PRODUCT EVALUATION OF ZEBRA MUSSEL CONTROL METHODS FOR SMALL VOLUME WATER USERS pdf

1: "Potential Control of Zebra Mussels Through Reproductive Intervention"

) CONCLUSIONS This product evaluation strongly suggests that for the small volume water user, filtration of source water is probably the most reliable, cost efficient, and universally applicable method of preventing zebra mussel colonization of small water user systems.

The views and ideas expressed in this report are those of the author and do not necessarily reflect the views and policies of the Ministry of Environment and Energy or the Ministry of Natural Resources, nor does mention of trade names or commercial products constitute endorsement or recommendation for use. The ministries, however, encourage the distribution of information and strongly support technology transfer and diffusion. The views and ideas expressed in this report are based on the criteria for testing and study design as approved by these agencies. This report was prepared as a collaborative effort by Aquatic Sciences Inc. The results do not reflect anything other than an assessment of single products in a single study as designed by the aforementioned group. Aquatic Sciences does not endorse or reject the use of any single product as tested in this study. Lowther Consulting - Cartridge Filter 14 4. As stipulated by this group, all products submitted for testing had to be non-chemical in nature. Six of the products were filters cartridge or multimedia while the remaining four products included three magnetic based products and one electrostatic device. The products were installed on pilot scale pumping systems which operated for approximately 11 weeks August 10 - October 19 in waters heavily infested by zebra mussels. Larval mussels entering each system were monitored throughout the study. Upon termination of the trials the products were removed and associated piping and tanks from each system were visually inspected and microscopically examined for zebra mussel colonization. It was evident after analysis that although the filter products were sometimes either difficult to install or maintain, they proved to be the most efficient at removing veligers larval stage zebra mussels from the incoming water and thereby preventing down stream settlement within the system. The hydrodynamics devices proved to be effective, preventing growth in the intake pipe, which was part of a recirculating system necessary for this installation, however, downstream surfaces were not protected. The electrostatic and remaining magnetic device had very limited effect on mussel settlement. Many of the small volume water users hereafter referred to as SVWU , for example cottages and resorts on these systems, have expressed fear and concern over potential problems these mussels may cause, should numbers increase. In response to a perceived need, the Ministries began requesting information from manufacturers in the private sector about non-chemical products which could be installed on small volume water systems for the purpose of preventing mussel growth within the system. From the approximately responses, 10 products were chosen for testing. These products in turn were handed over to Aquatic Sciences Inc. ASI by the manufacturers along with specific installation instructions, on July 9, The products chosen for testing included: Alex Milne Associates Ltd. Zebra Guard Sand Cottage Filter 2. Zebra Guard Cartridge Filter B. Cartridge Filter replaces footvalve C. Cartridge Filter installed after footvalve D. Surface Cartridge Filter installed on pump discharge E. Magnetic Units installed on intake pipe F. York Energy Conservation 7. Management 2 products 8. Hydrodynamics Unit 6JR 9. The intent of the survey was to determine general configuration of the average SVWU system. The following information was compiled: A copy of the questionnaire used during the phone survey is included in the report. Approximately 50 cottage and resort owners were contacted during the survey. A pressurized holding tank was also common, usually located close to the building. It should be noted that many of the people contacted were very well informed about the zebra mussel issue and the majority expressed relief and gratitude that this type of research had been initiated. Previous years monitoring by ASI indicated that it was an excellent source of veliger rich water during the summer months. These plates were checked periodically for mussel growth. Map of research site, "x" marks exact location. Pumping systems at research site blocks were used to keep the foot valves off lake bottom. Twelve systems were fabricated, one to accommodate each of the ten products and two control systems which were left unprotected Figure 2a, b. Each of the 10 systems

for product testing were identical except for slight variations to accommodate specific product installation requirements. All of the products were installed on August 8, by ASI divers. Manufacturers were consulted prior to installation and were invited to the site to verify that the products were installed to their satisfaction. The control systems were located at opposite ends of the product test site in the event that differences in veliger densities existed within the site. It was discovered, during the telephone survey, that the majority of SVWU systems operated on a demand only basis. That is, the pump only engaged when there was a demand for water in the building. To simulate this type of operation, all of the pumping systems were operated from a set of electrical timers which could be programmed to engage and disengage the pumps at specified times. The systems were therefore put in groups of three, each group operating at different times. The timers were set up such that each group of three pumps operated for a two hour period three times daily for a total of six hours without overlap. Each holding tank was fitted with a stand pipe drain which kept the tanks filled with water between pump cycles. The tank overflow drained back to the lake through r clear tubing. On system start up, flow through all systems ranged between 40 and 50 litres per minute. This proved to be invaluable, resulting in the accumulation of a significant amount of data for interpretation and also ensured that the systems were maintained operating, with few exceptions, trouble-free. Daily monitoring of the pumping systems included the collection of 20 litre grab samples from each of the holding tanks while the pumps were operating, Figure 4. Systems were allowed to flush completely prior to sample collection. This allowed an estimation of the number or density of veligers which were entering each system relative to the controls. These 20 litre samples were concentrated to approximately 2 mis through a 53 micron mesh. TTiis 2 ml sample was then examined under 80x magnification and a veliger density number per cubic meter calculated for each system. Page 4 Observations on condition live or dead of veligers and general water quality i. Actual turbidity measurements were obtained from a nearby water filtration plant which gives an indication of relative turbidity at the site. Flow through the holding tanks was checked periodically. Samples were collected and analyzed from settling plates on several occasions to determine if mussel colonization had begun in any of the holding tanks. An important aspect of this study was the daily monitoring of the products themselves in terms of the level of maintenance required for effective operation. The level of effort required to install each product was also considered when assessing overall performance. Generally, for this study, it was considered beneficial if two lay adults could easily install the product. The field testing portion of this project was terminated when veliger densities in the water source fell below 1 per litre and water temperatures were low enough that the majority of reproduction had ceased for the season. All products were removed on October 23, , by ASI divers. Visual inspections of all exposed surfaces were completed by the research technicians on site. The intake lines were then removed and drained. Four 15 cm sections of intake pipe, were then cut from the total length of the line, equidistant from each other, between the foot valve and the water line. The outside portions of these pipe sections were cleaned of all organic growth. The sections of pipe not used for detailed analysis were visually inspected for juvenile mussel growth on the inside surfaces. In addition to the pipe samples, the remaining P. The inside surfaces of the holding tanks were also scraped approx. After analysis, density calculations were made for each of the three surfaces sampled. The densities of veligers and the settlement of juvenile mussels on surfaces of the test systems will be compared to the unprotected control systems. Product installation and maintenance results will also be included. Technician taking sample for density analysis Products were rated on the basis of ease of maintenance, ability to removing incoming veligers and juveniles from the water stream and prevention of settlement in the intake pipe and settling chamber. For the most part this was due to its excessive weight approx. Even when diver assisted, great difficulty was experienced transporting the unit to the intake location and positioning the unit properly. This product cannot and should not be installed from a small boat. If installation is attempted in this manner, capsizing of the boat and serious injury could result. Professional installation is recommended. The manufacturer supplies recommend installation procedures. The manufacturer suggests filter backflushing every 50, gallons which in the case of our installation, would mean once every days. We found this frequency to be inadequate and the procedure had to be undertaken more

frequently approximately twice weekly , particularly toward the end of the project. There also appears to be insufficient diffusion of the backflushed water across the filter to adequately "re-fluff the filter media. Only a small area in the corner of the filter immediately surrounding the backflush port was being effectively backflushed. On eleven occasions during the study the pump for this system lost prime and failed to pump water due to clogging. On these occasions the unit had to be backflushed for thirty minutes or more before the pump could be re-started. It should be noted that turbidity in this vicinity was relatively high 9 NTU or higher on occasion which may be more than is experienced in many SVWU systems. Other problems encountered during installation included difficulty keeping the copper screen covering the top of the filter box in place and poor seals around the intake line entering the filter box. As part of the filter package a Zebra Guard wax was supplied for application to the outside surfaces of the filter box and associated piping to inhibit mussel growth and facilitate easy removal of adult mussels. Mean veliger densities passing through the filter in water samples over the study period were Unfortunately, analysis did not include age distribution. Microscopic analysis of the inside surfaces of the four preserved sections of intake pipe did not reveal any mussel colonization Figure The PVC substrate plates from the holding tank were also found to be free from mussel growth Figure 16 , however, three juvenile mussels were found in samples taken from the inside walls of the holding tank Figure

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2: PPT â€“ The Zebra Mussel PowerPoint presentation | free to view - id: f32a5-ZDc1Z

Product evaluation of zebra mussel control methods for small volume water users Item Preview.

The chlorine dioxide is generated from generators positioned on a portable vessel above the water intake facilities. The treatment using concentrated chlorine dioxide solution permits periodic treatment so that the same portable generators may be used to treat a number of water intake facilities. In one aspect, the invention relates to the treatment of fresh water intake pipes with concentrated solutions of aqueous chlorine dioxide. The zebra mussel biological name: Dreissena polymorpha is a species of fresh water clam native to the Black and Caspian Seas and was accidentally introduced into the Great Lakes in These mollusks have migrated rapidly and the infestation has caused serious problems for water users and suppliers throughout the Great Lakes and adjacent water bodies. These problems are expected to only worsen in the future. Water treating facilities, including municipal suppliers and industrial users, generally employ a water intake assembly known as a suction crib which is located offshore at distance ranging from 50 feet to 18, feet or more. The crib is a generally cylindrical structure with walls defined on the bottom by the lake bed, peripherally by a screen and rock pile formation formed around the screen, and on the top by a trash screen. The suction crib contains at its center a large diameter intake pipe for receiving fresh water and conducting the water to pumping and treating facilities onshore. It is common for eve large water treating facilities to draw all of its water from a single suction crib and intake pipe. The infestation of the zebra mussel presents a serious problem to water treating facilities because they tend to adhere to submerged surfaces including metal, concrete, plastic, and even teflon. If left unchecked the mollusks will infest the intake crib, plug intake screens, restrict flow in the intake pipe, and affect water odor and taste. McTighe et al, methods for controlling zebra mussel infestation may be categorized as ecological, biological, mechanical, and chemical. For various reasons including economy and long-term effectiveness see the aforementioned paper for details , the chemical control method appears to offer the most feasible approach for controlling zebra mussel infestation of offshore water intake facilities. The chemical treatment involves introducing a biocide comprising an aqueous solution of oxidizing chemicals into the intake crib to destroy the mussels therein. These chemicals include free chlorine, potassium permanganate, chloramines, ozone, and hydrogen peroxide. Each of these chemicals have certain disadvantages which may limit their applicability in the treatment of potable or industrial water. For example, chlorine has the potential of forming carcinogenics such as trihalomethanes. Potassium permanganate is known to be less effective than the other oxidizers, while the use of ozone is not presently cost effective. Definitive research on the biological efficacy of chloramines and hydrogen peroxide are not well documented at the present time. A presentation at the Second International Zebra Mussel Research Conference, referenced above, dealt with the effects of chlorine dioxide on Zebra Mussels. The Shoremont Water Treatment Plant is fed by an intake pipe extending from shore 8, feet into Lake Ontario and terminating in an open intake fixed within a suction crib on the lake bottom at a depth of 40 to 50 feet. Fresh water is drawn into the intake pipe by an onshore pumping station. To control zebra mussel infestation in the suction crib and intake pipe, a design was established for injecting a biocide directly into the crib. The plan that was adopted was to extend a pipeline of small diameter through the intake pipe from the onshore pump facility to the suction crib. The line would then serve to conduct the treating chemical to the crib and provide a continuous injection of the biocide. The biocide selected in the initial design was a combination of chlorine sodium hypochlorite and permanganate oxidizers. However, the MCWA has chosen to use only sodium hypochlorite. The treatment involves the use of dose rates ranging from 0. Although this method appears effective in controlling and preventing infestation of the zebra mussel, it is extremely expensive to install e. In addition, this method is limited to intake pipes which permit the insertion of the biocide chemical line therein. In summary, the infestation of the zebra mussel poses a serious problem for water treatment facilities having offshore suction intake and there is currently a need for a flexible and cost effective biocidal process for controlling the infestation. A novel feature of the process is that the

facility is treated with a concentrated solution of chlorine dioxide ClO2 and only for a relatively short periods of time and then discontinued until further treatment is required. The apparatus for performing the treatment process is also portable so that a single unit may be used to treat a number of such facilities as needed. Although the process may be adapted to any particular design of intake facility, it is expected to be of excellent utility in treating facilities comprising a suction crib containing an intake pipe. In the treating process of the present invention, chlorine dioxide is the preferred biocide because it has been found to be very effective in killing zebra mussel; it can be produced safely and economically; and it avoids the problem of carcinogenic by-products such as trihalomethanes. The central component for carrying out the process of the present invention is a chlorine dioxide generator CDG for reacting stable raw chemicals to form chlorine dioxide gas and further to combine the gas with lake or river water to form a concentrated aqueous solution of chlorine dioxide. Other required components include pumping means for delivering lake or river water to the CDG, raw chemical storage and facilities for delivering the reactants to the CDG, and flow line for conducting the treating solution from the CDG to the suction crib. In the process of the present invention it is preferable to use a CDG to produce ClO2 gas on site rather than transport the gas to the treatment site because ClO2 is a highly reactive, unstable, and potentially explosive compound. In accordance with the present invention, a portable work platform is positioned above the crib and secured in place as by anchoring to the lake or river bottom. The platform supports the CDG and all other necessary equipment for performing the process and may be a barge, work-boat, or a jack-up platform. As described in detail below, the crib and intake pipe are chemically treated by delivering from the CDG to the crib, via a delivery pipe lowered into or adjacent the crib, a concentrated aqueous solution of chlorine dioxide. For carrying out the process of the present invention, it is preferable for the water treatment plant pumping facilities to be in operation to assist in drawing the treating solution into the crib and the plant intake line. This mode of operation also has the important advantage that the entire plant is treated for controlling zebra mussel infestation since the treating chemical is drawn from the crib through the intake line and into the plant. Moreover, many pumping facilities cannot be economically shut down for treatment. The delivery line for conducting the ClO2 solution from the CDG to the crib may be fitted at the end with an elongate perforated sparger pipe for injecting the chemical over a larger area of the crib. At least two embodiments are envisioned. In the first, the sparger pipe is attached to the end of the delivery line and lowered from the platform and positioned in the crib e. The treating chemical is injected through the sparger and drawn into the crib and plant intake line by the suction of the plant pumping facility. The delivery line and sparger pipe are withdrawn after the treatment. In the second embodiment, the crib is provided with a sparger pipe fixed permanently inside the crib with an attachment fitting protruding through the crib cover screen for receiving the delivery line and treating chemicals. After completion of the treatment, the delivery line is disconnected from the sparger and recovered while the sparger remains in the crib for the next treatment. The sparger pipe may comprise a pipe formed into a large-diameter ring for adapting with better geometric conformity to the cylindrically shaped crib and injecting the treating chemical over a larger area of the crib. In operation, the treating process of the type described will be performed for the number of hours as needed to kill the zebra mussels. The delivery line will then be recovered and the treating unit may be moved for treating other intake facilities. It is expected that periodic treatment of intake facilities and water treatment plants using the process of the present invention will provide a cost effective and environmentally safe method of removing and preventing zebra mussel infestation. The duration of the treatment and concentration of the treating solution will depend upon the severity of the problem and the size of and capacity of the facility. However, it is preferred to employ a treating period either intermittent or continuous for to 14 days at treating time intervals ranging from 1 week to 1 year, preferably 1 month to 1 year. Suction crib 14 comprises chamber 15 enclosed by circumferential wall 17 and top screen In operation the water enters the crib through screen 18, flows into pipe intake 19, through pipe 12 to pump station 10, and thereafter is processed as in a municipal treating system or an industrial water source. The above description is representative of onshore water facilities with offshore suction. The method of the present invention is

particularly adapted to treating such systems by applying a biocidal solution of aqueous chlorine dioxide at the point of suction to control zebra mussel infestation of the water intake facility. It is preferred that the pumping unit of the water facility be in operation while carrying out the treatment with ClO2 to assist in drawing the treating solution into the crib and intake pipe. In this mode of operation, the treating chemical not only disinfects the crib but also the entire water facility since the biocide also flows through pipe 12 into pumping station 10 and to the plant beyond, and does not interrupt the facility operation. Briefly, the method according to the present invention involves the steps of: The treating period ranges from 1 to 14 days and may be by continuous or intermittent injection. Chlorine dioxide is an unstable, highly reactive gas which is soluble in water. It is therefore preferred to employ chlorine dioxide in an aqueous solution as generated by a chlorine dioxide generator. Such generators are disclosed in U. These generators typically comprise a reaction zone in which compounds e. The venturi creates a low pressure zone for drawing the chlorine dioxide gas from the reaction zone into the adductor where it is absorbed by the water flowing therethrough to form a concentrated aqueous solution. In the present invention, lake water is flowed through the venturi for forming the solution. Referring again to FIGS. The platform is anchored to the lake or river bottom using anchors 22 or, alternatively, pilings not shown. The chlorine dioxide generator 21 is in fluid communication with sparger pipes 23a and 23b through flexible hoses 24a and 24b respectively. The sparger pipes are attached to the flexible hoses using unions 25a and 25b. Sparger pipes 23a and 23b are sealed at the end and are provided with a plurality of injection holes 26 around the pipe for injecting biocidal solution 27 therethrough. Thus, biocidal solution produced in chlorine dioxide generator 21 is pumped through the flexible hoses 24a and 24b, into the sparger pipe 23a and 23b, and injected in to the lake water at or near the intake line suction through sparger pipe holes 26 and is drawn into the line without affecting water outside the crib. Sparger pipes 23a and 23b are fixed to shroud 28 by suitable securing means not shown. Shroud 28 is positioned above crib 14 and anchored thereto with anchor lines Shroud 28 has open ends 28a and 28b for allowing lake water to flow therethrough under the suction action of the water pumping station With the water plant pumping facility in operation, lake water flows into shroud 28 through end 28a, entrains biocidal solution 27 injecting through sparger holes 26, enters the crib through cover screen 18, and flows into pipe intake 19 to remove any zebra mussel attached thereto. The biocide solution entering the crib will also fill the crib chamber 15 by the action of turbulent eddies and mass diffusion to disinfect the crib. Shroud 28 serves to generally contain the biocide in a region above the crib. Although two sparger pipes are shown, a single pipe or additional pipes may be used as needed. After the treatment is complete, hoses 24a and 24b are disconnected at unions 25a and 25b, respectively, and recovered to platform Shroud 28 and sparger pipes 23a and 23b fixed thereto may be recovered using a crane after disengaging anchor lines Alternatively, by disconnecting the sparger pipes from the flexible hoses at unions 25a and 25b and recovering the hoses only, the shroud and sparger pipes may be left anchored to crib 14 to facilitate future treatments. In either case, the work platform 20 may then be moved to treat other intake facilities. Sparger pipe delivery lines 31a and 31b protrude upwardly through crib screen 18 and terminate in unions 32a and 32b, respectively, for receiving flexible hoses 24a and 24b. The sparger is provided with a plurality of holes 26 around the periphery for injecting the biocide therethrough. Once the hoses are connected, the biocide injection proceeds as has been described. This configuration has the advantage that the biocide is injected directly into the crib. In addition, the ring-shaped sparger is able to distribute the biocide uniformly over the volume of the crib. As noted above, the sparger pipes 23a and 23b may be inserted into the intake pipe further protecting the water outside the crib from ClO2 contamination. All equipment and flow lines are mounted on the deck of The schematic is a simplified representation of the system and certain variations are possible, as would be obvious to one skilled in the art, without departing from the inventive concept described herein. NaClO2 , a metal hypochlorite e.

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3: USA - Treatment of fresh water for zebra mussel infestation - Google Patents

The mussels affect industry and small-volume water users by clogging pipes and intake structures. Industries in infected areas regularly treat the water with oxidants, heat or molluscides to eradicate zebra muscles from the service water system.

Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use. Recommendations and opinions expressed herein do not necessarily represent the position of the U. Their creativity and insights contribute greatly the success of the project. We are especially grateful to our overseas participants who brought a new perspective - H. We are grateful to Congressman John D. Ecological Effects of the Zebra Mussel 10 2. Rate and Extent of Spread of the Zebra Mussel 25 3. Control of Established Species 30 4. Prevention of New Introductions 39 5. List of Participants 1. The purpose of the workshop was to review and evaluate existing information on the ecology and management of introduced aquatic nuisance species, with a particular emphasis on the zebra mussel Dreissena polymorpha , and make recommendations on how to extend our knowledge and understanding in critical areas. The first day of the workshop consisted of a public session. In this session, a series of formal presentations were made by invited experts on the biology and ecology of introduced species, and on their sources, prevention and management. Speakers were asked to provide extended abstracts of their presentations, which are included here in Appendix A. Two of the speakers, from the Soviet Union, submitted their entire manuscripts. Rather than attempt to abstract these manuscripts, they are included, with minor editing, as submitted. Although the range of expertise available to the workshop discussions was extensive, it was not exhaustive, and the time was not long enough to allow for detailed discussions of scientific, technical, or institutional knowledge. Therefore the report should be read as an overview of current knowledge and concerns. More importantly, the assembled wisdom of the workshop participants generated insights and recommendations with respect to research needs, management options, information coordination, and potential policy and legislation. The discussions from each working group are presented in the relevant sections. Recommendations are presented in the introductory section. Background Zebra mussels Dreissena polymorpha are a new invading species in North America with such an enormous feeding and reproductive capacity that they are spreading in epidemic fashion throughout the Great Lakes. Although the mussels are of immediate economic concern because they clog water intake pipes, the greatest concern is the possibility of catastrophic changes in the ecology of the Great Lakes. It has been estimated that the zebra mussels currently filter all the water in Lake St. Clair several times a day, dramatically shunting the energy flow in the aquatic food web away from fish. Zebra mussels can strongly outcompete other indigenous benthic organisms in many temperate aquatic habitats. The success of 1 this mussel will have severe and dramatic consequences on the ecological integrity of surface waters due to major shifts in trophic interactions the movement of nutrients and toxic materials, and competition with native species. The Environmental Protection Agency responded to the zebra mussel crisis by sponsoring this workshop of experts from the Soviet Union, Europe, Canada, and the United States to discuss approaches to prevention, control, and potential environmental impacts of invading species, particularly the zebra mussel. It was attended by scientists representing government research laboratories, academic institutions, state and federal regulatory agencies, and shipping and water supply organizations. The important issue of determining institutional responsibilities for carrying out these recommendations was not on the agenda for this workshop, and in any case was not within the authority of most participants to define. Since this workshop the U. Congress has passed and the President has signed into law, the "Nonindigenous Aquatic Nuisance Prevention and Control Act of ", PL which, among other actions, defines federal agency responsibilities. This Act will be discussed briefly below. Earlier Initiatives on Introduced Species The need for an overview of available knowledge and an integrated research plan for the zebra mussel is obvious, and several agencies have taken an initiative in this

direction. Some of the initiatives which were referred to by participants at the workshop include: Department of Zoology, University of Guelph conference identifying current, proposed, and required research on the zebra mussel. Environmental Protection Agency Great Lakes National Program Office organized a series of conference calls to develop an assessment paper on exotic species, with emphasis on the zebra mussel. The September workshop hosted by EPA was intended primarily to inform state and federal regulatory and national resource management agencies who are charged with implementing existing legislation. The workshop considered a broad spectrum of issues and users, and brought in European and Soviet scientists who had not previously been consulted. It was not intended to be definitive, but rather to be a substantial step towards developing a clearly defined strategy based on both scientifically and practically defined needs. The purposes of this Act are " 1 to prevent unintentional introduction and dispersal of non-indigenous species into waters of the United States through ballast water management and other requirements; 2 to coordinate federally conducted, funded or authorized research, prevention, control, information dissemination and other activities regarding the zebra mussel and other aquatic nuisance species; 3 to develop and carry out environmentally sound control methods to prevent, monitor and control unintentional introductions of non-indigenous species from pathways other than ballast water exchange; 4 to understand and minimize economic and ecological impacts of non- indigenous aquatic nuisance species that become established, including the zebra mussel; and 5 to establish a program of research and technology development and assistance to states in the management and removal of zebra mussels. Coast Guard to issue voluntary guidelines within 6 months to "prevent the introduction and spread at aquatic nuisance species into the Great Lakes through the exchange of ballast water of vessels prior to entering those waters. The Task Force, co-chaired by the Director of the U. EPA, the Commandant of the U. Coast Guard, the Assistant Secretary of the Army Civil Works , and the heads of any other federal agencies deemed appropriate by the chairpersons. The Task Force members or their official representatives are charged with implementing most of the provisions of the Act. These include development of an aquatic nuisance species program; development of Great Lakes regional coordination; and review of policy on intentional introductions. In addition, some of the Task Force members have broad authorization in areas related to introduced species. EPA, for example, is charged with conducting basic ecological research on factors that affect the well-being of ecosystems, and on indicators of ecosystem health. Great Lakes Non-Indigenous Species Coordination Committee, referred to above, met again in early December to develop a coordinated research plan. At this meeting members voted to include U. Workshop Objectives The formal objectives of the workshop were to: Identify the information gaps in our knowledge of zebra mussels and other introduced aquatic species that inhibit our ability to make management decisions; 2. Identify the research needs to fill the information gaps; 3. Identify advantages and disadvantages of management alternatives; and 4. From the outset it was recognized that the short workshop would not be able to produce all the answers. However, it is also recognized that this workshop is an early step in a much larger process to develop a coordinated program of research and management of non-indigenous species in the Great Lakes. Four working groups were defined. Predicting the rate and extent of spread. Predicting Ecological effects Control 2. Prevention of new introductions 4. Control of established species Because of limited time, the scope of discussion in three of the groups was limited to zebra mussels. However, the group discussing the prevention of new introductions clearly emphasized introductions in general, since the zebra mussel is already present. All discussions primarily focussed on the Great Lakes Basin, adding more localized or continent-wide consideration where appropriate. Each of the following chapters summarizes the discussions from one of the working groups. Summary of Recommendations Each of the four working groups developed a set of recommendations which ranged from specific research needs to overall coordination of the issues related to introduced species. Although the combined list appears long, and in implementing the recommendations one would have to consider the details, it is possible to extract a few basic themes that help to synthesize and summarize the recommendations. The need for an information clearing house, database, or series of databases became apparent - the short time that we have had to deal with the zebra mussel and the

urgency of the problems have led to a burst of research and management effort which would be far more effective if it were well coordinated. Similarly, a commission to help coordinate the effort on an international scale is highly desirable. A number of specific activities are recommended to ensure that the information in the database s is current and credible. These include the translation of the European and Soviet literature, monitoring programs, and the review and evaluation of control methods. Modelling is proposed as a method to help guide research, predict spread, evaluate control methods, and manage activities. Some management activities are singled out as particularly timely; namely, clarification of permitting procedures for control methods, development of a ballast water management plan, and the implementation of a public information system aimed at reduction of spread, effectiveness of management, and public support for the required research. Research designed to provide critical basic information is highlighted as a basic recommendation. The next step is to provide a forum which will allow the people concerned to prioritize recommendations and to propose appropriate action and develop a strategy for its implementation. The research and management community are willing; what is needed is the institutional support necessary to fund, coordinate, and implement a set of integrated programs. Ecological Research Needs and Recommendations For most of the ideas described below, there is an explicit need for studies on the basic biology and autecology of zebra mussels. To understand the ecological effects that zebra mussels cause we need basic information such as: Zebra mussels will impose dramatic effects upon the aquatic ecosystems in which they become established. The following list summarizes the possible effects of zebra mussels which should be addressed through research: Recommendations for Predicting Rate and Extent of Spread The prediction of the rate and extent of spread of zebra mussels is a complicated and difficult issue given the resilience and adaptability of the organism. Mapping exercises using a Geographic Information System would provide useful tools to document where zebra mussels are found now and where they are likely to move given the availability of adequate habitat. In order to make credible predictions the GIS analysis must be recalibrated and updated as new information becomes available. Throughout the course of discussion the group listed several recommendations to increase our understanding of zebra mussel dynamics. Replace European information with more relevant data from the North American experience. This increase in knowledge of habitat constraints would be used to calibrate population growth models and to predict the potential distribution of the mussels. This would be accomplished through a GIS analysis. Monitor existing zebra mussel population levels in infested lakes. Since there is some indication that the natural course of the invading zebra mussel population is to decline, we should continue to monitor existing populations. Similarly, we should identify any biological control agent that is in place or increasing, whether it be native or inadvertently introduced. Begin a review of potential biological control methods. Although there is a reluctance to expose ourselves to the risks inherent in introducing new organisms to an ecosystem, it would certainly be useful to have a better understanding of long-term control options. Since research to identify and possibly modify a predator, parasite or disease-based control is time consuming, this should begin at once. Implement a review of all control actions. In order to appropriately review all the control actions that can be used to manage problems caused by zebra mussels the appropriate expertise will be required for each type of problem and each type of action. Working groups could be formed to review suitable groups of actions. The purpose of the review would be not only to evaluate suitability and acceptability of the actions, but to synthesize the knowledge so that it can be included in a database and accessed by a clearing house. The review can be structured to identify uncertainties and to prioritize research requirements.

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4: Zebra Mussels and Aquatic Nuisance Species - Frank M D'Itri - Bok () | Bokus

chemical treatments) of zebra mussel control methods, water users were divided into two groups: 68 municipal water treatment plants (Figures) and 67 utility and industry (Figures).

However, researchers studying zebra mussel reproduction have unveiled previously unknown facts about zebra mussel physiology which may accelerate the development of other control methods. Zebra mussels, accidentally introduced into North American waters in the mid s, have spread rapidly to all of the Great Lakes and a growing number of U. One reason for the rapid spread of zebra mussels is their enormous reproductive capacity. Recent studies estimate that one female zebra mussel can release at least a million eggs per year. Researchers are examining mechanisms that regulate spawning in this bivalve and are working on developing species specific, ecologically safe control methods which target the reproductive cycle of zebra mussels. Cues Regulate Spawning Bivalves spawn in response to both environmental cues and internal chemical cues. Spawning may be influenced and regulated by water temperature, environmental chemicals e. These cues ensure that both sperm and eggs are present so that fertilization can occur, and that temperature is appropriate and food is available for larval development For example, in western Lake Erie, the zebra mussel spawn peaked in following a late summer increase in phytoplankton, ensuring adequate food for the developing larvae. However, when the late summer phytoplankton levels were much smaller than usual in , the spawning peak never occurred. If zebra mussels are artificially activated to spawn when phytoplankton levels are low, there would be little food available for larvae and the offspring would die before settling. If a chemical applied to mussels in a specific area causes them to spawn, this might trigger a chain reaction between males and females based on pheromones that would spread some distance beyond the initial application site -- similar to a row of dominos falling after just one push. Researchers are also investigating a control method to stop spawning entirely. Chemical Used to Control The application of chemicals to the waters of the Great Lakes basin to control an exotic species has already proven effective with sea lamprey control. After eight years of testing over 6, chemicals, scientists discovered that the chemical TFM controlled sea lamprey populations. When applied to riverine spawning beds, TFM kills sea lamprey during their vulnerable larval stage without harming other fish and with minimal affects on other aquatic organisms. However, the degree of response to serotonin was affected by water temperature. Animals did not respond to serotonin at 39 degrees Fahrenheit 4 degrees Celsius , however, they did respond at 54, 68, and 81 degrees Fahrenheit 12, 20, and 27 degrees Celsius. Serotonin is a small molecule made from an amino acid, a building block of proteins. It is found in the brains of most animals, where it is one of hundreds of chemicals that nerve cells use to communicate with each other. It also causes contraction of smooth muscles such as in blood vessels in humans and fish. The role of serotonin in zebra mussel reproduction is the latest in a long list of serotonin functions. Researchers are investigating other substances which may elicit the same response in mussels at lower concentrations. Researchers Seek Species-Specific Control An important question about reproductive control techniques is whether they would have species-specific effects. One problem with field application of serotonin is that it may trigger yet unknown responses in many organisms, including humans. However, a method of adapting serotonin to target zebra mussels may be possible. Research suggests that the receptors that bind serotonin in zebra mussels differ from those found in vertebrates. Therefore, it may be possible to engineer a serotonin-like compound that affects zebra mussels but not fish or people. Furthermore, other chemicals found within zebra mussels may trigger only zebra mussels to spawn. Using these species-specific chemicals would be an advantage over non-specific toxic chemicals presently used on a limited and restricted basis for zebra mussel control. As yet, it is unknown whether chemicals that disrupt zebra mussel reproduction would have to be applied throughout an entire lake in order to have an impact on zebra mussels at a particular site. But, to achieve lake-wide control over zebra mussels populations, intervention in reproduction may prove to be a better method than widespread application of molluscicides. Controlling zebra mussels throughout an entire

lake may be particularly important in dealing with their potential impact on fisheries as well as their demonstrated local impacts at water intake sites. Such challenges can only be met by identification and field testing of chemicals that trigger or inhibit zebra mussel spawning. Reprinted from Invertebrate Reproduction and Development, Spawning in the Zebra Mussel Dreissena polymorpha:

5: Ecology and Management Of The Zebra Mussel and Other Introduced Aquatic Nuisance Species

Zebra mussel infestations in MN Control methods & case studies Open water applications Product selection Project Evaluation. CHRISTMAS.

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Zebra mussel control strategies Figure www.enganchecubano.com mussel infestation in raw water chambers at Sligo drinking water plant (photograph by Eamon Fox).

7: Full text of "Product evaluation of zebra mussel control methods for small volume water users"

Zebra mussels (Dreissena polymorpha) were first discovered in Lake St. Clair in Since that time the mussel has spread throughout North America and has now invaded all the Great Lakes and.

PRODUCT EVALUATION OF ZEBRA MUSSEL CONTROL METHODS FOR SMALL VOLUME WATER USERS pdf

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