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REPORT

**EVALUATION OF THE GREAT LAKES
SEA GRANT NETWORK'S ZEBRA MUSSEL OUTREACH ACTIVITIES
FOR INDUSTRIAL AND MUNICIPAL WATER USERS**

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Prepared for the
Great Lakes Sea Grant Network

With funding from
Michigan Sea Grant Extension

By

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and

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Associate Professor

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Department of Agricultural and Extension Education
410 Agriculture Hall
Michigan State University
East Lansing, MI 48824**

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Michigan Sea Grant Extension approached the Center for Evaluative Studies, Department of Agricultural and Extension Education (AEE-CES) at Michigan State University to conduct an evaluation of the Great Lakes Sea Grant Network's zebra mussel outreach activities for industrial and municipal water users. The study was undertaken to gain information about past accomplishments of the program, to recognize strengths and weaknesses of the program, and to identify program areas that might be improved.

Several institutions assisted in this project. John Schwartz, Program Leader of Michigan Sea Grant Extension, provided the overall leadership in framing the study. He also assisted in identifying resource persons to assist AEE-CES in the development of the survey instrument and preparing the final report. Charles Pistis, District Extension Sea Grant Agent in Southwest, Michigan, and Michaela Zint, Zebra Mussel Information Contact at Michigan State University were instrumental in developing the survey instrument and providing comments for various drafts of this study. Michaela Zint also spent many hours communicating with the Great Lakes Sea Grant Network staff to get mailing lists for the industrial and municipal water users in the Great Lakes region.

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TABLE OF CONTENTS

Background	1
Adverse Effects	2
The Study	3
Methodology	5
Findings	7
Presence of Zebra Mussels at the Facility	8
Monitoring Programs for Zebra Mussel	9
Awareness of Zebra Mussel Information Contacts	10
Information Received about Zebra Mussels	11
Great Lakes Sea Grant Network As Information Source	12
Information Needs about Zebra Mussel	13
Perceptions About the Impact of the Great Lakes Zebra Mussel Network	15
Summary and conclusions	20
Extent of zebra mussel problem	20
Awareness of information and information sources about zebra mussels	20
How can the needs of the Great Lakes industrial and municipal water users be met?	21
Has the Network achieved its objectives by making effective use of its resources?	21
Recommendations	22
References	24
APPENDIX 1 Survey Instrument	25
APPENDIX 2 Summary of Postcard Responses	39
APPENDIX 3 Full List of Additional Information Respondents Suggested would be Helpful	40
APPENDIX 4 List of Comments and Suggestions to Improve the Zebra Mussel Education Program in the Great Lakes	41

LIST OF TABLES

Table 1. Water source for respondent's facility	7
Table 2. Type of water use by respondents' facility	7
Table 3. Facilities where zebra mussels have been found by type of water use	8
Table 4. Year when zebra mussels were <u>first</u> found at the facility (n=154).	8
Table 5. Location of zebra mussels at the facility	9
Table 6. Existence of a zebra mussel monitoring program at the facility.	9
Table 7. Type and frequency of zebra mussel monitoring (n=105).	10
Table 8. Awareness of zebra mussel information contact in the state.	10
Table 9. Source of learning about state's zebra mussel information contact	11
Table 10. Number of respondents who received information/educational materials about zebra mussels.	11
Table 11. Sources of the information received about zebra mussels	12
Table 12. Utilization of Great Lakes Sea Grant Network's zebra mussel	13
Table 13. Information received on zebra mussel topics	14
Table 14. Perceived impact of the Great Lakes Sea Grant Network	15
Table 15. Overall helpfulness of educational programs and services of the Network. . . .	16
Table 16. Do you have employees responsible for zebra mussel monitoring, control and disposal?	16
Table 17. Staff and estimated budget for zebra mussel monitoring, control and disposal activities.	17

Background

Zebra mussels (*Dreissena polymorpha*) are small mollusks with a maximum length of two inches (five centimeters). The species is native to Europe. As the name indicates, this freshwater organism is white striped and has two shells or valves, called bivalves. Zebra mussels taxonomically belong to the subclass *Heterodonta*, order *Veneroida*, suborder *Dreissacea*, family *Dreissenidae* and genus and species *Dreissena polymorpha*. It is an exotic pest species in the fresh water of North America.

The history of the zebra mussel invasion is not well known. However, according to a 1993 Great Lakes Sea Grant Network report, it was first discovered in 1988 in Lake St. Clair near Detroit. Within a year, the mussel was clogging municipal and power plant water intakes along western Lake Erie and had reached Lake Ontario. By 1990, small colonies were found in pockets of lakes Michigan and Huron, and the Superior Duluth-harbor at the westernmost tip of Lake Superior. One year later, the mussel had established a stronghold in the southern half of lakes Michigan and Huron and had spread to the inland water system. They have been collected in the Mississippi, Illinois, Ohio, Tennessee, Cumberland, and Hudson rivers in the early spring of 1992 (Miller et. al, 1992).

Zebra mussels are successful, prolific breeders. Zebra mussels are unisexual, and fertilization takes place externally in water (Gills, 1989). A study conducted in North America revealed that some females may produce as many as one million eggs in two years. According to Gillis (1989), Oogenesis (production of ova) and spermatogenesis (production of sperms) start to occur simultaneously when the water temperature rises to 12 degrees Celsius and reaches a maximum at 15-17 degrees Celsius. Studies in Lake St. Clair showed that most zebra mussels are sexually mature when they attain 8-10 millimeter shell length, but a few mature even at 5.5 millimeter shell length. Generally, the reproductive cycle is completed in two years. Peak reproduction normally occurs in June and July. However, sometimes, spring born larvae which settle rarely to mid-summer will reproduce in the fall of the same year.

Zebra mussels are most likely to enter water plants at the planktonic stage of veliger larvae. Their extensive reproductive capability, ability to adhere to a wide range of substrates, and the free floating veliger cause great problems to raw water users and their rapid spread and colonization of the Great Lakes and inland waterways. Therefore, water supplies and industries which draw large amounts of water from lakes and rivers with a planktonic stage of the veligers are more likely to suffer infestations.

Adverse Effects

The invasion of North American water bodies by the zebra mussel has raised significant concerns in public and private sectors regarding its control. It has created a number of problems associated with water use and freshwater ecosystems. Zebra mussels affect raw water users (primarily manufacturing plants, public water suppliers, agricultural irrigation, and power suppliers) in different ways. First, zebra mussels clog their water intakes, filters, and pipelines by forming colonies. They are able to stick to surfaces by secreting complex polyphenolic protein (Miller 1992). This adherence is further supported by their byssal apparatus. Second, they spoil or deteriorate the water quality due to their bio-fouling characteristics. Third, they increase the corrosion potential of steel and iron pipes. Finally, zebra mussels reduce the recreational and aesthetic value of shorelines, displace the native species of bivalves, and alter fish habitat by littering beaches and aquatic ecosystems.

Zebra mussels have greatly impacted the economy, aquatic ecology and overall environment of the Great Lakes since their invasion in 1988. Substantial costs are involved in countering the zebra mussel's adverse effects. Costs are incurred mostly in purchasing chemical mitigants and in developing new plant structures to deliver the chemicals and to monitor zebra mussel activity.

Both proactive and reactive control measures have substantially increased the operating and maintenance costs of industries and municipal water suppliers. For example, the estimated cost to cope with zebra mussel impacts at the Monroe Water Works was \$300,950 in 1991. Approximately \$100,000 was spent on new chemical (chlorine) storage, application, and monitoring at the raw water pump station during the same year. Annual chlorine consumption for offshore chlorination has increased by 36 percent since the plant started to implement control measures against zebra mussels (Lepage, 1991). This chemical mitigation using chlorine may, however, have effects on non-targeted aquatic creatures. As reported by Brungs (1977), fish are very sensitive to chlorine. Truchan (1977) found that chlorine is hazardous to fish species even at levels as low as 0.02 mg/l. Since phytoplankton is the backbone of the aquatic community, any deleterious effect on its health will affect fish populations. However, an additional \$300,000 would be necessary to build an ozonation system to replace the chlorination system presently used to combat the mussel problem.

Zebra mussels have affected all water-based enterprises, including recreational boating, shipping and tourism. Zebra mussels have direct impacts on raw water users and related industries. Use of chemical mitigants may alter the water quality, and aquatic food chains will likely be disrupted by the mussel's removal of plankton from the water column. Ecologists believe that zebra mussels affect the fish population by lowering the availability of phytoplankton and zooplankton and by destroying the habitat for spawning. Among the Great Lakes, Lake Erie is predicted to be the most heavily impacted by zebra mussel population.

Zebra mussels also impose costs on recreational boaters and commercial shippers by attaching to the hulls of ships. Mechanical removal or chemical control will not only increase maintenance costs, but also decrease the useful of vessels by subjecting them to wear and tear. Accumulation of zebra mussel shells along the coastline fouls beaches and diminishes their recreational value. Dead and decaying mussel tissues produce obnoxious smells which will negatively affect shore use and create environmental pollution. Additionally, sharp and broken shells make it difficult to walk on the beach without footwear. All of the above problems may result in declining numbers of tourist visits which will, in turn, have an adverse impact on the economy of shoreline communities.

Zebra mussels have drawn the attention of the U.S. government and public since 1988. Various strategies have been employed to control the zebra mussel infestation in the Great Lakes and the region's inland waters. Although it is difficult to estimate the exact economic impact of zebra mussels on the Great Lakes' fisheries, Mills (1990) estimated the economic impact on sport and commercial fishing in the Great Lakes region at \$164.45 million (1989 dollars). As reported in a survey conducted by Hushak (1990), zebra mussels' total damage to commercial shippers was estimated at \$1500 for 1989 and early 1990. In the same report, water intakes reported \$210,000 in damages and maintenance. Greenburg (1991) reported a total cost of \$ 9.1 million for zebra mussel control from a survey of 99 municipal water plants throughout the Great Lakes. These high control costs will be passed on to the consumer in the form of higher utility bills.

Various organizations and research institutes have been involved in developing educational programs to identify and assess the impact zebra mussel on industries, municipal water supplies and power plants of the Great Lakes. An annual allocation of \$ 1.58 million in public and private funds was estimated for research in the Great Lakes, yielding a ten year estimated expenditure of \$ 15.8 million in 1990 dollars (Mills, 1990).

The Study

The Great Lakes Sea Grant Network has been involved in zebra mussel outreach activities for the last 6 years. The Network has become a national resource for those needing to learn about zebra mussels and their potential impacts. All of the Great Lakes Sea Grant programs have already established single, easily accessible points of information. These established centers have compiled lists of key contacts in industry and government; developed approaches to observe and record zebra mussel infestation; produced periodic news releases; conducted public presentations; and recorded economic and ecological impacts (White, 1993).

Research Information Clearinghouse-- information on completed and ongoing zebra mussel-related research throughout the Great Lakes basin, publication of the *Dreissena polymorpha* Information Review, establishment of a lending library, and a toll-free telephone number for

easy access are some examples of outreach programs. A graphics library consisting of more than 100 slides, photos, illustrations and videotapes of zebra mussels has been established. The collection is cataloged and is available to government agencies, environmental organizations, schools, newspapers, TV stations and other interested groups. The Network has also developed and disseminated a variety of general information about zebra mussels and specific information on control strategies and techniques. Examples of these resources include fact sheet summarizing zebra mussel biology and general impacts, Zebra Mussel Watch-- a wallet-sized card, Impact of Zebra Mussel on Inland Waters, and a portable display on exotic species. Educational programs like conferences and workshops have also been organized.

Great Lakes industrial and municipal water users have been one of the program's primary audiences. Network activities have been responsible for disseminating the latest in zebra mussel monitoring, control and disposal information through one-to-one consultations, fact sheets, information packets, workshops and conferences targeted at this audience.

This study was conducted to assist the Great Lakes Sea Grant Network in evaluating its zebra mussel outreach activities for industrial and municipal water users. The purpose of the evaluation was to gain information about past accomplishments of the program, to recognize its strengths and weaknesses, and to identify areas of the program that might be improved. Specifically, this evaluation sought to answer the following questions:

1. Has the Network achieved its goals and objectives for meeting Great Lakes industrial and municipal water user needs?
2. In meeting its goals and objectives, has the Network made effective use of its resources?
3. Have the needs of Great Lakes industrial and municipal water users been met?
 - a. Have Great Lakes industrial and municipal water users been able to use the Network's materials and services?
 - b. Have Great Lakes industrial and municipal water users been able to make better decisions due to the Network's assistance?
 - c. Have Great Lakes industrial and municipal water users been able to save resources (e.g., time and money) as a result of the Network's activities?
4. How can the needs of the Great Lakes industrial and municipal water users be better met in the future? What materials and services should be provided?

The findings of this evaluation will assist the Network in improving its outreach activities by making more effective use of its resources. In addition, the findings provide guidelines to address the unique needs of the Great Lakes industrial and municipal water users.

Methodology

This evaluation followed a descriptive research design, utilizing a mail survey for data collection and analysis. Mail surveys have the advantages of low cost, uniform access to dispersed populations and lack of interviewer bias (Dillman, 1978). The survey instrument was developed after a careful review of the Great Lakes Sea Grant Network's zebra mussel outreach evaluation plan. A draft of the instrument was developed with the help of Michigan Sea Grant staff, and it was mailed to all Great Lakes Sea Grant Program Leaders for review. Based on this feedback, the instrument was revised. A six-page instrument was developed to assess the over-all impact of the Great Lakes Sea Grant Network on industrial and municipal water users in the Great lakes region (Appendix 1). The instrument included both closed and open-ended questions.

Respondents were asked to indicate whether or not zebra mussels have been found at their facility, whether they have a regular monitoring program for zebra mussels, whether they are aware of zebra mussel information contact in their state and of other sources of information about zebra mussels. They were also asked to rate the usefulness of zebra mussel educational materials on a 1 to 4 scale, with 1 being not useful and 4 being very useful. Similarly, they were asked to indicate whether they have received zebra mussel information on different topic areas and to rate the helpfulness of the information, on a 1 to 4 scale, 1 being not helpful and 4 being very helpful. The instrument also determined the perception of respondents regarding the impact of zebra mussel outreach activities on their facilities. It sought the perceptions of respondents regarding how helpful the educational programs and services of the Sea Grant Network were in controlling zebra mussels in their location. Finally, estimated expenditures for zebra mussel monitoring, control and disposal activities were requested.

The population for this study consisted of the zebra mussel contact persons at industrial and municipal water facilities drawing water from the Great Lakes or connecting waters. Because there was no mailing list available for this population, special efforts were made to develop a representative mailing list. Great Lakes Sea Grant Network Program Leaders and zebra mussel information specialists in all the Great Lakes States were asked to supply the mailing labels of industrial and municipal water facilities drawing water directly from the Great Lakes. Many of the Great Lakes Sea Grant offices did not have a comprehensive mailing list. Therefore, mailing lists of all surface water users were also requested from State Departments of Health and Natural Resources in all Great Lakes states. A comprehensive mailing list of all possible surface water users, i.e., both industrial and municipal drinking water, was prepared for New York, Ohio, Michigan, Indiana, Illinois, Wisconsin, and Minnesota. To improve the accuracy of this list a postcard, asking whether the facility draws water from one of the Great Lakes or connecting waters and who would be the primary contact for zebra mussel control at their facility, was mailed to 2,820 industrial and municipal water facility managers in February, 1994. 968 completed postcards were received. 263 facilities drew water directly from one of the Great Lakes or connecting waters and suggested a contact person for zebra mussel control at their facility

(Appendix 2). A revised mailing list was prepared from the postcard response, and this list served as the survey population for this study.

The instrument was mailed to the zebra mussel contact persons identified. The mail-out package consisted of the questionnaire, a cover letter and a pre-addressed, postage-paid envelope. The cover letter emphasized the importance of the survey, guaranteed confidentiality of responses and requested a prompt response. The packet was mailed to the identified contacts in March 1994. A follow-up reminder letter was sent after one week, and a second follow-up was mailed 3 weeks after the initial mailing. Non-response was controlled, using the Total Design Method (Dillman, 1978). One week after the first mailing, a follow-up letter was mailed to the sample population. Two weeks after the follow-up letters, non-respondents were mailed a second follow-up letter with a replacement questionnaire. The survey had a usable response rate of 85.2 percent.

Returned questionnaires were coded by the date received. Late respondents were compared with early respondents on their responses to selected survey questions. T-tests were used to determine if any differences existed between early and late respondents. No significant differences were found between early and late respondents; therefore, findings of this study can be generalized to the population (Miller and Smith, 1983).

Data were analyzed using the Statistical Package for the Social Sciences (SPSS/PC+). Descriptive statistics such as frequencies, percentages, medians, means and standard deviations were used to analyze the data.

Findings

A total of 224 zebra mussel contact persons responded to this evaluation (see Appendix 2). When asked from which Great Lake or connecting water their plant draws water, respondents indicated different sources. Lake Michigan was used most often (indicated by 26.9 percent); twelve- and-one-half percent indicated drawing water from more than one Great Lake and/or connecting water way (Table 1).

Table 1. Water source for respondent's facility

Source of water	Number	Percent
Lake Michigan	60	26.9
Lake Erie	44	19.7
Lake Superior	23	10.3
Lake Ontario	19	8.5
Lake Huron	16	7.2
Connecting water	33	14.8
<u>More than one source</u>	<u>28</u>	<u>12.5</u>
Total	223	100

Respondents were asked to indicate the type of water use in their facility. Over half (54.3 percent) of the respondents indicated that their facility was used to produce municipal drinking water and about 10% indicated cooling water or industrial water use. About one-fourth indicated that their facility serves more than one purpose, i.e., producing a combination of industrial, cooling and municipal drinking water (Table 2).

Table 2. Type of water use by respondents' facility (n=224).

Characteristics	Number	Percent
Municipal drinking water	121	54.3
Cooling water	25	11.2
Industrial process water	22	9.8
<u>More than one type of facility</u>	<u>55</u>	<u>24.7</u>
Total	223	100.0

Presence of Zebra Mussels at the Facility

When asked whether zebra mussels had been found at their facility, over two-thirds (68.8 percent) responded affirmatively. When segmented according to water use, zebra mussels were reported by all types of facilities. As shown in Table 3, the majority of facilities reported the presence of zebra mussels at their facilities, although the proportion was lowest among plants drawing water for industrial processes.

Table 3. Facilities where zebra mussels have been found by type of water use (n=224).

Type of facility	Number	Percent of total in each category
Municipal drinking water	86	71.1
Cooling water	22	88.0
Industrial process water	11	50.0
<u>More than one type of facility</u>	<u>35</u>	<u>63.6</u>
Total	154	69.1

Respondents were asked to indicate when zebra mussels were first found in their facilities. As shown in Table 4, zebra mussels started appearing in 1988.

Table 4. Year when zebra mussels were first found at the facility (n=154).

Year	Number	Percent
1988 or before	9	6.3
1989	20	13.8
1990	31	21.5
1991	34	23.6
1992	32	22.2
<u>1993</u>	<u>18</u>	<u>12.5</u>
Total	144	100.0

Respondents who mentioned that zebra mussels were found in their facility were further asked to indicate where in their system the mussel was present. As shown in Table 5, intake structures were the most frequently mentioned locations of zebra mussel accumulation. Other locations which were frequently mentioned include pump stations, travelling screens, trash racks, service water systems, forebays, condenser units, and fire protection systems.

Table 5. Location of zebra mussels at the facility (n=154).*

Location in the System	Frequency	Percent
Intake structures	145	92.9
Pump stations	47	30.5
Travelling screens	42	27.3
Trash racks	38	24.7
Service water systems	29	18.2
Forebays	23	14.9
Condenser units	23	14.9
Fire protection systems	20	13.0
Discharge lines	11	7.1
Filter beds/Filtration media	10	5.8
Reservoirs	7	4.5
Others	12	7.8

* Respondent could check more than one system.

Monitoring Programs for Zebra Mussel

Respondents were asked to indicate whether they have a regular monitoring program for zebra mussels. Less than one-half (47.5 percent) of the respondents indicated that their facility has such a monitoring program (Table 6).

Table 6. Existence of a zebra mussel monitoring program at the facility.

Monitoring Program	Number	Percent
Yes	105	47.5
No	116	52.5
Total	221	100.0

Respondents who indicated having a regular monitoring program were further asked to indicate the type of monitoring program and the frequency of monitoring. Findings in Table 7 indicate that sampling for adult mussels was the most frequently used monitoring method, followed by sampling for veligers, settling larvae, and visual inspection. The table also shows that most of the respondents take samples fewer than 12 times a year, regardless of which stage of mussel development was sampled. However, the frequency of monitoring veligers and settling larvae at several facilities was often higher than for adult mussels.

Table 7. Type and frequency of zebra mussel monitoring (n=105).*

Monitoring type and frequency	Number	Sampling Percent	Frequency Percent
<u>Sampling of adults</u>	59	56.2	
≤ 12 times/year	43		73.3
> 12 times/year	11		18.3
<u>Sampling of veligers</u>	42	40.0	
≤ 12 times/year	21		51.2
> 12 times/year	17		39.5
<u>Sampling of settling larvae</u>	23	21.9	
≤ 12 times/year	12		52.2
> 12 times/year	8		34.8
<u>Other:</u>	30	23.6	
Visual inspection	22		
Not specified	8		
≤ 12 times/year	22		88.0
> 12 times/year	3		12.0

* Respondents could check more than one type of monitoring method.

Awareness of Zebra Mussel Information Contacts

The Great Lakes Sea Grant Network established zebra mussel information contacts in each of the Great Lakes states beginning in 1988. Respondents were asked whether they were aware (before they received the survey) that their state has established a contact for zebra mussel information. Findings in Table 8 show that more than one-half (54.9 percent) of the respondents were previously aware of this source of information and assistance.

Table 8. Awareness of zebra mussel information contact in the state.

Response	Number	Percent
Yes	118	54.9
No	97	45.1
Total	215	100.0

Respondents who were aware of the presence of a zebra mussel information office/contact in their state were further asked to indicate how they learned of its existence. As shown in Table 9, Sea Grant sponsored educational events, Sea Grant agents/specialists, the American Water Works Association, and newsletters were the most frequently mentioned sources of information about the zebra mussel.

Table 9. Source of learning about state's zebra mussel information contact (n=118).*

Source	Frequency	Percent
Sea Grant sponsored educational event	40	33.9
My Sea Grant agent/specialist	24	20.3
American Water Works Association (AWWA)	23	19.5
Newsletter	17	14.4
Newspaper	9	7.6
The <i>Dreissena polymorpha</i> Information Review	6	5.1
Department of Natural Resources (DNR)	6	5.1
The Zebra Mussel Information Clearing House	4	3.4
Private consultants	4	3.4
Electric Power Research Institute (EPRI)	4	3.4
Television	1	0.8
Other agencies/associations:	20	16.9
Survey questionnaire	8	6.8
Discovered by oneself	3	2.5
Not specified	9	7.6

* Respondent could check more than one source.

Information Received about Zebra Mussels

When asked whether they received information about zebra mussels in the Great Lakes region, four out of five respondents indicated affirmatively (Table 10).

Table 10. Number of respondents who received information/educational materials about zebra mussels.

	Number	Percent
Yes	182	82.4
No	39	17.6
Total	221	100.0

The most frequently indicated sources of information about zebra mussels were State Sea Grant offices, newspapers, American Water Works Association, Sea Grant sponsored educational events, television, and Sea Grant agents or specialists (Table 11). The Department of Natural Resources, local consultants, radio, Electric Power Research Institute, and the *Dreissena polymorpha* Information Review were other frequently mentioned zebra mussel information sources.

Table 11. Sources of the information received about zebra mussels (n=182).

Information Sources	Frequency	Percent
My State's Sea Grant Office	115	63.2
Newspaper	111	61.0
American Water Works Association	87	47.8
Sea Grant sponsored educational event	79	43.4
Television	67	36.8
Sea Grant agent/specialist	55	30.2
Department of Natural Resources(DNR)	42	23.1
Local consultants	36	19.8
Radio	30	16.5
Electric Power Research Institute (EPRI)	31	17.0
The <i>Dreissena Polymorpha</i> Information Review	25	13.7
The Zebra Mussel Information Clearing House	24	13.2
Others agencies/associations	45	24.7
Zebra mussel conference	6	3.3
Health Department	2	1.1
Not specified	37	20.3

Great Lakes Sea Grant Network As Information Source

The Great Lakes Sea Grant Network has supported the development and distribution of a variety of educational materials about zebra mussels. Respondents were provided a list of these educational materials, and asked first to indicate whether they have utilized those materials and, second, to rate their "usefulness" on a 1 to 4 scale, with 1 being not useful and 4 being very useful. Findings are presented in Table 12.

Table 12. Utilization of Great Lakes Sea Grant Network's zebra mussel educational materials (n=182).*

Information Sources	% indicating receiving it	Usefulness of Information Mean (sd)
Information packets/fact sheets/brochures	59.3	3.01 (0.73)
Participation in conference(s) on zebra mussels	58.8	3.33 (0.83)
Other Sea Grant newsletters	52.7	2.98 (0.71)
Zebra Mussel Update	47.8	3.08 (0.75)
Personal contact with Sea Grant agent/specialist	35.7	3.50 (0.82)
Dreissena polymorpha Information Review	22.5	3.05 (1.0)
List of resources and contacts for zebra mussels	21.9	3.00 (0.83)
Videos demonstrating zebra mussel control	18.1	3.09 (0.95)
Contacted the Zebra Mussel Information Clearinghouse using 800 number	6.0	2.91 (1.45)
Information on zebra mussels via INTERNET	1.6	1.00 (1.00)
Contacted the Network's exotics graphic library	1.6	1.00 (1.00)

* Respondents could indicate more than one source.

As shown in Table 12, information packets/fact sheets/brochures on zebra mussels, participation in conferences, Sea Grant newsletters, the Zebra Mussel Update, and personal contacts with Sea Grant agents/specialists were most frequently utilized by respondents. The mean score of 2.98 or higher on a 1 to 4 scale on all of these items indicates that information provided by these sources was useful to the respondents. It should be noted that interpersonal sources of information such as personal contact with Sea Grant agents/specialists and participation in conferences, were rated more useful than impersonal sources.

Although few respondents reported using the Zebra Mussel Information Clearinghouse 800 number, respondents found the contact quite useful. Only thirteen respondents out of 182 indicated requesting technical publication reprints from the Clearinghouse's technical collection library. Use of INTERNET and Network's exotic graphic library has also been minimal. The lower use of some of these resources could be because these resources were not primarily targeted to this audience.

Information Needs about Zebra Mussel

The Great Lakes Sea Grant Network has developed zebra mussel educational materials on a variety of topics. A listing of zebra mussel topics was provided to the respondents. First, respondents were asked to indicate whether they have received information on these topics. If they answered affirmatively, they were further asked to rate the extent to which this

information was helpful with "1" not helpful and "4" very helpful. Findings are shown in Table 13.

Table 13. Information received on zebra mussel topics (n=182).

Topics	Percent receiving information	How helpful was information? Mean (sd)
Zebra mussel control methods	47.3	2.96 (0.79)
Biology and ecology of zebra mussel	44.2	3.00 (0.97)
Sighting updates	42.3	2.90 (0.97)
Monitoring methods	41.2	2.89 (0.77)
Ongoing research efforts	36.3	2.75 (0.84)
Legislative initiatives	19.2	2.42 (0.77)
Shipping and navigation impacts	18.1	2.25 (1.14)
State/federal regulations	16.5	2.62 (0.68)
Disposal methods (landfills, composing)	16.5	2.67 (0.92)
Economics of zebra mussel control	15.9	2.66 (0.90)

* Respondents could check more than one topic.

Findings in Table 13 show respondents have frequently received information in the areas of zebra mussel control methods, biology and ecology of the zebra mussel, sighting updates, monitoring methods, and ongoing research efforts. The information on these topic areas was also rated helpful, with mean scores ranging from 2.75 and 3.0 on a 1 to 4 scale.

Less than one-fifth of the respondents indicated receiving information on such topics as legislative initiatives, shipping and navigation impacts, zebra mussels disposal methods and economics of zebra mussel control. Further, these respondents rated the information on these topics as "somewhat helpful".

In an open-ended question, respondents were asked to list what other information about zebra mussels would be helpful to them. Information on low cost zebra mussel monitoring and control methods, past control efforts, research based information on the effect of zebra mussels on industrial and municipal water supply system, environmentally "friendly" and acceptable treatment methods, and information about the movement of zebra mussel were frequently indicated subject-matter areas that would be helpful. A full list of comments, ordered on the basis of questionnaires received, is provided in Appendix 3.

Perceptions About the Impact of the Great Lakes Zebra Mussel Network

An attempt was made to assess the impact of the Great Lakes Sea Grant Network's outreach activities as perceived by the zebra mussel contacts at industrial and municipal water facilities. Respondents were asked to indicate the extent to which they agree or disagree with eight statements pertaining to different level of impacts on water users. A four-point, Likert-type scale (i.e., 1 = strongly disagree, 2 = disagree, 3 = agree and 4 = strongly agree) was developed to assess respondents' perceptions. Findings are presented in Table 14.

Table 14. Perceived impact of the Great Lakes Sea Grant Network (n=182).

Statements	Mean (Sd)	Median
I have increased knowledge about zebra mussel issues.	2.99 (0.80)	3.0
The zebra mussel problem in my facility has been minimal.	2.94 (0.98)	3.0
I receive adequate educational support to address the zebra mussel problem.	2.73 (0.79)	3.0
My facility is able to control zebra mussels.	2.73 (0.99)	3.0
I receive regular updates on zebra mussels in the Great Lakes region.	2.71 (0.94)	3.0
My facility adopted new practices to control zebra mussels.	2.61 (1.08)	3.0
My facility has a regular zebra mussel monitoring program.	2.46 (1.00)	2.0
My facility has saved money.	2.20 (0.96)	2.0

Mean and corresponding standard deviation scores on each statement are presented in Table 14. Mean scores of 2.99 and 2.94, on a 1 to 4 scale, indicate that as a result of the Great Lakes Sea Grant Network's zebra mussel activities, respondents have increased their knowledge about zebra mussel issues and that the zebra mussel problem has been minimal at their facilities. With mean scores ranging from 2.71 to 2.73, respondents tend to agree that they have received regular updates on zebra mussels, received adequate educational

support to address the zebra mussel problem, and that facilities are able to control zebra mussels.

Respondents were further asked, "Overall, how helpful to you were the educational programs and services of the Sea Grant Network in controlling zebra mussels in your location?" Findings in Table 15 show that one-fourth of the respondents have found the Network's outreach activities quite to very helpful, over one-half rated these activities helpful to somewhat helpful. Only 10.5 percent of respondents indicated that the outreach programs have not been helpful.

Table 15. Overall helpfulness of educational programs and services of the Network.

	Number	Percent
Very helpful	33	21.6
Quite helpful	24	15.7
Helpful	58	37.9
Somewhat helpful	22	14.4
Not helpful	16	10.5
Total	153	100.0

An attempt was made to determine whether the Great Lakes industrial and municipal water users have saved money as result of the Network's activities. Respondents were asked to indicate whether they currently have employees responsible for zebra mussel monitoring, control and disposal at their facility. Although the number of facilities experiencing a zebra mussel problem increased significantly between 1989 and 1993, only about one-third (36.2 percent) of the respondents indicated that they have employees responsible for zebra mussel monitoring, control and disposal (Table 16).

Table 16. Do you have employees responsible for zebra mussel monitoring, control and disposal?

	Number	Percent
Yes	79	36.2
No	139	63.8
Total	218	100.0

Respondents who indicated having some employees responsible for zebra mussel monitoring, control and disposal were further asked to provide an estimated annual

expenditure (direct or indirect) for zebra mussel monitoring, control and disposal activities for the past 5 years. Table 17 summarizes the findings on the number of staff involved, their percentage of FTE time, and estimated expenditure for each fiscal year period.

Table 17. Staff and estimated budget for zebra mussel monitoring, control and disposal activities.

Year	Staff			Estimated Budget (\$)		
	n	Mean (Sd)	% time	n	Mean	Median
Current year (93-94)	69	2.84 (2.63)	18.65%	65	39,056	6,900
One year ago (92-93)	63	2.68 (2.01)	20.04%	61	45,238	7,750
Two years ago (91-92)	56	2.55 (2.11)	19.62%	54	73,434	9,000
Three years ago (90-91)	34	2.85 (3.51)	19.78%	32	85,220	10,000
Four years ago (89-90)	15	2.20 (1.52)	2.73%	12	36,133	5,500
Five years ago (88-89)	8	1.88 (1.81)	1.34%	5	10,220	100

Findings in Table 17 show that the number of facilities having personnel and budgets specifically for zebra mussel monitoring, control and disposal has been increasing between 1988-89 and 1993-94. However, at the facilities that have personnel assigned to zebra mussel monitoring, control and disposal, the number of staff responsible for these activities and the time they spend on these activities has remained the same during this period. On an average, 3 staff members are assigned to look after the zebra mussels monitoring, control and disposal in a facility, spending on average 20% of their time on these activities.

The average budget for zebra mussel monitoring, control and disposal was highest in 90-91 and has declined since then. Considering that zebra mussels have been spreading along the Great Lakes' shores, and that more industrial and municipal water plants are experiencing zebra mussel infestations at their facility or intake, the decline in mean and median budgets suggest the availability of more cost-effective and less time consuming monitoring and control methods, limiting the impact of the zebra mussels. It could also be attributed to the easy and quick ways to get the information.

Finally, in an open-ended question, respondents were asked to make any additional comments or suggestions to improve the zebra mussel control and educational programs in

the Great Lakes region. A sample of both positive and negative comments received is given below. A full listing of comments is provided in Appendix 4.

"The zebra mussel problem in the Upper Peninsula has not been addressed very well. Either, because it is not a problem yet or at least not enough for Sea Grant officials to be concerned enough to let the U.P. water users know of problems."

"It must be realized that we were seriously impacted by the mussel before anyone else in the U.S. and had to develop treatment strategies without outside help. Because of our early involvement, Sea Grant programs offered little new material to us but should be invaluable to those who have later experience with or not yet had an acquaintance with the animals."

"Determination made early on that intake could be treated through reception of discharge. This resulted in termination of most mussels. This has continued to be most effective control method."

"Articles on what industries and municipalities are doing to control zebra mussels. Regulatory information alternatives to Cl_2 treatment. Environmentally sound treatments. Natural predators to zebra mussels-fresh water sponge?"

"Since we have installed an intake protection system (Cl_2 feed) based largely on S.G. info and zebra mussel monitoring forecasts - this info is now of academic value only (to me). The only practical info I see from your program now is: 1) Alternative control chemicals (KMnO_4) should Cl_2 be restricted; 2) Zebra mussel densities in L. Michigan by H. Park to answer the questions 'Was our \$300,000-system necessary? Would we face loss of intake capacity?'"

"Our hot water treatment has been very effective at minimal cost - suggest portable hot water treatment be investigated more fully."

"The Lansing conference with a blend of biology, regulatory, control experience, information, is useful. Keep it up!"

"More television and air time dedicated to educating boaters and sport fisherman about cleaning bilges and lower units of boats when going from the Great Lakes to inland waterways."

"Emphasis on cost of treatment incurred by utilities should be emphasized more."

"Zebra mussel control conflicts with new safe drinking act regulations when it comes to applying a biocide to remove zebra mussels and changing biocide application points to control the formation of trihalomethanes."

"Most of the information I have received on zebra's comes from other plant directors and sales persons."

"Our local Sea Grant agent, ..., has been very helpful in providing information. Our facility has been only moderately affected by zebra mussel colonization, so no action has been taken."

"Provide information on trends of growth and activity on a timely basis. Share information on control methods that work and are blessed by DNR."

"We have received very little if any info from Great Lakes region Sea Grant. We have worked with the University of Wisconsin Sea Grant Advisory services."

"The greatest amount of information I have received has come from my local Sea Grant agent. He has been extremely helpful in providing me with information. The lack of response from my administrative levels is indicated by the lack of funding for monitoring and control."

"I receive very little information first hand from Sea Grant. The only direct mailings I receive are questionnaires. When I do receive information second hand, it's usually quite useful but not always timely."

"Basically I need to devote more time to absorbing the info I currently receive as well as to attending some educational conferences."

"Sea Grant has supplied a lot of information which has been helpful and appreciated. However, I believe many of our successes and failures concerning monitoring and control would have occurred despite this information. In fairness to Sea Grant, I believe their efforts continue to augment general knowledge of zebra mussels."

Summary and conclusions

Extent of zebra mussel problem

Lakes Michigan and Erie are the lakes most drawn upon by Great Lakes water users, primarily for municipal drinking water purposes. At over two-thirds of water plants zebra mussels have been found. Zebra mussel infestation was lowest among industrial process water plants (50%) and highest among cooling water plants (88%). At nearly all plants where zebra mussels were observed, they were located at the intake structures (93%), although they were also found in other locations within the system (primarily in pump stations, travelling screens and trash racks). At water systems where zebra mussels are presently found, in fewer than one-fifth the pests appeared in or before 1989. In the majority of water systems, zebra mussels have appeared since 1990, providing an indication of the rapid expansion in the Great Lakes and connecting waters.

Even though in over two-thirds of water plants surveyed zebra mussels are present, less than half of the plants (47.5%) have monitoring programs at their facility. Sampling of adults and veligers up to twelve times per year is the most commonly used method of monitoring. Several plants carry out a combination of monitoring methods. About one-third of the respondents indicated that their facilities have employees responsible for monitoring and controlling zebra mussels. The number of facilities that do have employees assigned to this task has increased over time; however, the average number of employees (3) and the average percentage of time they spend on the zebra mussel problem (19%) has not increased. Similarly, while initially there was an increase in the budget for zebra mussel control, average budgets have fallen in the last three years. This may be an indication that better, more cost-effective monitoring and control methods have become available over the years. However, because the zebra mussels are still spreading and because more plants will have to start controlling the pest, overall economic impact and total expenditures for zebra mussel monitoring and control could continue to rise in the foreseeable future.

Awareness of information and information sources about zebra mussels

Slightly over half the respondents knew of the existence of an information office/contact on zebra mussels in their state. About an equal percentage stated that they had learned about the existence of this office through Sea Grant agents and/or educational events. Therefore, the Sea Grant Network appears to play an important role in increasing awareness among water users about available zebra mussel help and information. However, given that over four-fifth of respondents indicated that they received information/educational materials about zebra mussels, it is surprising to note that the awareness of the zebra mussel information office/contact was not more extensive, especially as Sea Grant offices, agents/specialists and educational events were prominent sources of educational materials received. It may be that Sea Grant has not asked these offices to play a greater role to serve the educational needs of this audience.

Of the educational materials produced and disseminated by the Great Lakes Sea Grant Network, information packets/facts sheets/brochures, newsletters and the Zebra Mussel Update have been received most frequently by respondents. In general, these materials were deemed as "useful," receiving an average rating of 3 on a four point evaluative scale. Participation in zebra mussel conferences and personal contacts with Sea Grant agents/specialists were also useful. Importantly, respondents rated the usefulness of these sources higher than the printed materials. This could be because respondents like answers to specific problems they face that are only dealt with superficially in printed materials, or because they like to be pointed to particular references and solutions in the printed materials without having to read them cover-to-cover.

Few respondents indicated using the INTERNET, graphics library and the Clearinghouse technical library and its 800 number. The low use of these information sources may be because municipal and industrial water users are not the primary target. Therefore, the target audience for this survey may not have been aware of the existence of these sources. However, if the industrial and municipal water users are a target group, focus must be on increasing awareness, improving dissemination, etc.

The topics or areas of information received were considered somewhat helpful to helpful. Information on shipping and navigation impacts was considered least useful (not surprising given that the survey was directed at water consuming industries), while information on the biology, ecology and control methods was rated as the most useful.

How can the needs of the Great Lakes industrial and municipal water users be met?

The Great Lakes Sea Grant Network could serve the industrial and municipal water users by providing information and education about zebra mussel. Information on low cost zebra mussel monitoring and control methods, past control efforts, research based information on the effect of zebra mussels on industrial and municipal water supply system, environmentally "friendly" and acceptable treatment methods, and information about the dispersion or spread of zebra mussel were frequently indicated subject-matter areas that would be helpful to this audience.

Has the Network achieved its objectives by making effective use of its resources?

The Great Lakes Sea Grant Network is systematically addressing the informational and educational needs of industrial and municipal water users in the region. Overall, respondents perceived the Sea Grant educational programs and services to be helpful to very helpful. Only ten percent thought that they had not been helpful. The Sea Grant Network's impact has been greatest in increasing knowledge about zebra mussel issues, providing regular updates on zebra mussels distribution in the region and providing educational support. Sea Grant programs have also helped facilities control zebra mussels and introduce new control methods, thereby minimizing zebra mussels at the respondents'

facilities. Not all respondents, however, agreed that Sea Grant programs have saved them or their facilities money.

The Great Lakes Sea Grant Network has been instrumental in providing educational programs and services to industrial and municipal water users in the region. To date, the Network has focussed its activities primarily in meeting the immediate needs of Great Lakes water users. The Network's impact has been greatest in increasing knowledge about zebra mussel issues and in providing regular updates on zebra mussels in the region. The findings are indicative that the Network has made effective use of its resources in meeting its goals and objectives. Therefore, recommendations that follow should be considered enhancements or fine tuning rather than changes in program components.

Recommendations

Following recommendations are made to enhance the outreach activities of the Great Lakes Sea Grant Network:

Currently, many of the great Lakes Sea Grant offices do not have a comprehensive mailing list of industrial and municipal water users in the Great Lakes region. In the absence of such a comprehensive and periodically updated data base of water users, communication between the Network's staff members and its intended clientele becomes difficult. It is therefore recommended that the Network systematically identify, develop and share a data base of water users in the Great Lakes region. Because zebra mussels are spreading into the inland lakes and rivers, this data base should include water users from both the Great Lakes and inland rivers and waterways. Development of such a data base should be a prerequisite to the planning and implementation of effective educational programs.

Although over four-fifths of the respondents indicated receiving information about the zebra mussel from different sources, several of them were not aware of the Network's offices or contacts and their activities. The study identified a need to increase the client level of awareness about the Network's zebra mussel information offices or contacts in the Great Lakes states. To meet this need, both interpersonal and mass communication strategies could be adapted to disseminate information on the zebra mussel information offices or contacts and their activities. Some specific methods that could be used include: 1) more educational programs for industrial and municipal water facility managers sponsored by the Network; 2) increased networking with the American Water Works Association, the Electric Power Research Institute, state Departments of Natural Resources, and private consultants; and 3) greater utilization of mass media such as newspapers and newsletters.

Personal contacts with Sea Grant agents/specialists were highly valued by respondents as a means to obtain information about the zebra mussel problem. The information packets/fact sheets, conference, newsletters and zebra mussel updates were also frequently mentioned sources of useful information. It is, therefore, recommended that the Network: 1) continue its support to develop and disseminate educational materials about zebra mussels, and 2)

encourage and create opportunities for personal interactions between Sea Grant personnel and water users.

Findings of this study indicate that industrial and municipal water facility managers are informed about zebra mussel issues. They perceive the Network's programs and services as helpful in obtaining the information necessary to address the zebra mussel problem. However, they also indicated a desire to learn more about zebra mussel monitoring, control and disposal methods. Future educational programs for the industrial and municipal water facilities managers should focus on such areas as 1) low cost monitoring and control methods; 2) comparisons of the results of different control efforts; 3) research on the effect of zebra mussels on industrial and municipal water supply systems; 4) environmentally "friendly" treatment methods; and 5) information about the dispersal or expansion of zebra mussel. These future educational programs should be based on current research efforts and findings.

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APPENDIX 1
SURVEY INSTRUMENT

MICHIGAN STATE
UNIVERSITY

March 15, 1994

1~

Dear 2~:

The Great Lakes Sea Grant Network has asked Michigan State University's Center for Evaluative Studies to assist in conducting a comprehensive evaluation of its zebra mussel outreach activities.

The purpose of this evaluation is to assess the impact of the Sea Grant Network's zebra mussel outreach activities on industrial and municipal water users. The zebra mussel contact persons at Great Lakes industrial and municipal water facilities are being asked to provide feedback so improvements can be made to the program. Your participation in this survey will help direct future zebra mussel education programs.

Your participation in this study is voluntary. The returned questionnaires will be held in strictest confidence. The questionnaire contains an identification number for mailing purposes only. Our report to the Great Lakes Sea Grant Network will focus on group responses to the questionnaire. No identity of any facility will be disclosed.

We appreciate your cooperation in completing the questionnaire. Please return it in the enclosed pre-addressed, stamped envelope by April 1, 1994. Of course, feel free to contact us if you have questions regarding the questionnaire.

Thank you in advance for your cooperation.

Sincerely,

Murari Suvedi, Ph.D.
Coordinator



Department of Agricultural
& Extension Education

410 Agriculture Hall
Michigan State University
East Lansing, Michigan
48824-1039

517-355-6580
FAX: 517-353-4981

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**EVALUATION OF THE GREAT LAKES
SEA GRANT NETWORK'S ZEBRA MUSSEL OUTREACH ACTIVITIES**

**Questionnaire for Zebra Mussel Contact Persons
at the Great Lakes
Industrial and Municipal Water Facilities**

**AEE Center for Evaluative Studies
Department of Agricultural and Extension Education
Michigan State University
410 Agriculture Hall
East Lansing, MI 48824**

**EVALUATION OF THE GREAT LAKES
SEA GRANT NETWORK'S ZEBRA MUSSEL OUTREACH ACTIVITIES**

This study is being conducted by Michigan State University's AEE Center for Evaluative Studies to assist the Great Lakes Sea Grant Network in evaluating its zebra mussel outreach activities. The purpose of the evaluation is to gain information about past accomplishments of the program, to recognize strengths and weaknesses of the program, and to identify areas of the program that might be improved.

Directions:

Please answer each question as completely as you can. There are no right or wrong answers. The questions are designed to solicit your opinions.

Most questions can be answered by checking a space next to an item (Yes No), circling a rating number (1 2 3 4), filling a space (%), or by writing your thoughts/comments. The questionnaire will take approximately 10 minutes to complete.

Each questionnaire has been numbered to assist in the data collection process. All answers will be kept completely confidential.

Please return the completed questionnaire in the enclosed envelope to:

AEE Center for Evaluative Studies
Department of Ag. & Extension Education
410 Agriculture Hall
Michigan State University
East Lansing, MI 48824

EVALUATION OF THE GREAT LAKES

SEA GRANT NETWORK'S ZEBRA MUSSEL OUTREACH ACTIVITIES

1. From which Great Lake or connecting water does your plant draw its water?

- Lake Superior
- Lake Michigan
- Lake Huron
- Lake Erie
- Lake Ontario
- Connecting water (please specify): _____
- Other (please specify): _____

2. How would you characterize your facility's water use:

- Municipal drinking water
- Cooling water
- Industrial process water
- Other (please specify): _____

3. Have zebra mussels been found at your facility or intake?

Yes _____ No _____ (If No, go to Q. 6 below)

4. When did you first find zebra mussels in your facility or intake?

Approximate month: _____ year: _____

5. Where can zebra mussels be found in your system? (check all that apply)

- Intake structures
- Trash racks
- Travelling screens
- Pump stations
- Forebays
- Condenser units
- Service water systems
- Fire protection systems
- Discharge lines
- Reservoirs
- Filter beds/Filtration media
- Others (please specify) _____

6. Do you have a regular monitoring program for zebra mussels?

Yes _____ No _____ (If No, go to Q 8 on page 2)

7. What type of zebra mussel monitoring program do you have? (check all that apply)

<u>Type of monitoring program</u>	<u>How often do you monitor?</u>
<input type="checkbox"/> sampling of adults	<input type="text"/> (number of times per year)
<input type="checkbox"/> sampling of veligers	<input type="text"/> (number of times per year)
<input type="checkbox"/> sampling of settling larvae	<input type="text"/> (number of times per year)
<input type="checkbox"/> other, (please specify) _____	<input type="text"/> (number of times per year)

8. Were you aware that your state has established a contact for zebra mussels information before you received this survey?

Yes No (If No, go to Q.10)

9. How did you first learn about your state's zebra mussel information contact?

- Newspaper
- Newsletter
- Television
- Radio
- The Dreissena Polymorpha Information Review
- The Zebra Mussel Information Clearing House
- Sea Grant sponsored educational event in my state
- My Sea Grant agent/specialist
- American Water Works Association (AWWA)
- Department of Natural Resources (DNR)
- Private consultants
- Electric Power Research Institute (EPRI)
- Other, please specify: _____

10. Have you received information or educational materials about zebra mussels in the Great Lakes region?

Yes No (If No, go to Q 18 on page 6)

11. From which of the following source(s) have you received information about zebra mussels? Please check all that apply

- My State's Sea Grant Office
- Newspaper
- Television
- Radio
- The Dreissena Polymorpha Information Review
- The Zebra Mussel Information Clearing House
- Sea Grant sponsored educational event in my state
- Sea Grant agent/specialist
- American Water Works Association
- Department of Natural Resources (DNR)
- Local consultants
- Electric Power Research Institute (EPRI)
- Other (please specify): _____

12. The Great Lakes Sea Grant Network has supported the development and distribution of a variety of educational materials about zebra mussels. Listed below are possible sources of information. Please indicate whether you have utilized zebra mussel information from these sources, and the "usefulness" of each source by circling an appropriate number.

Key:

- 1 = Not useful
 2 = somewhat useful
 3 = useful
 4 = very useful

Information source about zebra mussel	Did you use/or receive it?		How useful was this information source?			
	Yes	No	Not useful	_____	_____	Very useful
Zebra Mussel Update	Y	N <input checked="" type="radio"/>	1	2	3	4
Dreissena polymorpha Information Review	Y	N <input checked="" type="radio"/>	1	2	3	4
Other Sea Grant newsletters	Y	N <input checked="" type="radio"/>	1	2	3	4
Information packets/factsheets/ brochures on zebra mussels	Y	N <input checked="" type="radio"/>	1	2	3	4
List of resources and contacts for zebra mussels	Y	N <input checked="" type="radio"/>	1	2	3	4
Participation in conference(s) on zebra mussels	Y	N <input checked="" type="radio"/>	1	2	3	4
Videos demonstrating zebra mussel control	Y	N <input checked="" type="radio"/>	1	2	3	4
Information on zebra mussels via INTERNET	Y	N <input checked="" type="radio"/>	1	2	3	4
Personal contact with Sea Grant agent/specialist	Y	N <input checked="" type="radio"/>	1	2	3	4
Contacted the Zebra Mussel Information Clearinghouse using 800 number	Y	N <input checked="" type="radio"/>	1	2	3	4
Contacted the Network's exotics graphic library	Y	N <input checked="" type="radio"/>	1	2	3	4
Other: please specify _____	Y	N <input checked="" type="radio"/>	1	2	3	4

13. Have you requested any technical publication reprints from the Clearinghouse's technical collection (library)?

Yes ____ No ____

14. The Great Lakes Sea Grant Network has developed zebra mussel educational materials on a variety of topics. Listed below are zebra mussel topic areas. Please indicate whether you have received information in these topic areas and circle how helpful the Sea Grant information was with respect to the following topics?

Zebra mussel information topics	Received information?		How helpful was information?			
	Yes	No	Not Helpful	Somewhat Helpful	Helpful	Very Helpful
Zebra mussel control methods	Y	N	1	2	3	4
Monitoring methods	Y	N	1	2	3	4
State/federal regulations	Y	N	1	2	3	4
Ongoing research efforts	Y	N	1	2	3	4
Economics of zebra mussel control	Y	N	1	2	3	4
Sighting updates	Y	N	1	2	3	4
Disposal methods (landfills, composing, etc)	Y	N	1	2	3	4
Legislative initiatives	Y	N	1	2	3	4
Shipping and navigation impacts	Y	N	1	2	3	4
Biology and ecology of zebra mussel	Y	N	1	2	3	4
Other, specify _____	Y	N	1	2	3	4

15. What other information about zebra mussels would be helpful to you? Please describe/list:

16. Please indicate the extent to which you agree or disagree with the following statements regarding the impact of Great Lakes Sea Grant Network's zebra mussel outreach activities by circling an appropriate number.

Statements	Strongly Disagree	Disagree	Agree	Strongly Agree
As a result of the Great Lakes Sea Grant Network's zebra mussel activities:				
I receive regular updates on zebra mussels in the Great Lakes region.	1	2	3	4
I receive adequate educational support to address the zebra mussel problem.	1	2	3	4
I have an increased knowledge about zebra mussel issues.	1	2	3	4
My facility has a regular zebra mussel monitoring program.	1	2	3	4
My facility adopted new practices to control zebra mussels.	1	2	3	4
My facility is able to control zebra mussels.	1	2	3	4
The zebra mussel problem in my facility has been minimal.	1	2	3	4
My facility has saved money.	1	2	3	4

17. Overall, how helpful to you were the educational programs and services of the Sea Grant Network in controlling zebra mussels in your location?

- Very helpful
- Quite helpful
- Helpful
- Somewhat helpful
- Not helpful

18. Currently, do you have employees responsible for zebra mussel monitoring, control and disposal at your facility?

Yes ____ No ____ (If No, go to Q.20)

19. What are your estimated expenditures (direct or indirect) for zebra mussel monitoring, control and disposal activities. Include the number of staff involved, their % time, and estimated expenditure for each fiscal year period.

<u>Number of Staff</u>	<u>% time/FTE</u>	<u>Estimated budget</u>
_____ Current year (93-94)	_____	\$ estimated for these activities: \$ _____
_____ One year ago (92-93)	_____	Total \$ spent for these activities: \$ _____
_____ Two years ago (91-92)	_____	Total \$ spent for these activities: \$ _____
_____ Three years ago (90-91)	_____	Total \$ spent for these activities: \$ _____
_____ Four years ago (89-90)	_____	Total \$ spent for these activities: \$ _____
_____ Five years ago (88-89)	_____	Total \$ spent for these activities: \$ _____

20. Please use the space below to make any additional comments or suggestions to improve the zebra mussel education program in the Great Lakes region.

Thank you for completing this survey. Please return it in the enclosed pre-addressed stamped envelope.

MICHIGAN STATE
UNIVERSITY

March 22, 1994

1 -

Dear 2 - :

Last week you were mailed a questionnaire about the Great Lakes Sea Grant Network's zebra mussel outreach activities.

If you have already completed and returned the questionnaire, thank you. If not, please take a few minutes and do it today. The questionnaire has been sent to a sample of Great Lakes industrial and municipal water facilities zebra mussel contact persons, so improvements can be made in the education programs provided by the Sea Grant Network. Your opinion will help direct future outreach activities of the Great Lakes Sea Grant Networks.

If you did not receive the questionnaire, or have misplaced it, please send a short note or FAX to the AEE Center for Evaluative Studies at Michigan State University address. You will be mailed another questionnaire.

Many thanks for your help. Your prompt attention and cooperation are greatly appreciated.

Sincerely,

Murari Suvedi, Ph.D.
Coordinator



**Department of Agricultural
& Extension Education**

410 Agriculture Hall
Michigan State University
East Lansing, Michigan
48824-1039

517-355-6580
FAX: 517-353-4981

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equal-opportunity institution*

MICHIGAN STATE
UNIVERSITY

April 10, 1994

1~

Dear 2~:

Last Month, a survey was mailed to you about the evaluation of the Great Lakes Sea Grant Network's zebra mussel outreach activities. This survey is important since it will help direct future zebra mussel related outreach activities of the Great Lakes Sea Grant Network. Your opinion will assure that on-going activities and new initiatives related to zebra mussel education will take your ideas into account.

As of today we have not received your completed questionnaire, but many thanks if you have returned the survey before we mailed you this letter. If by some chance you did not receive the questionnaire or if it was misplaced, a replacement questionnaire has been enclosed. Please take a few minutes to complete and return it in the enclosed pre-stamped envelope. It will take only about 20 minutes of your time. Of course, your participation in this study is voluntary and you may refuse to answer questions.

Your prompt attention and cooperation is greatly appreciated. Please return the questionnaire in the enclosed pre-address, stamped envelope by April 29, 1994. Feel free to contact me if you have questions regarding the questionnaire.

Thank you for your cooperation.

Sincerely,

Murari Suvedi, Ph.D.
Coordinator



Department of Agricultural
& Extension Education

410 Agriculture Hall
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East Lansing, Michigan
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MICHIGAN STATE
UNIVERSITY

February 7, 1994

Dear Colleague:

We need your help. We are developing a mailing list for a study about zebra mussel problems in the Great Lakes. Your organization is one of several municipal and industrial water users we may want to survey by mail.

Please complete and return the enclosed postcard by February 15, 1994. This should only take a minute, and your contribution could help save a great deal of time and expense.

Thank you in advance for your cooperation.

Sincerely,

Murari Suvedi, Ph.D.
Assistant Professor



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AEE Center for Evaluative Studies
Dept. of Ag. & Extension Education
410 Agriculture Hall
Michigan State University
East Lansing, MI 48824-1039

Nº 2926

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Does your facility draw water from one of the Great Lakes or one of the connecting waters: Detroit River, St. Clair River, St. Marys River, Niagara River, St. Lawrence Sea Way?

Yes No

Have zebra mussels been found at your facility or intake?

Yes No

Who would be the primary contact for zebra mussel control at your facility?

Name: _____

Address _____

Thank you for your cooperation.

APPENDIX 2

Summary of Postcard Responses

State	Post-cards mailed	Post-cards received	Draw water from the Great Lakes or connecting waters	Zebra mussel found at the facility	Do not draw water from the Great Lakes or connecting waters but found zebra mussel	Number of surveys mailed	Number of completed surveys received
Michigan	289	124	80	52	4	80	69
New York	631	293	67	56	15	67	56
Indiana/ Illinois	474	173	30	30	4	30	25
Ohio	1155	246	47	40	2	47	38
Wisconsin	124	70	27	18	3	27	26
Minnesota	147	62	12	0	0	12	10

APPENDIX 3

Full List of Additional Information Respondents Suggested would be Helpful

1. I would like to see more research done about the indirect effect zebra mussels have had with drinking water qualities, specially taste and odor problems.
2. Impact of zebra mussels on other aquatic life.
3. Listing by industrial category that will summarize control efforts for a given area, and industry type.
4. Information on past control efforts.
5. I have received a lot of material from so many sources. I may have overlooked some things I received from Sea Grant.
6. Status of other community control programs.
7. Biology of zebra mussels: natural predators.
8. Effective, low cost monitoring and control programs.
9. D.E.C. regulation on zebra mussel control methods.
10. Control with permanganate dosages.
11. Successful treatment methods that are environmentally acceptable.
12. Current methods of control. Examples of control being used at various facilities.
13. Nothing needed-- we have no significant mussel problem.
14. Good job!
15. Impact on sport-fishery.
16. Mostly interested in control methods of water utilities using chlorine-dose, duration, effectiveness.
17. Control experiences along Great Lakes (summary).
18. New or different control methods if/when they are developed.
19. Further information on game fishing and other species in Lake Erie.
20. What the trend for the future is predicted to be!
21. 1. Sighting updates, 2. Monitoring methods, 3. Research information, 4. New exotic invaders
22. Control at intakes.
23. Ongoing research papers.
24. Control methods, movement of mussels throughout the U.S.
25. KMnO_4 seems to be doing a very good job of controlling zebra mussels, along with taste and odor control our facility hires a diver every fall to inspect the intake cribs and wet well.
26. New or innovative means of cost effective control.
27. Control systems that work.
28. Feasibility studies of promising control techniques.
29. Source of revenue to fund treatment activities.
30. I have only requested info from the Sea Grant specialists that conducted seminar in Massena on February 1990. Other than that I receive no information about zebra mussels.
31. Any and all available. My predecessor went to sea grant conferences--I have not yet!
32. Effectiveness of various control methods (ex. Thermal treatment, chemical and mechanical.)
33. Water industry info, not industrial methods.
34. Other treatment methods.

APPENDIX 4

List of Comments and Suggestions to Improve the Zebra Mussel Education Program in the Great Lakes

1. The response I have provided are for the St. Lawrence Project on the St. Lawrence River near Massena, NY; the Fitzpatrick nuclear station on Lake Ontario near Oswego, NY; and the Niagara Project on the Niagara River near Niagara Falls, NY. I do not have cost estimates for the amount of \$ spent at each project, however our expenditures are substantial. We have installed chlorination systems at the hydroelectric facilities for the service water systems and have had several "Clamtrol" treatments at our nuclear station.
2. I would appreciate receiving any information on zebra mussels in Lake superior.
3. The zebra mussel problem in the Upper Peninsula has not been addressed very well. Either, because it is not a problem yet or at least not enough for Sea Grant officials to be concerned enough to let the U.P water (users) know of problems.
4. None found, program may be of more benefit if any are discovered.
5. I have not routinely received updated information on zebra mussels control, sightings, etc. Information is provided only on your demand.
6. We hire one diver three times a year, once in May, July and October to inspect our breakwater, docks and waterlines, this system works out at this time well for us.
7. We are a very small water system and would appreciate any info to help with zebra mussels.
8. It must be realized that we were seriously impacted by the mussel before anyone else in the U.S. and had to develop treatment strategies without outside help. Because of our early involvement Sea Grant programs offered little new material to us but should be invaluable to those who have later or not yet had an acquaintance with the animals.
9. I feel the program has been fine for our particular needs. There is close personal communication with our Sea Grant advisor and she has been very helpful to our public education program here.
10. We need to know inexpensive methods of zebra mussel control for small municipal water supplies.
11. The water we use comes from the City of Cleveland which sells the water to the Bedford City Water Department. 90% of the water used is plant is softened, reverse osmosis and about 40% distilled after going through the above purification system. Distilled water is circulated through the plant at 180 degrees F.
12. This Lake Keuka is free of zebra mussels at this time, but the lake is closely checked for zebras by the "keuka lake association" and also the New York Health department.
13. Sea Grant has supplied a lot of information which has been helpful and appreciated. However, I believe many of our successes and failures concerning monitoring and control would have occurred despite this information with each other. (In fairness to Sea Grant, I believe their efforts continue to augment general knowledge of zebra mussels.
14. Determination made early on that intake could be treated through receive discharge. This resulted in termination of most mussels. Has continued to be most effective control method.
15. Provide a summary of the types of control measures in use and who is using each type --Another survey! arghh!
16. This is a start. I need more information on zebra mussels. We are going to have problems shortly at our intake.

17. Most of the information I have received on zebra's come form other plant directors and sales persons.
18. Our local sea grant agent, Fred Snyder, has been very helpful in providing information. Our facility has been only moderately affected by zebra mussel colonization so no action has been taken.
19. We have not had any sightings yet at the Marquette BLP-Shiras Plant. We are keeping abreast with the issue and make inspections during our outages.
20. I would like to receive this information but have not this time.
21. Provide information on trends of growth and activity on a timely basis. Share information on control methods that work and are blessed by DNR.
22. Articles on what industries and municipalities are doing to control zebra mussels. Regulatory information alternatives to Cl₂ treatment. Environmentally sound treatments. Natural Predators to zebra mussels--fresh water sponge?
23. At this time, due to the sand area from which we draw water from, there has not been a problem with zebra mussels.
24. Sorry not much help about the informational media. Other persons were involved and may have had more impact, But they are not available.
26. Our water intake is used just in summer when winter comes we take it in, our facility is just summer cottages. When we pull in the water line we see a few zebra mussels on the intake. They are not a problem as yet. The only other place we have seen them is shells on the beach.
27. Switch to chlorination (continuous).
28. We have received very little if any info from Great Lakes region Sea Grant. We have worked somewhat with the University of Wisconsin Sea Grant Advisory Services.
29. Since we have installed an intake protection system (Cl₂ feed) based largely on Sea Grant information and zebra mussel monitoring forecasts--this information is now of academic value only (to me). The only practical information I see from your program is now 1. Alternative control chemicals (KMnO₄) should Cl₂ be restricted 2. zebra mussel densities in L. Michigan by H. Park -answer question "was our \$300,000 -system necessary? -would we none faced loss of intake capacity?
30. Our hot water treatment has been very effective at minimal cost - suggest portable hot water treatment be investigated more fully.
31. Currently not aware of how widespread zebra mussel infestation may be in our area. Would like to be brought up to date on this matter. For your information: This evaluation comes from the NASA center in Sandusky, Ohio. We have a 42 inch water intake line in Lake Erie at Rye beach located near Huron, Ohio. We also pump raw water to our location utilizing the city of Sandusky water intake line and out pumping station located in Sandusky. The department of Interior, National Biological Survey field office is located here at the NASA facility. They have done some zebra mussel research as related to fish in recent years. Thank you.
32. The sea grant program in our area had done as excellent job keeping us informed and updated on zebra mussels. The sampling and monitoring program has been funded through the state program in the past.
33. It would be nice to know what works well at low cost vs. what doesn't.
34. Percent (%) time represents my time only. The % of time spent at each facility varies. Costs vary by facility also. Monitoring is not conducted internally. Question 19 cannot be answered effectively.
35. I would like to receive information about zebra mussel monitoring programs and other educational materials.

36. At this time we do not have a zebra mussel problem at our intake. We monitor it every fall when we remove this pipes from the river.
37. Requires minimum staff time at present our total past expenditures have been significant-hundreds of 1000's. This will require review.
38. Presently we do not have any problems from zebra mussels. We would like to stay informed, though, in the event they become a problem in the future. We have had to scrap intake screens to restore flow to full capacity.
39. We spend approximately \$4000 per year to feed Potassium Permanganate. \$1000 per year is spent to send a diver to scrape our intake, if necessary, and videotape the intake screen and entry way. \$10,000 was spent in 1990 to install a feed line through out the 3300 foot intake, and purchase $KMnO_4$ feed equipment.
40. Please put me on a mailing list to receive materials regarding zebra mussels.
41. Haven't seen or heard much in the way of damage or harm, zebra mussels have done in this region where we live.
42. Did I miss something? I do not know where to send away for this extra information besides the Zebra Mussel Update Newsletter. This is very helpful in alerting us about veligers in the water in the spring and late fall. Also got good contacts for other information out of articles written.
43. We have found zebra mussels in the intake canal and attached forebay in the past, but they have not entered our systems and caused a concern. Therefore, no assistance has been required for their control.
44. Fortunately we are on the eastern end of Lake Erie and had plenty of times to study the problem and develop a plan of action early.
45. Sea Grant has been monitoring at our facility and at present that is the only monitoring done.
46. Your program probably works well. However, I have really never used it. My excuse is that I am new. I do intend to get involved with this issue a great deal and I look forward to what seems to be a wealth of available information.
47. We would like to receive more information regarding the answers to #14.
48. The Lansing conference with a blend of biology, regulatory, control experience, information, is useful. Keep it up!
49. We have been using Cl_2 with a minimum of increased cost. 1993-94 we will cleaning crib of 3-4 in. coverage of mussels. Contractors are used for all work.
50. Zebra mussels have not moved into the Fox River yet. This is expected in coming years as they have moved into lower Green Bay. The solution we expect to use is heat treatment preliminary engineering is complete.
51. It would be nice to receive periodic updates in brief about the zebra mussel situation.
52. Get information to General Public.
53. This survey makes the assumption that people remember where they received information from considering the quantity of articles T.V. and various lectures etc. available for input- we feel that questions relating to Ohio Sea Grant material are S.W.A.G'S at best.
54. More television and air time dedicated to educating boaters and sport fisherman about cleaning bilges and lower units of boats when going from the great lakes to inland waterways.
55. No comments. We have not experienced a problem with zebra mussels either at Duluth or Two Harbors, Minnesota. If we did experience any problem the Sea Grant Duluth office would be our first stop in obtaining help and information.
56. Water is drawn from the Municipal Water System.
57. When they start to bother us we may want some help.
58. Emphasis on cost of treatment incurred by utilities should be emphasized more.

59. The seaway has provided the opportunity to a great number of researchers to our facilities for info about the zebra mussels.
60. Basically I need to devote more time to absorbing the information I currently receive as well as attend some educational conferences.
61. Zebra mussel control conflicts with new safe drinking act regulations when it comes to applying a biocide to remove zebra mussels and changing biocide application points to control the formation of trihalomethanes.
62. Have had no problem.
63. Since we had zebra mussels at all facilities, new sightings are of little interest. Most important now is control techniques and information to legislative bodies regarding need for continued chemical control especially chlorine.
64. The greatest amount of information I have received has come from my local Sea Grant agent. Fred Synder. He has been extremely helpful in providing me with information. The lack of response from my administrative levels is indicated by the lack of funding for monitoring and control.
65. I receive very little information first hand from Sea Grant. The only direct mailings I receive are questionnaires. When I do receive information second hand it is usually quite useful but not always timely.

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