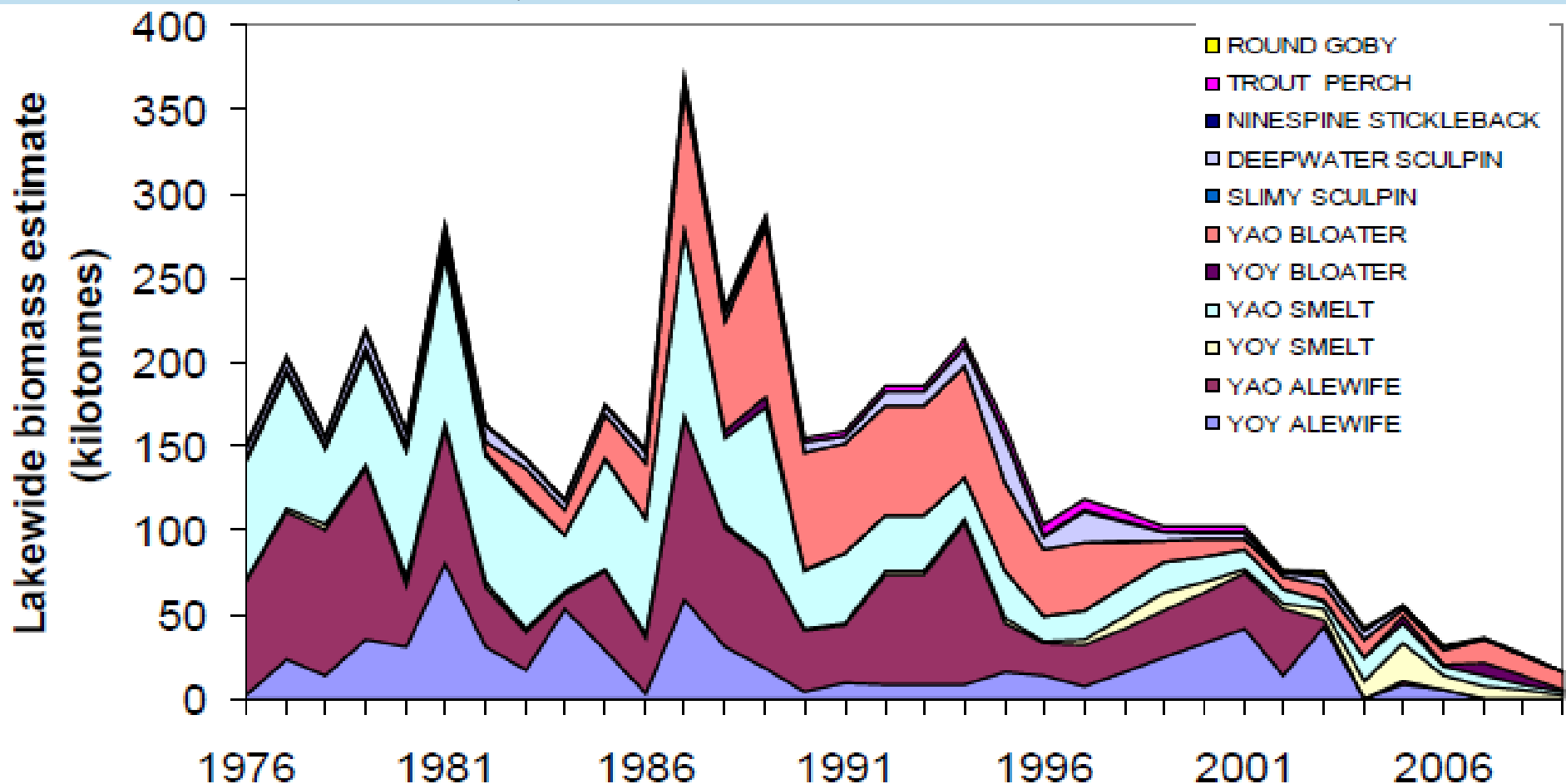


The commercial catch of L. Michigan whitefish has declined by 70% since the mid-1990s

- The average weight of a 7-year-old Lake Michigan whitefish dropped from more than 5 pounds in 1988 to barely a pound in 2008. The decline is blamed on the diporeia shortage.
- “A high percent of the fish biomass could be lost in the next couple years. We have a system that's crashing.... By the time the [Asian] carp get here, there won't be anything left for them to eat.”
 - Charles Kerfoot, Michigan Technological Univ. biologist

Lake Huron Example

- The baitfish decline in Lake Huron has been equally severe, dropping from 370,000 tons in 1987 to 20,000 tons in 2009.
- The chinook salmon population has taken an even bigger hit than it did in Lake Michigan, almost disappearing in 2003-2004.
- Angler use declined by 75%



Do ZMs Make Walleye Fishing Better?

- Lake Erie, which is heavily infested with zebra mussels, is known as "the walleye capitol of the world."
- That has led many anglers to conclude that ZMs do not affect walleye fisheries and may even be beneficial.
- But the Lake Erie walleye fishery has been deteriorating with only one strong year class (2003) produced in the last 9 years.
- The estimated walleye population in Lake Erie was 100 million about 20 years ago. By 2009, it had dropped to 18.4 million.
- If the estimate drops below 15 million, "crisis management" will go into effect, and bag limits will be reduced.



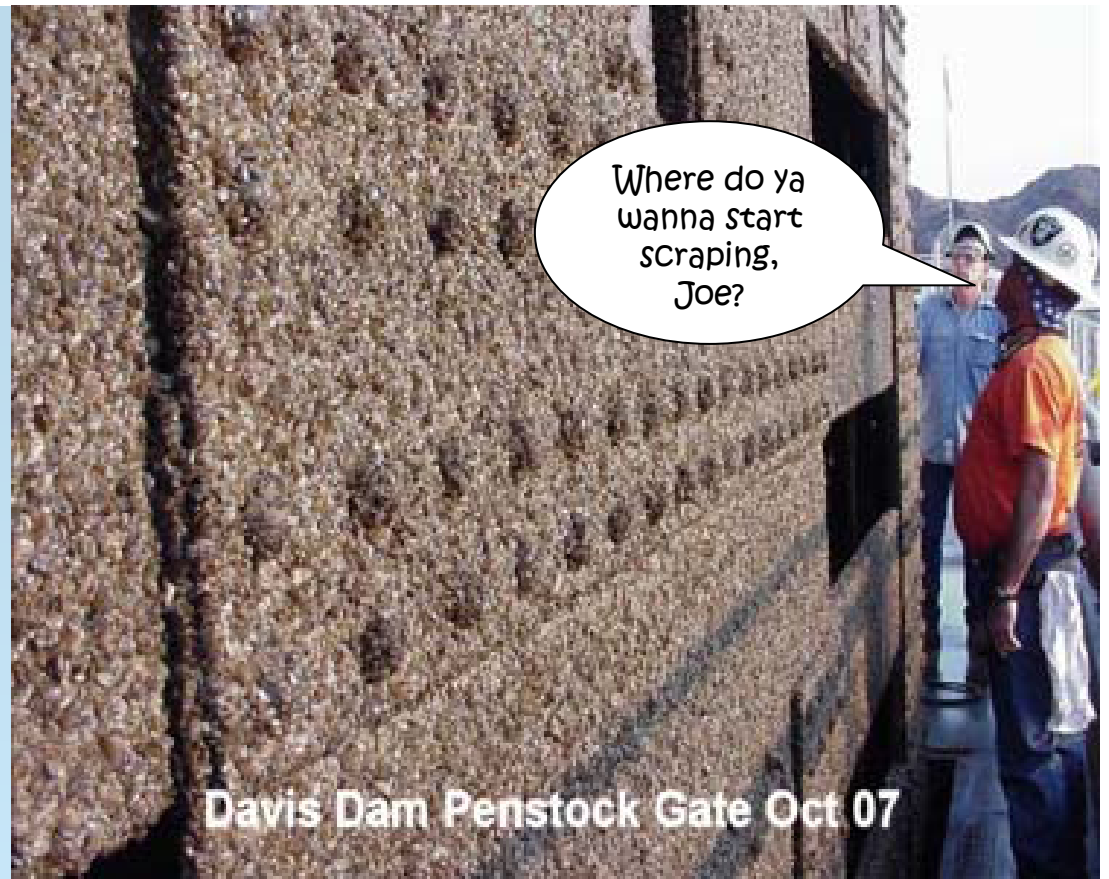
Are ZMs/QMs to Blame for Walleye Declines?

D'Arcy Egan, Cleveland Plain Dealer,
Excerpts from February 12, 2010 article

- Changes in Lake Erie, including the proliferation of toxic blue-green algae, may have far more to do with the declining population of walleye than how many fish are caught by anglers. Scientists found that while green algae supports rapidly-growing young fish, blue-green algae [caused by rising phosphate and nitrogen levels] is a killer.
- There are many theories for the recent spike in phosphate and nitrogen, but phosphate-spewing invasive species like quagga mussels are considered a culprit.
- Research conducted by the Canadian Dept. of Fisheries & Oceans, Ontario Ministry of Nat. Resources and Cornell University found that walleye population declines in the Bay of Quinte (L. Ontario) and Lake Oneida (NY) were due in part to food-web impacts of zebra mussels.

Economic Impacts

- U.S. Congressional researchers estimated ZM infestations cost U.S. businesses, industries and communities \$5 billion from 1993-1999.
- The cost to the power industry alone was \$3.1 billion.
- These estimates came before ZM/QM infestations outside the Great Lakes area. Taking into account current levels of infestation, those costs may now be double.
- Property values on ZM infested lakes could plummet, depending on location and availability of property on nearby uninfested lakes.



Scraping mussels off hydroelectric dams in the West costs billions

- Attached mussels increase drag on the bottom of watercraft, reducing speed, wasting fuel, and requiring scraping and repainting the watercraft's hull.
- Boat engines may be damaged by overheating due to ZMs blocking cooling water intakes.
- Anti-fouling paint will help prevent ZM attachment, but a single application may cost from a few hundred to more than \$1,000, depending on boat size.



Heavy ZM buildup on hull greatly increases drag

- Historic, sunken ships and artifacts may become completely obscured by ZM colonies growing on them.
- Swimming beaches will require constant clean-up to remove sharp, bacteria-laced mussel shells. **Some Great Lakes swimming beaches have been closed as a result of ZM-induced E. Coli outbreaks.**
- Aquatic communities impacted by zebra mussels are changing so fast that biologists are finding it difficult to predict the long-term impacts on gamefish. **But it is safe to say that less fish food means less fish, and that will surely reduce fishing opportunities and impact tourism.**

Possible Sources of ZM Contamination

- Boats/motors/trailers, including canoes, kayaks, jet skis, sailboats and all other types of watercraft
- Anchors, anchor ropes, life jackets, dock lines
- Water skis, inflatable rafts and tubes and tow ropes
- Sandals and other footwear used when wading or walking a beach
- Bait containers, lake water in bait containers
- Fishing/hunting equipment like waders, landing nets, decoys
- Dock moving/installation equipment
- Weed-harvesting equipment
- Nets, traps and other aquaculture equipment (state/federal/private)
- Sampling equipment used by natural resource agencies
- Float planes
- Pets that have been in the water
- Wetsuits, tanks, regulators and other scuba equipment

The Biggest Threats

- Boats with complex plumbing systems, such as multiple live wells. *These boats may be difficult to decontaminate because hot water must be forced through all of the hoses, pumps and valves to kill the veligers.*



This live-well diagram illustrates the complex plumbing systems found in many fishing boats

- Large boats left in slips or tied up to docks for long periods of time. *These watercraft are likely to collect adult ZMs which can infest other bodies of water should the boat be trailered.*
- Boats that are used often and on many different waters. *Not only is the risk of exposure higher, the drying period between uses is not long enough to kill veligers.*
- Boats, boat lifts or other pieces of equipment that have been used on infested waters and then purchased by buyers on uninfested waters.

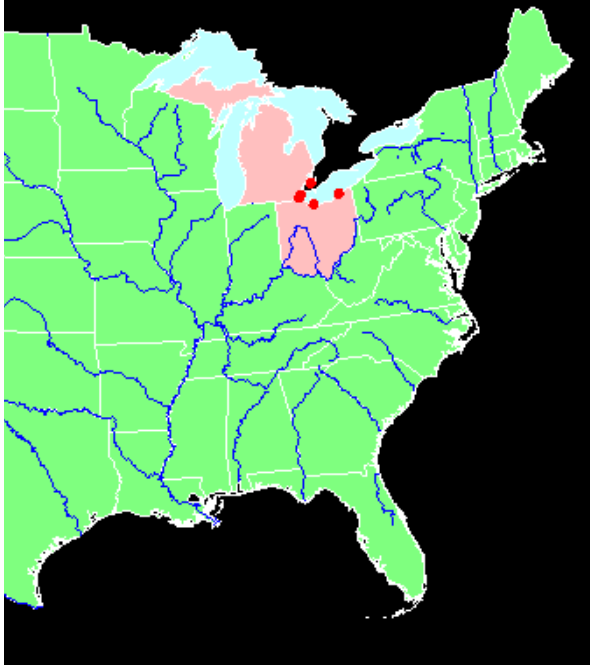


Boat lift removed from Rice Lake near Brainerd (infested with ZMs) and sold to buyer on Pelican Lake near Pequot Lakes (not infested).

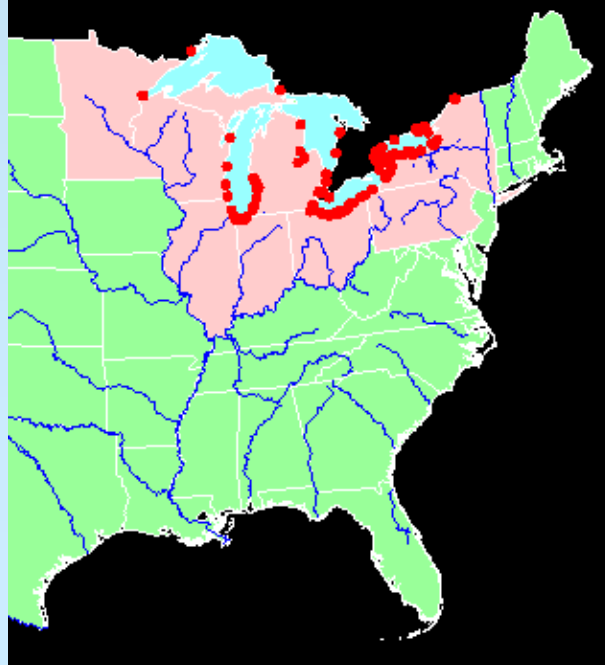
ZMs Spread at an Incredible Rate

- The first North American discovery came in 1988 when they were found in Lake St. Clair, which connects Lake Huron and Lake Erie.
- Two years later, they had spread to all of the Great Lakes.
- By 1995, they had spread to most major river systems in the East.

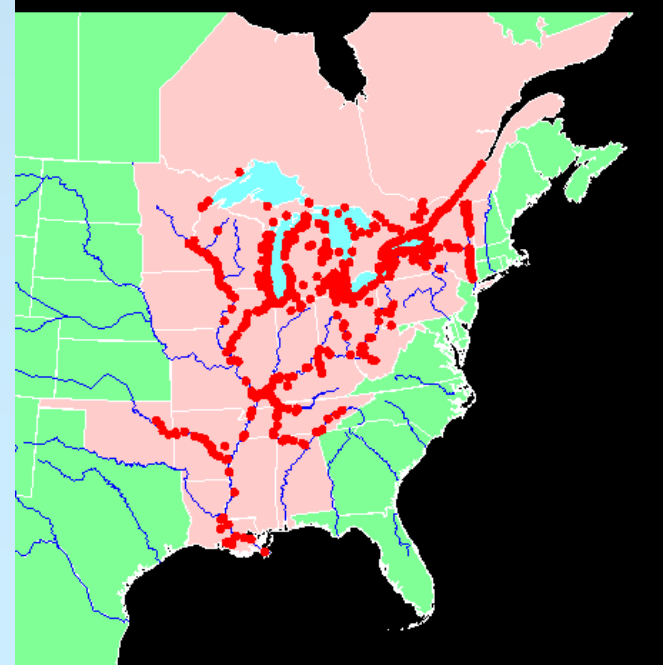
1988



1990

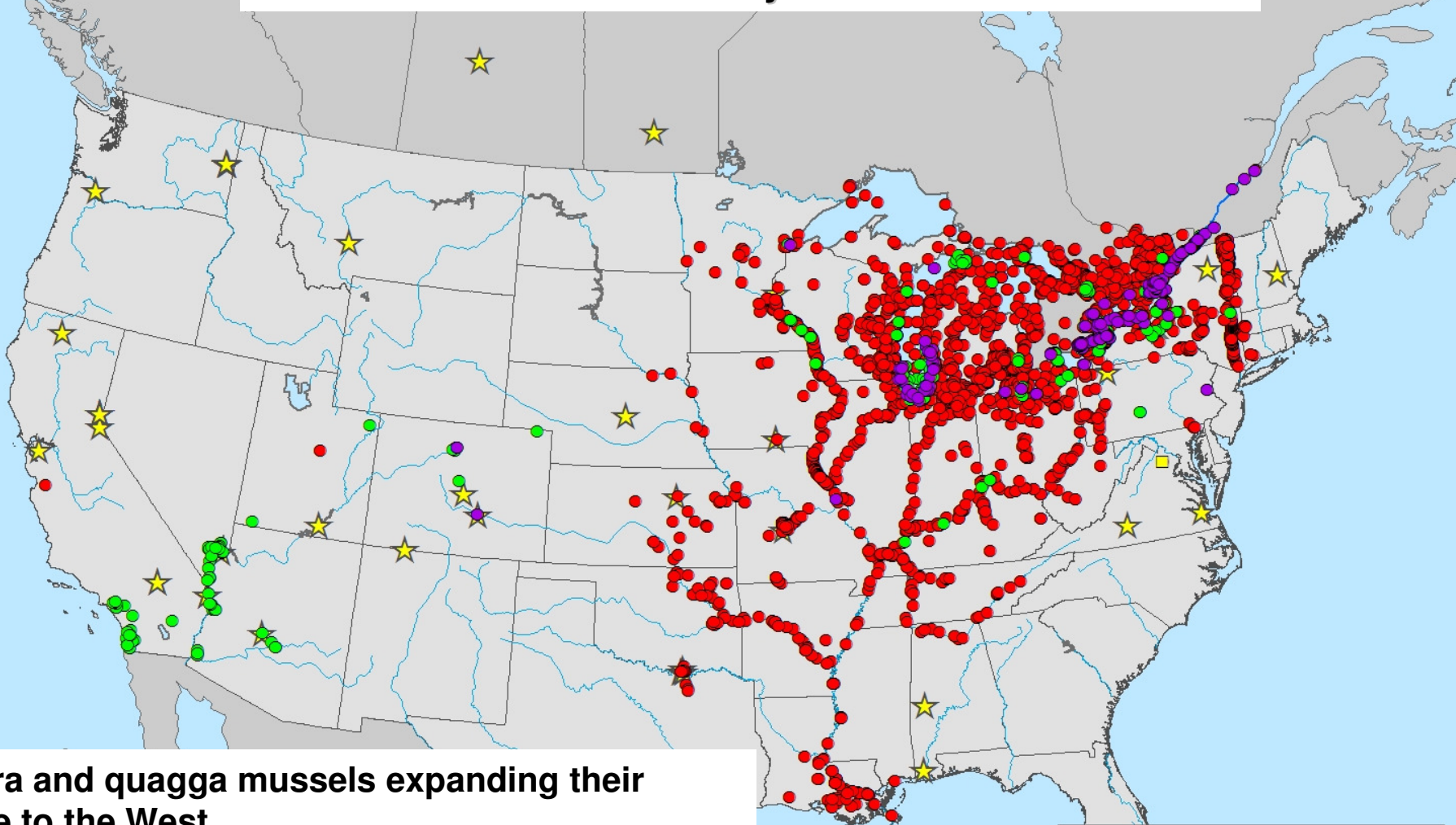


1995



Zebra and Quagga Mussel Sightings

February 2011

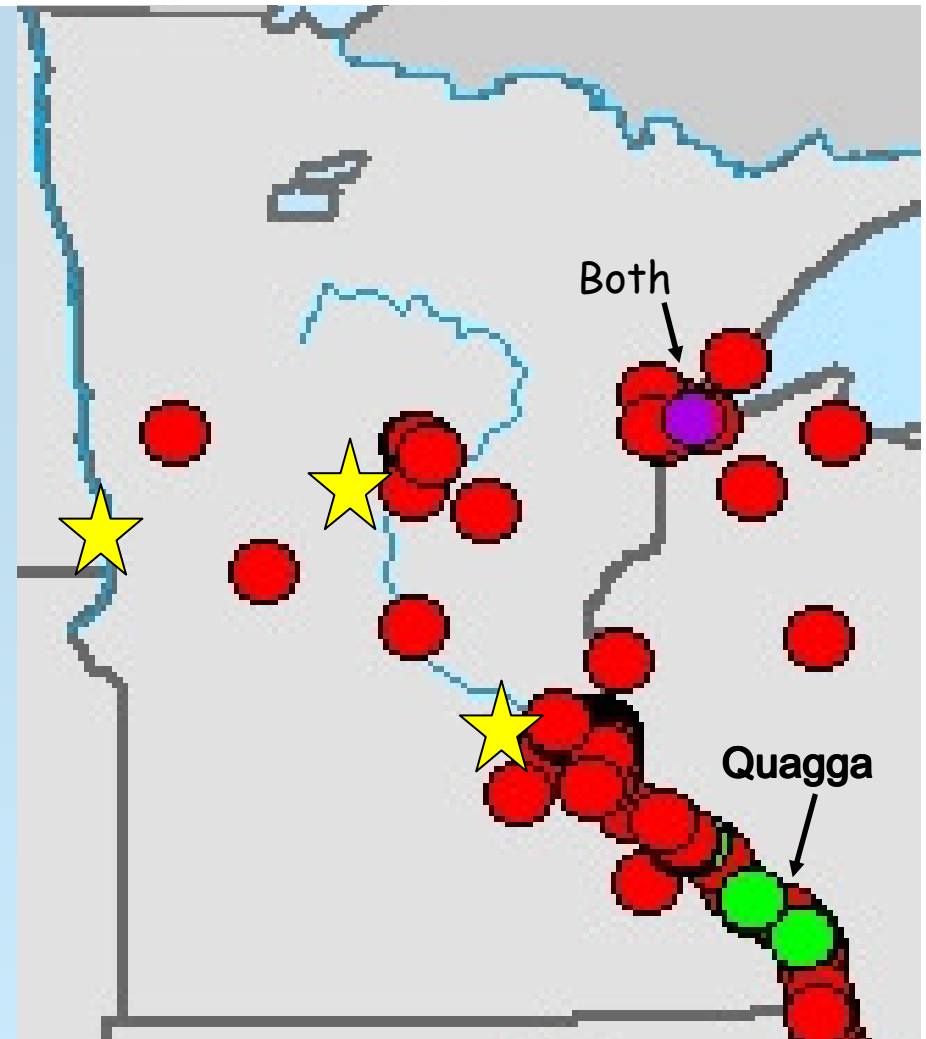


- Zebra and quagga mussels expanding their range to the West.
- Quagga mussels now more common than zebras in the West.
- **Trailered boats** blamed for spread in West.
- Zebras spread by **trailered boats** to many more waters in eastern U.S.

- Zebra mussel occurrences
- Quagga mussel occurrences
- Both species occurrences
- Zebra mussels eradicated
- Mussels trailed overland on boat hulls

Minnesota ZM/QM Distribution, 2010

- To date, Zebra mussels have been found in about 50 Minnesota lakes, rivers and wetlands.
- Major waters added to infested list in 2010 include:
 - Lake Minnetonka
 - Gull Lake
 - Red River
- Calcium, a key indicator of ZM colonization potential, is present in most Minnesota waters at levels high enough for shell formation. All other important water quality parameters appear to be suitable for ZM survival.



**Most MN waters
are at high risk
for ZM infestations**

Minnesota's ZM Program

- Motto: "Stop Aquatic Hitchhikers"
- DNR website has basic information on ZMs and other invasives.



MNDNR has partnered with local and federal agencies to place 31 billboards along MN highways

- DNR publishes a variety of invasive species brochures and ID cards.
- They also conduct public awareness events and provides speakers to lake associations and other interested groups.
- About 50,000 boat inspections are in an attempt to find any aquatic hitchhikers (not just zebra mussels) are conducted annually
- Despite these efforts, the spread of zebra mussels has accelerated.

"This year saw the largest increase in infested waters for the state since the first occurrence in the state." (MNDNR 2009 AIS Report)

MN Laws Relating to Zebra Mussels

It is ***unlawful*** to:

- transport aquatic plants, ruffe, round goby, zebra mussel, or other prohibited invasive species on public roads;
- transport infested water (including in livewells and bait containers). Note: *To keep unused bait at spiny water flea- or zebra mussel-infested waters, drain and replace with tap or spring water;*
- launch a watercraft with aquatic plants, zebra mussels or prohibited invasive species attached; and
- harvest bait (minnows, frogs, crayfish or other wild animals) from infested waters.

New Boat Drain Law **(effective July 1, 2010)**

- A person leaving waters of the state must drain boating-related equipment holding water and live wells and bilges by removing the drain plug before transporting the watercraft and associated equipment on public roads.
- Drain plugs, bailers, valves, or other devices used to control the draining of water from ballast tanks, bilges, and live wells must be removed or opened while transporting watercraft on a public road. Marine sanitary systems and portable bait containers are excluded from this requirement.
- A person must not dispose of bait in waters of the state.



Why has the Spread Accelerated in MN?

Infestation of large, heavily used lakes like Mille Lacs, Gull, Minnetonka, Pelican and the Le Homme Dieu chain has exposed an increasing number of lakes to ZMs because of transport on trailered boats. These waters have now been dubbed "**super-spreaders.**"

Excerpts from MNDNR 2009 AIS Report:

- Dive surveys in Mille Lacs Lake by DNR Fisheries and Ecological Resources staff found a ten-fold increase in zebra mussels over numbers from 2008.
- Veliger numbers were significantly higher than the previous years. All plankton samples collected in August and September had veligers present, indicating widespread reproduction in the lake.
- All data suggest that **the zebra mussel population in Mille Lacs has expanded enormously and is reproducing and settling at a high rate.**

ZM Explosion in Mille Lacs

2008: 0.4/sq. ft.

2009: 4.4/sq. ft.

2010: 14/sq.ft.

2011: "Off the charts" (DNR prediction)

The 2011 prediction is based on field observations of large numbers of juvenile ZMS during the summer of 2010 which are most likely the result of warmer weather and the longer-than-normal growing season.

- Inspections have been conducted by interns without thorough training or proper equipment for finding ZMs, especially the microscopic veligers.

- With 900,000 licensed boats in MN and an unknown number of out-of-state boats, less than 5% are inspected.



- Inspectors have not been authorized to check live wells, internal plumbing or interior compartments.

- If an inspector found ZMs on a boat, the operator was instructed to clean the boat off prior to launching or leaving an access site.

- The DNR has had no facilities, such as hot-water pressure washers, available for decontaminating boats.

New legislation to address these concerns is of vital importance.

- Boaters can be fined up to \$500 for transporting invasive species in MN, but such fines are rarely imposed.
- Inspectors have no enforcement authority, so they must contact a conservation officer to issue a citation.
- 59 citations were written in 2009 for all AIS violations.
- Boats can enter from other states without a border inspection.

Considering the level of monitoring and the large number of lakes at risk in MN, it's clear that a more aggressive approach is needed.

What Minnesota Lake Organizations are Saying



"At Minnesota Waters, we believe the current AIS aquatic is one of our state's defining ecologic, economic, and social crises. And while education, awareness and voluntary actions have greatly increased Minnesotans' knowledge of AIS - and prompted some positive action to stem their spread -- more must be done. AIS are a serious and pervasive threat to our lakes and rivers. To beat them, we will need to make equally serious investments and cultural changes. We need to change the game."



Excerpts From:
Zebra Mussel Bulletin
Feb. 26, 2009

- This could be the year Lake Minnetonka gets zebra mussels.
- The LMA has been very concerned about the likelihood that Lake Minnetonka will be infested with zebra mussels for a long time. Until recently, however, we have not had clear, objective information to assess our risk.
- The results from two separate studies are now available - and taken together, they point to an imminent threat of Lake Minnetonka getting zebra mussel.
- The MN DNR reports that the zebra mussel population in Mille Lacs Lake has exploded [2008 AIS Report].
- 730 boaters [annual estimate] come to Lake Minnetonka from Mille Lacs.
- The inspections that occur on each lake are 1) incomplete, only a fraction of the boaters entering or leaving the respective lake are inspected, and 2) the inspections are educational and the inspectors neither have the authority nor the ability to actually require boaters to empty their water reservoirs.

"This is a time bomb - tick, tick, tick"

Columbia River "Basin Watch" Newsletter

A 100th Meridian Partnership Program between resource managers, marinas, resorts and other water users to prevent the introduction of zebra mussels into the Columbia River Basin.



- You and your business have a stake in the future and what eventually will happen to the resources of the Columbia River Basin.
- We can keep mussels out of the Columbia Basin, but it will require that you become knowledgeable about the issue and get involved in the prevention effort.
- You don't want to be confronted with the situation that California, Nevada and Arizona water users are now facing and find yourself asking...

Why didn't someone do something to prevent this when we had a chance?

Getting Tough Out West

- ZMs and QMs are new to the West - first documented infestations in 2007.
- Some states like CA, CO, NV and UT have taken a very aggressive approach to keep mussels out.
- But others are moving slowly and their natural-resource agencies may lack enforcement authority.
- Western Regional Panel of the Aquatic Nuisance Species Task Force recently developed a comprehensive, **region-wide** program called "Q-Zap" (Quagga-Zebra Mussel Action Plan for Western Waters).
- The plan includes standard procedures for inspections and, if necessary, decontamination of watercraft.



Q-Zap Inspection/Decontamination Procedures

- **Step 1: Screening interviews** by certified inspectors are conducted on all arriving boats to assess the level of ZM/QM risk.
- **Step 2: Inspection of any suspect boat** is conducted to find attached mussels (dead or alive), standing/trapped water or attached vegetation. If any are found, decontamination and/or quarantine is required, or the boat is not allowed to launch.
- **Step 3: Decontamination** is conducted away from the water, where wastewater and solids can be contained.
- **Step 4: Quarantine/Drying** may be done as an “insurance policy” after decontamination or when decontamination facilities are not available.
Boats that have not been decontaminated or adequately dried will not be allowed to launch.

Note: Drying time may be as little as 3 days at temperatures above 100 °F or as long as 28 days at 30-40 °. High humidity lengthens drying time by as much as 7 days.

Decontamination Standards

- Hot water pressure washer set to achieve 140 F at point of contact
- Maintain contact for at least 10 seconds on all exposed surfaces
- Pressure washer capable of minimum 4 gpm at 3,000 psi
- Use pressure washer attachments for flushing sensitive areas and cooling system, live/bait wells, storage compartments, accessories, etc.
- Drain then treat (hot water) all areas of standing, trapped, stored water
- Maintain 60 seconds contact time for hard-to-access areas

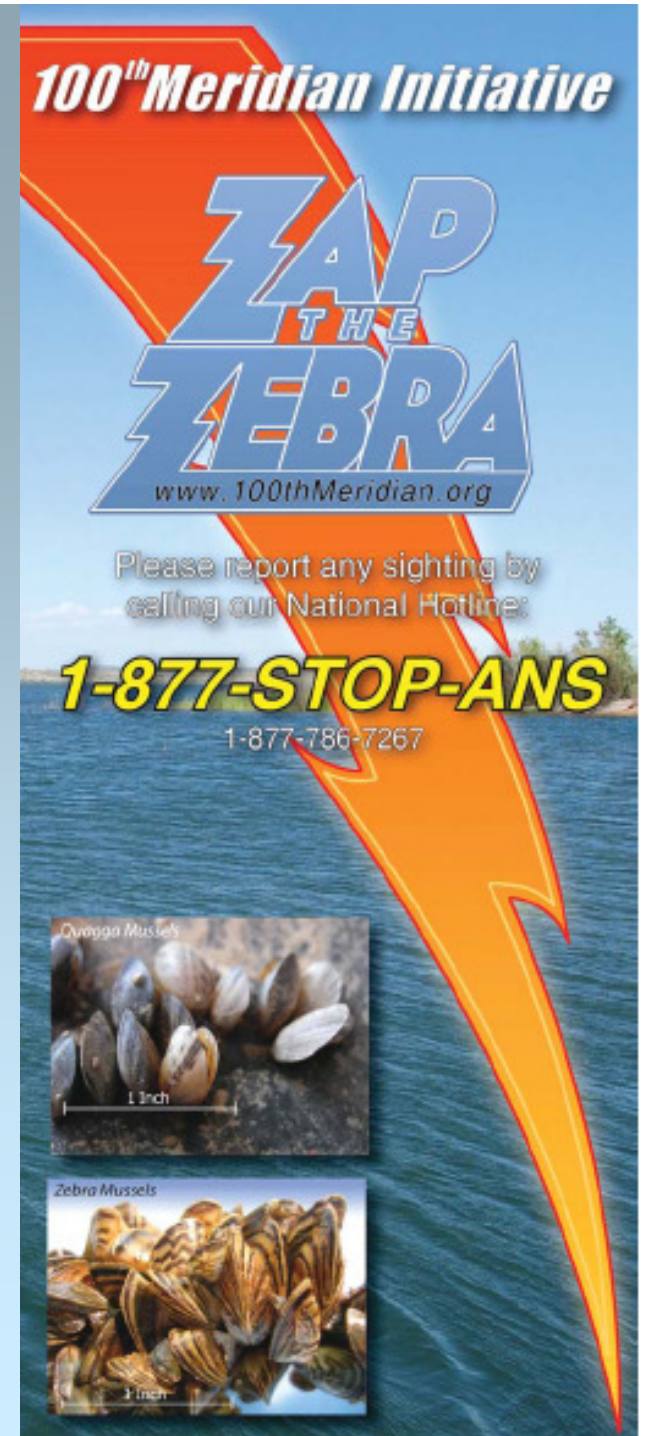
Containment: The Best Way to Keep ZMs Out

- Minnesota has almost 12,000 lakes (10 acres or larger) plus innumerable small lakes, ponds, rivers and streams. Right now, only about 50 water bodies are infested.
- It is much easier and much more economical to contain the infestation by inspecting boats leaving 50 bodies of water rather than inspecting all boats arriving at thousands of uninfested waters.
- DNR agrees with this philosophy and is beefing up inspections at infested lakes. But budget constraints allow them to inspect only a fraction of boats using these waters. And with no decontamination equipment or staff trained to use it, the ZM spread will continue.

Until we have a statewide program that ensures ZM containment at infested waters, we have no choice but to defend our lakes with a thorough inspection program with a decontamination option

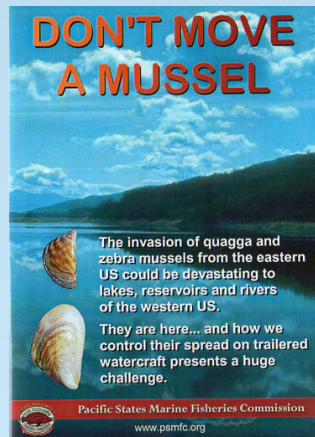
Education

- More public awareness of the ZM threat is a must. While there are several good general-purpose AIS publications available from the State (DNR and Sea Grant), they do not contain the detailed instructions necessary for thoroughly inspecting and decontaminating different types of watercraft.
- The “Zap the Zebra” brochure contains some excellent information, including a ZM distribution map, which clearly shows the threat we are facing.
- For more detailed information on zebra mussels, visit:
 - 100thmeridian.org
 - or Google USGS zebra mussels



Boat-Cleaning Information

• 100thMeridian.org has an excellent boat-cleaning video on their website called, "Don't Move A Mussel: Part II. It provides detailed boat-cleaning information plus decontamination procedures using both portable and permanent hot-water pressure washers.



• The most complete printed information on boat cleaning is California's 20-page "Guide to Cleaning Boats" brochure. It provides details on cleaning many different types of boats and boating equipment.

**PROTECT YOUR BOAT!
FIGHT QUAGGA AND ZEBRA MUSSELS**

A GUIDE TO CLEANING BOATS



AND PREVENTING MUSSEL DAMAGE

DON'T MOVE A MUSSEL
2009

Prevent the Spread of Zebra Mussels

CLEAN, DRAIN, DRY

*Condensed from
Massachusetts “Stop the
Spread of Zebra Mussels”
brochure*

- **You cannot see microscopic zebra mussel larvae (veligers).** You must thoroughly decontaminate.
- **Inspect and clean your boat** after removing it from the water and away from the launch ramp.
- **Thoroughly inspect all exposed surfaces on your vessel and trailer.** If you find any mussels, scrape them off and kill them by crushing them. Dispose of remains in the trash.
- **Remove all plants and mud from your boat, trailer and all equipment.** Dispose of all material in the trash.
- **Carefully feel your boat’s hull for any rough or gritty spots,** which may be young mussels that have settled on your vessel and cannot be seen. Microscopic quagga/zebra mussels will feel like sandpaper.

- Away from all waterways and storm drains, **drain all water from your boat (pull all plugs) and dry all areas**, including the motor, motor cooling system, live wells, ballast tanks, bladders, bilges, and lower outboard units.
- **Inspect, clean and dry** all life jackets, water skis or other items that have been in the water, including anchors, ropes, etc.
- **Clean and dry personal belongings**, clothing, and footwear that have come in contact with the water.
- **Wash, dry and brush pets** that have been in the water.
- **Divers** - thoroughly clean all regulators, BCDs, wetsuits and dive gear, making sure to clean both the inside and outside of the BCD. Use a commercially available dive equipment cleaning compound that contains ammonia, vinegar, or chlorine. Allow gear, suit and other equipment to dry before diving in different waters (veligers can survive on a wetsuit if left damp).

Certified Inspectors

- Inspectors should have advanced training for finding zebra/quagga mussels on watercraft.
- MN could model its inspection program after the WIT* program offered by PSMFC and used in many western states.
- Inspectors who complete the WIT course are “certified” in watercraft inspection and decontamination and will be able to train more inspectors.



Watercraft inspection training – Hood River, OR

**Pacific States Marine Fisheries Commission Watercraft Inspection and Decontamination Training for Zebra/Quagga Mussels*

Decontamination Facilities

- When an inspector identifies a suspect boat, there must be high-temperature pressure-washing facilities available, preferably on site, so the boat can be decontaminated before launching.
- **Pressure-washing should be done only by individuals with watercraft inspection training.**
- A portable system with a catch pad for collecting and re-using wash water is an economical choice for most access sites.
- Downside: Must be a disposal site for contaminated water so it does not flow back into the lake or into a storm sewer.
- **Price tag: \$5,000-\$25,000**



Portable system with catch pad

- A multi-lane set-up will clean boats in a hurry and prevent lengthy delays at high-use sites.

- This closed-loop system processes wastewater to remove contaminants and invasives, then reuses it for more washing.



High Volume Permanent/Portable System

- The wash pads collect the wastewater and then automatically transfer it to processing equipment within the enclosure.

- Water (can be lake water) must be added only to make up for losses from evaporation.

- Closed-loop systems can be permanent or portable.

- Price tag: \$200,000 and up.

What about Chemical/Biological Treatments to Get Rid of ZMs?

Potassium Chloride:

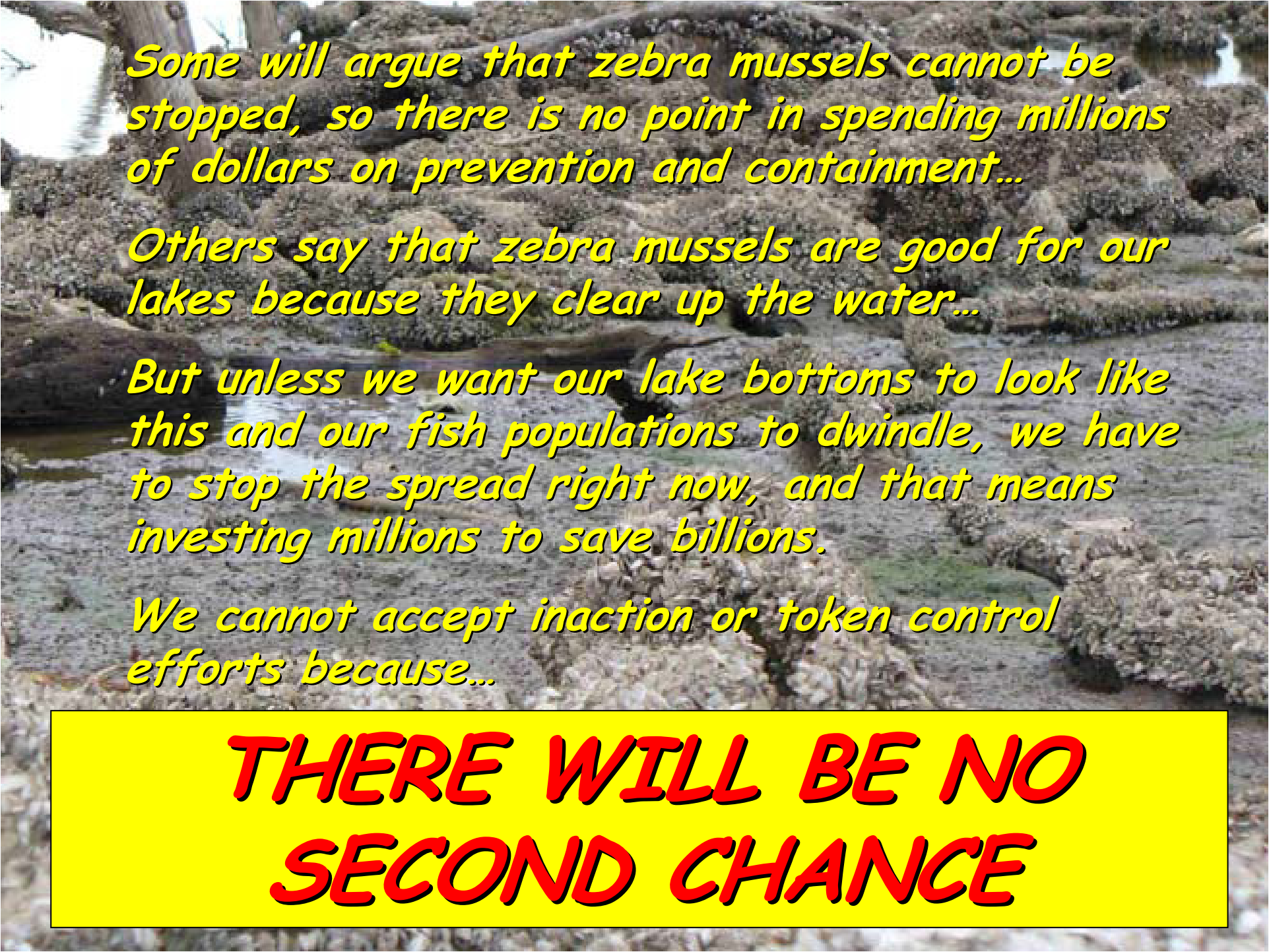
- Toxic to zebra mussels and reportedly non-toxic to fish and wildlife under specific treatment concentrations.
- Used successfully in an abandoned 12-acre quarry in Virginia that was infested with ZMs – **total cost \$419,000**.
- Cost prohibitive for most open-water applications.

Zequanox:

- Bacterial agent shown to be effective in killing ZMs but not fish and other aquatic organisms.
- Used successfully in closed situations, but recent open-water trials achieved only an 80-90% kill.
- Cost could be around **\$10,000/acre** for open-water use, so the cost to treat a 100-acre lake would be a million dollars.
- Size and complexity of most MN lakes may result in uneven mixing of any chemical/biological agent.

What You Can Do

- Be vigilant - if you see a boat with vegetation or any AIS attached, call TIP (800) 652-9093, or a Deputy Sheriff.
- Be patient with boat inspectors; they're trying to protect our lakes.
- Become a volunteer watercraft inspector by attending a DNR training session.
- Help monitor your lake to provide an early ZM warning.
- Spread the word on zebra mussels - everyone should understand the threat we are facing.
- Don't buy a used boat, dock, boat-lift or any other equipment that has been in infested water unless you are sure it has been decontaminated.
- Contact your legislators to express your concern and ask them to find methods of funding an aggressive ZM prevention/containment program before it's too late.



Some will argue that zebra mussels cannot be stopped, so there is no point in spending millions of dollars on prevention and containment...

Others say that zebra mussels are good for our lakes because they clear up the water...

But unless we want our lake bottoms to look like this and our fish populations to dwindle, we have to stop the spread right now, and that means investing millions to save billions.

We cannot accept inaction or token control efforts because...

***THERE WILL BE NO
SECOND CHANCE***

Double-click to start Lake Invaders



Other Invaders that can Harm our Fisheries



Spiny Water Fleas

- Eat other smaller zooplankton, like daphnia, which are an important food for many juvenile fish.
- Small fish have trouble swallowing the fleas because of the long tail, so they can multiply rapidly



Spiny water fleas stick to your line, sliding up as you reel in and gobbing up at the rod tip until you can no longer reel.

Asian Carp



- Silver carp (shown) may jump 10 feet out of the water when disturbed and sometimes jump into boats.
- Both silver and bighead carp eat huge quantities of the plankton that are the primary link in the aquatic food chain.
- Michigan Tech. Biologist W. Charles Kerfoot: ""By the time the carp get here [L. Michigan], there won't be anything left for them to eat."

Rusty Crayfish



- Highly aggressive; eat fish eggs, small fish and anglers' bait.
- I believe they have had a major impact on Leech Lake. When cormorants decimated the walleye and perch populations, rusties exploded. When the fish populations recovered, rusties tanked. Now the fish populations are slipping again and rusties are making a comeback.
- If they do, more stocking may be necessary.
- Need a much better understanding of their role in fisheries.