Developing Plans for Managing Invasive Aquatic Plants in Mississippi Water Resources

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Abstract

Invasive aquatic plants are an ever-growing nuisance to water resources in Mississippi and the rest of the United States. These plants are generally introduced from other parts of the world, some for beneficial or horticultural uses. Once introduced, they can interfere with navigation, impede water flow, increase flood risk, reduce hydropower generation, and increase evapotranspirational losses from surface waters. Invasive species also pose direct threats to ecosystems processes and biodiversity. All agencies and individuals responsible for water resources in Mississippi should be prepared for invasive aquatic plants through developing an aquatic plant management plan. Components of a plan include: Prevention, Problem Assessment, Project Management, Education, Monitoring, Site- or problem-specific management goals, and Evaluation. Prevention seeks to reduce the influx of new invaders into the resources, and respond rapidly once they are found. Problem assessment is to quantify the distribution and abundance of the target plant and its impacts on the resource. Project Management includes tracking available resources to fight the problem, including funds and labor. Education involves informing both the resource agency and the public in the problem and potential solutions. A monitoring component tracks the general condition of the resource in both biotic and abiotic attributes, to detect other changes associated with the resource. Site- or problem-specific goals addresses the management of target species based on a specific site basis, rather than attempting to find a single solution to the target plant problem through time for all locations. Finally, an evaluation plan quantifies the success of the management efforts based on economic, environmental, and efficacy thresholds. These components in a management plan will increase the likelihood of a successful approach to invasive plant problems.
Keywords: Invasive Species, Management & Planning, Recreation, Wetlands

Introduction

Invasive aquatic plant species are a major problem for the management of water resources in the United States (Madsen 2004). Nonnative invasive species cause most of the nuisance problems in larger waterways, often causing widespread dense beds that obstruct navigation, recreation, fishing, and swimming; and interfere with hydropower generation. Dense nuisance plants increase the likelihood of flooding and aid in the spread of insect-borne diseases. Invasive plants often reduce both water quality and property values for shoreline owners (Carpenter 1980, James et al. 2001, Rockwell 2003).

Invasive species also impact the ecological properties of the water resource. They may degrade water quality, reduce species diversity, and suppress desirable native plant growth. They may alter the predator/prey relationship between game fish and their forage base, resulting in stunted game fish (Lillie and Budd 1992). Invasive species may also change ecosystem services of water resources, altering nutrient cycling patterns, sedimentation rates, and increasing internal loading of nutrients (Madsen 1997).

For Mississippi water resources, the most likely or troublesome invasive plants to cause problems are likely to be one of seven species: alligatorweed, Eurasian watermilfoil, giant salvinia, hydrilla, waterhyacinth, and waterprimrose (Table 1). While these are the species most likely to cause the greatest concerns, many other native and nonnative species can cause nuisance problems, particularly in small areas.

Table 1. The six most likely invasive aquatic plant species in Mississippi.

Common name	Scientific name	Growth form
Alligatorweed	*Alternanthera philoxeroides*	Emergent
Eurasian watermilfoil	*Myriophyllum spicatum*	Submersed
Giant salvinia	*Salvinia molesta*	Floating
Hydrilla	*Hydrilla verticillata*	Submersed
Waterhyacinth	*Eichhornia crassipes*	Floating/Emergent
Waterprimrose	*Ludwigia* spp. (*L. grandiflora* and *L. hexapetala*).	Emergent

These species, as well as others, have been discussed extensively elsewhere (www.gri.msstate.edu, Madsen 2004). Species-specific management recommendations are available elsewhere (AERF 2005).

To manage these species for the long-term, water resource managers need to have an aquatic plant management plan – even for those water bodies that currently do not have invasive plant species. An aquatic plant management plan will establish protocols to prevent the introduction of nuisance plants, provide an early detection and rapid response program the water body so new introductions can be managed quickly at minimal cost, and aid in identifying problems at an early stage. A plan will assist in identifying resources, stakeholders, and build coalitions to manage problem species. The planning process will identify information already collected, and gaps in information that are needed. A plan will help in communicating the need to manage, and provide a rationale or approach for management.

An aquatic plant management plan should have eight components: prevention, problem assessment, project management, monitoring, education, management goals, site-specific management, and evaluation (Table 2).

Table 2. Components of an aquatic plant management plan.

Component	Description
Prevention	Education and quarantine combined with proactive management of new infestations (early detection and rapid response)
Problem Assessment	Identify problem, collect information, and formulate specific problem statements
Project Management	Accounting for your resources: financial, personnel, partnerships, and volunteers
Monitoring	Quantifying change in the water body
Education and Outreach	Learning about the problem and potential solutions, and informing the public about the program
Management Goals	Specific milestones by which to assess success or failure
Site-Specific Management	Select management techniques to specific parameters
Evaluation	Quantitatively assess success of management

Prevention

In most instances, invasive plants are introduced to a water body by human activity. Most commonly, invasive plants are transported to water bodies on boats and boat trailers. Prevention activities can include signage at boat launches and marinas, and other educational activities. Other successful prevention programs have included federal and state legislation, enforcement, educational programs in broadcast and print media, and volunteer monitoring programs (Baumann et al. 2001).

Combined with these prevention activities, an early detection and rapid response (EDRR) program is necessary to control new infestations at an early stage. Proactively controlling new infestations before they become large infestations is both technically easier and less expensive, resulting in cost savings in the long run. Eradication of small populations is much more likely than when managing large populations. Early detection and rapid response is emphasized by federal agencies involved in invasive species management (Westbrooks 2003).

Problem Assessment

Problem assessment is the process of both acquiring objective information about the problem, such as maps and data on plant distribution, and identifying groups or stakeholders that should have input into formulating the problem statement. A specific problem statement will help refine the issues of users and the nature of the nuisance problem. Problem assessment should also include identifying causes of the problem, and develop an understanding of the water resource by both identifying information already collected, and additional information needs.

Project Management

Project management is often a neglected aspect of managing invasive plants, particularly when volunteers manage the project. Successful projects are the result of good planning and management of assets, which would include financial resources, partnerships with others, and personnel (including volunteers). Adequate records of expenses are required, particularly if the project is funded by government entities. In addition, a good evaluation of success will include the expenditure of both time and labor.

Education and Outreach

Education and outreach should be initiated at the beginning of the program, and continue throughout the project. Education initially will consist of having the project group learn about the problem and possible solutions, which will help to build a consensus on the solution. As time progresses, education effort will extend outward to the public to inform them of the problem, possible solutions, and what the project is doing about the problem. As much as possible, inform the public openly about management activities. A public web page is one successful tool, but the project group can also utilize local media outlets, such as newspapers and radio. Lastly, if you have a successful project, share your success with others through professional or resource organizations, such as the Mississippi Water Resources Conference.

Monitoring

A monitoring program would not only include assessing the distribution of the target plant species, but would also include a program of monitoring other biological communities (including desirable native plant communities) in the reservoir, and water quality parameters, to evaluate if there are longer-term changes to the water body, or if management might have a positive or negative effect on other aspects of the water resource. Monitoring would include baseline data collection (as above), compliance monitoring involving a permit, assessments of management impacts to the environment at large, and could also include a "citizen" monitoring program. For instance, citizen monitors have been used for several decades to assess water quality in many water bodies, and can be as simple as measuring water clarity using a Secchi disk.

Plant Information and Methods

When monitoring invasive plant communities, the first question is what types of information are needed. Information needs would include a plant species list, including both invasive and nonnative species and other species of concerned (such as federally threatened or endangered species), maps for locations of species of concern or targeted for management, locations of nuisance growth, and bathymetric maps.

As much as possible, quantitative plant data should be used for assessment, monitoring, and evaluation. Quantitative data is more desirable because for four reasons (Madsen and Bloomfield 1993):

- Objective quantitative data produces facts on the distribution and abundance of plants; subjective surveys lead to opinion, rather than fact, as the basis for management decisions.
- Quantitative data allows for rigorous statistical evaluation of plant trends in assessment, monitoring, and evaluation.
- Quantitative data and surveys may eliminate costly but ineffective techniques in a given management approach.
- Quantitative data allows individuals other than the observer evaluate the data and produce their own conclusions on assessment, monitoring, and evaluation data.

Plant quantification techniques vary in their purpose, scale, and intensity (Table 3). Cover techniques include both point and line intercept techniques (Madsen 1999). These techniques give the best information on species diversity and distribution, and are statistically robust to small changes in plant community composition. Point intercept is also a good technique for ground-truthing remotely sensed data. The best method for measuring plant abundance remains biomass measurement, but it is time-intensive and best used for management evaluations (Madsen 1993). Hydroacoustic surveys are excellent for assessing the underwater distribution and abundance of submersed plants, but do not discriminate between species (Sabol et al. 2002, Valley et al. 2005). Hydroacoustic surveys are essentially a remote sensing technique, measuring submersed plant canopies while they are still underwater. Visual remote sensing techniques, whether from aircraft or satellite, have also been widely used to map topped-out submersed plants or floating and emergent plants (Everitt et al. 1999). While maps alone are useful, digital images can be used for statistical analysis by random or regular pixel sampling.

Table 3. Aquatic plant quantification techniques.

Technique	Utility
Cover Techniques: Point Intercept (Madsen 1999)	Species composition and Distribution, Whole-lake
Cover Techniques: Line Intercept (Madsen 1999)	Species composition and distribution, study plot
Abundance Techniques: Biomass (Madsen 1993)	Species composition and Abundance
Hydroacoustic Techniques: SAVEWS (Sabol et al. 2002, Valley et al. 2005)	Distribution, Abundance (no species discrimination)
Remote Sensing: Satellite, Aircraft (Everitt et al. 1999)	Distribution (near-surface plants only, no species discrimination)

Goals

As part of the plan, specific management goals should be formulated that are reasonable and testable. These goals will provide the basis to assess if the management program is successful. Goals should be as specific as possible, including indicating areas that have a higher management priority. Without specific goals, stakeholders will argue whether management was successful. With a specific goal, the evaluation data will indicate whether or not that goal was met. For instance, if vegetation obstructs recreational use of the water body, a goal of "unobstructed navigation" may result in unending management. If, however, the goal is to maintain navigation channels open to navigation 90% of the time, that is a testable and specific goal.

Once goals are made, these goals should be implemented to manage plants using techniques that are acceptable based on environmental, economic, and efficiency standards, acceptable to stakeholders, and acceptable to regulatory agencies. The techniques selected to manage plants will vary both spatially throughout the water body, and through time. I refer to this as site-specific management.

Site-Specific Management

Site specific management means that management techniques are selected based on their technical merits, and are suited to the needs of a particular location at a particular point in time. The techniques need to be selected based on the priority of the site, the environmental and regulatory constraints of the site, and the potential of the technique to control plants under those particular conditions.

Spatial selection criteria will include how dense the species are, how large an area is covered, the target species in question, water flow characteristics, other uses of the area, and potential conflicts between technique use restrictions and primary uses. For instance, you may have an area of nuisance growth that occurs close to a drinking or irrigation water intake (Figure 1). The primary use may disallow the use of herbicides based on use restrictions, so this might be an appropriate area for benthic barrier and suction harvesting. Another site may be located more than a mile from the same intake. This site might be amenable to an herbicide application, without competing with other uses. Lastly, you may have an area of scattered plants. If you had volunteers and the goal was to eradicate the plant from the waterbody, then hand pulling these plants to prevent the formation of a dense bed might be appropriate.

Through time, the selection of management techniques will also change based on the success (or failure) of the management program. For example, a small lake was dominated by Eurasian watermilfoil throughout more than 90% of the littoral zone (Figure 2). The best option might be a whole-lake treatment of the lake with fluridone, which would reduce the biomass by more than 90%. In the second year, small remaining beds might be managed with diver-operated suction harvesting, benthic barrier, or spot treatment with contact herbicides. By the third or fourth year, routine surveys may find only sporadic Eurasian watermilfoil fragments, which can be removed by hand harvesting. The foregoing example is essentially the history of Long Lake, WA.

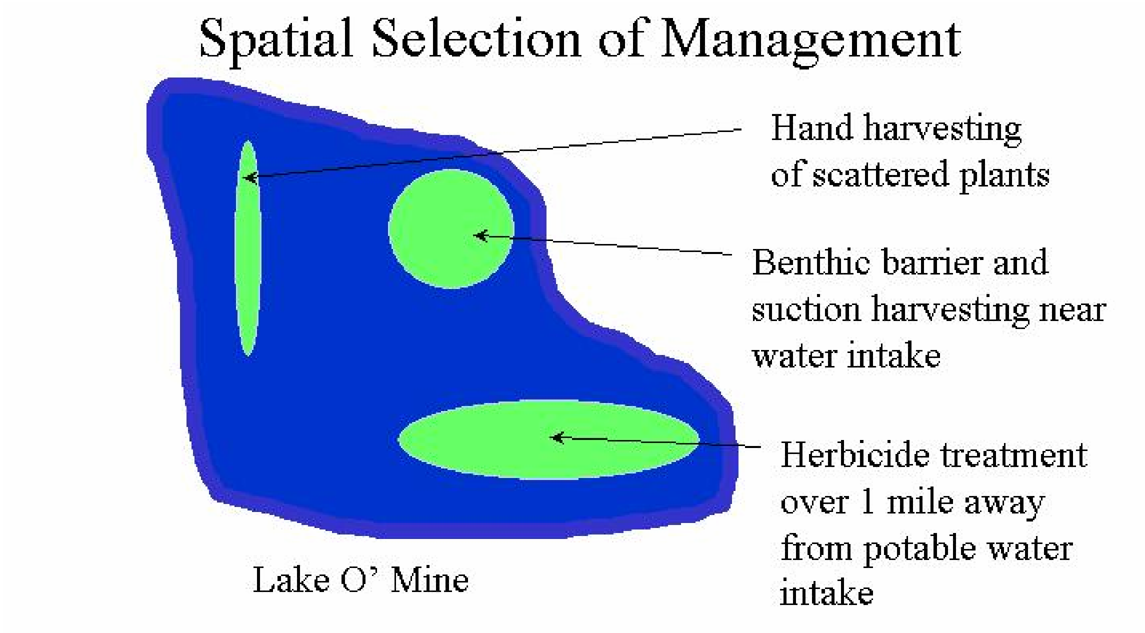

Figure 1. Spatial selection of management techniques.

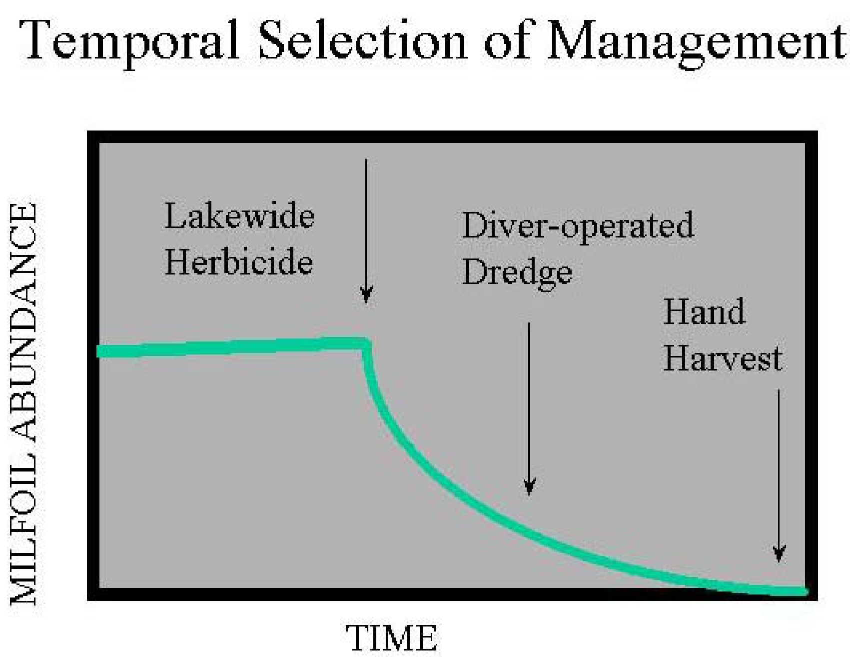

Figure 2. Temporal selection of management techniques.

Aquatic Plant Management Techniques

The basic types of aquatic plant management techniques include biological, chemical, mechanical, and physical control techniques. These techniques have been explained at length elsewhere (Madsen 2000, AERF 2005). All techniques should be selected based on their technical merits, as limited by economic and environmental thresholds.

Evaluation

Evaluation of management techniques and programs is typically lacking in even large-scale management programs. A quantitative assessment should be made of the effectiveness of management activities to control plants, the environmental impact (both positive and negative) of management activities, the economic cost per acre of management, and stakeholder satisfaction.

Summary

Planning should be iterative; a process that is ongoing and learning from past successes and failures. Learn from your assessments, and improve on management. The planning process helps to prepare for the unexpected in management, but likewise the plan may not survive intact after management activities commence.

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AN APPROACH TO INCORPORATE INVASIVE SPECIES AND WETLAND INDICATOR STATUS INTO WETLAND FLORISTIC QUALITY EVALUATION

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ABSTRACT

We evaluated four potential indices of wetland floristic quality, based on the general Floristic Quality Assessment Indices (FQAI) that have been developed and used extensively in various regions of the United States. The four indices that were evaluated, termed Floristic Assessment Quotients for Wetlands (FAQWet), incorporated components of overall species richness, wetland affinity, and the contribution of native versus exotic species to overall wetland vegetation quality. Index values for a set of ten wetlands in north Mississippi were evaluated against relative disturbance rankings of study sites, based on local and landscape-scale impacts from anthropogenic habitat modification and use (e.g., agricultural use, forest land cover, hydrologic and other on-site habitat modifications), the principal causes of habitat degradation in ecosystems worldwide. The adequacy of our four indices also was compared with that of the FQAI for the same set of wetlands. Of the indices evaluated, the one that correlated most closely with wetland disturbance rankings was that which incorporated the most information on relative importance of native and exotic plant species, in addition to wetland affinity:

FAQWet Index value =

$$\frac{\sum WC}{\sqrt{S}} \times \frac{\sum f}{\sum F},$$

wherein *WC* is the Wetness Coefficient for each species present, based on wetland indicator status; *S* is total species richness for the site; *f* is the sum of frequencies of native species among all sample plots; and *F* is the sum of frequencies of all species among all sample plots.

These results highlight the important effects attributable to exotic species dilution of native richness and have yielded a potentially useful criterion for evaluating ecological integrity of wetland ecosystems.

Keywords: aquatic plants, biological indicators, ecological integrity, exotic species, native species, wetland indicator status, wetlands