DRAFT

Model Rapid Response Plan for
Great Lakes Aquatic Invasions

A product of the Great Lakes Panel on Aquatic Nuisance Species

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with input from the
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Great Lakes Commission/Great Lakes Panel on Aquatic Nuisance Species

Introduction
The document that follows represents the development (evolution) of a model rapid response plan for Great Lakes aquatic invasions. This draft document will serve as a vehicle to develop a model plan for the Great Lakes-St. Lawrence region, ultimately representing input from stakeholders both within the region and beyond. The plan is intended to provide as much detail and depth about a response as feasible while still leaving enough flexibility for application to varying circumstances. In this initial draft, extensive research has been conducted by project staff to compile and integrate lessons learned from existing rapid response initiatives to serve as a basic framework for a regional rapid response plan. Research conducted on the rapid response plan thus far is based primarily on the literature review available online at: http://www.glc.org/ans/initiatives.

The purpose of the rapid response plan workshop is to continue building this framework based on the rapid response components listed below. The workshop is structured around these rapid response components, each highlighted with a presentation during the plenary sessions. Comprehensive discussion on each of the components also will be conducted during two breakout sessions.

Breakout Session 1
1) Communication/Organizational Structure (Ross Powers, U.S. EPA)
2) Outreach (Mike Hoff, U.S. Fish and Wildlife Service)
3) Detection and Monitoring (Identifying the Problem) (Donna Turgeon, NOAA)

Breakout Session 2
4) Decision Support System And Rapid Scientific Assessment (Carl Richards, Minnesota Sea Grant)
5) Management Options for Control/Eradication (Phil Moy, Wisconsin Sea Grant)
6) Implementation (Steve Early, Maryland DNR)
7) Adaptive Management (Lisa Jameson, National Park Service)

In this document, a series of objectives, a background statement and, in some cases, strategic tasks are presented for each rapid response component. Workshop participants are requested to review this document in its entirety in preparation for the workshop. **In your review, please select two components (one from each breakout session) on which to provide specific feedback/input on the objectives, background statements and strategic tasks during the breakout sessions.** The breakout sessions will be facilitated by the speakers presenting overviews on the rapid response plan components at the workshop. The themes/information presented in plenary presentations and discussion points from each of the breakout sessions will be incorporated into the next iteration of the model rapid response plan.

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

The Great Lakes-St. Lawrence ecosystem has been plagued by the invasion of more than 162 nonidigenous aquatic nuisance species (ANS) that have become established since the settlement of North America by Europeans (Ricciardi, 2001). The rate of ANS 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 ANS introductions result from recreational and commercial activities such as aquaculture industry, aquarium trade, recreational fisheries enhancement, 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 ANS introductions must remain the first priority in battling aquatic invasions.

Currently, policy makers, resource managers, outreach specialists and other stakeholders have little direction and legal basis to take action in the event when prevention efforts fail and the introduction of aquatic invasive species succeeds in the Great Lakes. As a result, the region is poorly equipped to deflect the large economic, social and ecological costs incurred by ANS infestations as 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 ANS population when the focus of management must shift rapidly from prevention to control. It is this brief window after theANS introduction where there is an opportunity to stop the permanent establishment of a new ANS population holding ecological and economic risks. Early intervention through early detection and rapid response is a critical strategy for preventing the establishment of new ANS 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 an ANS rapid response plan for the Great Lakes-St. Lawrence region, this project will build upon rapid response planning and initiatives from a variety of biotic and abiotic scenarios. Past ANS invasions and response efforts, both successful and unsuccessful, also will be used as case studies during plan development. The following fundamental questions, among others, will be considered in the development of the rapid response plan for Great Lakes invasions:

- How should the plan be structured to respond to ANS introductions and spread in a time frame that can maximize the possibility for eradication/control?
- How can the plan be structured to avoid institutional/jurisdictional obstacles that might impede action?
- How will the response efforts be funded?
- What type of institutional arrangement will most effectively advance such efforts?

These are all important policy and management issues that will be addressed during the development of this plan.

Goals Statement

The goal of this project is to develop a model rapid response plan as part of an overall regional effort to enhance capacity to anticipate, prevent and respond to new aquatic invasions of nonindigenous 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 control/eradication. 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 should to be established with a broad base of 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 of the model rapid response plan (regional, local, species specific, etc.), specific goals and objectives will need to be established.

In so doing, the following are some questions that can be used as guidance:

- Is control or eradication more realistic given existing technologies, resources, and known biological and ecological constraints?
- What is feasible and/or realistic in terms of ecological integrity and restoration in the wake of an invasion and response?
- How can economic interests be protected and economic loss be prevented from nonindigenous species invasions?
- Will the response be directed at a new invasion or a threatened/imminent invasion?

Components of Rapid Response Model Plan

1) Communication/Organizational Structure

Objectives

- Establish/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 and communication, and provide timely assistance where it is needed (MNRG, 2003).
- Identify the appropriate authorities that are needed to mobilize an effective rapid response for Great Lakes aquatic invasions and establish leadership and authority roles.
- Ensure that the appropriate stakeholders, agencies, and groups are involved in response plans, both in early stages of development and ensuing implementation.
- Ensure the timely exchange of information regarding ANS detection and rapid response planning and implementation.

Background

Integral to rapid response planning is a communication and organizational structure that entails information regarding how to disseminate essential information, as well as authority and leadership roles,

coordination, cooperation and partnerships. Legislative authority and policy also need to be taken into consideration under this component.

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 address those who generate and receive information, how information is exchanged, and the level of urgency for information transfer. There is a need for an effective and transparent communication structure to be integrated throughout all levels of a rapid response plan. For example, upon discovery of an aquatic invasive species, it should be known how to report the discovery and to whom that species should be reported. Once verification of the new invasive species has occurred, that information needs to be passed along to appropriate entities with decision-making authority, facilitating an assessment of the situation. If a rapid response is deemed appropriate, information needs to be communicated to appropriate stakeholders to engage them in the process. Previous rapid response efforts have determined that designation of a situation-specific public communication officer is a critical key to success of the overall process (Steve Early, Maryland DNR, personal communication, 2003). Other states, provinces, agencies, the media and the public need to be made aware 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 that of the National Response Center (NRC) for oil and hazardous materials. 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 for local, state, and federal agencies with potential jurisdictional responsibility.

In addition to communication efforts, a coordinated organizational structure is pivotal to effective rapid response efforts. The organizational structure must take into account the plethora of federal, state and local agencies and respective laws/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 are involved in the development and implementation of a response to an ANS invasion in the Great Lakes-St. Lawrence region. Parties involved in a response plan should to be identified in advance, including defining their roles and responsibilities. These parties and their responsibilities may vary depending on the scope of the infestation. The organizational structure should remain dynamic to facilitate functionality in jurisdictional situations subject to change. The structure also needs to identify the entity with final decision making authority, willing to act in that capacity. In certain cases, an incident command system may be needed (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 situations. (Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW), 2002).

To support organizational efforts, each local, state, and federal agency with responsibilities concerning invasive species issues in the Great Lakes region should identify a primary point of contact or Invasive Species Response Coordinator (ISRC) to orchestrate response in the event of detection of a new invasion. Each primary point of contact should have the authority or be willing to take the steps necessary to attain

the authority to implement his or her agency's role in a response, should it be necessary.

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 accurate, 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. This role is further described in the section on **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, classify the threat, and provide recommendations for future actions. The scientific assessment committee can determine if rapid response efforts are warranted and feasible. This process is further described in the section on **Rapid Scientific Assessment**.

The organizational structure of a rapid response plan is complex with several overlapping component parts at work. The following statement summarizes the basic components and how they are related in the communication/organizational structure. Upon detection of a new invasion, a central communication coordinator is notified who then informs the ISRC's and the scientific assessment committee. As an appropriate taxonomic expert (preferably serving on the scientific assessment committee) then verifies and identifies the invasion, the scientific assessment committee is kept "on deck" to assesses the ecological risks and the feasibility of stopping the invasion. The ISRC's and/or agencies that hold authority to take action, then use the findings of the scientific committee along with the best available economic and social information available in making the decision as to whether a response is in order and how to respond. The details of this process are described in the sections on **Decision Support System** and **Implementation.**

On a related note, a key component to the success of rapid response efforts is securing adequate and accessible funding for implementation. If at all possible, the organizational structure for rapid response needs to address where emergency funds can be established for rapid response prior to the 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 proposed federal legislation, *National Aquatic Invasive Species Act (NAISA)*, 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.

2) Outreach

Objectives

- Raise awareness/understanding and ensuing support for the need for rapid response to advance support for action
- Accurately communicate the results of rapid response efforts to stakeholders, agencies, and other interested parties
- Prevent establishment of ANS populations by raising awareness for the rapid response process and associated benefits

Background

A prerequisite for rapid response efforts is developing an awareness and understanding among appropriate stakeholders of why rapid response is needed and how it is to be implemented. The Great Lakes Panel on Aquatic Nuisance Species fully recognizes the importance of outreach in the *Information/Education Strategy for ANS Prevention and Control* (2001). A goal of the I/E strategy is to advance prevention of the unintentional introduction and dispersal of ANS within Great Lakes waters through implementation of information and education activities. Experience garnered from developing a prevention strategy for the round goby demonstrates the importance of education/outreach programs to rapid response. In this case study, it is recommended that public outreach efforts target potential water-users, federal, state, and local governmental entities as well as all other public and private organizations potentially affected (Keppner and Theriot, 1997). Outreach efforts targeted to key decision makers of local, state, and federal agencies are essential for ensuring cooperation and coordination. The invasion of the ruffe in Lake Superior exemplifies how more effective outreach was needed to facilitate cooperation between agencies. After federal and state agencies developed a program to prevent ruffe from spreading from Duluth Harbor by application of chemicals treatments, members of state agencies decided at the last moment not to support the plan (Schmitz and Simberloff, 2001).

As part of outreach efforts, it is strongly recommended that stakeholders are briefed before, during and after a rapid response is implemented. To effectively support rapid response efforts, these briefings should clarify the purpose for rapid response, elucidate the potential threats posed by the establishment of aquatic invasions, including discussion of the risks of not taking action, and most certainly, a timely report on the results of rapid response efforts. Support for rapid response is dependent upon the public's understanding and acceptance for the aggressive action needed to protect the integrity and biological diversity of the native ecosystem subject to ANS invasion (National Invasive Species Council, 2001). An awareness for potential health issues and hazardous situations associated with ANS invasions can also serve as persuasive information. In outreach efforts, the benefits of rapid response must be weighed against the risks of taking action, including the risks of not taking action. This exercise will not only help mitigate public opposition, it will aid in the prevention of future ANS invasions by raising awareness.

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

The public, and specifically recreational boaters and anglers, could also play an important role in the outreach network to support rapid response. 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. If informed and aware of pressing ANS issues and concerns, recreational and commercial water users could help gain the political will needed to win support for rapid response efforts.

3) Detection and Monitoring (Identifying the Problem)

Objectives

- Establish a coordinated regional monitoring network that will allow for the collection of baseline ecological survey information
- Identify potential ANS threats allowing for implementation of risk-mitigation measures
- Develop guidelines and recommendations for early detection and monitoring of new ANS introductions in the Great Lakes region allowing for decision-making that is efficient and environmentally sound
- Develop standardized means by which researchers and stakeholders can report and identify new infestations
- Establish a monitoring program that will track the spread of existing ANS infestations
- Identify invasion 'hotspots' which have either a high risk of being invaded or a high probability of being severely impacted by a new invasion

Background

Early detection and monitoring efforts are critical to the discovery of new introductions of nonindigenous aquatic species and in tracking the spread of existing invasions. In efforts to increase the probability for effective eradication or control of invasive species populations, early detection of nonindigenous invasive species is considered a fundamental prerequisite.

According to guidelines developed by the Early Detection and Rapid Response Subcommittee of the Invasive Species Advisory Committee, detecting and responding to aquatic invasions demands coordinated and sustained action. Efforts related to early detection and monitoring may include such activities as priority setting, identification of high priority species and at-risk sites; routinely monitoring certain areas; prevention and containment efforts; surveillance, detection and reporting activities including data collection and management; the collection, identification and storage of voucher specimens; and training volunteers and professional in detection, identification and removal techniques.

Predicting potential aquatic invasions of nonindigenous species may be an important step for early detection. Using a generic risk assessment approach and statistical models of fish introductions into the Great Lakes, Kolar and Lodge (2002) developed a quantitative approach to target species most likely to cause damage. 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 exist to show how faunal composition of lakes can be predicted from area, mean depth, water transparency, and nutrient availability (Marshall and Ryan, 1987).

The ability to monitor some ANS is limited because current sampling techniques are labor intensive. More effective and efficient monitoring techniques are needed (Research, Information Sharing, Documentation and Monitoring Workgroup, National Invasive Species Council, 2000). The efficient use of targeted surveys, passive detection networks, and active detection networks must be utilized until the new techniques are developed.

Several groups, including the ISAC ED&RR Subcommittee, the National Estuarine Research Reserve System, and the Federal Interagency Committee for the Management of Noxious and Exotic Weeds, have identified components for an early detection system. The following concepts, pulled primarily from the ED&RR Subcommittee's *Guidelines for ED&RR*, with some consolidation, 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 need to be utilized. Due to limited resources, it is important for active detection networks to be focused on high-priority targets, such as high-risk locations, high value resources, important 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 networks: Passive detection networks are monitoring efforts conducted by organizations or individuals who may fortuitously detect invasions as they conduct other activities.

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

- Authoritative verification: Collection 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. Taxonomic experts and/or diagnostic laboratories should be identified to deal with specific taxa and habitats. 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 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 disseminated 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 Tasks

- Develop and implement coordinated frameworks for active and passive detection networks to detect new invasions of nonidigenous aquatic invasive species prior to their establishment.
  - 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 each for its potential to cost effectively contribute to a regional monitoring program.
  - Develop monitoring techniques to sample aquatic invasive species with known and acceptable levels of uncertainty.
  - Develop incentives for passive detection networks to participate in the broader ANS early detection and monitoring network.
- Develop, implement and publicize a communication structure for forwarding information on known or suspected ANS to an "Invasive Species Notification System."
- Develop and implement a process for identifying high priority species for which to monitor, and process for identifying at risk sites where routine monitoring should occur.
- 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.
- Develop a protocol to ensure consistency in the collection of voucher specimens
- Develop resource list of appropriate taxonomic authorities who will be able to identify/verify and characterize voucher specimens in a timely manner
- Conduct ecological inventories (rapid assessments?) to establish baseline information (from this point forward) 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 model).
- Develop a regional shared database of aquatic invasive species locations for mapping and information sharing purposes. Participate in national spatial and information database efforts.
- Develop Great Lakes-specific training materials for the public and stakeholders to alert them of potential invasive species and guidance on what to do if these species are found.
- Encourage use of the Great Lakes monitoring network nationally, and coordination with national efforts through the use of a tiered monitoring approach.

4) Decision Support System And Rapid Scientific Assessment

Objectives

- Form a scientific assessment committee to determine the potential "invasiveness" of verified new ANS introductions
- Determine if an invasion merits a rapid response (risk assessment)
- Determine if a response is economically and technologically feasible
- Provide scientific support for any decisions
- Determine if it is possible to respond in an efficient and environmentally sound manner to prevent the spread and permanent establishment of aquatic invasive species

Background

Decision support and scientific assessment are both essential components in making rapid response happen and, although each involve a distinct set of activities, they need to be conducted in close coordination. Scientific assessment is a process for determining if a response is necessary and technically feasible based on the nature of the infestation. The basis of a scientific assessment is gathering, interpreting, and disseminating ecological and biological information relevant to a response decision. Assessing ecological risks is also a key component of a thorough scientific assessment. The scientific assessment committee (as described below) is chiefly responsible for these tasks. A key part of the scientific assessment is that it must be completed in a timely manner to ensure that the benefits of an early response are not lost.

Decision support is a broader process, taking scientific assessment into account as well as consideration for social, economic and political factors that come into play. A decision support system forms the foundation for taking action and implementing a rapid response. The scientific, social, economic and political factors ultimately should make the case for the decision to respond, indicating that no action would be more damaging than a response. A risk assessment is the process by which these factors are considered relative to one another in making the decision to take action. The ultimate decision will likely be made by the agency or entity holding the authority and means to take action.

It is important that decision support and scientific assessment are closely connected in their function to determine if a response will occur, based upon the best scientific, social, economic and political information available. 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 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 particular situations. (ISAC ED&RR Subcommittee, 2003). When an invasion is reported, the scientific committee would immediately convene to perform the following functions:

- initiate a preliminary assessment of the invasion and notify federal, state, local governmental representatives and other appropriate stakeholders of the invasion and its status
- evaluate the seriousness of the invasion and classify the threat (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 feasibility of containing and eradicating the infestation
- provide recommendations to the appropriate decision making authority regarding the

potential for rapid response efforts,
- provide guidance for efficient and environmentally sound control methods, if appropriate.

An exemplary case is that of the new 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.

The first step in making decisions regarding rapid response is to determine whether the discovery of an invasive species merits a rapid response. Information gained from 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 ANS 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 in the event of an invasion, there is a need to provide accessibility to relevant research findings, including a fundamental understanding of current food webs, habitats and biota inventory. A proactive measure to pursue is identification of potentially harmful species that are 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, thus raising awareness of the species and expediting the process of making a decision.

The decision support process must also identify, if possible, the vector(s) associated with the ANS 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 spend time and resources on a response.

If a response is both merited and feasible, the next step in the decision support process is 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 a rapid response plan, implementation should 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 equally. Factors that need to be examined carefully 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 and cost effectiveness. The limitations 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, then

the response action is put into place. 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 location.

It is considered essential that a wide range of expertise, agencies and organizations representing all vested stakeholders 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 buy-in and input. 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, but public involvement in short-term, immediate need responses 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. The Marine Conservation Biology Institute produced a decision tree for the control of marine pests. This particular example, provided on the following page, could be modified for use in the Great Lakes region.

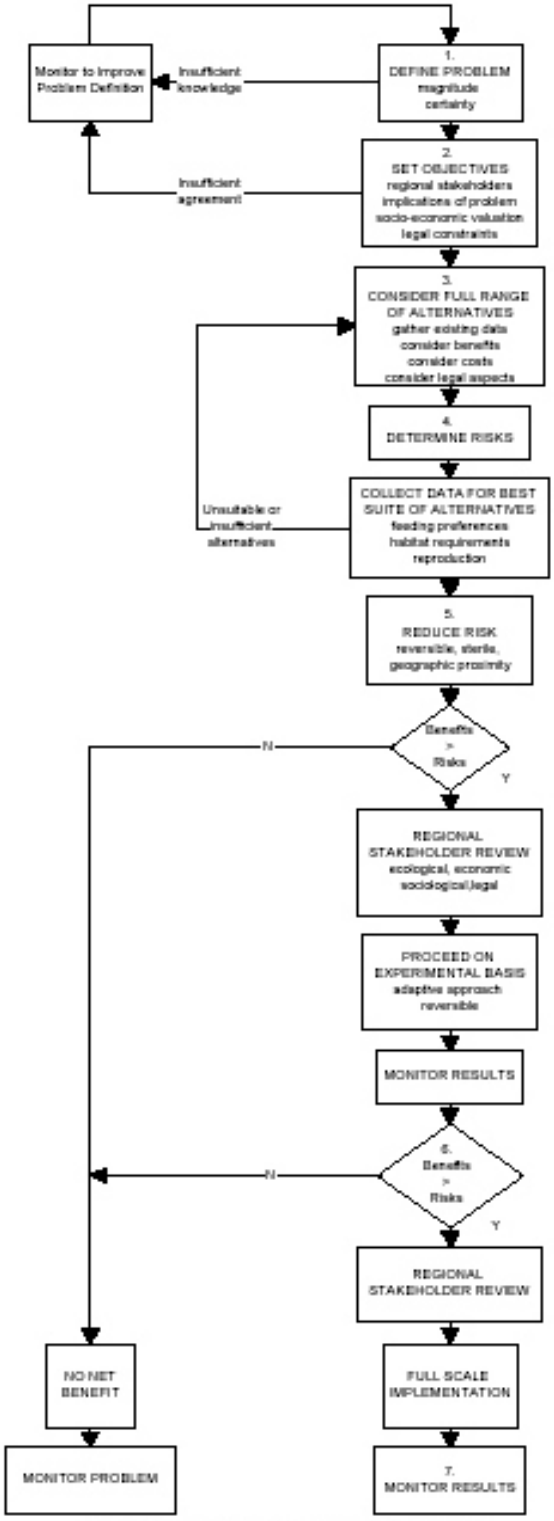

Figure 1. Rapid response decision tree

5) Management Options For Control/Eradication

Objectives

- Assess the possible biological, chemical, and mechanical tools available for a rapid response
- Where applicable, secure pre-approval for control tools
- Initiate the permitting process
- If feasible, establish a quarantine when a new invasion is detected

Background

As part of the process of rapid response, there is a definite need for a compilation of management options regarding control measures and tools available to managers to apply in response to an ANS invasion. In addition to mechanical/physical, biological and chemical responses, the process should provide direction on how to obtain preapproval and permitting for control measures, quarantine establishment and enforcement, and an assessment of specific control measures and management tools for high priority species.

To facilitate a response to an ANS invasion that is both rapid and effective, it is critical that a structure is in place to allow for permitting and preapproval of control measures. State and federal agencies need to have a toolbox of pre-approved control measures that can be selected and applied in a timely manner. Several of the most common control measures that are applicable to several invasive species should be pre-approved for specific situations.

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).

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 are two important management measures when trying to implement a rapid response to an invasive species. A quarantine is implemented in efforts to prevent spread of the unwanted organisms to other areas before responders have had a chance to act. This may mean closing ports to incoming and outgoing commercial and recreational traffic, or simply closing access to an inland lake or pond while managers assess the situation. Enforcement measures ensure that a quarantine is effective and may also be used to interrupt the introduction vector, if known. Depending

on the location and extent of the infestation, several agencies may have quarantine and enforcement authority and responsibility. These responsibilities should be predetermined so that action can be immediately taken in the event of an invasion.

Management tools should be assessed based on the species, location and extent of the infestation. The tools for response include mechanical methods (trapnets, trawling, etc), chemical methods (rotenone, Bayluscide, TFM), and biological control such as increasing predators and introducing pathogens (Wiley and Wydoski, 1993). Mechanical methods may be the most specific and selective while chemical methods tend to have wide-ranging effects on the ecosystem. Biological control methods are often controversial and take longer periods of time to attain permitting for implementaton. 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, much of it is also relevant to the Great Lakes region.

There are currently four registered toxicants available for use as piscicides in the United States (Schnick et al., 1986). They are rotenone, antimycin, TFM, and Bayluscide. 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 control/eradication options that can immediately be applied if a particular species is found. It is also important to understand that most control tools have associated risks. The ideal management tool and control/eradication tool would be highly specific to a target organism, hold no long-term effects, not create any health hazards, and remain cost effective. Rarely, if ever, can an option actually possess all of these characteristics.

Permitting for chemical response methods will likely need to go through the United States Environmental Protection Agency (U.S. EPA), state EPA's, and possibly the U.S. and local state departments of Agriculture. 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.

The management tools selected for application need to have clear and specific objectives in order to be effective in terms of management while maintaining environmental soundness. For example, is the goal of management efforts to eradicate or simply control the ANS invasion? Will the application of the management tool be a short-term response, or will it be a sustained effort? Answering these questions will help to determine which tool is most appropriate and the entity holding the authority for application depending on the management option and jurisdictional scope of application.

Education and public outreach also need to be considered as management tools to control the spread and introduction of invasive species. Education the public about the impacts of ANS and the steps they can take to limit the spread and maintain a successful quarantine can buy time while the decision making process is underway.

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 into the process of management. Institutional support from such entities is an important step in gaining public endorsement for implementing selected management options.

6) Implementation

Objectives

- Establish a process that facilitates a coordinated, timely response to an ANS invasion
- Establish secure and adequate funding strategy, includes both federal and state financial resources, to support plan implementation

Successful implementation of a rapid response to an invasive species is largely dependent upon the plan being operational on a local, state, regional and federal level. In preparation for a response to an ANS invasion, extensive groundwork needs to be conducted. Based on guidelines developed by the ISAC ED&RR Subcommittee (2003), the following elements are suggested to support implementation of a rapid response plan:

- long-term institutional and financial support for **planning**
- maintenance of **standing (SWAT) teams** ready to respond with flexibility to make some adjustments to the specific needs and circumstances of an invasion in a timely manner
- previous **training in eradication/control** that, ideally, would include mock exercises in emergency response
- **rapid response manuals developed in support of training programs**, including functional areas involved in the response (i.e., species-specific containment/control plans, species removal, relevant laws and polices, public outreach planning, safety measures, regulatory responses, etc)
- **schedules for action for rapid response teams** appropriate for the specific conditions of the invasion
- establishment of an "**incident command system**" for certain rapidly advancing or particularly serious infestation
- **mechanisms for stakeholder input** in the development of rapid response plans
- **threshold function to 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/agency roles and responsibilities are clearly defined, including coordination with public communication)
- **funding sources** that are adequate and accessible to mount an effective, timely and sustained response to new invasions that may need to be shared across jurisdictional boundaries
- **cooperation and communication with jursidictional authorities of bordering uninfested areas** to make provisions that decrease the chance of subsequent infestations
- provisions to facilitate an **understanding of relevant laws, regulations, policies and guidelines** that may affect response efforts by all members of the rapid response team

- provisions to enable personnel from a variety of agencies and diverse geographic locations to rapidly merge into a **common management structure**
- **sustained public outreach** programs to facilitate public understanding of response efforts based on authoritative balanced information provided early in the rapid response timeline

Implementation efforts need to be highly coordinated to limit redundancy and to ensure that the appropriate stakeholders are involved and informed of actions. It is particularly important that this coordination and planning is incorporated into the state ANS management plans. Because authority and leadership roles are critical to the implementation of a rapid response, the communication and organizational structure described above should be well developed on a state and federal level. 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.

Securing and appropriating adequate funding for the implementation of a rapid response is the largest potential obstacle to overcome. Many of the Great Lakes states already are functioning with limited funding under approved ANS management plans. Passage of the National Aquatic Invasive Species Act will require the integration of a rapid response element within those 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, sources of state and federal funding should be identified prior to the detection of an invasive species.

7) Adaptive Management

Objectives
- Monitor and evaluate the response after plan implementation
- Improve and update response actions based on results and new information
- Mitigate and restore effected areas to the extent possible

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. Its 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."

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.

The evaluation of the chosen management option should 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. 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 move to another option. The adaptive

management phase of the plan allows for the assessment of what strategies worked and those that did not. This experience is then applied to the next approach.

The need for mitigation and/or restoration of the treatment areas needs to be evaluated during and after implementation of control measures. 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 may be useful for determining the unintended or undesired impacts of ANS invasions.

All of the effort expended and funding spent during a rapid response will be futile if a re-introduction and infestation occurs. To prevent re-introductions the pathways/vectors 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. Post procedure monitoring will also be helpful during mitigation assessment and re-introduction risk evaluations.

Appendices

Appendix A: 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. Some examples case studies that will be listed in this appendix are given below.

- CDC/Public Health response model
- Ruffe - US FWS/ANS Task Force
- APHIS Agricultural Pest Model
- Northern pike eradication in Lake Davis, CA
- *Caulerpa taxifolia* in Southern California (Merkel and Woodfield, 2000)

Appendix B: Definitions

This appendix contains definitions of key words, terms, and phrases that are critical for the rapid response plan development.

- **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.

- **establishment**: To originate and secure the permanent existence of a locally reproducing and replenishing population of a specific aquatic invasive species.

- **monitoring**: To keep track of identified nonindigenous aquatic invasive species and/or specific water bodies systematically with a view to collecting information to enable a population assessment.

- **new ANS introduction** or **new species**

- **rapid** (as in response)
- **natural conditions**

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