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Waterways Experiment
Station

Zebra Mussel Research Technical Notes

Section 4 — Miscellaneous Technical Note ZMR-4-08

March 1995

Status of Zebra Mussels, Spring 1994

Background and purpose

The U.S. Army Engineer Waterways Experiment Station (WES) has organized zebra mussel working groups (WGs) of experts knowledgeable in zebra mussels, facilities, or control strategies. WG experts represent the U.S. Army Corps of Engineers, non-Corps agencies, the private sector, and academia.

Four WGs are centered around facilities of common interest, so that participants can interact and share information on successes and failures of ongoing and planned control strategies. These WGs focus their attention on power facilities; reservoirs, intakes, and pumping plants; vessels and dredges; and locks and dams.

This technical note summarizes the reports of WG participants concerning the status of zebra mussels during spring 1994.

Additional information

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Buffalo District
Gary Dye

Buffalo District's Black Rock Lock, located at Mile 4 on the Black Rock Channel (parallel to the Niagara River at Buffalo, NY), consists of a single chamber measuring 198 by 21 m, with an average lift of 1.7 m and a depth of 6.6 m over sills. This lock uses a low-water delivery miter gate operation; twin 2-m filling culverts with 46-cm lateral culverts serve as the primary filling method. Black Rock Lock is the only lock in the river and is augmented by additional gate valves (at each end, approximately 99 by 188 cm). The chamber requires approximately 11 min to fill.

Zebra mussels were first observed at the lock in 1989. Divers working on gate valves saw six to eight patches of adult mussels on the gates and concrete chamber walls. This initial colonization was possibly a result of vessels, including Buffalo District's own floating plant, transiting the lock from western Lake Erie in 1988. By late 1990, mussels covered the chamber completely, and by January 1993, zebra mussels were up to 8 cm thick on the upper operating gates, 3 cm on the lower operating gates, and up to 10 cm inside the culvert.

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No operational problems have been associated with zebra mussels because the lock has no small-diameter piping systems. Gauge wells or transducers and bubbler systems have removable surface systems for ice control. Quoins, miters, and sills are oak, and quoin-bearing surfaces are granite. Maintenance problems include additional time to clean work areas and remove shells, which must be addressed during repairs and winter maintenance. Elevated levels of corrosion proportional to degrees of fouling have been noticed and are being monitored. The odor of dead mussels has been noted throughout the lock during pumpout.

Seasonal closure of the lock due to ice on Lake Erie allows this structure to be dewatered for maintenance. The pumpout in January 1993 brought about a near-complete freeze-kill of mussels in the chamber. The only surviving mussels were in standing water or leakage that did not freeze. Recolonization was nearly complete by January 1994, but with smaller mussels in masses less than 3 cm thick. Debris left in the chamber after the killing of large masses caused minor operational problems in spring 1994, which could have been avoided by removing clumps of dead mussels before rewatering.

Since first discovered, zebra mussels have been a serious concern at Black Rock Lock. Related maintenance problems have been minor; however, the potential of the problem to increase has been recognized. The District will continue to deal with zebra mussels as thoroughly as possible using the freeze-kill method and closely monitoring infestation-prone substrates.

Huntington District
William L. Cremeans, Jr.

Zebra mussel samplings in Huntington District have indicated that numbers are greatest at downstream Ohio River projects (largest count, 334/sq m, at Meldahl Locks and Dam, River Mile 436). Population density decreases upstream, reaching a minimum at Willow Island Locks and Dam (River Mile 162). No zebra mussels have been found in reservoir projects on Ohio River tributaries.

Zebra mussels did not cause any noticeable problems in the District during 1993. However, a rapid population increase during the summer could cover the surfaces or restrict small raw water intakes, either of which could impede project operation. Buildup of thick zebra mussel layers is not anticipated.

Underwater camera inspection of project features is scheduled to replace operation of emergency gates as a means of monitoring, thus reducing delays to river traffic. This video method of inspection should be applicable for all projects, depending on turbidity conditions. Emergency gates, when available for maintenance and inspection, will continue to be examined for zebra mussels. As of March 1994, zebra mussels had not caused a serious problem in Huntington District; however, the District recognizes the potential of larger zebra mussel populations to interfere with lock and dam operation. Monitoring will continue.

Little Rock District
Gordon Bartelt

The Little Rock District's main project is the McClellan-Kerr Arkansas River Navigation System, which has 11 locks and dams. The first zebra mussel infestations in the Little Rock District were discovered by Entergy Corporation personnel on October 18, 1992, on rocks in the cooling water intake canal to the Arkansas Nuclear One power plant. Water from the District's Lake Dardanelle services this power plant.

Additional zebra mussels were discovered in short sections of the polyvinyl chloride (PVC) pipe used as monitors at two of the locks; however, the presence of zebra mussels at every lock has been verified by their attachment to tainter valves, tainter gates, and mooring bitts. The greatest concentration thus far has been about 0.3 to 0.4/sq m, which was found on the bottom surface of a mooring bitt during summer 1993.

The Little Rock District's Zebra Mussel Committee, which consists of individuals from the Hydropower Branch, Navigation and Maintenance Branch, and Hydrology and Hydraulics Branch, has decided on the following course of action:

- Install bioboxes in the two hydropower facilities on the Arkansas River (Dardanelle and Ozark) to test incoming generator cooling water for adult and larval mussels.
- When necessary, use pigs to clean pipes in inaccessible areas, and manual methods in accessible piping.
- Install chlorine injection systems at Dardanelle and Ozark that are similar to the system at Nashville District's Cheatham hydropower plant.

The District's short-term goal is to take any necessary measures to prevent zebra mussels from causing a hydropower facility shutdown. A longer term goal is to monitor zebra mussel-related problems at other locations and use information to design a zebra mussel control strategy.

Louisville District
Lisa Barnese-Walz
and
Robert M. Willis

Louisville District has eight operational locks and dams on the Ohio River and one, Olmsted Locks and Dam (Ohio River Mile 965), under construction. Two locks and dams are located on the Green River, and four are on the Kentucky River. Zebra mussels have been a potential threat to navigation in the District since they were first discovered in the lower Ohio River in 1991. Thus far, no sightings have been reported in either the Green or Kentucky Rivers.

The first zebra mussels observed were relatively large (5 to 20 mm long) and were present in low densities. Later, a few isolated adults were also found, first in the middle Ohio River. Within 1 year, there was a greater uniform spatial distribution and increased density; numbers increased to approximately 1 to 2 individuals/sq m. By the second and third year, these organisms were found in clusters and layers, with shell lengths ranging from 1 to 20 mm. Zebra mussels were most likely first introduced to the Ohio River when adults were detached from barges previously exposed to infested waters. Subsequent collections of immature specimens (up to 2 mm) indicate local reproduction.

During the initial phase of zebra mussel infestation of the Ohio River, Little Rock District used PVC plate monitors to determine zebra mussel presence at different locations. However, the PVC plates were less effective than other substrate sources. Zebra mussel presence can best be determined by examining large permanent or semipermanent structures (for example, lock walls, gates, towers, and buoys). Absence of zebra mussels on the plates in areas in which they were already known to occur could be explained by both low sampler surface area and low initial veliger density. Chances for veliger attachment and zebra mussel development on lock and dam structures is greater than on PVC

plates because of greater surface area. PVC plate monitors function best in areas of known zebra mussel occurrence to determine variations in abundance, size, and growth rates. The plate monitors are also suggested for use in restricted areas or other areas in which the examination of other substrates is difficult.

On May 3, 1994, zebra mussels were observed on a houseboat in Taylorsville Lake that had been transported from the Ohio River in 1993, indicating the ease with which zebra mussels can be spread from one water body to another and the potential severity of the problem. At present, densities are not great enough for tests involving different cleaning methods. Such tests could be possible in the future because significantly greater zebra mussel densities have been projected based on experiences in the northern United States and Canada.

Louisville District predicts that future zebra mussel densities will be significantly greater and will affect river ecology (including native mussels) and operations. Zebra mussels will likely be observed in lake projects, particularly those most heavily visited by boaters from other water bodies.

At Olmsted Locks and Dam, methods of preventing zebra mussel infestation include equipping the fire protection system water intake lines with removable filters or screens on tracks (to facilitate cleaning). Where economically appropriate, water intake lines leading to the filter system will be coated with or constructed of copper. A double filter system will isolate water from the system to produce an internal compartment of dead or anoxic water, and traditional float wells will be replaced with ultrasonic wells to detect water levels.

Problems with zebra mussels on mooring bitts and bulkhead recesses are not anticipated because operation of these structures will crush the shells. At the dam, the lifting mechanism for the wickets is oversized to compensate for the additional weight of a heavy zebra mussel accumulation. Bulkheads will be fully removed from water when not being used to desiccate any attached mussels. Culvert intake screens will be removable for cleaning and maintenance.

At McAlpine Locks and Dam, all service water used is treated city water; thus, no special precautions are needed for that system. Operation and maintenance of District locks and dams was modified by installing duplex strainers in all water intakes. Permanently mounted raw water screens will be replaced with removable screens when lock chambers are dewatered for repairs.

Louisville District anticipates that zebra mussels will complicate annual diving inspections. If infestations are extensive, cleaning of the most critical areas could be required before inspection. Cleaning options being investigated include an air injection or air bubbler system, which causes zebra mussels to be dislodged (described in Technical Note ZMR-3-08, Neilson 1992).

Additional problems associated with zebra mussels could be encountered during lock dewaterings. Louisville District is investigating ways to remove zebra mussels from work areas during dewatering to minimize potential increases in lock closure time. Problems with safety and industrial hygiene related to zebra mussel accumulation and decomposition could arise (as discussed in Technical Note ZMR-4-04, Shafer 1993).

Design modifications to reduce negative effects of zebra mussels are being incorporated into locks and dam and floating plants with attention given to safety, handling, effectiveness, and environmental compatibility. The Louisville District, in conjunction with WES and U.S. Army Engineer Construction Engineering Research Laboratories, is testing two antifoulant coatings at Markland Locks and Dam, including De Voe's ABC No. 3 (a cuprous oxide base system) and Inorganic Coating Company's IC-3 (an inorganic zinc silicate). If tests indicate that these coatings are effective and safe, an antifoulant coating will be specified. Structural modifications will emphasize duplication for cleaning purposes (that is, dual intakes) when possible. Other possible methods for zebra mussel treatment could include backflushing, chlorine, and heat treatment. Selection of any method will be done on a case-by-case basis. The District is also concerned that zebra mussels could cause problems with odor and gas production during decomposition. Disposal may have to be addressed during lock or dam gate bay dewaterings. Strategies will be updated as new information becomes available.

Long-term concerns include the extent to which anaerobic corrosion may shorten the life of paint and metal and reduce the maintenance cycles, and the possible negative effects of zebra mussels on native mussels. Monitoring of sedimentation rates and water temperature at the Olmsted Locks and Dam may reduce threats to native species.

Nashville District
John I. Case, Jr.

Zebra mussels have been found in most of Nashville District's commercially navigable waterways. The District is not currently experiencing any operational problems and has not seen a large increase in populations at navigation or hydropower projects; however, since spring 1992, when adult and larval zebra mussels were first found, the District has been particularly vigilant. Subsequently, these organisms have been found in most District locks on the Cumberland and Tennessee Rivers. Based on increases observed recently at Ohio River navigation structures in adjacent districts, Nashville District anticipates an increase during the coming months.

Test panels with a variety of paint and metallic coatings are in place at Cheatham Project (Cumberland River Mile 148.7) and at Pickwick Lock (Tennessee River Mile 206.7) to determine how effectively these materials repel zebra mussels. Even though no operational modifications are in place, structural modifications were completed by February 1994. For example, intake screens at Cheatham Lock were modified to make them removable and then painted with a copper-based antifoulant vinyl coating, Type 1, Class 1, Grade A (see Technical Note ZMR-3-11, Miller and Wells 1993). In addition, at Cheatham and Kentucky Locks, Nashville District installed water-level transmitters that are designed to be unaffected by zebra mussels (Technical Note ZMR-3-13, Miller and Nimmo 1993a). Current investigations concern new design methods for raw water intakes to replace present systems that are prone to zebra mussel infestation (Technical Note ZMR-3-14, Miller and Nimmo 1993b).

Nashville District installed chlorine injection systems to protect raw water cooling systems at several of its hydropower projects (as described in Technical Note ZMR-3-15, Bivens and Dardeau 1993). Piping to water quality monitoring stations has been treated with hot-dip zinc metal coating (Technical Note ZMR-3-12, Tippit 1993). A backwash filtration system for the Cheatham hydropower facility is also in design phase. In addition, Louisville District continues to work with the Tennessee Valley Authority, WES, and other Corps districts to develop control strategies.

New Orleans District
Edmond J. Russo, Jr., Mike Park,* and *Beth Nord

New Orleans District personnel observed zebra mussels in low densities (32 to 54/sq m) at the 73-m Harvey Lock (Mississippi River Mile 98.2) on the interior walls of a dewatered culvert valve. These organisms have been found in the District on the lower Mississippi River as far upstream as the 366-m Old River Lock (River Mile 304.2) and as far downstream as River Mile 54. Zebra mussels could easily spread to the Atchafalaya Basin through the Old River Control structure.

Raw water intakes will be modified to control zebra mussels in fire protection systems. No other modifications have been made to existing operational procedures. The high temperatures and brackish water within New Orleans District waterways might not be favorable conditions to support zebra mussel infestation at the majority of the locks and other structures. An inspection for the zebra mussel is conducted in conjunction with lock dewatering events; approximately one lock is inspected per year. However, structures identified as susceptible to infestation will be regularly monitored and inspected to avoid any operational problems that could occur from zebra mussels.

Pittsburgh District
J. Michael Fowles

On June 28, 1993, three zebra mussels were collected from two lock chambers at Pike Island Lock and Dam in the Pittsburgh District during routine inspection of floating mooring bitt tanks. Two mussels were taken from the bottom of the No. 10 floating mooring bitt tank in the 366-m chamber (each specimen approximately 25 mm), and one specimen from the No. 10 floating mooring bitt tank in the 183-m chamber (measuring slightly 25 mm).

On August 12, 1993, four additional zebra mussels were collected from the Pike Island facility. Three were taken from floating mooring bitt tanks Nos. 2, 10, and 12 in the 366-m chamber; one was from the No. 3 floating mooring bitt tank in the 183-m chamber (all measuring approximately 25 mm long).

As of April 1994, no other zebra mussels have been observed or collected at Pike Island or any other facility in the Pittsburgh District. However, monitoring of facilities continues. The District is primarily concerned with potential impacts of zebra mussels on the gauging and monitoring equipment at Pike Island and other Pittsburgh District locks on the Ohio River. Protecting these components will receive the highest priority.

St. Louis District
Jerry Rapp

Zebra mussels were first identified in the St. Louis District in November 1991 on the lift gate of the 366-m Melvin Price Lock. In January 1992, the mussels were found at Lock and Dam 24 during dewatering. Since then, zebra mussels have been detected at Lock 27, Lock 25, and throughout the District, along both the Illinois and Mississippi Rivers. Thus far, the five District reservoirs have not reported any zebra mussels. The record high water in 1993 saw minimal use of the rivers and lakes by recreational boaters, and thus somewhat dampened human influence on the spread of zebra mussels. The 1993 high water did, however, spread the zebra mussels into backwater areas and sloughs; farmers reported seeing these organisms 3 km from the main channel after the water receded. No zebra mussels have yet been found on the hulls of District vessels. Monitoring of the vessels and lakes continues.

Pressure transducers, which measure water-surface elevation inside the lock, seem to be impacted to the greatest degree by zebra mussels in St. Louis District. The transducers are periodically removed and cleaned and, if necessary, replaced.

Trash racks at the Melvin Price auxiliary lock were painted with various coatings prior to rewatering the cofferdam. The lock became operational, after diver inspections were made. Floating mooring bitts and cables have been coated at Melvin Price and the Service Base located on the Mississippi River downstream from St. Louis. The effectiveness of the coatings to repel zebra mussels will be evaluated.

The District anticipates that gauge wells and outlets will be infested with zebra mussels. Careful monitoring will continue. Possible solutions include treatment with chlorine, cleaning the outlet with high-pressure water, and physical cleaning by divers.

One major concern in the St. Louis District is the effect of zebra mussels on the year-round operation of the locks for navigational efficiency. Without regular dewatering, the buildup of zebra mussels could affect not only the operating equipment such as tainter valves, miter gates, and tainter gates, but could also increase filling and emptying times by increasing the roughness in the culverts or by clogging intakes, discharges, culverts, and port openings. Thus far, major infestations have been controlled in locks that are dewatered regularly. Locks that are not dewatered could be negatively affected by a 3- or 4-year infestation. Increased filling and emptying times could directly contribute to lockage time delays.

Results of the corrosion study at Black Rock Lock in the Buffalo District could affect the outcome of the Mississippi River navigation study and result in the need to replace or upgrade some of the 30 locks in the upper Mississippi River. Sheet pile locks are being considered to upgrade the system.

Infestations should peak in the District during the next 3 to 5 years. District personnel are particularly concerned about the effects of zebra mussels on facilities that are not regularly dewatered and on the sensitive equipment in gauge wells.

Tennessee Valley Authority Locks
Clayton Minchew

Zebra mussels have been found at 9 of the 10 TVA locks. The TVA is monitoring the zebra mussel expansion and studying infested facilities to learn about new control methods. The TVA Generation Group is conducting a coatings experiment at Cumberland Steam Plant, Cumberland River Mile 103. Several silicone-based coatings were applied to test strips, and copper epoxy and inorganic zinc products are being tried on trashracks.

The TVA is concerned about the effects of zebra mussel infestation because of the agency's investment in locks and dams and coal-fired power plants. Through a working arrangement with TVA, the U.S. Army Corps of Engineers operates and maintains the locks on the Tennessee River and its tributaries, while TVA makes modifications as needed to ensure efficient operation.

U.S. Coast Guard Cutters
LCDR P. M. Litherland, USCG, Cleveland, OH

On the Great Lakes, U.S. Coast Guard cutters (the 43-m ice-breaking tugs known as WTGBs and the 55-m buoy tenders called WLBs) are designed so the main diesel engine-cooling water overboard can be recirculated to the sea chest to melt ice during ice-breaking operations. This system design can also be used for monthly thermal treatment during zebra mussel settling times. Zebra mussel infestations are kept to a minimum when the sea chest temperature is elevated above 38 ^{o}C once each month. The sea chests on the cutters are painted with an inorganic zinc-rich, water-based paint with zero volatile organic compounds, which dries quickly and can be applied by rolling or spraying. The removable sea chest gratings have been hot-dip galvanized as a surface protection. These gratings show no apparent signs of zebra mussel attachment.

Future plans propose replacing the air-cooled refrigeration on the 55-m WLBs with a water-cooled system. When the cutters are altered in this manner, the cooling water intake line is installed with cleanout fittings of sufficient diameter to remove zebra mussels.

As of February 1994, no zebra mussels had been found on WLB-class cutters, probably because of their protective zinc paint. Some cutters have been equipped with larger diameter fittings for easier cleaning if zebra mussels become a problem.

Wilmington District
Robert E. Buchanan, Jr.

Wilmington District's Hydropower Complex consists of Kerr Powerhouse and Reservoir, Philpott Powerhouse and Reservoir, and Island Creek Pumping Station. Powerhouse weekly maintenance now includes examination of the turbine wheel pits, tainter gate areas, tunnels, and water intake areas. A hand-held sampler (as described in Technical Note ZMR-1-04, Miller and Dye 1992) is used to check the face of the dams and the tainter gates. The reservoir rangers patrol the lake shoreline to watch for zebra mussels and examine boats when possible. Engineering personnel periodically check the dissolved oxygen (DO) content, temperature, and pH at various water levels to determine if zebra mussels can survive at the turbine intakes. As of March 1994, the DO levels were too low for zebra mussel survival at that depth.

No zebra mussels have been detected in the Wilmington District; however, the District expects accumulations in the future. During summer 1993 at a lake upstream from Philpott, a boat from the Lake Michigan area was found to have zebra mussels attached. Because of increased public awareness concerning the zebra mussel, the District was able to eliminate a possible problem by preventing the zebra mussel from spreading upstream.

Wilmington District expects zebra mussels to invade its projects as it prepares to address the problem. The short-term goal is to ensure that dredge boat personnel can detect the zebra mussel and alert others of their presence. The District is working with Virginia and North Carolina environmental personnel to prevent the zebra mussel from entering the waters of these two states.

Summary

The above summaries reflect the status of zebra mussels during spring 1994 at select facilities monitored by Corps districts in the central and eastern United States, the TVA, and the U.S. Coast Guard. Some of the summaries show that even though zebra mussels are not yet considered a serious operational threat, the districts and agencies are vigilant in their monitoring programs. Where significant infestations have occurred (for example, in the Buffalo District), redesign of components and regular maintenance has been necessary. Problems associated with zebra mussels include corrosion, odor, and shell removal. Some usage of chemical treatment, particularly chlorination, has been reported; however, alternative control methods are being investigated to replace chemicals, as environmental restrictions become more stringent. In addition, thermal treatment (by the U.S. Coast Guard) and coatings (used by the Corps' Louisville, Nashville, and St. Louis districts) are being investigated.

All Corps districts and other agencies involved with zebra mussels expect the problem with these nuisance organisms to increase in the coming years, causing impacts to operations, maintenance, and populations of native biota.

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