AIS Early Detection and Monitoring: A Pilot Project for the Lake Michigan Basin

Guidelines and Recommendations

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With guidance from the
Early Detection and Monitoring Project Advisory Team
for the Lake Michigan basin

Table of Contents

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This document *AIS Early Detection and Monitoring: A Pilot Project for the Lake Michigan Basin* is presented to the project funder, U.S. Environmental Protection Agency (U.S EPA), Great Lakes National Program Office (GLNPO) as an informational resource to guide the development of an AIS detection and monitoring regime on a lakewide basis for Lake Michigan and to help set a framework on a regional scale for the Great Lakes basin. This project has been conducted by Great Lakes Commission staff, including: Katherine Glassner-Shwayder, (senior project manager) and John Hummer (project manager). A special thanks goes to Kevin Walters, former Commission program specialist, who committed a great deal of time and effort to the project. Assistance on this project was also provided by Ric Lawson and Sarah Whitney – also both formerly employed at the Great Lakes Commission. The project advisory team (listed on the following page) played an instrumental role in guiding staff in the development of this project, which includes members of the Great Lakes Panel on Aquatic Nuisance Species and the Lake Michigan Monitoring Coordination Council as well as some other interested regional stakeholders.

Project activities included an assessment of the Lake Michigan Monitoring Inventory, a survey to assess the current status of established monitoring programs conducting aquatic invasive species (AIS) monitoring in the Lake Michigan basin, and a culminating workshop to discuss project results and the next steps needed to advance the development of a coordinated monitoring network for the Lake Michigan basin. The Great Lakes Commission is pleased to acknowledge the individuals participating in this project providing guidance, review and technical assistance critical to the success of the project. Project participants are encouraged to continue their involvement in efforts to develop a coordinated early detection and monitoring program for Lake Michigan as well as the other Great Lakes.

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Guidelines and Recommendations

Introduction

The Great Lakes-St. Lawrence ecosystem has been plagued by the infestation of more than 162 nonindigenous aquatic invasive species that have become established since the settlement of North America by Europeans (Ricciardi, 2001 and Mills et al., 1993). The rate of AIS introductions has significantly increased in the last 50 years largely due to the opening of the St. Lawrence Seaway system and attendant waterborne commercial ship traffic. Other AIS introductions result from recreational and commercial activities such as aquaculture industry, aquarium trade, recreational fisheries enhancement (stocking), live bait business and horticultural practices, among others. Irrespective of how an invasive species is introduced, experience has shown that once invasive species become established on a wide-scale basis, controlling their spread is both technically difficult and expensive while eradication is nearly impossible. Therefore, prevention of AIS introductions must remain the first priority in battling aquatic invasions.

A reality of AIS introductions in the Great Lakes-St. Lawrence region is that public and private institutions are poorly equipped to deflect the large economic, social and ecological costs incurred when introduced species become established as reproducing populations. This situation is demonstrated by past and present costs in the control and cleanup of zebra mussels – estimated at millions of dollars annually (100^{th} Meridian Initiative) – and the current threat of Asian carp to the $4.5 billion Great Lakes sport and commercial fishery (Midwest Natural Resources Group, 2003). Of particular concern for this project is the period between introduction and establishment of a reproducing AIS population while the invasion is still in the early phases with localized populations. If early detection successfully occurs in this period, there is a window of opportunity when populations have not grown beyond levels that are technically and economically feasible to control. To capitalize on this window, management needs to shift from a prevention to a control mode that is driven by rapid response planning. (Early Detection and Rapid Response Subcommittee of the Invasive Species Advisory Committee serving the National Invasive Species Council, 2003).

Project Background

Statement of Purpose

The purpose of the *Aquatic Nuisance Species Early Detection and Monitoring Pilot Project for the Lake Michigan Basin* is to produce a set of guidelines and recommendations for a coordinated system to detect new AIS invasions and track the spread of established AIS populations in the Lake Michigan basin. The term *aquatic nuisance species* refers to those nonindigenous organisms threatening the diversity or abundance of native species or the ecological stability of the infested waters with inclusion of aquatic organisms from all taxonomic groups (e.g., fish, invertebrates, plants, algae, bacteria, etc.). However, the term aquatic invasive species (AIS) is used during the writing of this document to reflect more current usage. Project findings will also be used to advance the development of a Great Lakes region-wide AIS early detection and monitoring program. Early detection of AIS introductions and monitoring of established populations is considered essential for effective eradication and control efforts.

In establishing a coordinated system to detect new AIS introductions and monitor/track the spread of existing populations, there is a need for programs that are both active (dedicated collection of AIS data) and passive (incidental collection of AIS data). Given the influx of new invasions and the associated severe economic and ecological costs, there is a paucity of dedicated programs with the primary goal of detecting new invasions and monitoring existing AIS populations. Many monitoring programs exist in the Lake Michigan basin without an explicit goal or mandate related to AIS programs These programs, however, do hold the capacity to incidentally detect and/or monitor AIS invasions. As the need increases to make best use of limited funding and resources available for AIS detection and monitoring, it is important that both active and passive programs are integrated as part of any future coordinated detection and monitoring network to the extent possible.

In the fall of 2003, the Great Lakes Commission (GLC) received a grant from the U.S. Environmental Protection Agency, Great Lakes National Program Office to advance the development of a regional monitoring effort through initiation of an AIS early detection and monitoring pilot project in the Lake Michigan basin. A survey instrument was used as a means to help evaluate the degree of AIS monitoring currently being conducted in the basin. The survey was targeted toward programs identified as potentially having AIS detection and monitoring capability or an interest therein. The targeted audience also included members of the Great Lakes Panel on Aquatic Nuisance Species, including participants on this project's advisory team, as well as members of the Lake Michigan Monitoring Coordination Council (LMMCC). Most importantly, an analysis of survey results assisted in assessing the capacity for existing monitoring programs to detect the introduction of new AIS invasions as well as monitor their potential spread throughout the basin.

Geographic Scope

The geographic scope of this pilot project focused on the Lake Michigan basin and took advantage of existing monitoring resources within the LMMCC. Members of the Great Lakes Panel also served as project partners, sharing their programmatic expertise on AIS

detection and monitoring. Project participation by scientists, resource managers, educators and decision makers from both the LMMCC and the Great Lakes Panel played a significant role in the project survey and the ensuing guidelines and recommendations. The project builds on an existing framework of monitoring coordination and regional invasive species management as well as the ongoing development of a regional rapid response model plan (See http://www.glc.org/AIS/pdf/ModelRRPlan-II_04-04.pdf).

Preliminary Work

Preceding the AIS early detection and monitoring project, the Great Lakes Commission conducted an inventory of monitoring programs in the Lake Michigan drainage basin in the year 2000. The *Lake Michigan Tributary Monitoring Project* was funded by the Lake Michigan Team at U.S. EPA Region 5 with research assistance from ten local partners, An assessment of the Lake Michigan Tributary Monitoring Project (accessible on the Great Lakes Commission website at www.glc.org/monitoring/lakemich/index.html) was developed based on the initial inventory and includes a detailed review of monitoring programs in each of ten subwatersheds, along with an analysis of gaps and recommendations for further initiatives.

A primary result of the *Lake Michigan Tributary Monitoring Project* was an interactive monitoring inventory database called the Lake Michigan Monitoring Inventory (LMMI). Through the inventory, information about monitoring programs (or "metadata") was collected and a database was designed for long-term storage and access. Inventory information was compiled primarily during August, 2000, with some program updates since original data entry. As part of the *AIS Early Detection and Monitoring Pilot Project*, the LMMI was assessed to identify programs that regularly monitor or collect information regarding biotic and abiotic parameters in areas considered to be at high risk due to AIS invasions. Of particular concern for this project are those areas at high risk due to active AIS vectors, such as ballast water discharge in Great Lakes ports. Other areas considered to be at high risk include high quality habitat where AIS invasions could produce damaging impacts, similar to marine protected areas, such as national shorelines and state and national park areas, among others. The LMMI assessment was used to identify existing monitoring programs that could be broadened in scope to facilitate detection of aquatic nuisance species as well as identify the overall pool of survey recipients. Other survey recipients included members from the Lake Michigan Monitoring Coordination Council and the Great Lakes Panel on Aquatic Nuisance Species.

To determine applicability to AIS detection and monitoring programs, staff examined the LMMI online database in terms of several different search criteria in the following fields: organization, watershed, purpose, date, monitoring medium, type of monitoring, description, frequency, methods, quality, staff type, and parameters. After a preliminary assessment, the database search criteria listed below were found to have possible applicability for helping identify programs that may lead to the detection of new aquatic invaders.

"Monitoring Medium" and "Types of Monitoring" were the two fields of the inventory that provided the most results and best information in terms of identifying potential

survey recipients. The results were further broken down to determine those with "possible application to AIS monitoring/detection." After filtering out those programs that would not be applicable to AIS monitoring/detection, we were left primarily looking at programs monitoring biota and wildlife, fish or aquatic invertebrates, microbiological organisms, and those indicating they monitor multiple parameters.

LMMI Database Search Criteria (search criteria that could be applicable to AIS detection programs):
Monitoring Medium

- Possible application to AIS monitoring/detection
  - Biota/Wildlife
  - Multiple
- Not applicable to AIS monitoring/detection
  - Air
  - Land
  - Soil
  - Water
  - Others

Types of Monitoring

- Possible application to AIS monitoring/detection
  - Fish or aquatic invertebrates
  - Microbiological
  - Other wildlife
  - Other
- Not Applicable to AIS monitoring/detection
  - Chemical
  - Land uses
  - Physical

Survey Description

A survey was used as a means to help evaluate the degree of AIS monitoring currently being conducted in the basin and to provide as basis for the recommendations presented after this section on the survey, which includes a summary of responses. It is important to note that there were two parts to this survey. Part A (questions 1-20) requested basic background information and a detailed description of monitoring programs. All survey recipients were asked to complete Part A. Part B (questions 21-25) was only to be completed by those survey recipients who responded as having an "active" AIS monitoring/detection program. *Active detection* is defined as efforts which have specific responsibility to detect and monitor AIS. This is also known as "dedicated surveillance". *Passive detection* is defined as efforts which may incidentally detect invasions as they conduct other activities. This is also known as incidental surveillance.

A total of 127 surveys were sent out; 46 surveys were completed and returned, a response rate of 36%. (See Appendix A for a list of survey recipients). The 46 completed surveys

are in no way meant to be representative of the entire Lake Michigan monitoring community. Rather, the 127 surveys were sent out to entities and/or programs that the project staff and advisory team discerned had the capability to detect and monitor invasive species in the Lake Michigan basin; either actively (i.e. dedicated detection/monitoring) or passively (i.e. incidental detection/monitoring).

Questions on the survey fall into two different categories: check-box style questions and text response to more open ended questions. The check-box style questions are those which ask the survey respondent to check one or more provided answers to the question. In the summary of the survey responses given below, answers to check-box style questions are reported in tabular format. The percentages reported in the tables were calculated by dividing the frequency of a particular response by the total number of respondents (46). It is important to note that many survey respondents checked more than one box per question and therefore the total of the percentages reported for each question is often greater than 100%. In some cases, "no responses" may have led to a lower than 100 percent total response. Text response type questions are those questions which are open-ended and required the respondent to complete an answer in prose in efforts to capture information in further depth or from a different perspective. The answers to text response questions are also summarized in the section below.

Survey Questions and Summary of Responses

Question 1

Is your monitoring program capable of actively or passively detecting new introductions and monitoring existing populations of aquatic nuisance species? (Check "Both" if applicable.)

Response	Frequency	Percent
Actively	3	7%
Passively	25	54%
Both	15	33%
Neither	3	6%

Summary

The intent of this question was to find out which monitoring programs surveyed are capable of "actively" and/or "passively" detecting new introductions and monitoring existing populations of AIS in the Lake Michigan basin. *Active detection* is defined as monitoring efforts which have specific responsibility to detect aquatic nuisance species *(as defined by Project Advisory Team)*. It is also known as *dedicated surveillance*. *Passive detection* is defined as monitoring efforts which may incidentally detect invasions as they conduct other activities (*as defined by Project Advisory Team).* It is also known as *incidental surveillance*. A margin of slightly more that one-half of the programs surveyed (54%) indicated they are capable of undertaking passive detection of AIS, with an additional 33% capable of conducting both active and passive detection. This reveals that detecting and monitoring of AIS may be occurring in one form or another by over 85% of monitoring programs throughout the basin. These results indicate

that there is potential for existing monitoring programs to become capable of actively detecting new introductions and monitoring existing populations of AIS in the Lake Michigan basin. It is recommended as a priority action that opportunities are identified to build upon the capacity of existing monitoring programs to integrate an AIS monitoring protocol, taking either an active or passive approach.

Question 2

Monitoring program title. (Recipients were asked to fill in the title of their monitoring program, and to complete an individual survey for each program if they worked with more than one monitoring program.)

Summary

The intent of this question was to determine the titles of programs that monitor for AIS in the Lake Michigan basin. Of the 46 total respondents to the survey, nine (19.56%) indicated monitoring program titles which were clearly focused on AIS introduction and spread. This infers that a clear majority of those surveyed, more than 80%, conduct monitoring under the auspices of a program where the central focus does not include an AIS component. Although analysis of this question does not reveal how many of the 80% respondents may actually be monitoring AIS on some level, it could be surmised that a significant number of respondents are doing so, given the response rate of Question 1. In the current times of economic uncertainty, this tells us that many monitoring programs are attempting to get the most "bang for their buck" and are utilizing resources as efficiently as possible to accomplish diverse monitoring goals. Efficient use of existing monitoring programs is essential for maximizing the potential geographical coverage of AIS monitoring and detection.

Question 3

Describe the overall purpose or goal of the monitoring program.

Summary

The intent of this question was to get an overall picture of the purposes or goals of monitoring programs in the Lake Michigan basin. Due to the wide range of responses, it is of value to note the common responses to this question. These include:

- Monitor abundance and population parameters [of various species via different methods]
- Monitor the introduction, spread, range expansion, distribution, and/or abundance [of specific AIS]
- Assess water quality, sometimes by using an indicator species
- Observe/provide for short- and long-term ecological health [of various waterways]

Of note is the second bullet above, "Monitor the introduction, spread, range expansion, distribution, and/or abundance [of specific AIS]." This statement collectively characterizes some of the AIS-specific responses. The survey indicates that ten (22%) of the 46 respondents replied as having an AIS-specific purpose or goal for their monitoring

program. Given the amount of regularly-funded monitoring programs in the Lake Michigan basin (see Question 7), this figure reveals that challenges lie ahead in raising awareness for the importance of AIS early detection and monitoring. Representatives of the Lake Michigan monitoring programs need to be informed of the need to incorporate AIS monitoring as a central purpose or goal. Responses indicating AIS-specific purposes for monitoring programs are shown below.

AIS-specific responses:

- Assess, control, and detect populations of larval sea lampreys in Great Lakes streams
- Monitor the introduction or spread of invasive species in Lake Michigan
- The purpose of this project is to document range expansion, distribution and abundance of Eurasian ruffe and round goby and any response by native species in Lake Michigan and Green Bay.
- Determine the numbers and species of exotic species present in Reservation waters and accurately map where those specimens were collected with global positioning systems (GPS).
- Prevent or delay the spread of ruffe throughout the Great Lakes and inland waters
- Determine the presence of purple loosestrife
- Track the spread of invasive species and document the presence/absence in Wisconsin waters
- Prioritize where control of sea lamprey is needed and evaluate effectiveness of control strategies
- Provide an integrated sea lamprey management program
- Engage lake and stream associations in documenting the introduction of invasive species

Question 4

Please describe the portion of the Lake Michigan watershed in which your program monitors. Provide a narrative description and/or geographical representation of area.

Summary

The intent of this question was to determine the geographic scope of actual and potential AIS monitoring programs in the Lake Michigan watershed. Some of the more common responses included: all watersheds, all of Lake Michigan, southern basin of Lake Michigan, Illinois waters of Lake Michigan, Grand Traverse Bay watershed, and various rivers and creeks which drain into Green Bay. Given these responses, it is fair to say that most, if not all, major watersheds in the Lake Michigan basin are being monitored to some extent. Other responses indicated monitoring efforts are taking place at a wide range of other watersheds throughout the basin, including: the St. Joseph River, Muskegon River, Milwaukee River, west and west-central Michigan, Michigan waters north of Grand Traverse Bay, and western drainages in Wisconsin and the Upper Peninsula of Michigan.

Question 4a

Does your program monitor within any industrial ports?

Response	Frequency	Percent
Yes	18	39%
No	24	52%
Not Sure	1	2%

Summary

The intent of this question was to determine the extent to which monitoring is conducted in major industrial ports in the Lake Michigan basin. Such ports are deemed to be high risk locations for introduction, establishment and spread of AIS species due to the large volume of shipping traffic. Although a slight majority of respondents (52%) indicated they do not monitor within industrial ports, the good news is that nearly 40% do monitor in these high risk areas. These findings suggest that the capacity does exist to build comprehensive AIS monitoring coverage in high risk areas of Lake Michigan industrial ports. For more specific information on port coverage in the Lake Michigan basin, see question 4b below.

Question 4b

If you Answered "Yes" to question 4a, please name the industrial port(s) within which your program conducts monitoring.

Response	Frequency	Percent
Burns Harbor	6	13%
Chicago	2	5%
Green Bay	8	17%
Ludington	6	13%
Menominee	5	11%
Milwaukee	7	15%
Other	13	28%

Other ports: Muskegon (8), Escanaba (3), Port of Indiana (2), Gladstone (2), Sturgeon Bay (2), Calumet River (1), Benton Harbor (1), Manistee (1), Grand Traverse Bay (1)

Summary

The intent of this question was to determine which industrial ports in the Lake Michigan basin are being monitored. Results indicate that all of the major ports are being monitored to some degree. Each port has at least two programs conducting monitoring within them, and as many as eight programs are monitoring in the ports of Green Bay and Muskegon (responses elicited via the "other" category). Upon cross-analysis with Question 1, 100% of the programs conducting monitoring in industrial ports are, to some extent, monitoring for AIS, indicating that industrial ports are getting a good share of attention needed in terms of AIS monitoring. Of survey respondents, two programs are actively monitoring for AIS in industrial ports, eight programs are passively monitoring for AIS, and five programs are conducting both active and passive monitoring.

Question 5
When did the monitoring program begin? (Month/Year)

Summary
The intent of this question was to determine the duration for which Lake Michigan monitoring programs have been in existence. Responses to this question ranged from "1956" to "October 2003". Overall, one monitoring program began in the 1950s, two programs began in the 1960s, five began in the 1970s, 10 began in the 1980s, 10 began in the 1990s, and thus far, nine monitoring programs have begun in the 2000s. It is apparent that several more monitoring programs will be coming online in the coming decade if the current trend continues. These results reveal that the establishment of new monitoring programs have been on the rise for over five decades and indicate the recognized importance of monitoring throughout the Lake Michigan basin. The need for monitoring will continue to grow as prevention and control efforts continue for established AIS populations and as new AIS introductions continue to pose threats to the ecosystem.

Question 6
Is the monitoring program continuous?

Response	Frequency	Percent
Yes	35	76%
No	6	13%
Not Sure	2	4%

Summary
As indicated by the results from Question 5, new monitoring programs continue to be established in the Lake Michigan basin. The intent of this question was to ascertain the extent to which monitoring programs in the basin are maintained on a continual basis. A large majority (76%) of respondents indicated that their monitoring programs are maintained on a continuous basis. These results suggest that, once established, these programs are producing meaningful results, leading to continuation of the monitoring program for successive years. Awareness should be raised among residents and stakeholders in the Lake Michigan basin for the monitoring programs that are being maintained on a long term basis to gather monitoring data and conduct analyses for water quality parameters. It is recommended that the operation of these monitoring programs should be expanded in scope to include an AIS component as feasible.

Question 6a
If you Answered "No" to question 6, when does the monitoring program end? (Month/Year)

Summary
The intent of this question was to find out when monitoring programs with a finite ending date terminate. Only 13% of respondents in Question 6 indicated they did not have a continuous monitoring program. Of these six respondents, four indicated they have seasonal or sporadic monitoring programs on an annual basis, which could imply that

these programs could fit in the "continuous" monitoring category. One respondent indicated their monitoring is dependent upon grant funding and another indicated their program is scheduled to end in 2010. The results of this question, therefore, adds even more weight to the number of continuous monitoring programs in the Lake Michigan basin, and the need to develop the capacity of these existing programs to conduct AIS monitoring.

Question 7

Is funding support for the program long-term and reliable?

Response	Frequency	Percent
Yes	33	72%
No	6	13%
Not Sure	3	7%

Summary

The intent of this question was to determine whether monitoring programs in the Lake Michigan basin are adequately funded on a long-term basis. A large majority of respondents (72%) indicated that funding support for their monitoring program is long-term and reliable. Findings from Questions 6 and 7 suggest that that relatively stable funding is available to support long-term monitoring programs on a continual basis. It follows that the capacity of these programs should be increased to include an AIS component in the currently existing monitoring protocol.

Question 8

How often is information collected? Please select any or all that apply.

Response	Frequency	Percent
Daily	3	7%
Weekly	8	17%
Monthly	7	15%
Semi-annually	8	17%
Annually	12	26%
Other	18	39%

Summary

The intent of this question was to determine the frequency at which monitoring programs collect information in the Lake Michigan basin. Results indicate that monitoring frequency is highly diverse among respondents, with a high of 26% monitoring on an annual basis to a low of 7% monitoring daily. Programs that monitor weekly, monthly and semi-annually were all in the 15-17% range. The category of "Other" elicited the most responses for this question, showing the wide variability in monitoring frequency. Responses in this category included: "as discoveries are made," "as time allows," "depending on the weather," "depends on the site," and "as needed for program

implementation" among others. Many responses in this category included specific timeframes that did not fit neatly within any of the given response choices. Thus, results reveal that there is a need to coordinate related monitoring on a temporal basis in order to make better comparisons and usage of data when using monitoring frequency as a basis of analysis.

Question 9

Is a quality assurance procedure/plan in place (e.g., a U.S. EPA Quality Assurance Project Plan, or QAPP, which requires elements such as performance/measurement criteria for information collected, description and justification of sample design strategy, and equipment calibration)?

Response	Frequency	Percent
Yes	18	39%
No	16	35%
Not Sure	8	17%

Summary

The intent of this question was to determine how many monitoring programs in the Lake Michigan basin have some type of a quality assurance (QA) plan or procedures in place. Although a slight majority (39%) of respondents indicated that they do have such plans in place, an almost equal amount (35%) indicated an absence of QA plans. Interestingly enough, eight respondents (17%) were not sure whether they have a QA plan in place. These results indicate there is a need for communicating the importance of QA plans and procedures, and how they are developed to ensure the validity of monitoring efforts.

Of particular relevance in regards to monitoring is that all work performed or funded by the U.S. EPA involving the acquisition of environmental data must have an approved Quality Assurance Project Plan (QAPP). The QAPP is designed to document the planning, implementation, and assessment procedures for a particular project, as well as any specific quality assurance and quality control activities. It integrates all the technical and quality aspects of the project in order to provide a "blueprint" for obtaining the type and quality of environmental data and information needed for a specific decision or use. A U.S. EPA website, www.epa.gov/quality/qapps.html, provides links to references, training, and other online resources regarding development and implementation of QA plans and procedures.

Question 10

If applicable, what steps do you take to sanitize your equipment when transitioning from sampling in AIS infested waters to sampling in waters that are relatively uninfested?

Common responses

- Pressure washing
- Drying
- Clean with bleach
- Drain all water and remove any visible foreign material

Summary

The intent of this question was to determine the extent to which monitoring equipment is sanitized when changing locations from AIS infested waters to those which are relatively uninfested. About one-third of survey respondents (33%) indicated they conduct some form of sanitizing equipment before moving between water bodies. Common responses included steps such as draining all water and removing any visible foreign material, pressure washing, drying, and cleaning with bleach. Other responses included scheduling sampling in uninfested waters first and infested waters last, conducting open lake sampling only, and cleaning equipment with vinegar.

Many invasive species are spread by attaching to or being carried with boats and equipment used in an infested area and then subsequently used in an uninfested area. On a large scale, this phenomenon is well known in the shipping industry where invasive species are often inadvertently transported from one area to another in the ballast tanks and/or hulls of ships. On a smaller scale, invasive species that become attached to aquatic vegetation are easily transported between areas when the vegetation becomes entangled on boats, trailers and other equipment. Sanitization of these potential AIS vectors is an essential step in the prevention of new introductions and the spread of existing AIS populations, and should be continually stressed in monitoring protocol and through other educational means.

Question 11

To whom is monitoring data reported? Check all that apply.

Response	Frequency	Percent
Federal agency	20	43%
State agency	32	70%
Municipal agency (county, city, etc.)	10	22%
University	10	22%
Private entity	7	15%
General public	21	46%
Other	17	37%

Other: Great Lakes Fishery Commission (6), tribal government/agency (6), program funder (2), Great Lakes Panel on Aquatic Nuisance Species (2), lake association (1)

Summary

The intent of this question was to determine what agencies receive reported monitoring data. Results indicate that a clear majority of monitoring data (70%) is reported to state agencies. This signifies that states are responsible for most monitoring programs in terms of assessment and management action based upon the data they receive. It is likely that states are in the majority since they are required to report water quality data to the U.S. EPA under Section 305(b) of the Clean Water Act.

Results also indicate that reporting of monitoring data to the general public was practiced by nearly half of survey respondents (46%), while reporting to a federal agency was

roughly the same (43%). Although nearly half of the respondents *do* report monitoring data to the general public, an even larger number of respondents *do not* report data to the public. Given the recognized importance of early detections of AIS infestation in a timely manner, it is recommended that monitoring programs are required to report monitoring data to the general public. A fair amount of respondents (22%) report data to universities and municipal agencies, and several report data to the Great Lakes Fishery Commission, tribal governments/agencies, and private entities. A few respondents also report monitoring data to other entities, such as the Great Lake Panel on Aquatic Nuisance Species, program funders, and lake associations. Thus, results indicate the need for a more coordinated, consistent approach to the reporting of AIS monitoring data.

Question 12

What format is used to store the data (e.g., what computer application, hard copy, etc.)?

Response	Frequency	Percent
Computer/digital	41	89%
Hard copy	27	59%
Other	2	4%

Other: field notes (1), none kept (1)

Summary

The intent of this question was to determine the format in which most data is stored and is accessible. An overwhelming majority (89%) of respondents store their data in a computer/digital format which is considered a necessity if data is to be shared and communicated with a greater audience. Standardizing the type of digital format in which data is stored, however, will remain a challenge due to the availability of diverse types of database software on the market. There is a need to move toward a common digital format, at least among federal and state agencies, to facilitate data sharing and the process of accessing data that is more efficient, economic, and less burdensome. More than half of the survey respondents (59%) also reported storing their data in hard copy format. This traditional type of data storage serves well as a backup in the event of damage to computer/digital files. Hard copy is also the only format by which many old databases are kept. From a historical perspective, it is important to retain hard copy files, which are particularly valuable when comparing older monitoring data with today's data the assessment of long-term trends.

Question 13

How long is information stored? (e.g., # of months, years)

Summary

The intent of this question was to determine the duration for which most monitoring information is stored. This is an important factor in determining data accessibility into the future. Responses of "forever," "archived," "permanent," "indefinitely," and similar responses were furnished by well over half (61%) of survey respondents. These results suggest that it is recognized for many monitoring programs the need for cataloging data

on an historic basis. For programs that do not store monitoring information in perpetuity, it is recommended to begin such practices. Archiving monitoring data allows for determining long-term and historic trends, as well as being able to compare current data with historic findings.

Question 14

Select the category(s) that best describes the type of information being collected.

Response	Frequency	Percent
Aquatic Invertebrates	18	39%
Chemical	12	26%
Physical	14	30%
Land use	4	9%
Microbiological	3	7%
Fish	29	63%
Wildlife	0	0%
Aquatic Nuisance Species	15	33%
Vegetation	9	20%
Other	5	11%

Other: phytoplankton (2), zooplankton (1), plankton (1), water quality (1), algae (1)

Summary

The intent of this question was to determine the basic parameters and types of information for which Lake Michigan basin monitoring programs are collecting data. Results reveal that a significant number of programs (63%) are collecting fish-related data. This finding is considered beneficial for collecting AIS monitoring information given that several invasive fish, such as the Asian carp and Eurasian ruffe are species of priority concern. Capitalizing on this finding, it is recommended that fish monitoring programs address the need to incorporate AIS monitoring within their programs. Sampling techniques and equipment used to monitor non-AIS fish species are, in some cases, appropriately designed to sample invasive fish species as well. (See Questions 21b and 22b below for more information about sampling techniques.)

Results from this question also indicated that many respondents (39%) collect information on aquatic invertebrates. As with fish data, this category has close ties with AIS monitoring needs and should be incorporated as a component within the established monitoring protocol.

Nearly one-third of survey respondents (33%) indicated that AIS information is collected in their monitoring programs. This finding suggests that for early detection and monitoring network in the Lake Michigan basin, the capacity exists for an active AIS monitoring program. In noting the high level of established monitoring programs reporting the collection of fish data (63%), consideration should be given to incorporating a specific component for invasive fish Other areas where there are potential linkages with AIS monitoring include those collecting water quality information such as physical (30%) and chemical data (26%), and collection of vegetation data (20%). There were

"other" responses indicating specific collection of phytoplankton, zooplankton, plankton, and algae.

Question 15

For each box checked in question 14, please give a specific description of the information being collected. List all parameters/specific indicators measured by your monitoring program.

Summary

The intent of this question was to gather details regarding specific information being collected by programs conducting monitoring in the Lake Michigan basin. Due to the wide variation in responses, the most common, collective responses are listed below:

- Fish: length, weight, age, sex, maturity, fin clips, coded wire tags, lamprey wounds, health parameters, relative abundance
- Water quality parameters: variety of physical and chemical measurements
- Stream and lake benthic macroinvertebrates and zooplankton
- Vegetation: absence/presence for invasive species (i.e. milfoil), abundance

As noted in the Summary for Question 14, nearly one-third of respondents indicated that their monitoring programs collect some form of AIS data, mostly through "passive detection" protocols. As noted in the summary for Question 14, each of the areas in the bullet-list above have some form of biological relationship to AIS. It is apparent that there is untapped potential for more programs in the Lake Michigan basin to monitor for various AIS parameters. It is recommended that opportunities are explored for these established programs to actively collect AIS data.

Question 16

What aquatic nuisance species have you detected or recorded during your efforts to monitor for other parameters?

Response	Frequency	Percent
Ruffe	3	7%
Alewife	9	20%
Round goby	17	37%
Sea lamprey	7	15%
Common carp	6	13%
Rainbow smelt	3	7%
Three-spine stickleback	3	7%
Rusty crayfish	4	9%
Fishhook waterflea	6	13%
Spiny waterflea	4	9%
Zebra mussel	20	44%
Quagga mussel	4	9%
Purple loosestrife	11	24%
Eurasian milfoil	9	20%

Asiatic clam	1	2%
Grass carp	1	2%
Phragmites spp.	1	2%
White perch	3	7%
Spotted knapweed	1	2%
Echinogammarus spp.	1	2%
Curly-leaf pondweed	2	4%

Summary

The Great Lakes have been subject to the invasion of nonindigenous species since at least the 1800s. As of 2006, there have been more than 180 AIS introductions in the Great Lakes. (source: NOAA Great Lakes Environmental Research Laboratory - www.glerl.noaa.gov). The sea lamprey is one of the earliest known invaders to the Great Lakes, discovered in Lake Ontario in the 1830s (Mills et al., 1993). Several other species such as alewife, common carp, Eurasian water milfoil, curly-leaf pondweed, purple loosestrife, and rainbow smelt have also been established in the Great Lakes for many decades. Other species such as round goby, zebra mussels, and ruffe were only discovered in the Great Lakes during the last twenty years.

The intent of this question was to determine the extent to which monitoring programs in the Lake Michigan basin detect or record AIS while monitoring for other parameters. Results indicate many programs do, in fact, detect and/or record a variety of AIS while conducting other monitoring. Survey respondents (43%) most commonly reported that they either detect and/or record information about zebra mussels. This finding is not surprising given that zebra mussels are one of the most widely spread and best known aquatic invasive species in the Great Lakes. Round goby were reported as being the second most commonly detected and/or recorded AIS by survey respondents (37%). Round goby were first detected in the Great Lakes in 1990 in the St. Clair River and are considered of priority concern because of their rapid spread and adverse ecological impacts. An additional 24% of respondents indicated that they detect or record information about purple loosestrife. Purple loosestrife is a conspicuous species because it inhabits wetlands above water while most other AIS plants grow submerged in water bodies.

Question 16a

How do you record the invasive species you collect? Check all that apply.

Response	Frequency	Percent
Presence/absence	24	52%
Quantity	28	61%
Species Identification	35	76%
Other	6	13%

Other: Anecdotal information (1), total length of each specimen (1), length + weight + photograph (1), spread of the invasive species (1), quantify of fish (1), some aging work completed for invasive fish (1)

Summary

In order to make AIS information collected by monitoring programs as useful and meaningful as possible, it is important that there is commonality in terms of how data is collected and recorded. A simple species-specific sampling protocol is needed to ensure that key information is recorded during the discovery of suspected new AIS species or the finding of already established species.

The intent of this question was to determine *how* monitoring programs record invasive species. Of the 46 total survey respondents, 76% reported that their monitoring program records species identification information on invasive species that the program encounters. This reveals that a large majority of monitoring programs in the Lake Michigan basin hold the capacity to identify aquatic invasive species. Nearly 61% indicated that they record the quantity of invasive species that their program encounters, while 52% indicated that they record presence and absence information. Additionally, 13% of survey respondents indicated that they record "other" information on invasive species that they encounter. The "other" information includes total length of each specimen; length, weight, and a photograph of each specimen; the spread of invasive species; and aging statistics for invasive fish species.

Question 16b

What specific agencies/offices do you contact regarding aquatic nuisance species you may collect and/or record? Check all that apply.

Response	Frequency	Percent
U.S. EPA	4	9%
U.S. Fish & Wildlife	11	24%
State agency (DNR, DEQ, etc.)	34	74%
Municipal agency (county, city, etc.)	5	11%
University	17	37%
Private entity	4	9%
Other	10	22%

Other: lake associations (2), Great Lakes Panel on ANS (2), AIS Task Force (2), Sea Grant office (2), NOAA-GLERL (1), variety of sources (1), Great Lakes Fishery Commission (1), Ruffe Control Committee (1), water utilities (1), power plants (1)

Summary

A clearly defined, effective communication structure will facilitate timely information exchange among the appropriate entities in a monitoring network. To maximize the effectiveness of this structure, it is important to identify those who generate and receive information, how information is exchanged, and the level of urgency for information transfer. For example, upon discovery of an aquatic invasive species, it should be known how to report the discovery and to whom the information should be reported. Once verification of the new invasive species has occurred, that information needs to be passed along to appropriate entities with decision-making authority, facilitating an assessment of

the situation. If a rapid response is deemed appropriate, information needs to be communicated to appropriate stakeholders to engage them in the process. Previous rapid response efforts have determined that designation of a situation-specific public communication officer is a critical key to success of the overall process (Steve Early, Maryland DNR, personal communication, 2003). It is critical that other states, provinces, agencies, media and the public are apprised of the situation and associated activities as appropriate.

The intent of this question was to determine what agencies are most frequently contacted by Lake Michigan monitoring programs as a result of finding AIS species. Survey respondents (74%) most frequently indicated that they contact state agencies (Dept. of Natural Resources, Department of Environmental Quality, etc.) regarding aquatic nuisance species that they collect and/or record. In some cases, the state agencies themselves are conducting the monitoring so it is intuitive that the agency would be informed of AIS findings. Thirty-seven percent of survey respondents indicated that they would contact universities regarding AIS information collected during monitoring initiatives, making it the second most common response. University researchers often have AIS identification expertise and also conduct field research through which they may passively detect AIS. The survey also revealed that the U.S. Fish and Wildlife Service is a fairly regular entity in which to report AIS data that is collected during monitoring activities.

Many survey respondents indicated that they would contact multiple entities. Hence, the wide range of entities to which AIS information is reported is evidence that the need exists for an efficient, effective means of coordinating AIS information reports from monitoring initiatives. It is recommended that a standard reporting protocol coupled with a central reporting mechanism be developed to address this need.

Question 17

If you suspected you found a new aquatic nuisance species in the Lake Michigan basin, what would you do?

Common responses

- Preserve the specimen and contact AIS specialist
- Confirm species identification with experts
- Report to appropriate authorities, agencies, organizations
- File a written report and/or publish in peer-reviewed literature
- Contact one of the entities listed below: (per individual responses to survey)
    - State DNR
    - State DEQ
    - University of Michigan
    - U.S. EPA
    - U.S. FWS
    - Local lake associations
    - Office of the Great Lakes
    - U.S. Geological Survey

- GLIN
- IL Natural History Survey
- Sea Grant
- Great Lakes Fishery Commission
- Great Lakes Commission
- Aquatic Nuisance Species Task Force – Great Lakes Panel on Aquatic Nuisance Species
- MLSA Science Advisory Committee

Other responses: Initiate a press release after confirming identification

Summary
Question 17 is closely related to Question 16. A reporting protocol to ensure timely and accurate transfer of information to the appropriate entities is essential to the discovery of suspected new AIS species. The common actions taken, indicated by survey respondents, are preserving the specimen for identification by an expert, reporting information to appropriate entities (entities determined by individual respondent), and writing a report on the sighting/occurrence. Furthermore, one respondent indicated that they would initiate a press release after confirming the identification of new AIS.

Question 18
If you do not record aquatic nuisance species found during your routine monitoring efforts, what is the main obstacle or reasons for this? Please check all that apply.

Response	Frequency	Percent
Unable to identify	2	4%
Cost prohibitive	1	2%
Not within scope	4	9%
Lack expertise/training	3	7%
Not interested in AIS	0	0%
Too labor intensive	0	0%
Other	1	2%

Summary
The intent of this question was to determine what barriers may exist which prohibit monitoring entities from recording AIS detections during their normal monitoring activities. The majority of respondents to the survey indicated that they do indeed record information regarding AIS that they encounter during their routine monitoring efforts. (See Question 16 above.) Of those monitoring programs that do not record AIS information, four indicated that they do not do so because it is not within the scope of their initiative. Three others indicated that they lack the expertise or training needed to effectively record AIS information. Surprisingly, only one survey respondent indicated cost as the prohibitive factor for documenting AIS information during routine monitoring efforts.

Monitoring programs which do not record AIS information because it is not within their scope are not likely to do so in the future. Some monitoring initiatives have tight restrictions on authorized work. Monitoring programs which indicated that they lack expertise, training, or are unable to identify AIS may be able to participate in future AIS monitoring if some simple training and/or education is made available.

Question 19

Would you/your monitoring program be willing to consider participation in a coordinated, regional AIS early detection and monitoring network which includes regular reporting protocols (e.g., quarterly, online submittal)?

Response	Frequency	Percent
Yes	22	48%
No	8	17%
Not sure	12	26%
Only if training is available	2	4%

Summary

This question is an attempt to estimate the level of participation and/or interest in a possible regional AIS detection and monitoring network. The majority of respondents (48%) indicated that they would be willing to consider participation in a coordinated, regional AIS early detection and monitoring network which includes regular reporting protocols. A smaller percentage of respondents (17 %) indicated that they would not be willing to participate while 26% indicated that they were not sure. An additional 4% of respondents said they would consider participation if training was available.

There are likely many reasons that some respondents indicated they were not sure if they would participate in a monitoring network. Their participation could be dependent upon cost, specific details and requirements for reporting, time/effort requirements, among several other possible reasons. The development of any AIS monitoring network will need to take these reasons into careful consideration to make participation as easy, cost effective, and convenient as possible.

Question 20

What considerations do you think should be taken into account during the development of a coordinated system to monitor for new introductions and invasions and track the spread of existing populations of aquatic nuisance species in the Lake Michigan basin?

Common responses

- Monitoring must not be too time intensive
- Establish consistent protocols
- Provide training on protocols, species identification, etc.
- Target high risk and high probability areas
- Provide stable funding to compensate for costs
- Provide practical and reliable methods

- Ability to assess abundance of all life stages

Other responses

- Establish protocols based on objectives: monitor, detect, track spread, estimate abundance
- Training for groups or organizations who need it, communication of results and issues, allow for different degrees of involvement
- Independent resources for species verification
- Description of quality assurance involved

Summary

This question gave survey respondents the opportunity to provide open-ended ideas and input regarding the development of a coordinated AIS early detection and monitoring program for Lake Michigan as summarized above. The responses indicate that the development of a coordinated monitoring network should not involve a significant investment of time.. Findings also suggest that time and resources not directly related to primary monitoring objectives is limited since the vast majority of monitoring programs in the Lake Michigan basin with the capability to detect new invasions of AIS are not doing so., Consistent protocols are needed to facilitate collection of AIS data that is useful and compatible among the diverse monitoring programs operating in the basin. It is also suggested that these protocols are easily integrated into existing monitoring programs. Training needed should be minimal and provided at little or no cost and should include essential elements such as species identification. When possible, funding to cover the costs of training should be provided.

Many respondents indicated that it is important that a coordinated AIS monitoring network targets high risk and high probability areas. As defined by the project advisory team, high risk areas are pristine aquatic ecosystems vulnerable to harmful impacts caused by AIS introduction and spread. Such areas may be similar to marine protected areas and could include, but are not limited to, national shorelines and state and national park areas. High probability areas are defined as those areas located where there is a high probability of AIS introduction and spread. Delineation of such areas may be based on popularity among boaters and anglers such as shorelines and also where shipping is active such as ports and harbors.

The findings here signify the importance of recognizing that high risk and high probability areas should be the primary focus of a coordinated AIS monitoring network. to ensure an efficient, time-sensitive, cost-effective program. This approach would also help direct resources to those high priority areas where new AIS introductions are likely and/or existing species might be found. See Question 24 below for further information on AIS monitoring in high risk and high probability areas.

It is important to note that there were two parts to this survey. Part A (questions 1-20) requested basic background information and a detailed description of monitoring programs. All survey recipients were asked to complete Part A. Part B (questions 21-25) was only to be completed by those survey recipients who responded as having an

"active" AIS monitoring/detection program. Active detection is defined as efforts which have specific responsibility to detect and monitor AIS. This is also known as "dedicated surveillance".

Question 21

Is your program designed to monitor for new introductions or invasions of aquatic nuisance species?

Response	Frequency	Percent
Yes	13	28%
No	4	9%
Not sure	1	2%

Summary

This question was designed to determine which monitoring programs actively monitor for new introductions of invasive species as opposed to existing populations. A total of 18 (39% of the 46 total) survey recipients responded to question 21. Of the 46 total survey respondents, 28% responded that their program is designed to monitor for new introductions or invasions of AIS, while 9% responded that their program is not designed for this purpose. One respondent was not sure. In addition to the 9% who indicated that their program was not designed to monitor for new introductions, the remaining 28 respondents (61%) who did not complete Part B of the survey can also safely be added to the 9% who indicated that their program was not designed to monitor for new introductions. This reveals that a total of 70% of survey respondents do not actively monitor for new introductions of AIS in the Lake Michigan basin.

Question 21a

If you answered "Yes" to question 21, what new introductions or invasions of aquatic nuisance species does your program actively monitor for in the Lake Michigan basin?

Responses

- Sea lamprey
- Zooplankton, benthic invertebrates and forage fish
- Zooplankton and phytoplankton
- Carp, white perch, gizzard shad, alewife, other non-native fish species
- Aquatic plants
- Plankton and fish species
- Primarily bottom fish capable of being captured in a bottom trawl
- Eurasian water milfoil
- Zebra mussels, quagga mussels, *Echinogammarus spp.*
- Any fish or aquatic invertebrate vulnerable to a bottom trawl
- Fish and stream invertebrates
- Fish species

Summary
There is a wide variety of aquatic invasive species that are being monitored in the Great Lakes. Several survey respondents reported that their program is capable of detecting and monitoring for a variety of different species. This is because some sampling equipment – such as plankton nets, trawling gear, and an array of other nets – are non-species specific, allowing for open-ended collection of species. It was found that several of the monitoring programs that monitor for new AIS introductions specifically assess ecological and species composition changes.

Question 21b
If you answered "Yes" to question 21, what specific technique(s) does your program utilize to monitor for new introductions or invasions of aquatic nuisance species?

Response	Frequency	Percent
Trawling	4	9%
Plankton nets	2	4%
Electrofishing	3	7%
Water samples	4	9%
Tagging	0	0%
Other	9	20%

Other: visual observation (3), fyke nets (2), Ponar dredge (1), traps (1), benthic grab (1), gill nets (1)

Summary
The most commonly reported sampling technique by survey respondents was trawling (9%) and various water sampling methods (9%). Trawling is a common means of sampling and collecting fish while water sampling techniques may be used to collect specimens of zooplankton and phytoplankton. Electrofishing and visual observations also accounted for 7% of survey responses, respectively. Plankton nets, fyke nets, Ponar dredges, traps, benthic grabs, and gill nets were also reported as sampling techniques, though in low numbers.

Question 22
Is your program designed to monitor existing populations of aquatic nuisance species?

Response	Frequency	Percent
Yes	16	35%
No	2	4%
Not sure	0	0%

Summary
This question was designed to determine which monitoring programs surveyed actively monitor existing AIS populations. A little more than one-third (35%) of survey respondents indicated that their monitoring programs are designed to monitor existing populations of AIS. While only two survey respondents indicated that their program does

not monitor existing AIS populations, it can be inferred that the additional 28 respondents (61%) who did not complete Part B of the survey also represent programs that do not actively monitor existing populations of AIS. By not completing Part B of the survey, respondents were, in essence, indicating that their programs do not conduct any active AIS monitoring or detection.

Question 22a

If you Answered "Yes" to question 22, what existing populations of aquatic nuisance species does your program actively monitor for in the Lake Michigan basin?

Response	Frequency	Percent
Zebra mussels	6	13%
Round goby	5	11%
Eurasian ruffe	5	11%
Eurasian water milfoil	5	11%
Purple loosestrife	4	9%
Spiny waterflea	3	7%
Sea Lamprey	3	7%
Fishhook waterflea	3	7%
Asian carp	1	2%
Other	6	13%

Other: Any species susceptible to program specific gear (2), carp (1), non-native fish (1), quagga mussel (1), *Echinogammarus spp.* (1)

Summary

Survey respondents most commonly (13%) indicated that their programs actively monitor for existing populations of zebra mussels. Round goby, Eurasian ruffe, and Eurasian water milfoil were the next most common responses, each representing 11% of survey respondents.

Question 22b

If you answered "Yes" to question 22, what specific technique(s) does your program utilize to monitor existing populations of aquatic nuisance species?

Response	Frequency	Percent
Trawling	7	15%
Plankton nets	3	7%
Electrofishing	5	11%
Water samples	3	7%
Tagging	1	2%
Other	13	28%

Other: visual observations (3), fyke nets (3), traps (2), gill nets (2), van Dorn water sampler (1), benthic grab (1), lampricides (1)

Summary
Question 22b examines what sampling methods are used to actively collect data on existing AIS populations. The most common method reported was trawling (15%). In contrast to Question 21b, electrofishing was the second most common method reported, with 11% of the responses. A variety of additional methods were also noted.

Question 23
Is your program designed to predict new introductions or invasions of aquatic nuisance species?

Response	Frequency	Percent
Yes	0	0%
No	17	37%
Not sure	1	2%

Summary
None of the survey respondents indicated that the prediction of new AIS introduction or invasions was part of their monitoring protocol. A predictive approach to AIS invasions is still in its infancy, which may help explain why none of the survey respondents who actively conduct AIS monitoring reported using prediction tools. A significant challenge posed by establishing an AIS early detection and monitoring program is how to design a sampling protocol for organisms that do not currently exist and/or have not yet been discovered in the system. To meet this challenge, the monitoring protocol will need to develop a methodology for the unknown.

As researchers continue to develop prediction models and learn more about invasion histories of AIS, prediction may become a more useful tool for detecting and monitoring new AIS introductions. Research thus far on a predictive approach has focused on developing a protocol based on common characteristics and life histories that have been identified for successful invaders. AIS prediction tools developed by Kolar and Lodge (2002) involve a risk assessment tool and statistical models of fish introductions into the Great Lakes. Their research is focused on developing a quantitative approach by which to target prevention efforts on species most likely to cause damage based on invasion history. Through this method, fish that pose a high risk to the Great Lakes, if introduced, are identified. Related research has used a macrophyte monitoring tool to predict the likelihood of Eurasian water milfoil presence in inland lakes (Buchan and Padilla, 2000). The application of this method to the Great Lakes is unknown.

Question 23a
If you answered "Yes" to question 23, what new introductions or invasions of aquatic nuisance species does your program actively initiate predictions for in the Lake Michigan basin?
Responses: There were no affirmative responses to Question 23a.

Summary
The absence of affirmative responses to this question indicates that the monitoring programs that were targeted in this survey are not designed to predict new introductions or invasions of aquatic nuisance species. Current research is being done to model which Ponto-Caspian species may be most able to adapt to conditions in the Great Lakes. Shipping routes are also being assessed to determine likely vectors for introduction. The results from these studies will provide valuable information for developing the predictive tools needed for more effective AIS early detection and monitoring system in the Lake Michigan basin.

Question 23b
If you Answered "Yes" to question 23, what specific technique(s) does your program utilize to predict new introductions or invasions of aquatic nuisance species?
Responses: There were no affirmative responses to question 23b.

Summary
None of the survey respondents indicated that their respective programs are designed to predict new introductions or invasions of aquatic nuisance species. Therefore, there were no responses to question 23b.

Question 24
Which of the following does your program routinely monitor? Check all that apply.

Response	Frequency	Percent
Locations at high risk for AIS introductions	8	17%
High value natural resources (e.g., high quality habitat areas)	7	15%
Pathways for AIS introductions	2	4%
Species of concern	8	17%
None of the above	2	4%

Summary
This question attempts to determine where established active AIS monitoring programs focus their efforts. This question is based on the need to use limited monitoring resources as efficiently as possible given the large-scale geographic scope of the Lake Michigan basin where comprehensive monitoring coverage is not feasible. Survey respondents most commonly (17%) indicated that their monitoring programs focus on high risk locations for AIS introductions and specific species of concern. Locations at high risk for AIS introduction may include ports and shorelines where high levels of shipping activity and/or recreational fishing is known to occur. Other areas may include locations near other known sources of AIS introduction. High value natural resources, such as high quality habitat areas, were the next most frequently reported response (15%) of active

monitoring programs. Only 4% of survey respondents indicated that they actively monitor pathways for AIS introductions. An example of pathway monitoring is periodic sampling of ballast water from ships.

Question 25

Please provide any other relevant information that you think would contribute to a more complete understanding of your monitoring efforts as they may relate to AIS early detection and monitoring.

Summary

This question sought to gather any additional information from survey respondents that could contribute to a more complete understanding of their program's monitoring efforts as they may relate to AIS. Responses to this question varied widely; many contained situation-specific and/or site-specific information, making it difficult to provide a concise summary. Some of the more notable responses are listed below. Others are available by request. Please contact John Hummer (jhummer@glc.org) or Kathe Glassner-Shwayder (shwayder@glc.org) for further information.

- Our extensive network for sea lampreys provides opportunity to detect the unknown creature incidental to collections for sea lampreys. Our guidance to field staff is to save (preserve) any aquatic organism that appears strange, out of place, or unknown to the collection for later verification.

- During the first year of the program, exotic fish species locations were mapped using GPS. and exotic species collected were photographed, measured, weighed and released. Smaller exotics were simply identified, counted and released. One specimen, a white perch, was preserved and later its identification verified. Other exotics, such as *Orconectes rusticus*, are noted on field sheets and released.

- It would be useful to have access to information from surrounding states on new introductions or new findings of aquatic plants. Hydrilla is a good example. Michigan would like to know when it gets to OH, IN, or WI.

- Our program searches for ruffe in locations where they are most likely to expand. That objective may or may not lend itself to a fixed index monitoring system. Some stations utilize a fixed index system in order to monitor for other parameters, as well as monitor range expansion. Objectives of monitoring need to be well defined in plan.

- Monitoring efforts are integrally tied to a research program. For instance, the monitoring program detected the decline of the benthic amphipod Diporeia. Research efforts are now underway to determine the exact reason for the decline. Sampling does not occur in shallow areas (< 15m) or in hard substrate areas (rocky shoals, reefs).

- The Lake Michigan prey fish survey serves two important functions in monitoring aquatic nuisance species vulnerable to the bottom trawl: (1) the prey fish survey is useful in documenting both the spread and increases in abundance of newly-arrived aquatic nuisance species throughout the main basin of Lake Michigan, and (2) the prey fish survey is needed to assess the effects of the invader on the prey fish community in the main basin of Lake Michigan. Through long-term research, it may be possible to identify the effects of an invasion on the fish community.

- We consider other exotics such as Gypsy Moths, Oak Wilt, Ash Bore, etc. to be "aquatic nuisances" since their impact on a shoreline or streambank can have a devastating effect on the nature of a waterbody, its fishery, and its bio-chemistry.

Recommendations

One of the primary goals of this project was to provide recommendations for developing an AIS early detection and monitoring network in the Lake Michigan basin. The following recommendations were developed from a number of sources: analysis of survey results, discussions from the project workshop, comments submitted by individual project advisory team members, as well as a literature review conducted as preliminary research to support project development. A survey question number follows each draft recommendation that was developed as a result of survey responses.

1. ***Maximize capacity and geographic scope of AIS early detection and monitoring in the Lake Michigan basin and beyond by establishing an AIS Early Detection Monitoring Network.***
   Currently, there are many monitoring programs in the Lake Michigan basin that are not monitoring for aquatic nuisance species, either actively or passively. Some of these programs may have the potential and/or capability to detect new AIS introductions and monitor existing populations in the basin. Monitoring programs with the greatest scope and interest in AIS detection should be thoroughly assessed and a system established for training personnel within the programs to detect, identify and report any invasions. A single agency or collaborative entity should be designated with the responsibility to centralize these activities and establish monitoring standards. This network could first be established as a pilot effort in the Lake Michigan basin before expanding throughout the Great Lakes basin. .Efficient use of established monitoring programs is essential for maximizing the potential geographical coverage of AIS monitoring and detection. ***(Questions 1 and 2)***

2. ***Early detection and monitoring of AIS must become integrated with or become a primary goal of more monitoring programs to aide in the effective prevention and control of AIS populations that continue to grow in the Great Lakes region.***
   A margin of slightly more than 20% of survey respondents listed AIS monitoring as a central purpose or goal of their monitoring program. Given the risk of new AIS introductions in the Lake Michigan basin in the near and long-term future, more monitoring programs should assume roles of dedicated AIS detection and monitoring. The need for monitoring will continue to grow as the battle continues to control established AIS populations and prevent new introductions from becoming threats to the ecosystem. ***(Question 3, 5, 6, 6a)***

3. ***Address and eliminate barriers that inhibit programs' abilities to collect and record AIS data while their primary monitoring functions are carried out.***
   Reasons as to why more monitoring programs are not actively attempting to collect AIS data must be further investigated and barriers must be addressed. More programs in the Lake Michigan basin have the potential to monitor for various AIS parameters than are actually conducting such monitoring. Some of the barriers to actively participating in AIS monitoring are related to funding and staffing issues while others may stem from lack of awareness of the ecological and economic risks associated AIS invasions. An education program needs to be established to fully inform

monitoring managers about the importance of early detection of new AIS invasions and provide them with simple methods to adapt their programs to identify and report detections in the course of their regular monitoring. Such a program needs to account for and address the most common barriers to participation in early detection monitoring. ***(Question 18)***

4. Training and education for early detection and monitoring of AIS must be made more readily available to monitoring programs.

Simple training and/or education on AIS identification, sampling and reporting should be made more widely available. Training programs need to ensure filters (how and to whom data is reported) are in place for accuracy in identification and reporting of AIS infestations. A web-based delivery model would likely be most effective as the targets for training are widely distributed and would be unlikely to travel for non-priority training. There are several monitoring programs in the basin that could participate in an AIS monitoring network if given proper instruction. State-administered water quality monitoring programs, such as the Michigan Clean Water Corps, and the states' Sea Grant networks, are viable mechanisms through which to conduct such training and education targeted toward volunteer monitoring entities, with joint support from U.S. EPA**. (*Question 18/Workshop*)**

5. Participation in an AIS monitoring network must be made as time efficient and cost effective as possible.

The development of an AIS monitoring network will need to carefully consider many issues to make participation as easy, cost effective, and convenient as possible. These issues include indirect costs to programs not specifically dedicated to AIS monitoring, standards for monitoring and reporting, and overall time and effort requirements to participate in such a network. Participation in a coordinated monitoring network must not be too time intensive on the part of field monitors. Programs which do not have a directive to monitor for AIS have very little, if any, extra time to share. Therefore, network design – including communication, data collection, quality assurance/quality control, a central reporting mechanism, and other considerations – should include specific instructions and targeted short-term training for participants to achieve maximum efficiency for their efforts and input to the network. **(*Questions 19 and 20*)**

6. AIS early detection and monitoring efforts must be adequately funded on a long term basis.

Financial support for AIS early detection and monitoring must be made more readily available and integrated into existing monitoring programs. New funding will be needed to establish the early detection network, and a much smaller amount will be needed for ongoing operation of network activities. Modest additional funding could be provided to the programs that will conduct the actual monitoring. Over 70% of survey respondents indicated their financial support for monitoring was long-term and reliable. More funding should be utilized and/or made available to allow an increasing number of programs to include AIS parameters in their monitoring protocol, especially since a majority of these programs operate on a long-term continuous basis. **(*Questions 6 and 7*)**

For further information on Great Lakes region funding opportunities, the following two web sites serve as good starting points:

GLIN - Funding and Grant Sources in the Great Lakes Region – http://www.great-lakes.net/infocenter/news/funding.html. This Great Lakes Information Network (GLIN) link streamlines the process of searching for Great Lakes-related funding opportunities online.

Great Lakes Program Funding - http://www.epa.gov/glnpo/fund/. This U.S. EPA-GLNPO web page lists a variety of Great Lakes funding sources and links.

7. As part of an AIS Early Detection Monitoring Network, standards will need to be established for AIS data collection and reporting.

Steps must be taken to make AIS information collected by monitoring programs as accurate, useful and consistent as possible. A basic sampling protocol is needed to ensure that key information is recorded during the discovery of suspected new AIS introductions or the spread of established AIS populations (e.g., a hand-held sampler for zebra mussel collection capable of making qualitative and semi-quantitative assessment of zebra mussels). Guides to help with proper identification should be developed, and a protocol to allow for expert confirmation will also be needed. The planned (or intended) use of the data should drive data collection in terms of what data is collected and how. The data collection regime should be augmented with a common reporting protocol. It should be recognized that implementing standard protocols may be difficult due to competing established protocols that may conflict with network standards. It is recommended at this early stage, that existing protocols be utilized and adapted into standardized protocols over time. **(*Question 16a & 17*)**

8. Resources for an early detection and monitoring network should be directed toward high risk and high probability areas for AIS invasions.

High risk and high probability areas should be primary targets of a coordinated AIS monitoring network. *High risk areas* are considered to be high quality habitat where there is an elevated risk of being impacted by new AIS introductions. These areas may be similar to marine protected areas and could include, but are not limited to, national shorelines and state and national park areas. *High probability areas* are those areas where there is an elevated probability of the occurrence of new AIS introductions such as ports, harbors and shoreline areas. Focusing on high risk and high probability areas is one approach by which to ensure an efficient, time-sensitive, cost-effective AIS early detection and monitoring program. This process of prioritizing would also help to direct resources to those areas where it is more likely that new introductions of AIS and/or existing species might be found. **(*Question 20*)**

9. Program leaders conducting early detection and monitoring should become knowledgeable of and focus on known existing pathways and likely new pathways of AIS introductions.

Monitoring known existing pathways of AIS introduction (i.e. ballast water from ships) along with likely new pathways should be a high priority in prevention and control activities. The pathways of introduction of invasive species, according to the

Invasive Species Advisory Committee - Pathways Task Team, fall into three broad categories: 1) Transportation-related pathways; 2) "Living" industry pathways; and 3) Miscellaneous pathways. For a complete listing and description of the pathways identified, visit http://www.invasivespeciesinfo.gov/toolkit/pathways.shtml. ***(Question 24)***

10. Programs that monitor fish populations or other parameters, such as water quality, should – to the extent possible – incorporate AIS early detection and monitoring protocols.

Fish monitoring programs, in particular, should incorporate AIS early detection and monitoring within their sampling protocol given the findings that more than 63% of survey respondents indicated they sample for fish. Sampling techniques and equipment used to monitor native fish species are, in some cases, well suited (or easily adapted) to sample AIS fish species as well. Programs that monitor other parameters, such as ambient water quality or habitat type should also, to the extent possible, incorporate AIS monitoring within their normal protocol. The early detection network should examine each of these types of programs and design detection protocols that complement existing protocols. ***(Question 14)***

11. Predictive tools and/or models should be further developed and utilized to the greatest extent possible for detection of new AIS infestations.

As researchers continue to develop predictive tools, such as computer modeling, and learn more about AIS invasion histories, prediction of potential invaders may become an important tool for AIS detection and monitoring. It is recommended that research continue in the area of prediction of potential AIS invasions. Notably, the identification and risk assessment of potential aquatic invaders could provide valuable criteria for the allocation of resources supporting detection and monitoring efforts critical for effective management of AIS invasion threats (Ricciardi and Rasmussen, 1998). ***(Question 23 & 23a)***

12. Reporting on trends and impacts of AIS should be carried out as part of an AIS early detection monitoring network.

Two types of reporting related to AIS should be implemented: 1) Trend reporting (identifying patterns of invasive and potential invasive species on multiple temporal and spatial scales as compatible and appropriate to the bioregion.) and 2) impact analysis of AIS invasions. Monitoring and recording of AIS trends will provide a long-term tool to assess the effectiveness of policy and management actions in combating AIS invasions. Reporting on ecological and economic impacts of AIS will provide scientific data and evidence on the effects of AIS invasions, with a secondary goal to raise public and political awareness of AIS problems and the need for public funds to address these problems. ***(Workshop)***

13. AIS reporting must be coordinated through a centralized data repository and information clearinghouse.

The need exists for an efficient, effective means of coordinating AIS reporting from the wide array of monitoring programs in operation. Standard reporting protocols coupled with a central reporting entity are recommended to address this need.

Standard reporting protocols should include reporting procedures regarding discovery of AIS species, such as where AIS discoveries are reported, circumstances when reporting occurs, and authoritative taxonomic identification and verification of species upon which reporting is based. A lead organization should be identified to assume the role of coordinating a centralized data repository and information clearinghouse. Information should then be distributed in a systematic way to all stakeholders as guided by a pre-planned communication network. Political/jurisdictional issues need to be carefully addressed. **(*Question 16b*)**

14. AIS early detection and monitoring data must be reported in a coordinated, consistent manner.

Given the wide range of agencies where monitoring data is reported, there is a critical need for the development of a coordinated, consistent approach to the reporting of AIS monitoring data, States should be kept well-informed of AIS early detection and monitoring data due to the capacity and authority held by state agencies to respond to the detection of AIS invasions within a rapid response framework.

It was noted in the survey that more than half of respondents indicated that results are not reported to the general public. It is recommended that the public be kept well-informed of new AIS introductions and the spread of existing AIS populations. This can be accomplished by GIS-based web applications, a relatively new and innovative tool that is being used to track AIS introductions and the spread of established AIS populations. The Great Lakes Commission has developed a model GIS mapping tool to track AIS populations of priority concern in Michigan that is available online at www.glc.org/ans/initiatives.html#gis. ***(Question 11)***

15. Data sharing and accessibility must be a key component of an AIS early detection and monitoring network.

Early detection and monitoring programs – in particular those coordinated by federal and state agencies -- should move toward a common digital format to make the data sharing and accessibility process more efficient, cost effective, and less burdensome. For example, agencies should agree to use the same data entry fields and coding methods. The implication of data sharing should also be carefully considered to ensure compatibility with all of the programs involved. Consistent data definitions and inter-operable formats are essential so that summary statistics and analyses are readily available to support risk assessments. Data needs to be shared among researchers and managers. Funders should reinforce the need for sharing of data through their grant application guidelines. This is particularly important for accessing and analyzing data from academia and nongovernmental organizations. An online database incorporating data into a GIS format may be one approach by which to share data. In many cases, there may be political sensitivities and privacy issues to consider. The simpler the data is the more easily it can be shared, collected and reported. It is also recommended that detection and monitoring programs should retain hard copies of historic data. ***(Question 12)***

16. Participants in an early detection and monitoring network should archive monitoring data as well as establish pre-invasion baseline data.

Monitoring programs, including an early detection network repository, should store monitoring information in perpetuity. Archiving monitoring data allows for determining long-term and historic trends, as well as being able to compare current data with historic findings. Establishing pre-invasion baseline data is needed in determining impacts from new invasions and may also facilitate "syndromic detection" of new invasions. Detection of AIS invasion symptoms ("syndromic detection") such as changes in population structure of native species, habitat, etc. may be an alternative or additional approach for detecting new invasions. It is important to note that pre-invasion baseline data will most likely be needed for syndromic detection. ***(Question 13)***

17. Quality assurance plans and procedures must be become an integral part of any AIS early detection and monitoring program.

The importance of quality assurance (QA) plans and procedures, and how they are developed, should be conveyed to those responsible for relevant monitoring programs. Over half of all survey respondents either did not have QA plans and procedures in place, or were not sure if they did. All work performed or funded by the U.S. EPA that involves the acquisition of environmental data must have an approved Quality Assurance Project Plan (QAPP). A QAPP documents the planning, implementation, and assessment procedures for a particular project, as well as any specific quality assurance and quality control activities. A single QAPP or quality management plan (QMP) could be developed by the early detection network. ***(Question 9)***

18. Sanitization of monitoring equipment must be stressed and implemented on an ongoing basis.

Sanitization of monitoring equipment is an essential step in the prevention of new AIS introductions and the spread of established AIS populations. Sanitation procedures should be continually stressed in monitoring protocol and through other educational means. Many invasive species are spread by their attachment to the hulls of boats, bilge water or are transported on boating equipment used in an infested area and then subsequently transferred to an uninfested area. ***(Question 10)***

19. Both spatial and temporal coordination is needed within an AIS early detection and monitoring network.

Early detection and monitoring for AIS should be coordinated on both a spatial and temporal basis. Survey results revealed that monitoring frequency and coverage was highly diverse among respondents. Targeted areas for early detection and monitoring should be coordinated and defined by watershed boundaries, or when appropriate, by identifying high risk and high probability areas such as marine protected areas, national shorelines and industrial ports. These targeted areas need to be monitored on a regular basis to ensure that they remain clear of new ANS. ***(Question 8)***

20. Coordination with regional and national initiatives is essential to establish broader data sharing, reporting and outreach efforts.

Coordination with initiatives such as the Great Lakes Observing System (GLOS) will further enhance data sharing, reporting and outreach efforts. GLOS is an integrated

observing system being developed to provide critical real-time data for multiple users and is a regional node of NOAA's national Integrated Ocean Observing System (IOOS). GLOS will also be linked to the National Ecological Observatory Network (NEON), which supports research on populations, species, communities and ecosystems. These systems, when in place, should be considered as potential vehicles to both receive data and disseminate information. ***(Workshop)***

21. Existing regional and national resources should be applied to their fullest extent when developing an early detection and monitoring network for the Lake Michigan basin.

A regionally-based early detection and monitoring network should build on an existing framework of monitoring coordination and invasive species management. It is recommended that this network be integrated as part of the development of a rapid response plan for the Great Lakes region. A coordinated early detection/rapid response network could potentially be modeled after a system designed by the National Invasive Species Council, which provides a blueprint for coordinated action on invasive species. (See www.invasivespeciesinfo.gov/council/actionc.shtml.) Further, the existing framework of monitoring coordination provided by the Lake Michigan Monitoring Coordination Council and the regional coordinative support for AIS management provided by the Great Lakes Panel on Aquatic Nuisance Species serve as foundations upon which to build such a network for the Lake Michigan basin. ***(Workshop)***

Concluding Summary

The establishment of a long term, extensive detection and monitoring network is recognized as a fundamental component for effective AIS prevention and control in the Great Lakes region (Great Lakes Commission 2000). Discovery of AIS invasions in a relatively "early" timeframe is critical in facilitating management efforts that are technically and economically feasible. The Great Lakes Commission offers this summary of project findings and recommendations as guidance to identify priorities and establish a framework for a coordinated system to detect new AIS introductions and track the spread of established populations in the Lake Michigan basin as a pilot for a comprehensive Great Lakes program.

A primary theme that emerged repeatedly throughout the conduct of this project is the prospect of using established water quality monitoring programs to maximize the potential geographic scope of AIS monitoring and detection. It is recommended that this prospect be further explored by assessing each of the established monitoring programs in the Lake Michigan basin to determine their capacity to formally integrate an AIS component. This concept is rational from a funding perspective since more than 70 percent of survey respondents have indicated that financial support for those established monitoring programs was long term and reliable.

To advance efforts to incorporate an AIS component as part of established monitoring programs, barriers to implementation must be addressed For instance, concern was expressed that the primary purpose of these programs (e.g., native fish surveys) could be compromised by adding an unfunded workload associated with the integration of an AIS component. Another issue raised is the need assess whether established monitoring programs truly hold the capability to detect new AIS introductions in an "early" timeframe. There is concern that in areas where programs are not dedicated solely to AIS monitoring, AIS populations will become well established before discovery, thus missing the window of opportunity for effective management. Given this projected scenario, consideration should also be given to establishing dedicated (active) monitoring programs for the detection of new aquatic invasive species, particularly for those species considered of high ecological and/or economic risk. The design of this monitoring program should encompass all categories of plant and animal species, targeting high risk entry points such as industrial ports and recreational boat landings. Long term funding is needed for dedicated AIS monitoring programs to provide baseline data upon which to maintain ongoing analysis of AIS invasions.

Another significant lesson recognized during this project, given current funding constraints, is the pressing need to direct limited monitoring resources toward high risk and high probability areas as associated with AIS invasions. This process of prioritizing is necessary to direct funds to those areas where the risks are the greatest and/or where AIS invasions are more likely to occur. In high risk areas, the costs are far greater if AIS invasion occurs, given the threat to biodiversity and high quality aquatic habitat. In high probability areas, the benefits reaped from AIS monitoring efforts are likely to be greater since AIS vectors are more active in areas such as ports and shorelines. The first step in establishing high priority monitoring programs is identifying areas of high quality habitat

and determining priority pathways of AIS introduction (e.g. ballast water, organisms and trade, canals and waterways) and spread (e.g., transport from the Great Lakes to inland waters by recreational boating). It is also recommended that there is an emphasis on public awareness to demonstrate the need to establish AIS monitoring programs, particularly in areas of high risk and high probability.

The importance of institutionalizing AIS detection and monitoring programming was a significant recommendation that evolved from the project workshop (Muskegon, June 2004). It was recognized during this workshop that the Lake Michigan Lakewide Management Plan (LaMP) could serve as a useful forum by which to integrate a dedicated AIS detection and monitoring protocol. Formal integration of AIS detection and monitoring into an established management plan could lead to implementation and funding opportunities. Notably, the LaMP of 2000 recognized that AIS invasions have caused irreparable harm to the ecosystem of Lake Michigan. The prevention of unintentional AIS introductions in the Lake Michigan basin as well as throughout the Great Lakes have been identified in the LaMP as a priority action. The LaMP also recognizes the need for AIS prevention and control as stated Subgoal 4: "All habitats are healthy, naturally diverse, and sufficient to sustain viable biological communities" (Lake Michigan LaMP 2002). One of the goals and challenges listed in Lake Michigan LaMP 2002 is "to eliminate further AIS introductions by 2010." The Lake Michigan LaMP 2004 outlined next steps for the region by which to advance AIS prevention and control in the Great Lakes ecosystem, including continue work "to educate people in the basin about the importance of preventing the AIS introduction and spread." Public accessibility to detection and monitoring data has been noted as fundamental component of an AIS outreach program. The recommendations offered in this report on AIS detection and monitoring will help in developing a framework by which to address these challenges.

The Clean Water Act (CWA), established under the authority of the U.S. EPA, was identified as another opportunity during the project workshop to institutionalize AIS detection and monitoring. As mentioned previously, consideration should be given to integration of an AIS component as part of established water quality monitoring programs, in this case those funded under the CWA. Support for this option should be strong given the growing concern among the states sharing Lake Michigan's resources, (Illinois, Indiana, Michigan and Wisconsin) of the costly impacts caused by AIS invasions to recreation, industry, tourism and lifestyles in the Lake Michigan basin. The states, collectively carry the burden of controlling established AIS populations in Lake Michigan, and have expressed a common interest in investing time and resources to support the prevention of further introductions. It is widely recognized that once AIS populations become established, eradication is technically and economically problematic if not impossible. This provides a strong case to move quickly in advancing an early detection and monitoring program associated with existing programs such as the CWA so efforts can effectively proceed in mobilizing management for effective elimination or control.

Coordination is integral to an effective AIS detection and monitoring network that is formally instituted among appropriate agencies, organizations and stakeholders to the greatest extent possible. The LaMP holds the capacity to advance such coordination

among a wide array of agencies, organizations and stakeholders. As part of this effort, training sessions for agency personnel and appropriate volunteers are needed to conduct the monitoring programs with agreed upon quality assurance protocol. Such sessions could be conducted in an interactive web-based format.

Using watershed boundaries can be an effective means for coordinating AIS detection and monitoring programs, recognizing the LaMP as the overall guide for watershed-based monitoring efforts. Fundamental to a coordinative network for a Lake Michigan AIS monitoring regime is an institutional mechanism, such as a memorandum of agreement, providing a basis for collaboration among a diverse group of agencies and other stakeholders participating in the AIS detection and monitoring network in the basin.

Data sharing is a significant challenge in executing these coordinative efforts for the detection and monitoring network. To facilitate data sharing, consideration must be given to the protection of data ownership rights of participating agencies. There is also a need to contend with ubiquitous turf battles. To help address some of these issues, data sharing agreements or other arrangements should be instituted early on to guide AIS network monitoring partners in working together on a collaborative basis. It is suggested that a plan for data sharing as a prerequisite for project funding as a way to reinforce the high value placed on this aspect of early detection and monitoring programs. Centralization of reporting and information on a lake-wide basis is also needed. A reporting center should function on the basis of a quality assurance program and a verification system for incoming species data. The reporting center should also serve to maintain data compatibility that is in a uniform format. Upon verification of data that is compatible, a regional platform such as geographic information system (GIS) should be utilized in tracking AIS introduction and spread. A GIS tracking system is also an effective means by which to disseminate AIS monitoring information to governmental agencies as well the general public. The Great Lakes Commission has developed a model GIS mapping tool to as way to visually track AIS populations of priority concern in Michigan that is available online at www.glc.org/ans/initiatives.html#gis .

Monitoring for the unknown is an extremely challenging endeavor. Ecological forecasting for AIS invasions is emerging as a promising tool to address this challenge. One predictive method being pursued in forecasting potential AIS invasions is based on the assumption that invasive species possess distinguishing characteristics from non-invaders, such as early sexual maturity, high fecundity, asexual reproduction, with general habitat and diet requirements, as well as the ability to survive in habitat where anthropogenic impacts are prevalent. Statistical models of life history characteristics along with environmental tolerances of previously successful invaders provide the information upon which predictions are based. A scenario for which the forecasting approach has been applied is the prediction of fish species to invade the Great Lakes from the Ponto Caspian Basin (a documented donor region for introduced species in the Great Lakes) (Kolar 2004). Ecological forecasting is strongly recommended as a component of AIS detection and monitoring programs to improve efforts in detecting organisms that have yet to be discovered in the Great Lakes ecosystem.

As mentioned in the aforementioned discussion on the LaMP, the public sector plays an important role in a lakewide AIS detection and monitoring network. Volunteer monitoring efforts provides a significant level of support for program operation. A key source of motivation for volunteer participation is to encourage ownership of the resource, a process that is highly dependent on awareness and understanding of how and why the aquatic resources needs to be protected from AIS invasions. Training and education on AIS identification, sampling and reporting should be made accessible to those interested stakeholders. Quality assurance protocol needs to be integrated into the Volunteer training programs to ensure accuracy in identification and reporting of AIS detection, as well as consistency in sampling techniques.

The recommendations presented in this report regarding an AIS detection and monitoring network support not only the goals of the Lake Michigan LaMP, but also are of significance for *the State of the Lakes Ecosystem Conference* (SOLEC) and associated suite of indicators. A primary goal of SOLEC is to develop a comprehensive, basinwide set of indicators that objectively represents the condition of the Great Lakes ecosystem. A SOLEC indicator of particular relevance, *Impacts from Non-Native Species*, will require data generated, in part, by a coordinated detection and monitoring network by which to systematically report on AIS impacts. Such a network would include consistent sampling methods, data collection and reporting under the guidance of a quality assurance plan. Also of note is that SOLEC indicators serve as a basis for reporting on progress under the Great Lakes Water Quality Agreement in a predictable, compatible and standard format. Data supporting the indicators currently comes from established monitoring programs of multiple agencies and organizations, but additional monitoring will be required to fully implement the SOLEC suite of indicators. Notably, strong linkages exist between SOLEC indicators and those identified for the LaMPs. (See U.S. EPA SOLEC web site, www.epa.gov/glnpo/solec/)

The recommendations and analysis presented in this report are offered as guidance in development of a coordinative network of AIS early detection and monitoring programs for the Lake Michigan basin. The network will ultimately assist in establishing a regime serving the Great Lakes region. Early detection and monitoring for AIS invasions on a lakewide scale is an ambitious, long-term effort that will require a sustained commitment of personnel, financial resources and expertise. This investment is critical in building the foundation needed to launch an effective prevention and control program for the protection of the Great Lakes ecosystem from future AIS invasions.

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AIS Early Detection and Monitoring: A Pilot Project for the Lake Michigan Basin
June 8th, 2004
Lake Michigan Center – Grand Valley State University, Muskegon, Michigan

9:00am	Greetings and Introductions	**Kathe Glassner-Shwayder**, Great Lakes Commission
9:15am	Project Overview	**Kevin Walters**, Great Lakes Commission
9:30am	National AIS Monitoring Perspective	**Phil Andreozzi**, National Invasive Species Council
9:45am	*Passive Monitoring Perspectives* • Michigan DEQ Monitoring Programs • Monitoring Aboard a Schoolship	**Roger Eberhardt**, Michigan DEQ **Colleen Masterson**, Inland Seas Education Association
10:15am	*Active Monitoring Perspectives* • Clean Boats, Clean Waters: Volunteer Watercraft Inspection Program • Monitoring for Ruffe	**Laura Felda-Marquardt**, WDNR/ UW-Extension, Rhinelander **Stewart Cogswell**, U.S. Fish & Wildlife Service, Green Bay FRO
10:45am	**Break**	
11:00am	*GIS Mapping of AIS Invasions in Michigan: A Model Tool for Monitoring Programs*	**Tom Rayburn**, Great Lakes Commission
11:15am	A Summary of Survey Responses	**John Hummer**, Great Lakes Commission
11:35am	Presentation of Draft Recommendations	**Kevin Walters**
11:55am	Breakout Assignments	**John Hummer**
12:00pm	**Lunch**	
1:00pm	*Concurrent Round Table Discussions I* • Sampling & Reporting Protocols • Monitoring Needs	Facilitators: **Don Schloesser**, USGS **Ric Lawson**, Great Lakes Commission
2:30pm	**Break**	
2:45pm	*Concurrent Round Table Discussions II* • Sampling & Reporting Protocols • Monitoring Needs	Facilitators: **Don Schloesser**, USGS **Ric Lawson**, Great Lakes Commission
4:15pm	Reports from Round Table Discussions	**Facilitators**
4:45pm	Next Steps	**Kevin Walters**
5:00pm	**Adjourn**	

Appendix C: Workshop Agenda and Participants

A special acknowledgement goes to the participants of the project workshop for committing to help analyze survey results and develop recommendations that will move the Great Lakes region forward in successful early detection and monitoring of aquatic nuisance species.

Philip Andreozzi
National Invasive Species Council

Holly Arrigoni
U.S. EPA, Region 5

Judy Beck
U.S. EPA, Region 5

Stewart Cogswell
U.S. Fish & Wildlife Service

Roger Eberhardt
MI Office of the Great Lakes

Laura Felda-Marquardt
UW-Extension, Rhinelander/WDNR

Emily Finnell
MI Office of the Great Lakes

Kathe Glassner-Shwayder
Great Lakes Commission

Tom Goniea
MI Dept. of Nat. Resources

John Hummer
Great Lakes Commission

Ric Lawson
Great Lakes Commission

Beth MacKay
Ontario Ministry of Nat. Resources

Colleen Masterson
Inland Seas Education Association

John Perrecone
U.S. EPA, Region 5

Carl Ruetz
Grand Valley State University

Don Schloesser
U.S. Geological Survey

Carol Swinehart
MI Sea Grant

Janet Vail
Grand Valley State University

Kevin Walters
Great Lakes Commission

Workshop Summary: *AIS Early Detection and Monitoring: A Pilot Project for the Lake Michigan Basin*

As part of the AIS early detection and monitoring pilot project, a workshop was held on June 8th, 2004 in Muskegon, Michigan. The main objectives of the workshop were to review the project survey results and provide input and further development on draft guidelines and recommendations for an AIS early detection and monitoring network in the Lake Michigan basin. Workshop topics included active AIS monitoring perspectives, passive AIS monitoring perspectives, the role of volunteer monitoring, communication and reporting protocols, and monitoring gaps. The workshop was attended by stakeholders representing state and federal agencies, the Great Lakes Panel on Aquatic Nuisance Species and the Lake Michigan Monitoring Coordination Council as identified in the participant list found in Appendix C.

A series of pre-identified questions guided a roundtable discussion at the workshop. Discussion was framed in two basic areas: 1) Monitoring Needs and 2) Sampling and Reporting Protocols. These questions are listed below with a summary of the main points and themes that were discussed – bulleted below each set of questions.

The following questions guided the discussion around the theme of "monitoring needs:"

1. In efforts to institutionalize a monitoring network, how can we ensure that the appropriate entities are participating in the network?
2. What criteria should be applied to identify high-probability areas and high-risk areas where monitoring efforts should be focused?
3. What is the role of the public in ANS detection/monitoring programs and how can public participation be encouraged and most effectively utilized?
4. How can baseline monitoring information be used to support ANS detection and monitoring efforts (i.e., disturbances/impacts resulting from ANS invasions, etc.)?
5. In establishing a monitoring network, how can efforts be coordinated with existing programs, such as the Lake Michigan Lakewide Management Plan (LaMP) and work of State of the Lakes Ecosystem Conference (SOLEC) on Great Lakes indicators?
6. What do you consider to be the priorities for ANS detection and monitoring given the limited resources available?
7. Discuss any other important issues regarding ANS detection and monitoring that have not been addressed.

The following thoughts and responses were offered by workshop participants which address any of the above questions regarding "monitoring needs":

- More state participation needed in the Great Lakes Observing System (GLOS) and the National Ecological Observatory Network (NEON) to institutionalize
    - NEON has large outreach component
    - NEON/GLOS should be reviewed as a possible vehicle to receive data and disseminate information
- Immediate need to gather information but also need to integrate older data

- Some goals/draft recommendations seem to be in conflict
    - For example, should AIS monitoring be conducted by existing programs or by new programs?
- Ensure data is communicated to, and accessible by the public (education/outreach component)
- Data needs to be shared among researchers/managers. This is particularly important for data from academia.
- What kind of balance can we get between active vs. passive within existing resources?
- Example of water quality programs (EPA) why not add/integrate some ANS monitoring – not difficult (i.e., train volunteers). Should EPA take the lead?
    - Should be joint EPA/state training
    - What to do with data collected is key question
- Should be voluntary, not mandated for states
- Once decision is made training must follow right away
- Coordination required across a diverse group of agencies/NGOs/Canadians
- Need a lead for centralization of information/reporting
    - Information should then be filtered down to all stakeholders. Political/jurisdictional issues need to be carefully addressed.
- Coordinated ED/RR reporting system through the National Invasive Species Council
- There is some ongoing discussion already on a centralized system. Reporting would include numerous fields with some required to be filled in and others optional – could very easily be uploaded on to a common site
- Feeling that Congress should not be involved; we need to pick our own way that benefits all
- Need to use watershed boundaries in an early detection and monitoring system
- Still need a quality assurance and species verification system
- MI GIS project may act as platform for other agencies to share information – possible proposal opportunity?
- Additional information on monitoring needs to be gathered (beyond survey respondents)
- Use “active” monitoring at the right time/ take advantage of public/political awareness
- Two types of reporting – trends vs. impacts (impact reporting with goal to attract public/political attention and support)
- Don suggested response to Q.11 on survey likely captures majority of ANS monitoring occurring on Great Lakes – also that there is a lot of information exchange happening
- What should reporting structure be? More than one repository?
- National program could have regional structure not necessarily standardized collection process
- Consider the role of the public beyond voluntary – are we missing any obvious sectors who may contribute to monitoring information?
- Many groups we may not think of that are collecting information (academic, NGOs) – but are there structures whereby that information is contributed? (i.e.,

academia publishing papers, associations involved in issue that represent NGOs, etc.)
    - University-collected data presents a challenge in terms of access to their information: need to influence funding sources to encourage sharing of data
- Funding bodies could encourage (through MOUs, etc.) to have groups contribute information
- Need to look for species that we don't think are here yet
- Ownership motivates volunteerism – easiest on smaller systems
    - Other volunteers to consider – Coast Guard Auxiliary; Angler Education Program; Trout Unlimited; Inland Seas Education Association participants; Clean Marinas Program; Coastal America "recognized aquariums program" (i.e., Shedd Aquarium); museums; Great Lakes Fishery Trust; media, focus on groups who have provided help in the past.
    - Use the "Clean Marinas" Sea Grant initiative as an example
- Quality of data collected by volunteers in general is quite good
- Need to ensure filters for accuracy in reporting/identification
- Standard messages for volunteers, media
- Need clear procedures for rapid response
- Address public fear of chemicals for acceptance of rapid response

The following questions guided the discussion around the theme of "sampling and reporting protocols:"

1. In efforts to develop an early detection and monitoring regime on a basin-wide scale, is it feasible to integrate incidental ANS detection and monitoring into existing programs. If so, how can this be achieved without burdening program goals?
2. Based on your experience, provide input on how to efficiently collect ANS data without compromising other objectives?
3. Is it feasible to institutionalize a standardized reporting system to support ANS detection and monitoring regime on a basin-wide scale?
4. What protocols are needed to support a standardized reporting system? (i.e., sampling techniques, temporal issues such as frequency and timing of sampling, spatial issues such as longitude/latitude of sampling location)
5. Who are the appropriate recipients of reports/data?
6. What information should be reported and how can it be applied most effectively?
7. Are there any other important issues regarding ANS detection and monitoring that have not been addressed?

The following thoughts and responses were offered by workshop participants which address any of the above questions regarding "sampling and reporting protocols":

- Difficult to convert to standard protocols, work with existing protocols; adapt to standard protocols over time
- States need to be 100% "plugged in" to any reporting process

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- Common usage of data more important
    - Use of data may shape collection of it
    - Need to filter information/data most usable – i.e., water quality, fishing
- Consistent reporting framework and metadata
- What information would be needed?
    - Information to feed into forecasts
- Difference between detection and monitoring spread. Or is there?
- Detection/verification only small part of the issue
- "Value-added" information for public/lakefront use
- Value of monitoring data:
    - Managers and decision makers will find the data very useful, particularly it is presented in a timely manner.
    - Lake associations, fishermen, boaters, etc. will all also be interested.
- Monitoring important for other regions and unknown questions, too
- Is presence/absence enough? Or should it include more details and context?
- Conditions is also important – context
    - Adds complexity, workload, resources though
- Detection network should be focused on leading edge of spread
- Pull in metadata sets and overlay
- Syndromic detection: detecting symptoms of an invasion.
    - Need baseline data for syndromic detection.
- Available GIS data can be added for analysis without added collection effort
- Simple data helps with data sharing, collection, report rates
- Quantity?
    - More complicated; meaning? Equipment specific; interpretation problems
- Uses?
    - Difference between individuals and established populations
    - Management agency can quantify after new discovery
- Unknown discoveries?
    - Pique interest; increase coverage
    - Credible information?
    - State filters?
    - Verification without overwhelming bureaucracy?
    - Open system, but not wide open
- How to approach prediction?
- Work through the GL Panel/LaMP forums with draft recommendations
- Possible entities to include in a monitoring network:
    - DEQ watershed monitoring which occurs in 5 year cycles
    - Angler monitoring network could be a valuable asset for early detection and monitoring
        - 1.3 million anglers
        - Website with information for reporting
    - Inland Seas Education Association
        - Focus on hands-on education of children
        - Long-term database of monitoring in Suttons Bay & Traverse Bay