Model Rapid Response Plan for Great Lakes Aquatic Invasions

Iteration III

DRAFT: December 2006

This document is being prepared for the U.S. Environmental Protection Agency,
Great Lakes National Program Office
By the Great Lakes Commission Staff of the Resource Management Program
With guidance from the Rapid Response Project Advisory Team

This project was made possible through a grant from the U.S. Environmental Protection Agency, Great Lakes National Program Office

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Acknowledgements

The *Model Rapid Response Plan for Great Lakes Aquatic Invasions* has been prepared for the U.S. Environmental Protection Agency, Great Lakes National Program Office. This project has been a work in progress since October 2001 under the auspices of the Great Lakes Commission. Commission staff of the Resource Management Program contributing to the development of this document include: Thomas Crane (Program Manager), Katherine Glassner-Shwayder (Senior Project Manager), Kevin Walters (formerly employed at the Commission as Program Specialist through September 2004)) and Sarah Whitney (formerly employed at the Commission as Project Manager through August 2003). Oversight for the rapid response project and development of the associated model plan has been provided by the Rapid Response Project Advisory Team (Appendix A) and the Great Lakes Panel on Aquatic Nuisance Species.

Great Lakes Commission staff is working in collaboration with Michigan's Department of Environmental Quality (DEQ), Office of the Great Lakes, in efforts to operationalize the model rapid response plan on a state and regional level. DEQ staff, with assistance from Great Lakes Commission staff and the Michigan's Hydrilla Task Force, have taken a lead role in development of a species-specific case study to test the functionality of the model rapid response plan. The species selected for the rapid response case study is hydrilla (*Hydrilla verticillata*), a noninidigenous invasive plant that has been identified by the state of Michigan ANS Council as a potential invader of Michigan waters.

Introduction

The introduction and spread of nonindigenous aquatic invasive species (AIS) in the Great Lakes-St. Lawrence system continues to threaten the economic and ecological health of the region. Currently, no protocol exists to facilitate a timely response to AIS invasions to allow for the implementation of appropriate eradication and/or control measures. The absence of a mechanism to respond to AIS invasions has been problematic, as evidenced by the invasions of nonindigenous fish, such as the ruffe (*Gymnocephalus cernuus)* and round goby (*Neogobius melanostomus*) that have advanced without intervention, causing extensive damage. A "rapid response" capacity for newly discovered AIS invasions is critically needed to enhance opportunities to prevent and/or slow the spread of these newly introduced populations and mitigate associated impacts.

Recognizing the need for rapid response planning on a regional basis, the Great Lakes Commission has conducted the project *Rapid Response Plan for Great Lakes Aquatic Invasions* with funding from the U.S. Environmental Protection Agency, Great Lakes National Program Office. The primary goal of this project is to work with regional stakeholders in developing a set of tools integrated as part of a model rapid response plan to address Great Lakes AIS invasions. The model plan is being offered as guidance on a regional basis to federal and state entities responsible for responding to aquatic invasions. The driving force in the development of the model rapid response plan is to provide the Great Lakes-St. Lawrence region with increased capacity to anticipate, prevent and respond to AIS invasions within a timeframe that will maximize the effectiveness of management actions.

The primary product of this project, *Model Rapid Response Plan for Great Lakes Aquatic Invasions,* as presented in this document, has been developed by Great Lakes Commission staff with oversight from the Rapid Response Project Advisory Team as listed in **Appendix A**. The model plan is intended to provide the depth and detail needed to guide planning for a species-specific response to new AIS invasions with enough flexibility for application to various jurisdictional scenarios. It should also be noted that the intent here is to provide generic guidance on rapid response planning applicable on state, regional and even federal levels. Extensive research has been conducted by project staff, with guidance from the project advisory team, to compile and integrate lessons learned from existing rapid response initiatives as well as related prevention and control programs. This research is documented in the bibliography at the end of this document.

To further advance plan development, the workshop, *Rapid Response Plan for Great Lakes Aquatic Invasions,* was conducted July 23-24, 2003 in Ann Arbor, Mich. The workshop, organized and facilitated by Great Lakes Commission staff, convened 55 local, state and regional representatives to participate in a forum for the advancement of rapid response planning for AIS

invasions on a regional basis (refer to the workshop agenda presented in **Appendix B**). The high level of participation in the workshop is testimony to the significant interest among regional stakeholders to institute rapid response plans as part of AIS prevention and control programming in the Great Lakes-St. Lawrence region. Workshop plenary sessions provided the opportunity for expertise to be shared on each component of the model rapid response plan under development. Breakout sessions held during the workshop enabled regional stakeholders to contribute to further development of the plan components. The lessons learned from both the plenary and breakout sessions of the workshop have been incorporated in the the *Model Rapid Response Plan for Great Lakes Aquatic Invasions*..

The overall project design has also incorporated application of a case study scenario for a specific aquatic invasive species of high priority concern in the region in an effort to test the functionality of the model rapid response plan. In so doing, the case study has been used to evaluate which aspects of the plan are effective and which parts need further refinement. Additionally, the case study scenario tested the model's adaptability to a state-specific setting while still maintaining applicability to the Great Lakes – St. Lawrence region. The species selected for the rapid response case study was hydrilla (*Hydrilla verticillata*), a noninidigenous invasive plant that has been identified by the state of Michigan ANS Council as a potential invader of Michigan waters. See the section, *Species-Specific Case Study* in this document for more details.

Defining the Problem: What are the driving forces in planning for a rapid response to Great Lakes aquatic invasions?

The Great Lakes-St. Lawrence ecosystem has been plagued by the infestation of more than 162 nonidigenous 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.

When prevention efforts fail and the introductions of aquatic invasive species occur in the Great Lakes-St. Lawrence system, policy makers, resource managers, outreach specialists and other stakeholders currently have few legal and management tools available to take action both on a short-term and long-term basis. A case in point is the lack of regulations needed to implement management measures on private property in the event of an AIS invasion. Momentum for mobilization of a rapid response plan can be quickly sunk by public opposition to use of management tools, such as chemical application and/or biocontrol, essential to effectively battling the spread of AIS infestations. There is an urgent need for research to further develop a set of tools that are specifically targeted for AIS eradication and control and that are environmentally sound when applied in an aquatic ecosystem. It is also critical to institutionalize a suite of legal and regulatory strategies that can be implemented, wherever the jurisdictional lines fall, in response to AIS invasions.

A reality of AIS warfare 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 by aquatic invasions. This situation is demonstrated by past and present costs in the control and clean-up of zebra mussels and the current threat of Asian carp to the $4.5 billion Great Lakes sports and commercial fishery (Midwest Natural Resources Group (MNRG), 2003). This deficiency is particularly apparent during the critical period between introduction and establishment of a new AIS population when the focus of management must shift rapidly from prevention to control/containment. It is during this brief window after introduction where the opportunity exists to stop the permanent establishment of a new AIS population. Intervention through early detection and rapid response is a critical strategy for preventing the establishment of new AIS populations. Early detection and rapid response efforts increase the likelihood that invasions will be addressed successfully while populations are still localized and population levels are not beyond that which can be contained and eradicated (Early Detection and Rapid Response (ED&RR) Subcommittee of the Invasive Species Advisory Committee (ISAC) serving the National Invasive Species Council (NISC), 2003).

In the development of a model AIS rapid response plan for the Great Lakes-St. Lawrence region, this project builds upon rapid response planning and initiatives from a variety of abiotic (e.g., oil spills) and biotic (e.g. snakehead fish) scenarios. Past AIS invasions and response efforts, both successful and unsuccessful, were also studied during plan development. The following fundamental questions were among those considered in the development of the rapid response plan:

- How can the plan be structured to respond to AIS introductions and spread in a time frame that can maximize the possibility for eradication and/or control?
- What types of institutional arrangements will help avoid political/jurisdictional obstacles that might impede implementation of rapid response?
- Has the input/feedback of public stakeholders been integrated into rapid response planning efforts?
- How will the response efforts be funded?
- Who should hold authority in leading the development and implementation of a rapid response plan?
- What options are feasible for AIS eradication and control given existing technologies, resources, and known biological and ecological constraints?
- How can the plan maintain environmental soundness of aquatic ecosystems during implementation of eradication and/or control/containment measures?
- What is realistic to achieve in terms of ecological integrity and restoration in the wake of an invasion and response?
- How can economic interests be protected and economic loss prevented in the event of AIS invasions?

Goal Statement

The goal of this project is to develop a model rapid response plan on a regional basis to enhance capacity to anticipate, prevent and respond to new invasions of nonindigenous aquatic invasive species in the Great Lakes-St. Lawrence region. The rapid response plan should be designed to address the critical period between introduction and establishment of new invasive species when the focus of management must shift rapidly from prevention to eradication and/or control. In so doing, the ultimate goal of the model rapid response plan is to capitalize on the window of opportunity to stop the establishment of new harmful invasive species shortly after introduction, when prevention has failed (MNRG, 2003). In the development and implementation of rapid response plans, environmental soundness must be maintained to avoid causing other ecological problems. It is implicit that the model plan be established with a broad base of public and private support to maximize viability in terms of funding and implementation. Therefore, a secondary goal of this project is to build consensus for the model rapid response plan among stakeholders, particularly those who will play a role in plan implementation. Depending upon the application (local, state,watershed, regional, federal or species-specific, etc.) of the model rapid response plan, specific goals and objectives should be developed with consideration of the following issues as guidance:

- Species-specific information on AIS
- Habitat consideration
- Geographic and temporal framework
- Eradication/control tools available for use
- Jurisdictional challenges
- Status of political will for response

A critical element to the success of rapid response planning is to create the public will allowing for quick and effective action in the event of AIS invasions. In so doing, consideration should be given to broadening the scope of conservation ethics to include the prevention and control of invasive species, to garner public support as achieved by similar campaigns to prevent forest fires, encourage recycling and clean-up chemical pollution (Westbrooks, *Workshop: Rapid Response Plan for Great Lakes Aquatic Invasions,* 2003). The first step in this endeavor is to develop societal awareness for the damaging consequences imposed by AIS invasions if left unchecked. It is the realization of the escalating ecological, economic and societal costs incurred by AIS invasions that will inevitably drive the need for rapid response and other AIS prevention and control strategies.

Components of the Model Rapid Response Plan

1) Organizational Structure and Communication

Objective

Ensure that institutional arrangements regarding organizational structure and communication, are established to facilitate preparation and implementation of rapid response plans for Great Lakes aquatic invasions

- Establish institutional arrangements needed to effectively implement rapid response to AIS invasions;
- Ensure the timely exchange of information necessary in AIS detection and rapid response planning and implementation;
- Ensure that the appropriate stakeholders, agencies, and groups are involved in response plans, both in early stages of development and ensuing implementation;
- Identify the appropriate authorities and establish leadership roles that are needed to mobilize an effective rapid response for Great Lakes aquatic invasions;
- Establish and implement protocols, such as a memorandum of agreement, on a regional level, to help overcome the multijurisdictional challenges regarding communication and organizational responsibilities needed for effective rapid response (MNRG, 2003);
- Develop processes, marshal resources among agencies and partners, seek opportunities for collaboration, communication, partnerships and provide timely assistance where it is needed (MNRG, 2003).

Background

Fundamental to establishing the organizational structure and communication for AIS rapid response planning is the establishment of a coordinative body with the capacity to function on a transboundary basis to effectively address AIS invasions. Ultimately, this body must operate to effectively eradicate and/or control a new AIS invasion within a reasonable timeframe to limit the extent of ecological and economic damages. A useful model that can be used as guidance in this endeavor is the National Contingency Plan established to respond to chemical and oil spills (Environmental Protection Agency, 1993). The National Contingency Plan, operating under the auspices of the National Response Team (a coalition of 16 federal agencies co-chaired by U.S Environmental Protection Agency and the U.S. Coast Guard), provides the organizational structure facilitating rapid response planning through Regional Contingency Plans in the following ways (Powers, *Workshop: Rapid Response Plan for Great Lakes Aquatic Invasions,* 2003):

- provides institutional support for multi-agency coordinated response through inclusion of state and federal agencies
- defines jursidictional responsibilities
- establishes open lines of communication

- categorizes type of problems to be addressed in rapid response planning
- provides committee support to collect and disseminate information on response policies, "preparedness" information, and science and technology
- operates with financial agreements in place

In developing a regional rapid response plan for AIS invasions, the organizational model provided by the National Contingency Plan should be carefully considered. This comparative analysis is particularly important given common rapid response requirements for coordination, cooperation and partnerships that build capacity on a multijurisdictional level. Further commonalities include the need to address transboundary environmental problems that are time sensitive due to the high risk level posed by ecological, economic and societal impacts.

A coordinated organizational structure is pivotal in launching effective rapid response efforts. The organizational structure must take into account the various federal, state and local agencies and respective laws and ordinances that have been established to prevent new invasions and manage existing ones (Schmitz and Simberloff, 2001). The organization of a rapid response plan must also lay the groundwork to ensure that appropriate stakeholders, agencies, and groups actively participate in the development and implementation of a response. Parties involved in response planning should be identified in advance, to include definition of roles and responsibilities which may vary depending on the scope of the infestation. The organizational structure should remain dynamic to facilitate functionality in jurisdictional situations subject to change.

It is critical that an entity with a leadership role is integrated as part of the organizational structure empowered with final decision making authority, with the entity willing to act in that capacity. In certain cases, an incident command system may be needed to ensure effective flow of information (ISAC ED&RR Subcommittee, 2003). As a proactive measure, the planning process may benefit from identifying state and regional leadership teams to address general rapid response issues outside of specific rapid response incidents, before invasions occur. (Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW), 2002). In establishing an organizational structure for rapid response where the process of decision making will be utilized, it is noteworthy that in most cases (but not all) the state will have operational jurisdiction for control actions. Cooperation by federal agency authority will be key in the process of effective decision making (U.S. Coast Guard, U.S. Army Corps of Engineers) (Personal Communication, Mike Conlin, Office of Resource Conservation, July, 2004).

To support organizational efforts, a primary point of contact or Invasive Species Response Coordinator (ISRC) needs to be established for each local, state, and federal agency with AIS responsibilities in the Great Lakes region. Within each agency, the ISRC should be equipped to orchestrate agency response in the event of detection of new AIS invasions. Each primary point of contact should have the authority or be willing to take the steps necessary to attain the authority to implement the agency's role in a response.

As part of the organizational structure of a rapid response plan, it is important to integrate a group of taxonomic experts that can identify and verify claims of new invasions on an efficient and authoritative basis. This expertise can come from local, state, and federal agencies, and also the larger scientific and academic communities. Taxonomic experts may also be used to provide information about specific taxon, habitats, and ecology necessary to help facilitate risk assessment and control measure implementation. A database has been designed by the ANS Task Force to direct users to invasive species experts, with particular attention to taxonomic experts qualified to confirm AIS sightings. This database is available online at http://www.dorklegion.com/USGS/experts/search.php. The role for taxonomic experts is further described in the section on **Early Detection and Monitoring**.

Once a species invasion is verified, a scientific assessment committee comprised of relevant members of the academic, state and federal agency scientific community and local stakeholders, should be convened. A scientific assessment committee can initiate a preliminary assessment, evaluate the seriousness of the invasion, and provide recommendations for future actions. The scientific assessment committee can determine if rapid response efforts are warranted and feasible, as further discussed in the section on **Rapid Scientific Assessment**.

As part of this rapid response component, there is a need for communication on an ongoing basis to ensure that all appropriate stakeholders, agencies and groups are engaged in the response. A clearly defined communication structure will facilitate timely information exchange among the appropriate entities in the rapid response network. To maximize the effectiveness of this structure it is important to determine those who generate and receive information, how information is exchanged, and the level of urgency for information transfer. Of critical importance in a rapid response is the need for an effective and transparent communication structure to be integrated throughout all levels of the plan. 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 for verification. Once verification of the new invasive species has occurred, the 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 based on the assessment, 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) as discussed in the **Implementation** section. The role of the public communication officer is to ensure that the media and the public as well as other states, provinces, agencies are apprised of the situation and associated activities as appropriate.

One option for facilitating communication during rapid response efforts is the assignment of an agency or regional entity to a central communication coordination role similar to the way that the National Response Center (NRC) functions in the event of oil and hazardous materials spills. The NRC could play this role for biotic invasions if feasible both institutionally and politically. When a new invasion is detected or suspected, the central communication coordinator should be notified immediately by the individual, agency, or entity making the claim. The central communication coordinator then is tasked with contacting and informing all of the primary

points of contact (ISCRs) for local, state, and federal agencies with potential jurisdictional responsibility. As modeled in the National Response Plan, an on the scene coordinator (OSC) should be pre-designated to provide the leadership needed to avoid confusion in directing implementation of a plan response. The OSC determines the status of the rapid response and monitors the situation to determine the need for federal involvement and the role of other participating agencies. (Powers, *Workshop: Rapid Response Plan for Great Lakes Aquatic Invasions,* 2003).

It should be noted at this point that successful implementation of rapid response plans is highly dependent on securing adequate funding as discussed in the **Funding** section. If at all possible, the organizational structure for rapid response plans should account for how and where emergency funds can be secured for rapid response prior to actual detection of new invasions. If a funding source is not in place prior to invasions, the success of a rapid response is seriously compromised. The federal legislation, *National Aquatic Invasive Species Act (NAISA)*, as proposed in 2003, will require states to incorporate rapid response planning into their state management plan efforts and authorize limited funding for rapid response emergency funds and contingency strategies.

The organizational structure and supporting communication needed to make a rapid response plan operational is complex with several overlapping components at work**.** The functionality of a rapid response plan is strongly dependent on sound organization that is reinforced through effective communication**.**

Strategic Tasks: Organizational Structure and Communication

- Establish and implement protocols, such as a memorandum of agreement on a regional level, to help overcome the multijurisdictional challenges regarding organizational structure and communication needed for effective AIS rapid response (MNRG, 2003).
- Convene, with Invasive Species Response Coordinator (ISRCs') oversight, appropriate federal, state and local agencies within the Great Lakes region to serve on a multijurisdictional team (rapid response team) to implement a rapid response plan for Great Lakes AIS invasions.
- Define the roles and responsibilities of the participating agencies on an AIS rapid response team in conjunction with determining a command structure by which to commit agency support during a response.
- Identify authorities on the rapid response team legally empowered to make decisions during the implementation of a rapid response plan upon discovery of an AIS invasion.
- Pre-designate an on-scene coordinator (OSC) on the location of the AIS invasion to coordinate the logistics of a response on a local level.
- Assign a pubic information officer to provide consistent information to the public on status of the AIS invasion and associated rapid response.
- Identify/integrate a funding mechanism(s) as part of the organizational structure to support preparation and implementation of a rapid response plan (e.g., the National Contingency Plan holds the legislative authority to respond to oil spills for the public good (Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act).

- Establish a network of communication among members of the regional rapid response team with the purpose of facilitating the flow of information in the event of an AIS invasion.

2) Outreach

Objectives

Provide a multi-tiered communication system to:

- Ensure that the public is educated on aquatic invasive species and associated risks posed by aquatic invasions to support the political will need to implement rapid response plans.
- Maintain a balanced level of awareness and understanding among public and private stakeholders on why a rapid response is needed in the event of an AIS invasions, including clarification of the benefits versus risks (or perceived risks) of a response.
- Ensure public involvement during the development of rapid response plan with an eye towards generating public faith in management decisions;
- Ensure that during the process of AIS detection and rapid response, information flows expeditiously and accurately between appropriate members of the rapid response team as well as public/private stakeholders, when appropriate;
- Maintain a network parties and stakeholders informed on rapid response activities, related progress and results of plan implementation;
- Establish functional feedback loops between public/private stakeholders and agencies with jurisdictional authority in efforts to provide effective communication through out the entire rapid response process

Background

The effectiveness of rapid response planning is highly dependent on outreach efforts applied during all phases of AIS invasions (pre-invasion, during the progression of the invasion and rapid response implementation, and post-response). Before an AIS invasion is discovered, outreach efforts are needed to cultivate an awareness and understanding among public and private stakeholders on the risks posed by an AIS invasion and the benefits (versus costs) of rapid response in mitigating those risks. Fundamental to this understanding is recognition of the potential ecological and economic costs of **not** responding to invasions of nonindigenous species. *An informed public that is aware of the threats posed by AIS invasions is very important in cultivating the political will needed for approval of rapid response plans.* In the absence of consensus among the public stakeholders and governmental agencies, plan implementation can be weakened to the point of paralysis.

Upon approval of a rapid response plan, public support needs to be maintained throughout the process of plan implementation with a focus on how rapid response efforts are progressing in preventing the spread of the AIS invasion. Post-response communication and outreach efforts should be undertaken to convey results of the rapid response plan, including an evaluation regarding rapid response efforts. On an internal level during all phases of rapid response planning, communication conducted by a primary coordinator needs to be established among team members and across agencies to ensure coordination and collaboration through out the

entire process.

The Great Lakes Panel on Aquatic Nuisance Species fully recognizes the importance of outreach programming on invasive species problems plaguing the Great Lakes as represented in the *Information/Education Strategy for ANS Prevention and Control* (Great Lakes Panel on Aquatic Nuisance Species 2001). A primary goal of the Great Lakes Panel's Information/Education (I/E) Strategy is to advance prevention of the introduction and dispersal of nonindigenous aquatic nuisance species within Great Lakes by long-term efforts to raise awareness and understanding for the issue. To achieve this goal, the I/E strategy provides recommendations on how to modify behavior and measures practiced by target groups associated with invasive species problems. The I/E strategy also offers guidance on approaches to raise the profile of AIS problems in the region based on threats to ecological integrity and biodiversity of the Great Lakes. Such efforts are critical to securing the long-term political will and dedicated public resources needed to effectively addressing AIS problems in the Great Lakes.

The prevention program on round goby introduction and dispersal, conducted by the U.S. Fish and Wildlife Service, provides an example of public outreach applied on a species-specific level. All parties potentially affected by the goby, such as water-users, local, state and federal governmental entities as well as all other public and private organizations were targeted by outreach in this program. (Keppner and Theriot, 1997). Outreach strategies have also been applied during the process of round goby prevention programs to help build cooperation and coordination among key decision makers representing local, state, and federal agencies.

The case of ruffe invasion in Duluth Harbor of Lake Superior exemplifies the importance of using outreach to prevent political obstacles from derailing rapid response efforts. Upon discovery of this aquatic invasive fish, a ruffe control plan was developed by federal and state programs to prevent the ruffe from spreading beyond Duluth Harbor. The proposed plan met public resistance due to the proposed use of chemical application and was not approved by state agencies at the last moment (Schmitz and Simberloff, 2001). In retrospect, it could be said that a stronger outreach program was needed in the control plan to inform the public of greater risks of not taking action (thus leaving infestations uncontrolled, allowing further spread into the Great Lakes system) versus the ecological and economic costs of chemical application.

Pre-invasion

Prior to an invasion, it is strongly recommended that an outreach/communications team is established within each Great Lakes state to provide support for AIS rapid response efforts. Representation on the team should include local, state, and federal agencies as well as private and public stakeholders, including environmental groups. In consultation with outreach specialists, a strategic outreach plan should also be developed to address the challenges posed by AIS rapid response. In development of the plan, consideration should be given to the environmental and social constraints involving rapid response. Critical to the success of a rapid response outreach plan are use of consistent messages, a defined network of groups targeted by the outreach activities, and a comprehensive articulation of goals and objectives.

Support for rapid response is dependent upon public understanding and acceptance for the aggressive action needed to protect the integrity and biological diversity of the native ecosystem subject to AIS invasions (National Invasive Species Council, 2001). Awareness for potential health issues and hazardous situations associated with AIS invasions can also serve as persuasive information in support of rapid response. As part of this discussion, there needs to be clarification on how eradication and/or control measures can be used without causing permanent damage to the ecosystem being considered for treatment. Fact sheets targeted to the public can serve as useful outreach tools to convey information before imminent AIS invasions actually occur. The fact sheets should cover such issues as:

- Characteristics of the invasive species and the risks posed by invasion.
- Why a rapid response is needed to eradicate and/or control an AIS invasion?
- What are the benefits of a rapid response versus the risks of not taking action?
- What management options are feasible to eradicate and/or control the AIS invasion and how do the management measures function?
- What situation will trigger the response action?
- What are the short and long-term impacts of the management options (e.g. use of chemicals) considered for use?
- What, if any, risks do the selected treatment pose to humans who work or live on the water body?
- How will people be notified that a rapid response is being implemented and when it is completed?

To foster public support for the plan of action, agencies must strive to build faith in their decisions by maintaining an open process. An important aspect of open communication for AIS rapid response is the establishment of a central point of contact. A lead agency can address this need by setting up a 1-800 telephone number and/or website where the public can receive consistent information regarding response efforts. *In addition, the lead agency involved in the AIS response should establish a dedicated public communications officer who can deal directly with the media* (Early, *Workshop: Rapid Response Plan for Great Lakes Aquatic Invasions*, 2003). The public communication officers should deliver timely and consistent messages. Coordination among agencies is essential to using consistent messages when dealing with the public. Contradictory or conflicting messages weaken public faith in agency actions and decision making.

Due to the political sensitivity of rapid response initiatives, it is recommended that generic pre-prepared press release statements are made available when needed. In the event of AIS detection, these generic releases should be ready for use allowing tailoring to the specific situation at hand. Pre-prepared responses may include announcement of AIS detection, rapid response options and planning, rapid response implementation, and post-response outcome.

During the pre-invasion stages, the Great Lakes user groups, such recreational boaters and anglers, could also play an important role in actively participating in an outreach network to support rapid response efforts. Generally speaking, these user groups spend significant time on Great Lakes waters in a wide variety of geographic locations, thus carrying credibility in regards to resource quality issues. Furthermore, these user groups generally place a very high value on

the Great Lakes ecosystem and have genuine concern for keeping it healthy. If informed and aware of pressing AIS issues and concerns, recreational and commercial water users could help gain the political will needed to get approval for implementation of a rapid response plan.

Progression of Invasion and Rapid Response Implementation

When an invasion is verified, the stakeholders most directly effected by both the invasion and any possible response measures should be quickly identified. These may include, among others, property owners surrounding an infested lake or commercial interests using the resources of an infested harbor. Once identified, these stakeholder groups can more effectively be targeted with specific outreach tools. For example, private property owners surrounding a lake may be targeted using door-handle hangers and lake association meetings while commercial entities may more easily be informed by way of mailed notices providing information on the AIS invasion.

The development of a rapid response plan should be a 'two-way street' in terms of information flow between management agencies and the public. The stage can be set for this ongoing dialogue during plan development through open forums, such as town meetings and lake association meetings to encourage a question and answer type of interaction. Communication with the public on rapid response should be structured in a way that helps enlist the support of the public in solving the problem by speaking *with* stakeholders versus *at* them. Also important is involving stakeholders that are not directly impacted by an invasion in the response process. A significant challenge in gaining approval for implementation of a rapid response plan is to convey the message to the general public that local impacts potentially caused by rapid response eradication and/or control are being made for the greater environmental, social and economic health of the region.

After the decision to implement a response has been made and during the implementation phase, there is a critical need for management to have the final say in the implementation of the response plan. There will always be some opposition to taking action and thus the entity with ultimate authority must carefully consider all stakeholder input when making the final decision to respond. Subsequently, after a response is initiated, all stakeholders should be kept informed of response progress and any situational changes that evolve along the way.

Post Response

Post-response outreach and communication efforts should be undertaken to convey the outcome of the rapid response to appropriate parties. A successful response to an invasion can serve as a positive message to stakeholders which they in turn will hopefully pass on to stakeholders involved with other AIS invasions. The concept of "stakeholder networking" can then build upon the process of cultivating a support for response actions to future AIS invasions.

Also needed after a response has been completed is an evaluation and assessment tool. Such a tool will assess whether outreach efforts were successful in notifying and educating a broad range of stakeholder groups about the initial invasion, subsequent response efforts, and response outcomes. The assessment tool should measure both the public's awareness and acceptance of the rapid response effort by asking questions such as "are you aware that a response was implemented?" and "do you support how the response was conducted?" and very importantly,

"are you satisfied with the outcome of the response?" This type of information needs to be archived for reference to strengthen future rapid response efforts.

Strategic Tasks: Outreach

Pre-invasion

- Convene an outreach/communication team to develop a strategic plan that is conducted in close consultation with a network of outreach specialists. Outreach products of the plan should identify target groups with a vested interest in protecting the resource from an AIS invasion, to include the media, general public, commercial and recreational water users, angling groups, environmental groups, legislators and other elected officials, among others. Strategic tasks of the plan should be tailored to the needs of each group targeted.
- Establish a central point of contact through means such as a 1-800 telephone number or dedicated website to report on AIS sightings or access information on invasions.
- Designate a public communications officer for the lead agency/organization involved in a response as the point of contact for communication/outreach activities.
- Prepare generic press releases which can be tailored to specific situations.
- Begin an aggressive outreach campaign for those invasions considered imminent through the use of fact sheets, informational meetings, postcards, flyers, etc.

Progression of the Invasion and Implementation of Rapid Response

- Identify and design outreach tools that are effective in conveying information during the progression of the invasion (door-handle hangers, fact sheets, media announcements and related stories, etc.).
- Use a dedicated website to provide ongoing information on the AIS invasion, including a clear statement on the need for rapid response to an invasion. The site can be used to post reports on the range of the invasion, provide the status of current efforts and direct users to the appropriate source/links for further information. If at all possible, maps and photos should be included on the site to provide visual information on the AIS invasion.
- Continue efforts to identify effected stakeholder and interest groups and target them with outreach products.
- Provide open public forums (town hall meetings, lake association meetings, etc.) to inform the public on specific information regarding the AIS invasion and gather input from stakeholders. The open forums should be led by facilitators skilled in dealing with political sensitivities of the issue.
- Contact local media sources (newspapers, television stations, radio stations) to further raise awareness and the profile of the invasion and subsequent response.

Post Response

- Formally document outcome of rapid response efforts.
- Develop and conduct an assessment of effectiveness of rapid response plan based on results.
- Convey assessment to all public and private stakeholders, including agency representatives.
- Establish a process documenting the "lessons learned" for application during future invasions.

3) Early Detection and Monitoring (Identifying the Problem)

Objectives

- Assess the functionality of existing detection and monitoring programs to facilitate effective response to AIS invasions;
- Establish a coordinated regional network using this assessment to allow for the collection of baseline ecological information which includes AIS invasions;
- Maintain a process by which to identify invasion 'hotspots' which have either a high risk of being invaded or a high probability of being severely impacted by a new AIS invasion due to the high quality of the resource;
- Assess existing and develop efficient sampling protocols for AIS early detection and monitoring of Great Lakes habitat;
- Develop and maintain an integrated and centralized program for reporting and verifying Coordinate all aspects of an AIS detection and monitoring on a regional scale new infestations/invasions through the development and use of an implementation plan;
- Maintain an effective the early detection and monitoring program at all levels through an evaluation program.

Background

The states sharing the resources of the Great Lakes are becoming increasingly aware of the negative impacts caused by aquatic invasions to their industries, tourism and quality of life.. In collectively carrying the burden of controlling AIS populations established in Great Lakes waters, the states also share the challenge of preventing future introductions. Once AIS populations become established, eradication is technically and economically problematic, if not impossible. Even modest control measures are costly and difficult to implement. Early detection of AIS introductions and assessment (through monitoring) of established populations will help increase chances for more effective eradication or control.

The effectiveness of AIS rapid response is highly dependent on early detection of new introductions and monitoring of established populations. There is a brief window of opportunity for eradication shortly after a new non-native species has been introduced and before permanent establishment can occur. However, the only way to capitalize on this opportunity is if the invasion is detected early enough while populations are still localized and population levels are not beyond that which can be contained and eradicated. In efforts to increase the probability for effective eradication and/or control of AIS populations, early detection is considered a fundamental prerequisite.

According to guidelines developed by the ISAC ED&RR Subcommittee, detecting and responding to aquatic invasions demands coordinated and sustained action. Efforts related to early detection and monitoring involve a wide range of activities, including:

- identification of high priority species and at-risk sites;
- routine monitoring of certain areas;
- prevention and containment efforts;

- surveillance, detection and reporting activities including data collection and management;
- collection, identification and storage of voucher specimens; and
- training of volunteers and professional in detection, identification and removal techniques.

The prediction of potential aquatic invasions of nonindigenous species has been identified as an important step for early detection. Kolar and Lodge (2002) developed a quantitative approach to identify nonindigenous fish species most likely to cause damage, using a generic risk assessment approach and statistical models of fish introductions into the Great Lakes. The models categorize fish as established, quickly spreading, and nuisance species. Fish that pose a high risk to the Great Lakes, if introduced either intentionally or unintentionally, are identified. Furthermore, Ricciardi (2003) suggests that an empirical approach could be applied to predict the impact from introduced species based on their invasion history. Methods also exist to show how faunal composition of lakes can be predicted, in terms of vulnerability to AIS invasions; based on the lake area, mean depth, water transparency, and nutrient availability (Marshall and Ryan, 1987).

The capacity to monitor aquatic invasive species on a species-specific level is limited because current sampling techniques are labor intensive and often too costly to implement. There are however, a wide range of existing entities that currently conduct monitoring programs that target native and/or non-invasive species populations in the Great Lakes region. In the course of these monitoring, efforts invasive species may be inadvertently detected. Examples of such programs include Michigan Department of Environmental Quality water quality surveys and the Inland Seas Education Association's educational monitoring programs in Grand Traverse Bay, Lake Michigan. This type of "passive" or incidental detection and monitoring should be used to its fullest extent.

The Great Lakes Commission has recently been working on an AIS early detection and monitoring pilot project (also funded by U.S. EPA – GLNPO) for the Lake Michigan basin. The purpose of the project is to produce a set of guidelines and recommendations for a coordinated system to detect new invasions of AIS and track the spread of established populations in the Lake Michigan basin. A survey of Lake Michigan monitoring entities was conducted as part of the project to create a foundation for the guidelines and recommendations. Additionally, a project workshop was held to review survey results and analysis as well as provide feedback on the first draft of recommendations. Project guidelines and recommendations are available online at http://www.glc.org/ans/initiatives.html. While the project focuses on the Lake Michigan basin, the outcomes have application to the entire Great Lakes basin and beyond. The recommendations formulated during the course of the project should be carefully considered during rapid response planning efforts for invasive species in the Great Lakes.

Several groups, including the ISAC ED&RR Subcommittee, the National Estuarine Research Reserve System, and the FICMNEW, have identified components for an early detection system. The following concepts, summarized from the ED&RR Subcommittee's *Guidelines for ED&RR*, should be considered in the development of an early detection and monitoring system. Additional details addressed by other entities have been incorporated as appropriate.

- **Active detection networks/targeted surveys**: Active detection networks are monitoring programs comprised of organizations that have specific responsibility to detect aquatic invasive species. This is also sometimes referred to as "dedicated surveillance." Due to limited resources, it is important for the small number of operating active detection networks are focused on high-priority targets, such as high-risk locations, high value resources, priority pathways and populations and species of specific concern. Short-term, targeted surveys by trained professionals can augment active detection networks and provide an efficient use of resources (time and funding) for taxonomically challenging priority species or in high risk/high value habitats.

- **Passive detection and reporting networks:** Passive detection networks are monitoring efforts conducted by organizations or individuals who may fortuitously detect invasions as they conduct other activities. This is also sometimes referred to as "incidental surveillance".

- **Reporting systems:** Reporting mechanisms allowing for collection of information from active or passive detection networks would ensure that information about new detections is transmitted to appropriate entities in an expeditious manner.

- **Maintaining state of the art monitoring:** Long-term programs are needed to facilitate sufficient, ongoing training to professionals and volunteers engaged in early detection, monitoring, and collection and reporting of suspect species. Training will reduce the frequency of inaccurate reports and reduce redundant reporting of common species.

- **Authoritative verification:** Expert taxonomic confirmation and diagnostic laboratories are needed to confirm AIS identification, including specific taxa and associated habitats. A taxonomic expert database is operating under the auspices of the ANS Task Force (refer online to www.anstaskforce.gov/default.php for more details on the Task Force) to assist in the AIS verification process by directing users to invasive species experts. The database can be accessed online at: www.dorklegion.com/USGS/experts/search.php. It has been set up as a 2-tier system with the first tier accessible to the public. The public portion of the database guides the user to a state contact acting as a filter for information and identifications. If the state contacts are not able to answer verification inquiries, the state are given access to the second tier experts.

  As part of the verification process, collections of voucher specimens need to be maintained to allow for authoritative taxonomic identification that meets international standards. Verification can be used to authoritatively determine the presence or absence of a species in an area, whether it is an initial introduction into the country or the movement of previously reported species into a new area of the country. Data collection standards should be developed and adopted. Reference collections should also be developed, as they will be valuable in providing comparative material for confirmation of known species and resolution of unknown species. It may be useful to include both morphological and genetic vouchers in the collection, as molecular tools may be

particularly effective in resolving taxonomic issues (Ruiz and Hewitt in Wasson et al, 2002).

- **Ecosystem damage surveillance:** Detection of damage associated with aquatic invasive species is frequently the first indication of a new invasion. This is often the case with invasive pathogens and parasites. It is essential that surveillance be conducted to look for ecological anomalies that may indicate an invasion before any causative species are identified.

- **Communication and coordination:** A transparent and intuitive communication and coordination structure must be in place to ensure that information reaches decision makers in a format they can use and understand. Knowledge, skills, gaps and deficiencies associated with specific early detection and monitoring programs must also be conveyed to a broader audience so that lessons can be learned and improvements can be made before the next species is found.

- **Data coordination/accessibility:** Reports and data concerning invasions must be broadly accessible, easy to use, and exchanged among interested parties routinely. It is also important that data obtained from various technologies be integrated across a range of temporal and geographical scales so that they provide coherent, timely input into the decision making process.

Strategic Task: Early Detection and Monitoring

- Develop and implement coordinated frameworks/networks for active and passive detection to maximize the probability of AIS detection prior to the establishment of the invasive population.
    - Develop a comprehensive inventory of current environmental monitoring programs, systems and techniques in the Great Lakes (at both regional and state/provincial levels) and evaluate for potential in contributing to a regional monitoring program on a cost effective basis.
    - Identify and evaluate gaps of existing programs and determine what additional monitoring programs are needed.
    - Develop quantitative monitoring techniques/protocols for AIS sampling accounting for acceptable levels of uncertainty.
    - Develop incentives for passive and volunteer detection networks to participate in the broader AIS early detection and monitoring network.
    - Develop simple training programs and/or education tools on AIS identification, sampling and reporting. Take advantage of existing monitoring entities in the region with capacity to participate in passive AIS detection and monitoring given the proper knowledge and skills.
- Develop Great Lakes-specific training materials for the public and stakeholders to raise awareness for potential invasive species and guidance on measures to be taken upon AIS discovery.
- Utilize the ANS Task Force Taxonomic Expert Database (http://www.dorklegion.com/USGS/experts/search.php) to identify/verify specimens in a

timely manner.
- Create a specimen repository where voucher specimens of invasive species can be kept for reference.
- Develop a protocol to ensure appropriate treatment and preservation of samples that will be retained as voucher specimens.
- Develop, implement and publicize a reporting system/communication structure to forward information on known or suspected AIS to an "Invasive Species Notification System" identifying a lead agency or organization when possible.
- Develop and implement a process for identifying high priority species for which to monitor using a set of criteria based on "invasiveness" characteristics. The Great Lakes Panel on Aquatic Nuisance Species should be consulted regarding a regional list on high priority invasive species as developed by the Panel's Research Coordination Committee.
- Establish locations in the Great Lakes basin where routine monitoring should occur based on the identification of 1) "hotspots" characterized by high invasion risks such as industrial ports with high volumes of shipping traffic, or 2) high value resources that could be severely impacted by a new invasion such as national system of lakeshores and parks.
- Implement short-term, targeted surveys by trained professionals for taxonomically challenging priority species or in high risk/high value habitats.
- Provide ongoing training for professionals and volunteers engaged in early detection, collection and reporting of suspect species.
- Conduct ecological inventories to establish baseline information on existing populations of species, as well as habitat/organism relationships (see CRIMP report on *Revised Protocols for Baseline Port Surveys for Introduced Marine Species: Survey Design, Sampling Protocols and Specimen Handling* as a model).
- Develop a regional shared database of AIS sightings and established AIS populations for mapping and information sharing. Participate in national spatial and information database efforts (***Obtain specific names of databases)***.
- Encourage use of the Great Lakes monitoring network and coordination with national efforts through the use of a tiered monitoring approach.

4) Decision Support and Rapid Scientific Assessment

Objectives
- Determine the potential "invasiveness" of verified new species in establishing associated risks;
- Determine if the AIS invasion merits a response, by applying the scientific assessment, as part of a decision support system;
- Ensure that the decision to respond is based on political, economic, social and technical feasibility;
- Determine if it is possible to respond in an environmentally sound manner to prevent the spread and permanent establishment of the AIS population;
- Establish legal authority, if not already existing, for the parties responsible for decision making and implementation of the rapid response action;

- Ensure existing justification for rapid response by providing documented, compelling evidence for decisions on rapid response, based on an established protocol.
- Establish a systematic process that can be efficiently applied to recommend a response to an AIS invasion or not. It is critical that the process is driven by credible, non-biased information as presented in the aforementioned list.

Background

A decision support system that is coupled with scientific assessment is essential in providing justification as to whether rapid response proceeds. Although each component involves a distinct set of activities, decision support and scientific assessment need to be conducted in close coordination. The decision support system, a conceptual framework for how to address apprehended AIS invasions, provides a means for disparate parties to proceed with a path based on consensus of those parties. The decision support system requires focused attention at critical point in the process, analysis based on several driving forces, and input/participation from agencies and public/private stakeholders (Richards, *Workshop: Rapid Response Planning for Great Lakes Aquatic Invasions*, July,2003). Scientific assessment is a sub-process underlying the decision support systems for determining if a response is warranted given potential impacts and technically feasible based on the characteristics of the invasive species and the nature of the infestation. The basis of a scientific assessment is gathering, interpreting, and disseminating biological and ecological information relevant to a response decision. An assessment of ecological risks posed by both the AIS invasion and the associated response is also a key component of a thorough scientific assessment. The scientific assessment committee (as described below) is chiefly responsible for these tasks. The process of scientific assessment must be completed in a timely manner to maximize the benefits of an early response.

The broader process of decision support takes scientific assessment into account as well as consideration for social, economic and political factors that emerge during the invasion event. A risk assessment is the process by which these factors are considered relative to one another in determining if a response is justified or not. A decision support system integrates this information, thus forming the foundation for implementing a rapid response plan if the benefits of a response prove to outweigh risks of not taking action. Throughout this process, it is important that decision support and scientific assessment are closely connected in their function to determine if a response should proceed. A decision should not be solely based upon a scientific assessment, and likewise, a decision should not be made without close consultation from the scientific community.

The decision making process involving rapid response is extremely complex, requiring analysis of several factors, frequently simultaneously in a relatively short period of time. To support this process, a common/centralized data base is needed to "house" the data collected in this analysis. The data must be interpreted as valid information in making decisions, taking uncertainty into account. Also important in maximizing the effectiveness of a decision support system is making the process "user friendly" particularly in regards to how information is applied in making decisions.

The scientific assessment committee – comprised of membership from the academic sector, state

and federal agencies, among others from the scientific community – should include both standing and supplemental members (FICMNEW, 2002). The committee should be structured to remain fluid, to take advantage of closest available resources as well as responding to the uniqueness of specific situations (ISAC ED&RR Subcommittee, 2003). Upon the report of an AIS invasion, it is recommended that the scientific committee is immediately convened to perform the following functions:

- Initiate a preliminary assessment of the AIS invasion, including species characteristics, and notify federal, state, local governmental representatives and other appropriate stakeholders of the invasion and its status.
- Evaluate the extent and degree of seriousness of the invasion and classify associated risks (e.g., will the invasion result in a substantial threat to the public health or welfare on a regional and/or national scale?).
- Assess the technical feasibility of control and/or eradication of the infestation.
- Provide recommendations to the appropriate decision making authority regarding the benefits and costs of rapid response efforts, including consideration for environmental soundness.
- In preparing for rapid response, provide guidance for efficient and environmentally sound eradication and/or control methods, if appropriate.

An exemplary case is that of the pest advisory group formed by the Animal Plant Health Inspection Service (APHIS). Upon discovery of the invasive pine shoot beetle, the group was able to share information and develop response strategies (Haack and Poland, 2001). Through the process, the group was able to rapidly establish the extent of the invader's distribution and its potential impacts on industry as well as start the process of developing a regulatory response.

A critical point that must be addressed early on in the decision-making process is to determine if a response to the invasion is merited. Information gained from early detection and monitoring efforts and a scientific assessment should be utilized to predict the likelihood of colonization and the predicted impacts if the species is left unchecked. It is very difficult to determine if an AIS population will take hold and even more so to predict ensuing impacts. If it is known that an invader species will not become established due to inadequate biotic or abiotic requirements, then a response may not necessarily be needed. However, the likelihood of establishment is often difficult to determine, and therefore caution should be used. The rapid scientific assessment should examine food webs, habitats, and the current biota inventory to predict potential impacts. The extent of the infestation, the life history of the organism involved and the limitations posed by the infested area are factors that also should be taken into consideration.

To expedite the decision making process when an AIS invasion is apprehended, there is a need for accessibility to relevant research findings to help establish an understanding of the various factors that must be analyzed in the process of making a decisions. Some of these factors are biological and/or ecological in nature such as food webs, habitats and biota inventory. A proactive measure that should be pursued is identification of potentially harmful species likely to invade a particular region or habitat in the future. Key information (such as impact, range and life history) of high risk species can be researched before invasion actually occurs to provide supporting evidence on which to base a decision. Other factors to be researched involve

consideration of social, political and economic forces influenced by the outcome of the decision.

The decision support process must also identify, if possible, the vector(s) associated with the AIS introduction and determine the feasibility of interrupting that process. If the vector for introduction cannot be determined or can not be interrupted to prevent/minimize introduction, it may not make sense to invest time and resources on a response. The technical feasibility of eradication and/or control of the specific AIS infestation is another critical area in need of research and evaluation, before hand, if at all possible (see section on **Management Options for Control/Eradication** below).

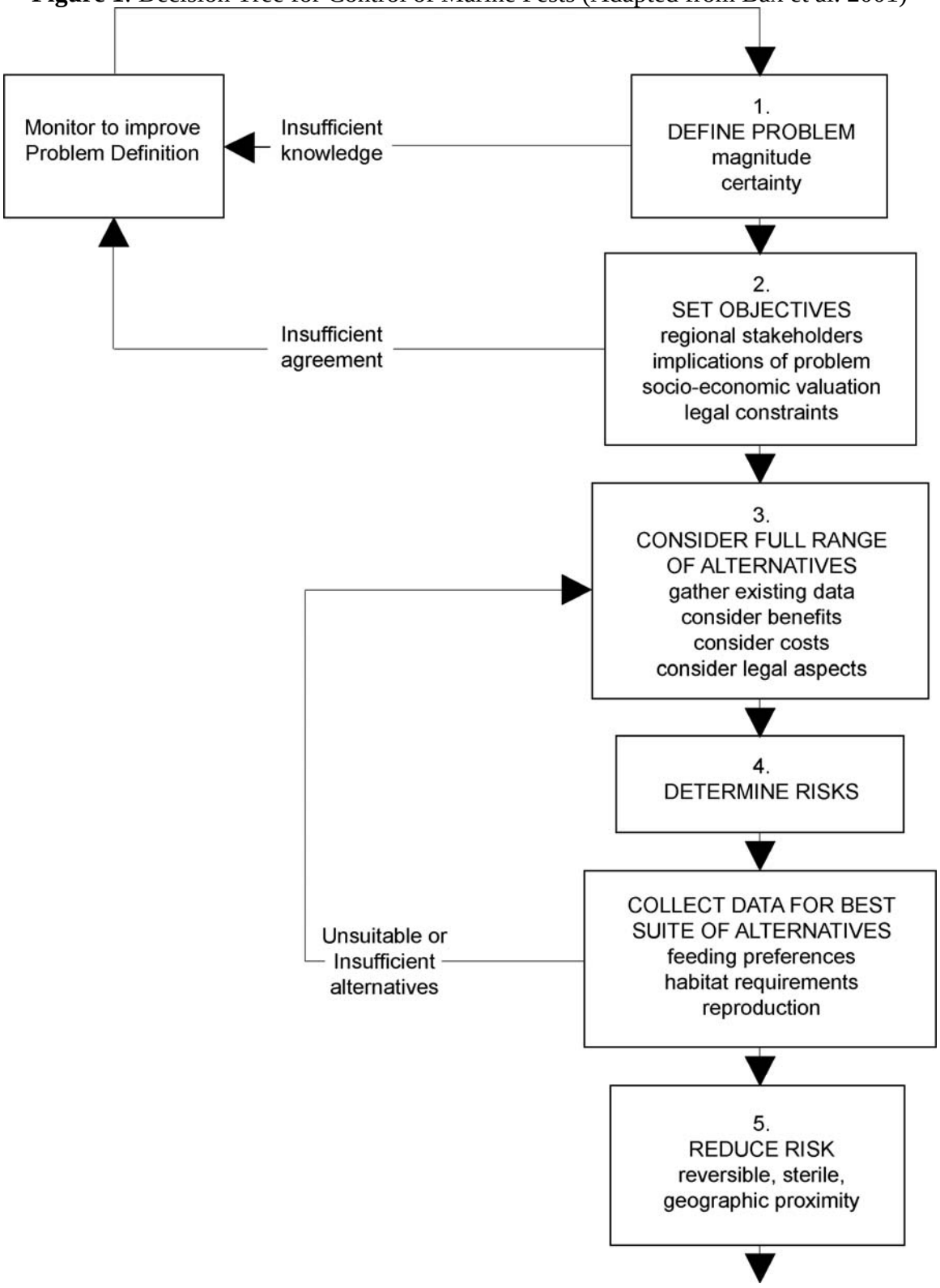
If the scientific assessment indicates that a response is merited and also feasible, the decision support process should be further applied to evaluate the risks and benefits of implementing the response. ***If the predicted costs and impacts of the damage caused by the invasive species outweigh the risks and costs associated with implementation of a rapid response plan, support then exists for response efforts to proceed.*** However, if costs and impacts of the invasive species do not outweigh those of the response, or if they are not known, further assessment and/or evaluation may be needed. Both economic and ecological costs should be considered as appropriate. Factors that need to be examined include, among others, decisiveness and precision of a response, the response period (short term or sustained), predicted effectiveness, public health and safety issues, environmental soundness, technical feasibility along with cost effectiveness. The geographic constraints posed by the infested area also need to be taken into consideration.

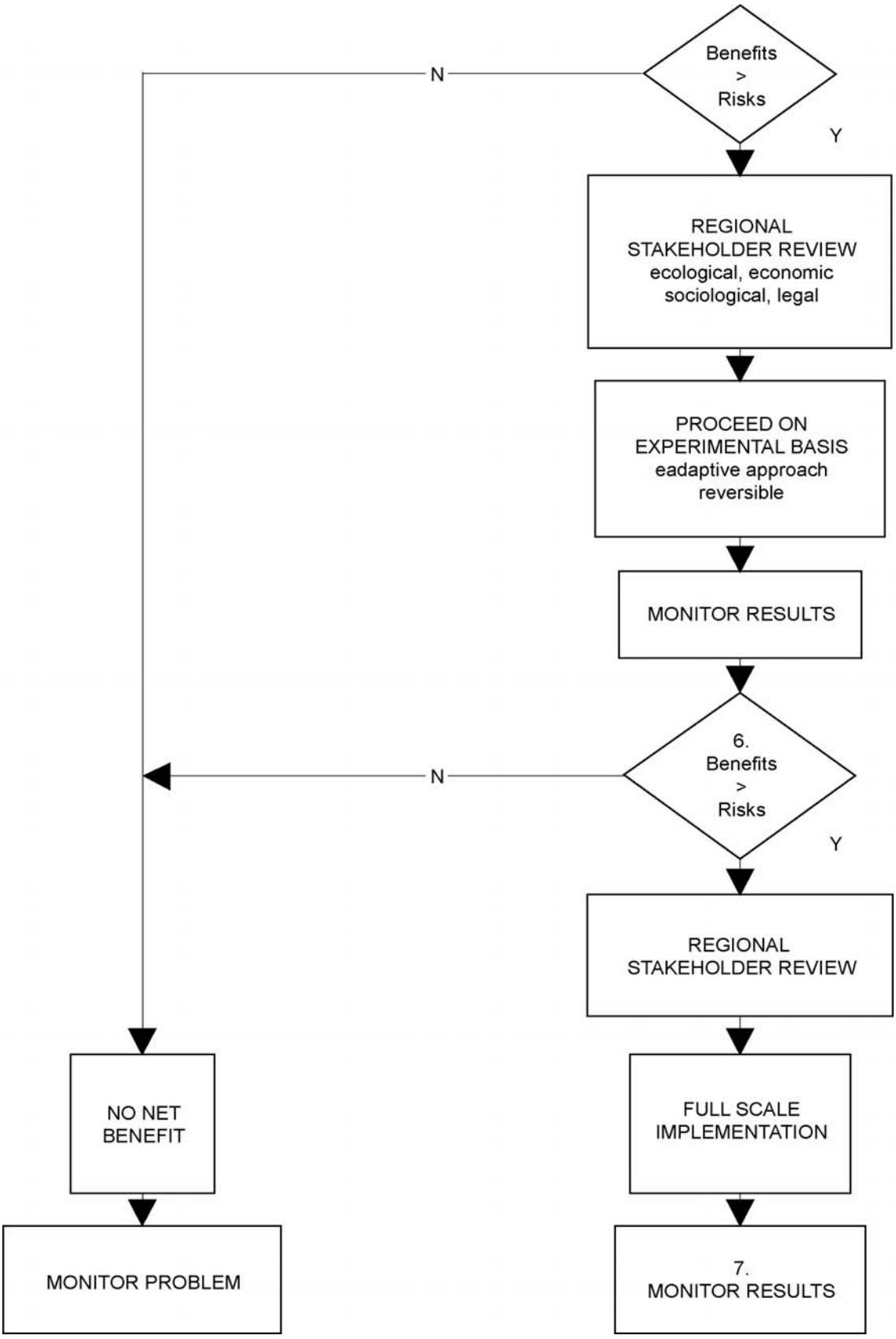
The risk assessment should contain a set of threshold criteria that drive decisions for response. For example, if a predetermined degree of economic or ecological loss is incurred or reliably predicted by the AIS invasion, support then exists for the response action to proceed. Threshold criteria can also be spatially based. For example, a rapid response could be considered if an invasive species is found upstream of a specific habitat of high quality.

It is considered essential that a wide range of public/private stakeholders, specialists, agencies and organizations are involved in the decision making process. Public involvement is considered particularly important since "rapid" response can be stalled or even backfire in the absence of public consensus and buy-in on the response plan. Stakeholder involvement can occur during both pre- and post-invasion rapid response planning efforts. Based on the Rapid Response Team Region V's experience in responding to abiotic emergencies (oil spills, chemicals, etc.), it has been found valuable to get the public involved in long-term responses. On the other hand, public involvement in short-term situations in need of immediate action can defeat the purpose of a "rapid" response.

The development of a decision tree may be a useful exercise to graphically depict the steps of the decision support system for rapid response. The following example of a decision tree was produced as an outcome of a pest control workshop, conducted in 1998 by the Marine Conservation Biology Institute. The example, reproduced in Figure 1 below, illustrates the critical points of a decision support system for control of marine pests (Bax et al. 2001). Consideration should be given to this example as a decision-making model that can be applied for Great Lakes aquatic invasions.

Figure 1: Decision Tree for Control of Marine Pests (Adapted from Bax et al. 2001)




Benefits > Risks
N
Y
REGIONAL STAKEHOLDER REVIEW ecological, economic sociological, legal
PROCEED ON EXPERIMENTAL BASIS eadaptive approach reversible
MONITOR RESULTS
6. Benefits > Risks
N
Y
REGIONAL STAKEHOLDER REVIEW
NO NET BENEFIT
FULL SCALE IMPLEMENTATION
MONITOR PROBLEM
7. MONITOR RESULTS

Strategic Tasks

- Establish agreements (i.e., memorandum of understanding) and institutional arrangements that are needed to conduct a decision support system.
    - Based on these arrangements, a coordinated body should be convened to serve in a decision-making capacity with a primary agency/organization designated to lead the process. Representation should include, among others, the states/provinces, Great Lakes Commission, Great Lakes Fishery Commission, International Joint Commission, U.S. Army Corps of Engineers, U.S. EPA, U.S Fish and Wildlife Service, National Park Service, U.S. Coast Guard, tribal authorities and Council of Great Lakes Governors. It is recommended that the decision-making body is vested with the legal authority needed to make rapid response decisions that can be implemented, with special legal authority given to the designated lead.
    - Funding strategies for rapid response efforts should also be determined as part of institutional arrangements, including cost-share agreements on a multijurisdictional (i.e., federal, state, local) and international basis. If budget constraints seem to be prevailing, a compelling case needs to be made for rapid response action.

- Define a framework, targeted for the specific AIS invasion, to establish the flow of information in the decision-making process. The framework should identify critical decision points and depict the role of scientific assessment, including associated risks, through out the process (a model flow chart for rapid response decisions will be adapted from the pest control decision tree shown in Figure 1).

- Establish a centralized repository where data can be compiled, displayed (e.g. Geographic Information Systems), interpreted, accessed and targeted for use information in the decision making process on a basin-wide scale. Important in the collection of data is determining/articulating the destination where it will be used as information during the process of making decisions (e.g. Great Lake Commission, International Joint Commission, Great Lakes Fishery Commission, Michigan ANS Advisory Council)

- Develop an appropriate set of decision making tools (e.g., statistical analysis) with the capacity to weigh the factors (e.g., biological/ecological, technical, economic, social) that are driving the decision for rapid response to AIS invasions.

- Scientific Assessment
    - Establish a team of experts to serve on a scientific assessment committee
    - Establish a protocol for scientific assessment applying the following guidance:
        - Conduct a sighting confirmation through
            - taxonomic evaluation
            - targeted confirmation sampling
        - Characterize the nature of the invasive species to determine
            - known life history and behavior of the organism;
            - organism/environment relationships;
            - distribution/invasiveness in native range;

    - success in other non-native introductions;
    - opinions on AIS through published literature, expert opinion
  - Determine the infestation extent by
    - targeted sampling of similar habitats in the water body;
    - population size and age structure;
    - sampling of connecting and adjoining water bodies
  - Initiate a preliminary assessment of the invasion and notify federal, state, local governmental representatives and other appropriate stakeholders of the invasion and its status.
  - Delineate environmental factors influencing potential action
  - Size and location of infested water
    - For example, wetland, bay, pelagic waters
    - Likelihood of spread to adjacent waters
    - Distance to urban centers/recreational/commercial use
  - Physical and chemical characterization of infested area
    - Bathymetry/substrate
    - Circulation patterns
    - Conductivity/nutrient status
    - Temperature
  - Status of existing biological community
    - Stable/perturbed ecosystem
    - Community composition
    - Threatened species
    - Societal uses (e.g. anglers, water supply, contract recreation)
  - Identify vector/mode of transport
    - Source
    - Potential frequency of re-introduction
  - Estimate potential impacts (ecological, economic, political, and social)
  - Identify range of potential actions for response (barriers, biological, chemical, combination, status quo) (This strategic action is closely linked with **Management Options for Control/Eradication** section)
  - Evaluate alternatives (cost, probability of success, effect on aquatic community, effects on established beneficial uses)

- Apply scientific assessment to make a decision on how to proceed for a response to the AIS invasion. As part of this process, a set of threshold criteria should be developed to drive decisions for action (e.g. predicted level of economic or ecological loss, if a species is found in a certain location). It should be noted that no action on rapid response is considered an option. If the decision supports a response, it is recommended that the AIS populations are hit early and at full force.

- Conduct a communication and education campaign targeted to all stakeholders during the entire process of decision making with the objective of making the process user friendly and transparent both to the public and the agencies making the decision.

(Note that source of information presented on **Scientific Assessment** is adapted from a presentation of Carl Richards at the *Workshop: Rapid Response Planning for Great Lakes Aquatic Invasions,* 2003.)

5) Management Options for Eradication and/or Control

Objectives

- Develop a set of accessible tools by which to manage for eradication, control, containment, quarantine or impact mitigation associated with specific aquatic invasive species or taxonomic groups;
- Establish process by which to select management tools to implement by assessing the characteristics and requirements for using various physical/mechanical, biological, or chemical tools approved for application during a rapid response to newly discovered invasions;
- Where applicable, secure pre-approval for tools needed to implement management strategies;
- Secure access to the permitting process for application regarding scenarios involving high risk species and generic jurisdictional scenarios;
- Encourage research and development to expand the tool kit targeting taxonomic groups where eradication and/or control and containment measures have yet to be developed;
- Ensure that all appropriate authorities participate in rapid response planning, to provide the operational and legal support needed to evaluate, select and implement management options.

Background

There is general agreement that only a limited set of physical/mechanical, biological and chemical tools have been approved for use in managing AIS invasions through rapid response. Given this reality, it is critically important in preparation for rapid response that efforts continue to identify/assess existing management strategies and associated tools available for use in responding to AIS invasions. Resources must also be committed to advance research and development to expand the rapid response tool kit targeting aquatic invasive species with an emphasis on those taxonomic groups (e.g. invertebrates, microbes, etc.) where management experience is lacking (Dean Wilkinson, National Invasive Species Council, personal communication, April 2004). It goes without saying that efforts must also continue to promote the prevention of AIS introduction and spread through educational campaigns, regulatory measures (restriction of AIS possession and/or transport) and other legislatively-based prevention strategies.

Rapid response management strategies include a spectrum of eradication, control, containment and/or impact mitigation measures. Management options selected for implementation are determined by specific conditions of the AIS invasion and the feasibility (i.e., technical, economic, political) of using existing management tools. The goal of eradication is to reduceAIS populations to levels not reproductively viable (including resting stages), resulting in complete elimination of the AIS population within the area of invasion. Containment, a form of control, is

designed to restrict the spread of an invasive species and to contain the population within a defined geographical range. The goal of AIS control aims for a long-term reduction in density and abundance to below a pre-set acceptable threshold (McNeely, et al. 2001). Mitigation of impacts is considered a last resort, if eradication, containment and control are not options or have failed in managing an AIS invasion. If mitigation is the only alternative, lessons are needed on how to adapt to the AIS invasion in the best achievable way, while still maintaining efforts to protect the integrity of the ecosystem, including biodiversity and endangered species (Wittenberg and Cock, 2001). Fundamental to the selection of management options for rapid response is to determine realistic objectives. For example, is it the intention to eradicate the AIS population or to reduce it to a certain level? If the latter, to which level will it be reduced, and how will it be maintained at such a level? Objectives should also define spatial and temporal boundaries for implementation of management options (McNeely, et al., 2001).

In preparing for a response to an AIS invasion that is both rapid and effective, it is important that a structure is in place allowing for pre-approval and permitting of management strategies (e.g. eradication and/or control) and associated tools (e.g. mechanical/physical, biological and chemical). The pre-approved set of tools needs to be accessible to state and federal agencies to facilitate timely selection and application. Several of the most common options applicable to several invasive species should be pre-approved for specific situations. The U.S. Army Corps of Engineers uses a national permitting process to establish an initial acceptable regional permit for the use of specific chemicals. It is recommended that this approach is applied as a model for approval of eradication and/or control measures for AIS rapid response.

Expertise regarding the approval process is needed, particularly in terms of meeting the requirements of the National Environmental Policy Act (NEPA), the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and possible other environmental regulations. An environmental assessment typically is required under NEPA for any proposed chemical treatment. Such an assessment must include a description of the proposed treatment, why the treatment is needed, a description of the environment to be treated, projected environmental impacts of the proposed treatment, mitigating measures to offset adverse impacts of the treatment, unavoidable adverse impacts, irreversible and irretrievable commitments of resources, documentation of public and agency interest, and alternatives to accomplish the proposed work (Wiley and Wydoski, 1993). It is important to note that the requirements under NEPA only need to be met if a response occurs on federal land/water, with the use of federal funding, or involves the actions of a federal agency. However, there are some categorical exclusions. If there is absolutely no federal involvement, the requirements of NEPA do not need to be met.

In order to have a rapid response be truly “rapid”, the ground work for a NEPA environmental assessment should be in place. It is recommended that federal entities with jurisdictional authority in the Great Lakes region (U.S. Forest Service, National Park Service, U.S. Fish & Wildlife Service, etc.) could convene a regional workshop where the primary pieces of a NEPA document could begin to be put together for relevant invasive species in the Great Lakes (*Workshop II: A Rapid Response Plan for Great Lakes Aquatic Invasions – Species Specific Case Study*, 2004). This process could also take place with a more generic focus so that the assessment document could be adapted to any number of possible invasive species scenarios. In any case, if

no NEPA work is in place prior to an invasion, the assessment and subsequent documents are likely to slow any response considerably.

Environmental assessments are typically reviewed by the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency, state agencies, and the public. If the benefits of a treatment unequivocally exceed the negative impacts and no adverse comments are brought up by the reviewers, the planned treatment usually is approved to proceed. In certain cases, a pretreatment study may be needed to adequately prepare the environmental assessment. If there are severe and/or significant adverse environmental impacts or public health concerns predicted from the implementation of the treatment, a more detailed environmental impact statement must be prepared.

Quarantine establishment and enforcement of AIS regulations are two important management options that need to be considered in early stages of implementation of an AIS rapid response. Quarantine is implemented in efforts to prevent spread of the unwanted organisms to other areas, in many cases, before decisions are made on long-term response action. Quarantine may involve closing ports or modifying access to ports to incoming and outgoing commercial and recreational traffic, or simply closing access to an inland lake or pond while managers assess the situation. Completely closing a port to commercial/recreational traffic may not be feasible or legal, based on the precedent of interstate commerce. A critical objective to achieve in quarantine is limiting or eliminating access or exchange of material or organisms from a given habitat without complete closure of the system.

Enforcement measures, often needed in quarantine efforts, may also be used to interrupt the vector of AIS introduction, if known. In the case of hydrilla, a high-risk invasive weed, approximately sixteen states either have laws or are in the process of developing laws restricting the possession and/or transport of hydrilla. The federal Plant Protection Act of 2000 restricts the interstate transport of noxious weeds including hydrilla (Rick Hobrla, Michigan DEQ, personal communication/email, April, 2004). Depending on the location and extent of the infestation, several agencies may have quarantine and enforcement authority and responsibility. These responsibilities should be predetermined to facilitate immediate action in the event of an invasion. In many cases, the U.S. Coast Guard will likely play a major role in quarantine establishment and enforcement. The U.S. Army Corps of Engineers may also be involved if structures need to be modified, added or eliminated.

The management tools used in rapid response efforts, described by category in the summary below, should be applied with a scientific understanding of effectiveness as well associated risks (Wittenberg 2000 and Howard 2000).

- Physical/mechanical: removal of the species by hand or with appropriate machines such as harvest and trawling vehicles (e.g., water hyacinth), or firearms (e.g., for culling large mammals), or traps (for some vertebrates, fish, or insects). Other examples include trap nets, water drawdown and exposure to heat.
- Chemical: application of herbicides and insecticides, in efforts to target only the invasive species of concern, avoiding the potential problem of resistance developing over time.

Examples of chemical used in the event of aquatic invasions include rotenone, Bayluscide and TFM.

- Biological: intentional use of populations of natural enemies of the target invasive species or other methods. Examples of biological control involve, for example, mass release of sterile males of the target species, inducing resistance in the host against the invasive species that is attacking it, releasing the natural enemy to control the invasive species. Biological control may give long-term suppression of an invasive species without recurrent costs as has been illustrated by the control of purple loosestrife by the beetle. It should be implemented in line with existing national regulations, international standards and prior risk analysis.
- Habitat management: measures like prescribed burning, grazing, etc. (may not be applicable to aquatic scenarios.)
- Integrated pest management: combines the methods described above, based on ecological research, regular monitoring and careful coordination.

Physical/mechanical methods may be the most specific and selective while chemical methods tend to render wide-ranging effects on the ecosystem. Biological control methods are often controversial and take longer periods of time to attain permitting for implementation given the relatively high level of uncertainty associated with biological control organisms. The Australian Center for Research on Introduced Marine Pests has produced an excellent document reviewing rapid response options and control measures (McEnnulty et al., 2001). While the document is specific to marine pests, the information is also relevant to the Great Lakes region.

A novel approach to AIS management involves looking broadly at the invaded ecosystem and trying to determine the underlying causes of the AIS invasion or factors that are facilitating the invasion. Many researchers and managers believe that eradication is not feasible. An alternative is to closely examine the ecosystem and try to eliminate the facilitating factors and thereby control and inhibit the spread and establishment of the AIS population. For example, instead of treating a lake with herbicides year after year in an effort to eliminate Eurasian milfoil, an alternative approach would be to try and eliminate nutrient loading that may be facilitating the growth and spread of the milfoil (*Workshop II: A Rapid Response Plan for Great Lakes Aquatic Invasions – Species Specific Case Study*). In the long-term, controlling nutrient loading (a facilitating factor) may be more cost effective than repeated eradication measures (herbicides). Put simply, rather than attack the problem directly, attack the cause of the problem.

In the formal evaluation of rapid response management tools, it is a useful exercise for the response team to assess specific characteristics and requirements of these tools associated with physical/mechanical, biological and chemical management options. An example of an assessment matrix for rapid response management tools is presented (below) in Table 1. The matrix could also be used in the evaluation of management options for specific species and associated habitat where AIS invasion occurred.

Table 1: Assessment matrix for evaluating the feasibility of various management options.

Assessment	Physcial/ Mechanical		Biological		Chemical	
	A	B	X	Y	1	2
Timeline to apply treatment						
Specificity of treatment to invading species						
Authority to access invaded habitat						
Required Federal permits for application						
Required state permits for application						
Required training needed to apply treatment						
Safety concerns for applying treatment						
Costs of treatment						
Effectiveness of treatment						
Appropriate to specific habitat under consideration						
Long-term ecological impacts (restoration)						
Evaluating existing guidance on use/impact						
Detoxification time						
Assessment for threatened & endangered species						
Public acceptance of approach						

The classic method for assessing management options is a benefit-cost analysis. This requires that the expected present value of the benefits (e.g. ecological, economic, social) of the management program is no less than the expected present value of the costs of the treatment. The following discussion is given for the purpose of example: "While eradication may involve high initial economic costs, if eradication is achieved, it is invariably more cost-effective than any measure that requires continuous expenditure over long periods of time. On the other hand, eradicating the last few individuals might be exceedingly expensive; for example, malaria eradication programs in tropical countries have proven very cost effective in the early stages but the last stage has seldom been achieved" (McNeely et al. 2001). The law of diminishing returns must certainly be taken into account in a benefit-cost analysis.

Also fundamental to the selection of management tools is an assessment of characteristics of species or taxonomic group, location and extent of the infestation. Currently four registered toxicants, rotenone, antimycin, TFM, and Bayluscide, are available and approved for use as piscicides under specific conditions in the United States (Schnick et al., 1986). The Fisheries Act of Canada does not permit the application of any toxic substance in waters inhabited by fish, but the Pesticide Chemicals Act of Canada does allow for the use of a specific form of rotenone in small landlocked lakes (Wiley and Wydoski, 1993).

A suggested approach is to create a list of undesirable species and associated pre-approved management options/tools that can immediately be applied if a particular species is found. It is also important to understand that most eradication/control tools have associated risks. The ideal

tool would be highly specific to a target organism, holding no long-term effects, such as bioaccumulation in the food web or creating any human health hazards as well as being cost effective. Rarely, if ever, can all of these characteristics be attributed to one management option.

Permitting for chemical response methods will likely require approval of the U.S. Environmental Protection Agency (U.S. EPA), state EPA's and/or departments of environmental quality, and possibly the local state and/or U.S. agricultural departments. Physical response methods may need to be approved by the U.S. Army Corps of Engineers if the work takes place in, on, or over a navigable waterway. Biological control methods will likely need approval from the U.S. Fish and Wildlife Service as well as local state departments of Natural Resources. Whatever the chosen response, communication and coordination among these and other agencies is critical to success.

Education and public outreach also need to be considered as tools for rapid response management to eradicate and/or control an AIS infestation. It is critical that the public is kept informed on AIS invasions, associated risks and management options that can be applied to limit the spread and maintain a successful quarantine while the decision making process is underway (refer to section on **Outreach)**.

Technical expertise and scientific support is essential to the selection and implementation of management options. It is critical that appropriate agencies/institutions, such as the U.S. EPA, NOAA, and the U.S. Army Corps of Engineers, are identified and integrated as part of the process of rapid response management. Institutional support from such entities is an important step in gaining public endorsement for implementing selected management options.

The process and tools described in **Management Options for Eradication and/or Control** are closely linked with the aforementioned section on **Decision Support and Rapid Scientific Assessment** section and the **Implementation** section that follows. The processes described in each section should not occur independently from one another. For example, the scientific assessment committee described in the **Decision Support and Rapid Scientific Assessment** section will likely play an integral role in assessing and recommending the preferred management option and associated tools. The final decision to use the recommended management option and subsequent implementation will likely be carried out by the agency/entity with jurisdictional authority. As mentioned earlier in this report (section on organizational structure and communication) the state in most cases will have operational jurisdiction for control actions. Here again, the compelling need for well defined and developed coordination, organization and communication structures is evident for rapid response planning.

Strategic Tasks*: *Management Options for Eradication and/or Control

- Take the necessary steps required to prepare for mobilization of containment and quarantine options, often needed immediately following an AIS invasion for interim use while decisions are being made on permanent management strategies.

- Evaluate management options for implementation of rapid response:
    - Identify appropriate management options based on nature of AIS invasion,

species-specific characteristic, spatial and temporal boundaries of invaded habitat and other driving forces;
- Develop an assessment matrix of treatment options to track the characteristics and requirements for using mechanical/physical, biological and chemical tools available for implementation of management options;
- Conduct a benefit/cost assessment in determining those management tools feasible for use.

- Select management options for rapid response implementation (refer to **Decision Support and Scientific Assessment** section above).

- Establish a legal framework to support implementation of management options for rapid response:

  Pre-approval and Permitting
  - Research viable options currently available and approved for pest management with applicability to AIS invasions;
  - Pursue opportunities to secure pre-approval of eradication and/or control management options;
  - To assist in permitting efforts, refer to the U.S. Army Corps of Engineers national permitting approach as a model to establish an initial acceptable regional permit for the use of specific chemicals;
  - Contact local, state and federal; agencies and relevant offices regarding permitting requirements and proceed accordingly to fulfill permit requirements needed for treatment application.

  Establish Legal Powers for**:**
  - Prohibition on further AIS releases to the natural environment whether intentional or through negligence
  - Regulation of quarantine, containment, possession, transport and trade;
  - Notification requirement for all land owners and residents promptly to inform the relevant authority of AIS detection
  - Authority for domestic officials to notify, cooperate and consult with counterparts in neighboring countries on possible invasion and coordinate management programs
  - Authority for appropriate officials to use cost recovery mechanisms (polluter pays) and/or revenues from national or regional environmental funds to finance AIS rapid response plan
  - Inspections, confiscations, disinfection of equipment, destruction of infested material
  - Implementation of selected management tool (e.g. chemicals)
  - Closure of contaminated areas to navigation or traffic (delineation of a safety/quarantine zone);
  - prohibitions/restrictions on transfers of living material from contaminated to "clean" areas
  - Ban on anchorage and provision of alternative buoys or moorings

- Establishment of compliance program based on enforcement and economic incentives

- Set the stage for implementation of management options (refer to **Implementation** section below)
    - Identify logistical issues such as institutional barriers, timelines, and limitations for each potential treatment option.

- Conduct an outreach campaign targeted to the appropriate stakeholder groups to support management efforts.

- Establish a program for research and development to expand the tool kit for rapid response management.

6) Implementation

Objectives

- Establish a process and infrastructure that facilitates logistical support for a coordinated, timely response to an ANS invasion;
- Address logistical needs through development of a response implementation plan;
- Ensure that the goals and objectives of an implementation plan are met by utilizing real time evaluation.

Background

Successful implementation of a rapid response to an AIS invasion is largely dependent upon the plan being operational on a local, state, regional and federal level. In preparation for a response to an AIS invasion, extensive background work needs to be conducted such as preparing interjurisdictional agreements, marshalling of response resources, identifying logistical needs, and laying the groundwork for effective communication involving agencies as well as public stakeholders.

The case of the 2002 invasion of northern Snakehead *(Channa argus)* in Walkingfish Pond, Crofton, Maryland (Patuxent River drainage) illustrates the importance of strong logistical support during the implementation phase of rapid response. Steve Early, Maryland DNR, recounts the story of the Snakehead to highlight the logistical issues key to the success of a rapid response as adapted from the workshop proceedings, *Rapid Response to Aquatic Nuisance Species in the Northeast* (Northeast Aquatic Nuisance Species Panel, 2003).

The northern Snakehead, a top-level predatory fish native to eastern Asia and well adapted to temperate climates, was caught by anglers on three different occasions during the spring of 2002 in Walkingfish Pond. Investigation by the Maryland police led to the admission by a local resident of a release into the pond of 2 snakeheads, purchased in a live food fish market in New York. Walkingfish Pond, is approximately four acres with an average depth of 4-8 feet. With only 100 yards of low lying forested land separating the pond from the Patuxent River, there was

significant concern of accessibility to the Patuxent River drainage during overflow events resulting from extreme rainfall events or high river stages. The reported ability of the Snakehead to breathe air and survive several days out of water, if kept moist, added to concern over the spread of this invasive fish. Subsequent electro-fishing surveys in the adjacent river, however, did not result in the collection of any Snakeheads.

In immediate response to the discovery of the Snakehead in Walkingfish Pond, the secretary of Maryland DNR convened a scientific advisory panel on July 19, 2002 to recommend appropriate action. Subsequently the panel recommended treatment with herbicides to facilitate rotenone application for eradication of all fish life in the pond and two adjacent ponds with a potential water connection. Other methods evaluated for use, including explosives, draining, and chlorine, were not considered as effective/feasible.

The following logistical issues played a role in supporting implementation, as reported by Early at the Great Lakes Panel's *Workshop: Rapid Response Plan for Great Lakes Invasions* (July 2003):

> sighting verification; immediate establishment of an advisory panel, pesticide permits; chemical acquisition and storage; applicator training and health certification; physical pond containment to prevent fish escape; weather prediction; hydrologic connection to other water systems; evaluation of potential impact to threatened endangered species; physical access to site for equipment; controlling press and public access to limit chemical exposure and prevent additional fish movement; air traffic control; parking and traffic control in a restricted area; authority to enter private property; coordination with other agencies including the U.S. Fish and Wildlife Service; local government support (e.g. county police; local landfill; fire department); state departments of Agriculture and Environment; acquisition, installation and maintenance of appropriate signage; response to concerned public; and detection of similar species.

Following chemical treatment, total eradication of fish life was reported in Walkingfish Pond with rapid response efforts totaling $110,000. Additional sampling in the adjacent river indicated no other sighting verifications of the Snakehead. Although Maryland anglers continue to report possible Snakehead sightings on a weekly basis, verification procedures have indicated that these Snakeheads were native species.

Quintessential to effective implementation is a high level of coordination to ensure that the appropriate stakeholders are involved and informed of actions. As emphasized by Early in the case of the Snakehead, coordination of public outreach merits the assignment of a public communications officer, preferably from the agency leading the rapid response, remaining on the case from start to finish. He stressed the need for a single operational point of contact with the press to ensure delivery of a correct and consistent message (refer to sections on **Organizational Structure and Communication** and **Outreach**). To reinforce this coordination, it is recommended that rapid response efforts and associated outreach are integrated as part of the state AIS management plans. A memorandum of understanding is another useful tool to assist in the coordination between federal and state agencies involved in response efforts (MNRG).

Coordination of rapid response efforts, however, can be disrupted if a power struggle arises between agencies. For example, a conflict could possibly emerge due to cross purposes evolving from precedent set by state rights versus federal authority. Conflict can also be caused by a lack of public support for plan implementation due, perhaps, to the perception that chemical treatments will result in unnecessary ecosystem impacts. In such cases, a mechanism of conflict resolution needs to be utilized in efforts to maintain approval and support for response actions by appropriate parties, including the public.

It is critically important for authority and leadership roles to be well defined on a state and federal level to effectively implement a rapid response (refer to section on **Communication and Organizational Structure.** Implementation of a response to an invasive species will most likely be conducted by the agency with the authority to respond or the agency with jurisdictional responsibility/rights over the infested area. Another priority issue that needs to be addressed for successful implementation is the establishment of legislation for administrative rules and regulations enabling rapid response to AIS invasions. Establishment of funding sources, such as environmental trust funds and matching grants through federal legislation, in the pending National Aquatic Invasive Species Act as proposed in 2003, is yet another.

Implementation of a rapid response is a process that entails strategic tasks from all of the sections comprising this model plan. This phase of rapid response is an all encompassing process and should not be considered as a distinct component or list of tasks. Likewise, the strategic tasks below should not be considered an exhaustive list. The strategic tasks that follow are adapted from guidelines developed by the ISAC ED&RR Subcommittee (2003) and are recommended to support implementation of a rapid response plan.

Strategic Task: Implementation

- Develop and apply an implementation plan that accounts for all aspects of a rapid response plan as highlighted in this model plan. The plan should also define goals and objectives within an established geographical area and timeframe. Legal authority should be applied, where appropriate, in support of implementation.
    - Establish an "on-call" advisory team (Invasive Species Response Coordinators (ISRCs)) that would coordinate implementation in the event of an invasion (refer to **Organizational Structure and Communication** section**)**.
    - Provide for stakeholder input in the development of response plans with an emphasis on the implementation phase (refer to **Outreach** section).
    - Assign an "on-call" public relations officer to handle coordinated/consistent communication with the public in the event of an invasion (refer to **Outreach** section).
    - Provide training for eradication and/or control that, ideally, would include mock exercises in emergency response.
    - Develop rapid response manuals in support of training programs including functional areas involved in the response (i.e., species-specific containment/control plans, species removal, relevant laws and policies, public outreach planning, safety measures, regulatory responses, etc.).

- Establish thresholds which trigger a scale-up of the rapid response plan to address cross-jurisdictional and/or rapidly advancing invasions. At each scale of operation, it is essential that there is an adequate mobilization of resources and that individual roles and responsibilities area clearly defined, including coordination and public communication.
- Utilize information from AIS monitoring programs to support implementation (refer to **Early Detection and Monitoring** section).
- Monitor for abiotic factors that could affect implementation efforts and make appropriate adjustments.
- Connect implementation activities to the decision support system backed up by scientific and risk assessments to choose the best management option based on technical, political and socioeconomic feasibility (refer to **Decision Support System and Rapid Scientific Assessment**).
- Follow-up response implementation with an assessment of results, mitigation for response side-effects, and long-term monitoring (for incidental spread) to adequately convey the level of success (refer to section on **Adaptive Management**).

- Establish an incident command system to coordinate implementation of response actions (refer to **Organizational Structure and Communication** section):
  - Establish agreements which enable personnel from a variety of agencies and diverse geographic locations to rapidly merge into a common management structure;
  - Create and maintain standing teams ready to respond with flexibility to make some adjustments to the specific needs and circumstances of an invasion in a timely manner;
  - Mobilize the responders responsible for setting up and carrying out containment, quarantine, and eradication and/or control efforts.

- Arrange agreements with jurisdictional authorities of bordering uninfested areas to make provisions that decrease the chance of subsequent invasions.

- Integrate, as part of the response implementation plan, a mechanism by which to resolve conflict on any level that might impede a response.

- Secure funding sources that are adequate and accessible to mount an effective, timely and sustained response to new invasions with the provision that these sources may need to be shared across jurisdictional boundaries (refer to **Funding** section).

7) Adaptive Management

Objectives

- Ensure that an adaptive management plan is developed with objectives to assess outcomes of rapid response implementation;

- Develop feedback process by which response efforts can be "adapted" based on assessment and desired outcomes;
- Determine the level to which the value and function of an invaded habitat can be restored based on technical feasibility and public acceptability;
- Build capacity for habitat restoration among agencies and stakeholder groups.

Background

The Canadian Ministry of Forests defines adaptive management as "a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. The most effective form - *active* adaptive management - employs management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed." (http://www.for.gov.bc.ca/hfp/amhome/amdefs.htm) An adaptive management scheme is crucially important to the implementation of a rapid response. Ideally, adaptive management will include an evaluation of plan effectiveness, mitigation and/or restoration of treatment areas, an assessment of re-introduction risks, and post-procedure monitoring. Additionally, education and outreach efforts should continue during the adaptive management phase of the rapid response plan to help articulate/communicate outcomes of the response.

The evaluation of the chosen management option should be used to determine if the desired outcomes have occurred and whether or not the goals and objectives set during the initial phases of plan implementation were met. Criteria should be developed to help determine if the response action was successful or not. Examples of such criteria include achieving a controllable abundance level of the invasive species, or a zero population abundance if the desired goal is eradication. The evaluation of the response actions should be an ongoing process rather than a one time occurrence. If the preferred management option is not producing the desired outcomes and meeting goals, there needs to be a mechanism in place to quickly make the decision to implement changes and adjustments or move to another option. The adaptive management phase of the plan allows for an assessment to determine the strategies that proved effective and those that were ineffective. This experience is then applied to the next approach or alteration of the current approach, thereby 'adapting' to unexpected or undesired outcomes.

In addition to evaluation of the response action, an assessment of response impacts should also be undertaken. This assessment will form the basis for any required mitigation or restoration efforts. The assessment should include involvement from relevant stakeholders. Due to the challenges associated with impact assessment, baseline information is usually needed to determine the degree of impact. Post-procedure conditions can then be compared to pre-procedure and pre-invasion condition to make a comprehensive assessment and determination of the need/extent for mitigation or restoration. The need for mitigation and/or restoration of the treatment areas needs to be evaluated both during and after implementation of eradication and/or control measures.

The U.S. Department of the Interior (DOI) currently conducts natural resource damage assessments (NRDAs) of critical habitat in the event of an oil or hazardous material spill. These assessments are used to place a dollar figure on damages from oil spills and other hazardous

materials so that a claim can be made against identifiable polluters. A similar assessment technique may be useful for determining the unintended or undesired impacts of AIS invasions. The case for mitigation or restoration of the treatment areas will likely rest upon associated costs and benefits. As often is the case, funding for mitigation procedures, particularly those that were not predicted, will be very limited. Before attempting any restoration, clear expectations should be stated, perhaps including a site plan for the effected area and a feasibility study for restoration efforts.

Defining clear goals and expectations will be key to mitigation and restoration efforts. The level to which an effected area is to be restored should be clearly defined. In many cases, restoration efforts seek to restore the altered area back to "normal" or "original" conditions (i.e. pre-invasion conditions). To define restoration success and determine the acceptable level of the pre-invasion state has been reached, baseline survey data is needed. Baseline, pre-invasion data will allow managers to know when restoration efforts are complete and goals have been met. Also important in determining the extent of restoration is determining the level to which the value and function of an invaded habitat can be restored based on technical feasibility and public acceptability.

An alternative to restoration is utilization of the resulting system which is considered another form of adaptive management. If rapid response to a particular invasion is unsuccessful, or if the management option severely impacts or alters the system beyond restoration, new values for the resulting system should be found. In such cases where restoration to 'normal' conditions is not possible or feasible, some sort of functional recovery should be pursued. A functional recovery requires knowledge of historic stakeholder values and the possible development of new values.

A regional example of utilization of a resulting system involves the invasion of the alewife into the Great Lakes from their native habitat in the Atlantic Ocean. Fisheries biologists used the release of other non-native species (Pacific salmon) as a biological control. The Great Lakes were irreversibly altered and managers and stakeholders alike had to adapt to a new aquatic ecosystem. A thriving and lucrative recreational fishery was born out of the introduction of Pacific salmon and alewife populations, held to acceptable levels, and integrated as an important link the foodweb of the Great Lakes. In light of the large number of established AIS populations in the Great Lakes, adaptive management is a reality that resource managers will always have to apply as part of management strategies.

The effort and resources expended during a rapid response will be wasted if a re-introduction and infestation occurs. To prevent re-introductions the pathways and vectors for introductions must be examined and altered. Post procedure monitoring is critical to determine the long-term success of the rapid response plan and potential application for other scenarios. If evaluations of response efforts initially indicate successful eradication and/or control and then subsequent invasions of the same species are detected by post procedure monitoring, the original introduction pathway may not have been stopped. Post procedure monitoring will also be helpful during mitigation assessment and re-introduction risk evaluations.

The adaptive management process is likely to be long-term as some of the effects of the invasion, response actions, and any mitigation/restoration efforts are not likely to be immediately evident. Due to the ongoing and long-term nature of the process, careful documentation of what has been accomplished before and after management efforts should be conducted. Documentation will not only assist in strengthening further response and associated management efforts related to a specific invasion, but it will also be helpful for future invasions in other areas.

Strategic Tasks

Establish an adaptive management plan to:

- Establish long-term goals and objectives for adaptive management and associated restoration and mitigation efforts. Goals/objectives should be based on definition of key terms ('normal conditions', 'original state 'success criteria', etc.).
- Acknowledge the level of uncertainty related to the policy or management options being considered as the "best" for the specific AIS invasion.
- Apply thoughtful selection of the policies and management option to be implemented as a rapid response to an AIS invasion.
- Mitigate and/or restore impacted areas to acceptable levels as determined by technical feasibility and stakeholder values and desired functions. An open forum process that is mediated may be necessary to accomplish this task.
- Monitor, evaluate and assess response outcomes and impacts with consideration of the original objectives (eradication, control, etc.) and identify unintended and/or undesired impacts of response actions.
- Apply the assessment of response outcomes to verify if expected results were achieved.
- Incorporate the assessment findings into future decisions and improvements to the response action.
- Document adaptive management practices that allow for efficient use of information in subsequent invasions.

(Graphic to be added on adaptive management feedback loop)

8) Funding

Objective

- Provide a means of adequate, longterm funding that is readily accessible for rapid response planning and implementation efforts.

Background

The largest potential obstacle to overcome for implementation of a rapid response is securing adequate funding. A funding plan should be developed both on a regional and state by state basis. As part of the plan, potential funding sources should be identified, including a description of potential means by which to secure the funding from the sources and a timeline/flowchart of the steps involved.

Many of the Great Lakes states are already functioning with limited funding under approved state ANS/AIS management plans. Passage of the National Aquatic Invasive Species Act (NAISA) proposed in 2003 stipulates integration of a rapid response element within those state management plans. Language introduced in the NAISA bill includes authorizations for contingency strategies and their implementation as well as a rapid response emergency fund. To help overcome potential funding obstacles, additional sources of state and federal funding should be identified, including interagency crosscut budgeting. It is strongly recommended that authorizing legislation does not result in unfunded mandates. Advocacy groups should encourage that Congress fully funds authorized rapid response programs.

Funds provided from different local, state and federal agencies as well as other sources should not be considered as one pool of money because each entity will likely have its own mandate by which it must operate. Another approach to explore is the establishment of a pool of money earmarked as an AIS emergency response fund under the auspices of an NGO such as the Great Lakes Protection Fund. A regional entity, such as the Great Lakes Panel on Aquatic Nuisance Species could be instrumental in soliciting the wide-spread support needed for the emergency fund given the geographic scope and membership diversity as represented on the Panel.

The oil spill contingency fund accessed and set up by the Regional Response Team is an example of how an AIS response fund could operate. Cost recovery for environmental damage such as that caused by pollution is sometimes achieved through traditional liability mechanisms. The "polluter pays" principle is one such strict traditional liability mechanism (Shine et al., 2000). The oil spill contingency fund is another example of cost recovery based on liability.

The U.S. Department of the Interior currently conducts natural resource damage assessments (NRDAs) of critical habitat in the event of an oil or hazardous material spill. These assessments are used to place a dollar figure on damages from oil spills and other hazardous materials so that a claim can be made against identified polluters. A similar assessment technique should at least be considered for determining the unintended or undesired impacts of AIS invasions. However, it should be noted that the polluter pays principle and other liability mechanisms can be difficult and controversial in AIS cases since invasions are often ongoing, not site-limited and involve more than a one-time liability payment (Shine et al., 2000). Most importantly, ascertaining proof that links a person or entity directly with an invasion can be extremely challenging, if not impossible. To further complicate matters, there can be a confounding timelag between the first introduction and subsequent detection and response activities.

Strategic Tasks

- Develop a funding plan to identify potential resources from federal, state and local agencies as well as public and private entities. As part of the plan, develop explicit strategies to secure and maintain long-term funding for preparation and implementation of a rapid response plan. Also to be considered is crosscut budgeting.
- Determine the feasibility of conducting natural resource damage assessments in the event of an AIS infestation with consideration of the "polluter pays" option.

- Examine existing policy and legislation to determine applicability to AIS response funding and propose new policy and legislation directed at current AIS rapid response funding needs.
- Implement advocacy efforts to ensure that Congress authorizes and appropriates funding for rapid response programs.
- Prepare cost estimates for several general response scenarios, as examples for policy makers, which can be adapted for expeditious use in the event of a new AIS invasion.

Species-Specific Case Study

The overall project design for rapid response planning (sponsored by U.S. EPA, Great Lakes National Program Office) incorporates the application of a case study scenario for a specific aquatic invasive species of high priority concern in the region. The primary purpose of the species-specific case study is to test the functionality of the model rapid response plan for Great Lakes Aquatic Invasions. In so doing, this case study is being used to evaluate which aspects of the plan are effective as presented in the model plan and which parts need further refinement. Additionally, individual case study scenarios test the model's adaptability to a state-specific setting while still maintaining applicability to the Great Lakes – St. Lawrence region.

The species selected for the rapid response case study is hydrilla (*Hydrilla verticillata*), a nonindigenous invasive aquatic plant that has been identified by the state of Michigan's ANS Council as a potential invader of Michigan waters as well as other waters in the Great Lakes region. Normally a warm-water plant species that has infested southern states, a northern variety of hydrilla has recently been found as far north as Maine and Washington State. There is considerable concern among resource managers that hydrilla infestations in a Michigan lake could render profound impacts on fisheries, boating, swimming, and other recreational uses of the lake. The effect of hyrdrilla infestations on aquatic ecosystems could potentially be more detrimental than Eurasian watermilfoil (*Myriophyllum spicatum*). Hydrilla can damage freshwater ecosystems both biologically and economically (Langeland 1996, Pimental et al. 2000).

Hydrilla infestations in states such as Florida and California have proven detrimental and expensive. While hydrilla has been found in both states for over 30 years, each state has responded differently to the initial infestations. In Florida, hydrilla was not initially recognized as being different from the native plant *Elodea Canadensis*. Once identified as a non-native invasive, response was slow and even staunchly opposed by certain interest groups. Once the seriousness of the problem was recognized, maintenance management was initiated. However, it was soon found that the $5 million that was allocated was inadequate so the plant continued to spread. Hydrilla is currently considered an extremely aggressive aquatic invasive plant found in over 40 percent of Florida's public waters and maintenance control costs are in excess of $17.5 million annually. Recognizing this, the state of California has adopted the policy of eradication to manage hydrilla infestations. Upon discovery of hydrilla in California waters, the invasive

plant is quickly and efficiently eradicated. Today, only a few isolated populations of hydrilla exist and costs of management are far less than in Florida. Management efforts continue in eradicating those populations still remaining. In California, the cost of hydrilla management was shown to increase rapidly as the area impacted by the infestations expanded (Rejmanek and Pitcairn, 2002). Due to the great speed with which hydrilla can enter and become dominate in the macrophyte community of aquatic systems and the high costs associated with its control and/or eradication, responses to AIS verified discoveries must be initiated as quickly as possible.

Although hydrilla is not yet known to be in Michigan waters, the Michigan ANS Council determined that development and implementation of a rapid response plan for hydrilla holds practical management implications for this particular aquatic invasive species and could also serve as the basis for response to other potential AIS infestations. In planning for possible hydrilla infestations, the ANS Council formed a hydrilla task force.

Michigan's Hydrilla Task Force, in consultation the Great Lakes Commission AIS project staff, selected hydrilla as a viable case study for the *Model Rapid Response Plan for Great Lakes Aquatic Invasions.* Coupling the regional rapid response model plan with species-specific work of the Hydrilla Task Force has proved to be a strong partnership beneficial for both efforts in addressing the risks of AIS invasions.

Commission project staff attended the initial meeting of the Hydrilla Task Force to begin developing the case study and introduce the draft model rapid response plan to the meeting participants. Following the initial meeting, members of the Hydrilla Task Force and Commission project staff met weekly via teleconference from March through April of 2004 to begin developing the case study. The second iteration of the draft model rapid response plan presented in this document was used as the foundation for development of rapid response scenarios to hydrilla infestations in the state of Michigan. During the weekly conference calls, each component of the model plan was discussed and textual content relevant to hydrilla rapid response was subsequently developed to serve as a case study for both this project and the state of Michigan. The model rapid response plan was used as a starting point for the case study, providing a framework for the layout, components and information flow of the case study.

Staff also conducted a second project workshop, *A Rapid Response Plan for Great Lakes Aquatic Invasions: Species-Specific Case Study,* focusing on the case study. The workshop was held on July 22, 2004 at the Great Lakes Commission office in Ann Arbor, Michigan. Participants attended the workshop both in person and via web/teleconference. The primary objective of the workshop was to apply the model rapid response plan to species-specific scenarios on hydrilla. The workshop examined how rapid response planning should be modified for different jurisdictional scenarios in the event of hydrilla infestations. More specifically, the workshop examined model plan components in the context of the following hydrilla invasion scenarios: invasion of a private lake with multiple owners, invasion of a Great Lakes harbor, invasion of a private pond, invasion of state managed waters, invasion of federally and state managed waters, and invasion of tribally managed waters. The workshop agenda has been included as Attachment C.

The section that follows is Michigan's case study rapid response plan for hydrilla invasions. As mentioned previously, development of the plan was led by Michigan's Hydrilla Task Force in consultation with Commission project staff . The *Model Rapid Response Plan for Great Lakes Aquatic Invasions* provided a framework that was used in the development of the hydrilla rapid response plan.

[Upon approval, *Rapid Response to New Aquatic Invasive Species in Michigan Hydrilla verticillata: A Case Study* as developed by Michigan Hydrilla Task Force will be available as an appendix to this report.]

Appendices

Appendix A: Rapid Response Project Advisory Team

Name	Organization
Pat Charlebois	Illinois-Indian Sea Grant, Illinois Nat. History Survey
Matt Colmer	U.S. Coast Guard
Mike Conlin	Illinois DNR
Mark Coscarelli	Public Sector Consultants
Michele DePhilip	Nature Conservancy, Great Lakes Program
Margaret Dochoda	Great Lakes Fishery Commission
Mark Dryer	U.S. Fish & Wildlife
Roger Eberhardt	Michigan Department of Environmental Quality
Duane Heaton	U.S. EPA Great Lakes National Program Office
Mike Hoff	U.S. Fish & Wildlife Service
Gary Isbell	Ohio DNR
Sandy Keppner	U.S. Fish & Wildlife Service
Mike Klepinger	Michigan Sea Grant
Paul Marangelo	Nature Conservancy, Michigan Program
Ron Martin	Wisconsin DNR
Max Michael	Indiana Dept. of Env. Management
Joe Mion	Ohio DNR
Ross Powers	U.S. EPA, Region V
David Reid	National Oceanic & Atmospheric Administration
Donald Schloesser	U.S. Geological Survey
Kristin TePas	Illinois-Indian Sea Grant
Dan Thomas	Great Lakes Sport Fishing Council
Marc Tuchman	U.S. EPA GLNPO
Kristin Wakefield	Pennsylvania DEP, Coastal Zone Management Program
Gwen White	DJ Case & Associates

Great Lakes Commission Staff
Kathe Glassner-Shwayder, Senior Project Manager
Kevin Walters, Project Specialist
Sarah Whitney, Project Consultant

Appendix B: Agenda – Workshop I

Workshop: Rapid Response Plan for Great Lakes Aquatic Invasions

July 23-24, 2003
Courtyard Marriott-Ann Arbor
3205 Boardwalk
Ann Arbor, Michigan
Phone: 734-995-5900

FINAL AGENDA

Day 1 – Wednesday, July 23

1:00 p.m.	**Greetings and Introduction**	**Marc Tuchman**, U.S. EPA GLNPO and **Roger Eberhardt**, MI DEQ
1:15 p.m.	**Rapid Response Plan for Great Lakes Aquatic Invasions** - Project Overview - Model Plan Framework	**Kathe Glassner-Shwayder**, Great Lakes Commission **Kevin Walters**, Great Lakes Commission
1:30 p.m.	**The Case for Early Warning and Rapid Response to New Invasive Species in the United States**	**Randy Westbrooks**, U.S. Geological Survey, Biological Resources Discipline
2:15 p.m.	**Aquatic Nuisance Species Task Force/Federal Perspectives on ANS Rapid Response**	**Sharon Gross**, U.S. Fish and Wildlife Service
2:30 p.m.	**Break**	
2:45 p.m.	***Communication and Organizational Structure*** An overview of the RRT Region 5 multijurisdictional experience in coordinating responses to chemical spills as a model for aquatic nuisance specie rapid response	**Ross Powers**, U.S. EPA – Region 5
3:05 p.m.	***Outreach*** *Experiences and knowledge gained from the invasions of the ruffe*	**Mike Hoff**, U.S. Fish and Wildlife Service
3:25 p.m.	***Detection and Monitoring*** *An overview of ANS detection and monitoring efforts in Hawaii*	**Donna Turgeon**, National Oceanic and Atmospheric Administration
3:45-5:45 p.m.	Breakout Session 1 Group 1: Communication/Organizational Structure Group 2: Outreach Group 3: Detection and Monitoring	*Facilitators* Ross Powers Mike Hoff Donna Turgeon
5:45 p.m.	**Adjourn for the Day**	
6:15 p.m.	**Reception Hosted by the Great Lakes Commission**	

Workshop: Rapid Response Plan for Great Lakes Aquatic Invasions
FINAL AGENDA

Day 2 – Thursday, July 24, 2003

8:00 a.m.	**Continental Breakfast**	
8:25 a.m.	**Agenda Review**	**Kathe Glassner-Shwayder**
8:30 a.m.	***Decision Support & Rapid Scientific Assessment***	**Carl Richards**, Minnesota Sea Grant
8:50 a.m.	***Management Options for Eradication/Control*** An overview of eradication/control tools and approval measures	**Phil Moy**, Wisconsin Sea Grant
9:10 a.m.	***Implementation*** Response to introduction of the snakehead fish in Maryland	**Steve Early**, Maryland DNR
9:30 a.m.	***Adaptive Management*** Controlling invasive plants in our National Parks	**Lisa Jameson**, National Park Service
9:50 a.m.	**Break**	
10:05 a.m.	**Breakout Session 2** Group 1: Decision Support/Scientific Assessment Group 2: Management Options for Eradication/Control Group 3: Implementation Group 4: Adaptive Management	*Facilitators* Kathe Glassner-Shwayder Phil Moy Steve Early Lisa Jameson
12:05 p.m.	**Lunch**	
1:30-2:50 p.m.	**Breakout Session Reports** – Brief synopsis of group discussion on each component of the rapid response plan	
2:50-4:00 p.m.	**Panel: Making Rapid Response Happen – The Operational Challenge**	
2:50 p.m.	**Introductory Remarks**	*Facilitator*: **Kathe Glassner-Shwayder**
3:00 p.m.	**State Perspective**	**Roger Eberhardt**, Michigan DEQ
3:15 p.m.	**Regional Perspective**	**Mike Hoff**, U.S. Fish and Wildlife Service
3:30 p.m.	**National/Federal Perspective**	**Chris Dionigi**, Department of Interior, National Invasive Species Council
3:45 p.m.	**Making Rapid Response Happen: Assignments and Next Steps**	**Kathe Glassner-Shwayder**
4:00 p.m.	**Adjourn**	

Appendix C: Agenda – Workshop II

WORKSHOP II: A Rapid Response Plan for Great Lakes Aquatic Invasions Species Specific Case Study

FINAL AGENDA

July 22, 2004
Great Lakes Commission, Ann Arbor, Michigan

12:00pm – 12:15pm	Sign-on & Set-up	
12:15pm – 12:30pm	Introductions & Logistics	Kevin Walters, Great Lakes Commission
12:30pm – 12:50pm	Rapid Response Planning	Kathe Glassner-Shwayder, Great Lakes Commission
12:50pm – 1:30pm	Hydrilla Case Study in Michigan: Lessons Learned	Roger Eberhardt, Michigan DEQ
	Scenarios for Discussion	*Facilitators*
1:30pm – 2:30pm	Scenario 1: Rapid Response in a Private Lake	State Agency
2:30pm – 2:45pm	*Break*	
2:45pm – 3:45pm	Scenario 2: Rapid Response in the Great Lakes	Marc Tuchman, U.S. EPA - GLNPO
3:45pm – 4:45pm	Scenario 3: Rapid Response in Other Inland Waters • State/Federally Shared Waters • State Only Waters • Tribal Waters	Mike Hoff, U.S. Fish & Wildlife State Agency Rep. Tribal Rep.
4:45pm – 5:00pm	Next Steps	Kathe Glassner-Shwayder

Appendix C: Case Studies

This appendix serves as a listing of rapid response case studies, including both successful and unsuccessful endeavors. These case study examples illustrate what worked and what did not work in other situations. Ideally, the lessons learned will be applied to rapid response efforts in the Great Lakes region.

- Case Study I: Ruffe – U.S. Fish and Wildlife Service & National Aquatic Nuisance Species Task Force
- Case Study II: *Caulerpa taxifolia* in Southern California (Merkel and Woodfield, 2000)
- Case Study III: Snakehead, Maryland DNR

Case Study I: Eurasian Ruffe

Text from: *EPA Briefing Paper: Great Lakes Nonindigenous Invasive Species.* Written by: Katherine Glassner-Shwayder, 2000. U.S. Environmental Protection Agency, Great Lakes National Program Office.

Species Characteristics

The Eurasian ruffe (*Gymnocephalus cernuus*) is a native of Eurasia. Many of the ruffe's characteristics cause concern, including its ability to rapidly reproduce, laying as many as 13,000 to 200,000 eggs per season. Females tend to live seven years, while males tend to live roughly three to five years with seven being the longest (McLean, Jensen 1996). The ruffe is known to actively compete with sport and forage fish, such as its relative and Great lakes native the yellow perch, for nesting and feeding sites (Picard 1995, Kindt, Busiahn 1994). To compete successfully, the ruffe relies on sensory organs called neuromasts, which lie in its head and lateral lines. These organs provide protection for the ruffe by detection vibrations from predator and prey in the dark bottoms of the lakes (McLean, Jensen 1996). The ruffe has a variable diet, focusing mainly on benthic insects but is also know to feed on the eggs of other species, such as whitefish (McLean, Jensen 1996, McLean 1993).

In a study done by the University of Minnesota Sea Grant, the ruffe was found to be more of a temperature generalist when compared to yellow perch. Because of their similarities, the ruffe directly competes with yellow perch for habitat resources. This study demonstrated that ruffe is able to thrive in slightly cooler waters (17 C), whereas the yellow perch functions better at 23 C. The ruffe is thus able to grow longer into the winter months and begin its growth earlier in the spring. To make matters worse, not only does this extra growth require a longer period of food intake, but the ruffe is also less efficient at using its food than the yellow perch, requiring it to eat more. This extra foraging leaves a much greater dent in the local ecosystem structure than would naturally occur (Minnesota Sea Grant). These alterations have been linked to population declines in yellow perch, trout perch, walleye (which feeds on perch) and emerald shiner. With ruffe sizes of only four to six inches, the ruffe does little to help make up for the commercial, recreational and ecological value lost from these other species (Kindt, Busiahn 1994). The ruffe's potential range is thought to extend from the Great Plains to the East Coast and into Canada, based on the similar conditions required for perch (Kindt, Jensen 1994).

Invasion in the Great Lakes

The ruffe was first found in the Great Lakes in 1986 in Duluth Harbor, Minnesota (Picard 1995). It was discovered during a local fish survey and is thought to have been transported to the area via ballast water (McLean 1993). Between 1986 and 1993, the ruffe increased its population 100 fold in the St. Louis River to comprise 80 percent of total fish abundance collected in trawls. It has since spread into Thunder Bay, Ontario; the Ontonagon River; many tributaries of Lake Superior, including the Sand, Flag, Iron, Amnicon, and Brule rivers; and Thunder Bay, Michigan in Lake Huron (McLean, Jensen 1996).

Management for the ruffe began in 1991 with the creation of a special Ruffe Task Force by the Great Lakes Fishery Commission. In 1992 the National Aquatic Nuisance Species Task Force determined that the ruffe was an aquatic nuisance species according to law and appointed members to a Ruffe Control Committee. The committee then worked on the management plan that had been developed by the Ruffe Task Force and attempted to develop a plan that would confine the ruffe to the western side of Lake Superior. However, in August 1995, two months after the committee submitted its plan to the ANS Task Force, ruffe were found in Lake Huron in Thunder Bay, Michigan, and revisions had to be made to the plan. Eight components comprise the management plan: population reduction, ballast water management, population investigation, surveillance, fish community management, education and bait fish management (Ruffe Control Committee 1996). In September 1999 an evaluation of the plan found mixed results. Population reduction appeared poor, as did ballast water management outside of Lake Superior. However, surveillance, education and baitfish management received good scores with helpful educational materials such as brochures, pamphlets and wallet-sized identification cards. Additionally, although populations in the smaller, less managed waters had increased since the plan's implementation, no spread from its 1995 location was observed (Busiahn 1999).

Most of the management for the prevention of ruffe spread has been done through a voluntary ballast water management plan implemented in 1993 by the Great Lakes shipping industry. This plan states not to take on ballast water from ruffe inhabited waters between May and June, when fish may be small enough to pass through filters. If water must be taken in these areas, that water must be exchanged at a depth of at least 240 feet in Lake Superior west of a demarcation line between Ontonagon, Michigan and Grand Portage, Minnesota (McLean, Jensen 1996). This is based on the reasoning that the St. Mary's River would provide access to all other Great Lakes, making control efforts virtually impossible. However, research continues to investigate ways to prevent the ruffe's spread outside of Lake Superior through ballast water, including using heat, electrical charges, gas, sound, pulverization, carbonation, alteration after intake, obtaining water at different water levels, ultrasonic treatments, filters and increased saline content (Glassner-Shwayder 1995, Picard 1995).

Case Study II: Caulerpa Taxifolia

Text from: *Rapid Response to Aquatic Nuisance Species in the Northeast: Developing an Early Detection and Eradication Protocol Workshop Proceedings*. Presentation by Lars W.J. Anderson, Ph.D. USDA-ARS Exotic and Invasive Weed Research, Davis, CA.

Rachel Woodfield, *Noxious Seaweed Found on Southern California Coastal Waters*, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Regional Office. http://swr.nmfs.noaa.gov/hcd/CAULERPA.htm

Species Characteristics

Caulerpa taxifolia is a green alga native to tropical waters that typically grows to small size and in limited patches. In the late 1970s this species attracted attention as a fast-growing and decorative aquarium species that became popular in the saltwater aquarium trade. A clone of the species was cultured for display at the Stuttgart Aquarium in Germany and provided to aquariums in France and Monaco. Around 1984 this species apparently escaped or was released from an aquarium into Mediterranean waters, and rapidly spread from an initial patch of about one square yard to over two acres by 1989. Genetic analysis suggests that all *Caulerpa taxifolia* plants in the Mediterranean are clones of the original, inadvertently released saltwater aquarium plant.

In areas where the species has become well established, it has caused ecological and economic devastation by overgrowing and eliminating native seaweeds, seagrasses, reefs, and other communities. In the Mediterranean, it is reported to have harmed tourism and pleasure boating, devastated recreational diving, and had a costly impact on commercial fishing both by altering the distribution of fish as well as creating a considerable impediment to net fisheries. The dense carpet that this species can form on the bottom could inhibit the establishment of juveniles of many reef species, and its establishment offshore could seriously impact commercial fisheries and navigation through quarantine restrictions to prevent the spread of this species.

This alga poses a substantial threat to marine ecosystems Southern California, particularly to the extensive eelgrass meadows and other benthic environments that make coastal waters such a rich and productive environment for fish and birds. The eelgrass beds and other coastal resources that could be directly impacted by an invasion of *Caulerpa* are part of a food web that is critical to the survival of numerous native marine species including the commercially and recreationally important spiny lobster, California halibut, and sand basses. However, this threat is not exclusive to California as this seaweed has been observed to survive many months in 50° F water.

Invasion in California

When the invasive marine alga Caulerpa taxifolia was discovered June 12, 2000 in California at Agua Hedionda Lagoon, there was already an awareness of the risks and potential impacts to the environment due to a fifteen-year history of spreading in the Mediterranean Sea. Furthermore, this strain had already been placed on the Federal Noxious Weed list in 1999. This knowledge greatly facilitated both consensus building and setting clear eradication goals among a large number of federal, state and local agencies as well as private groups and non-governmental

organizations that became the "Southern California *Caulerpa* Action Team" (SCCAT). The ability to quickly initiate field containment and treatment within three weeks of discovery was enabled by (1) timely notification of the "find"; (2) the proactive staff of the San Diego Regional Water Quality Control Board who deemed this invasion tantamount to an oil spill, thus freeing up emergency funding; and (3) the mobilization of field diver crews already working in the area. Additional resources from Cabrillo Power (electrical power utility) and eventually a series of federal grants, state funds and nongovernmental organization grants have sustained the program. Through the SCCAT members, regulatory issues were identified and resolved in on-going meetings that also included recommendations for changes in public access and usage of the lagoon. The weakest link in the chain of action was the absence of a clearly responsible "lead agency" with both the authority to act and readily available funds.

SCCAT, in effect, became the lead agency by default, and, through its members provided the impetus, expertise, and political will to do what was necessary. Through SCCAT, three essential components were brought to bear on the problem: (a) expertise, and knowledge about the biology of C. taxifolia; (b) knowledge of the uses, "ownership" and characteristics of the infested site; and (c) knowledge and experience in the implementation of aquatic plant eradication. These, combined with the requisite resources (ca. $1 million per year) have resulted in containment, treatment and excellent progress toward eventual elimination of the alga from Agua Hedionda. Successful rapid response to other aquatic invasive species will require similar readiness to act and immediate access to adequate funding. By conducting "fire alarm" exercises with potential invasive species, the expertise, resources, regulatory issues, and entry pathways can be identified before the arrival of the pest, thereby greatly reducing the times needed for an effective and appropriate response.

Case Study III: Northern Snakehead Fish

Text from: Department of the Interior, Fish and Wildlife Service. October 4, 2002. *Injurious Wildlife Species; Snakeheads (family Channidae), Final rule.* Federal Register: Volume 67, Number 193, Page 62193-62204.

Rapid Response to Aquatic Nuisance Species in the Northeast: Developing an Early Detection and Eradication Protocol Workshop Proceedings. Presentation by Steve Early, Maryland Department of Natural Resources, Baltimore, MD.

Species Characteristics

The northern Snakehead (*Channa argus*) is a top-level predatory fish native to eastern Asian. It is able to tolerate a considerable temperature range, from warm temperate to boreal climates, where this species can live under ice. It is reported to be an air breather, which means that it can live in oxygen-depleted waters by gulping air at the water's surface and can survive several days out of water if kept moist. Potentially, the fish could live in most North American fresh water. Although there is limited information on the fecundity of snakeheads, scientific data indicate that fecundity increases greatly in larger snakeheads and follows increasing body length.

At all life stages, snakeheads will compete for food with native species. Snakehead fry feed on zooplankton; juveniles feed on insect larvae, small crustaceans, and fry of other fishes; and

adults are predators, feeding on other fishes, crustaceans, frogs, smaller reptiles (snakes, lizards), and sometimes birds (particularly young waterfowl) and mammals. Native fish and wildlife populations that prey upon fishes, crustaceans, frogs, snakes, lizards, and young waterfowl would face reductions resulting from the loss of food sources. Native fish populations in particular would likely be reduced through predation if snakeheads were introduced and became established in bodies of water. Through predation, ecosystem balance and predator-prey relationships could be modified drastically should snakeheads become established in waters with low diversity of native fishes and low abundance or absence of native predatory species. Therefore, the likelihood and magnitude of adverse impacts on native wildlife through competition for food and predation on native wildlife is high.

Invasion in Maryland

On May 18, 2002 an angler caught an 18-19 inch fish that he was unable to identfy from Walkingfish Pond in Crofton, Maryland (Patuxent River drainage). The angler photographed and then released the fish, which was subsequently identified as a species of Snakehead. On June 30, 2002 another angler caught and retained a 26-inch Snakehead. On July 8, the same angler caught eight juvenileSnakeheads with a dip net. The Department of Natural Resources (DNR) captured more than 100 young of the year Snakeheads. All were positively identified as Channa argus, the northern Snakehead. Investigation by the DNR Police led to the admission by a local resident of a release into the pond of two 12-14 inch fish sometime during 2000. These fish had been purchased at the live food fish market in New York.

Walkingfish Pond covers approximately four acres with an average depth of 4-8 feet. Several aquatic plant species, including watershield (*Brasenia schreberi*), bladderwort (*Utricularia* sp.), white waterlily (*Nymphaea odorata*), slender pondweed (*Potomogeton* sp.), and duckweed (*Lemna* sp.) are established over 95 percent of the pond.

Fewer than 100 yards of low-lying forested land separate the pond and two adjacent ponds from the Little Patuxent River. While there is not a regularly flowing connection between the pond and the river, or clear evidence of recent overflow, it is possible that water is exchanged between the ponds and river during extreme rainfall events or high river stages. The grassy darter, a Maryland endangered species, is found in the adjacent river. Electrofishing surveys in the adjacent river did not collect any Snakeheads.

The Secretary of DNR convened a scientific advisory panel on July 19, 2002 to recommend appropriate action. Subsequently the panel recommended treatment with herbicides to facilitate rotenone application for eradication of all fish life in the pond and two adjacent ponds with potential water connection. Other methods including explosives, draining, and chlorine were not considered as effective.

Many logistical issues arose during the response: pesticide permits; chemical acquisition and storage; applicator training and health certification; physical pond containment to prevent fish escape; weather prediction; hydrologic connection to other water systems; evaluation of potential impacts to threatened and endangered species; physical access to site for equipment; controlling press and public access to limit chemical exposure and prevent additional fish movement;

providing parking and traffic control in a restricted area; authority to enter private property; coordination with other agencies including the U.S. Fish and Wildlife Service, county police, local landfill, fire department, ambulance, and state departments of Agriculture and Environment; acquisition, installation and maintenance of appropriate signage; response (up to 100 daily) to concerned public; and identification of similar species. Control is estimated to have cost $110,000.

Subsequent sampling in the ponds verified total eradication of fish life. Additional sampling in the adjacent river has not found any Snakeheads. Maryland anglers continue to report possible Snakeheads on a weekly basis though all have been native species. Had tropical depressions occurred during the interval between sighting and treatment, it is very likely the pond would have flooded and Snakeheads could have escaped to a large riverine system. Immediate response to at least ensure total containment is paramount.

On July 23, 2002 the Secretary of the Interior proposed that the 28 Snakehead species be added to the list of injurious species, which would prohibit importation of the fish anywhere in the United States and make it illegal to transport the fish across state lines. In 2003, the Maryland General Assembly passed legislation providing state agencies the authority to enter private property to control nuisance aquatic species.

Appendix E: ***Rapid Response to New Aquatic Invasive Species in Michigan Hydrilla verticillata: A Case Study*** as developed by Michigan Hydrilla Task Force (to be included upon approval)

Appendix E: Definitions

This appendix contains definitions of key words, terms, and phrases that are critical for the rapid response plan development ***(to be completed for final document)***.

- **control**
- **containment**
- **early detection**: To discover or ascertain the existence, presence or fact of nonindigenous aquatic invasive species not previously known to exist in a particular body of water, prior to the successful widespread establishment of the species.
- **eradication**
- **establishment**: To originate and secure the permanent existence of a locally reproducing and replenishing population of a specific aquatic invasive species.
- **invasiveness**
- **monitoring**: To discover and track nonindigenous aquatic invasive species and/or specific aquatic habitats systematically with a view to collecting information to enable a population assessment.
- **natural conditions**
- **new ANS introduction** or **new species**
- **rapid** (as in response)
- **rapid scientific assessment**

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