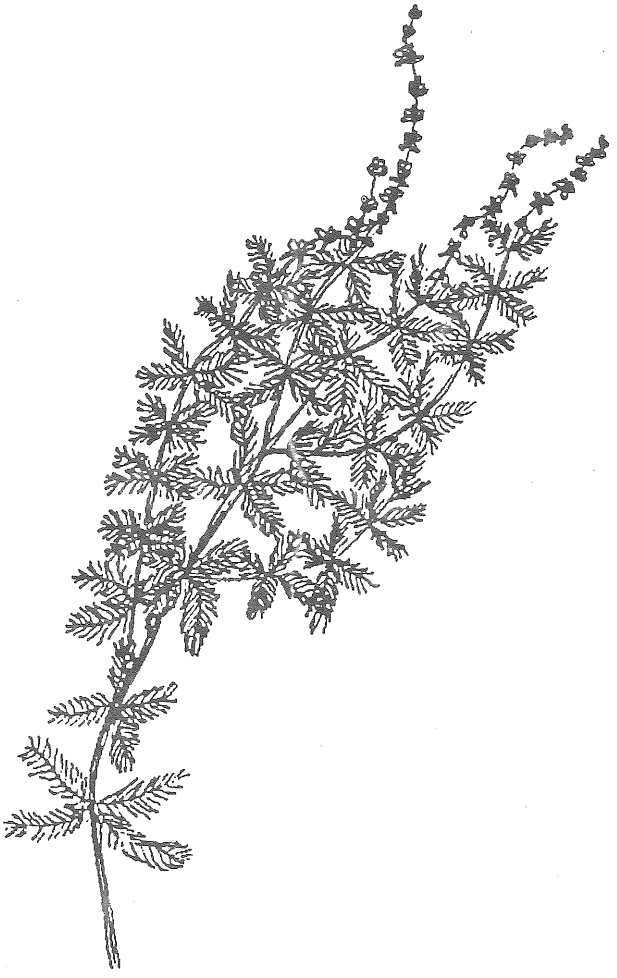
RESULTS OF MANAGEMENT WORKSHOP

EURASIAN WATERMILFOIL

IN

NORTHERN LATITUDES



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Minnesota Department of Natural Resources

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WORKSHOP ON MANAGEMENT OF EURASIAN WATERMILFOIL IN NORTHERN LATITUDES

Held February 27- March 1, 1990 at the
Freshwater Foundation - Navarre, Minnesota

INTRODUCTION

The Freshwater Foundation, together with the Minnesota Department of Natural Resources, convened this special workshop to identify strategies for controlling Eurasian watermilfoil. This prolific aquatic plant has recently been discovered in Minnesota lakes, and has quickly become one of the major lake management problems in the state. While the Minnesota experience is brief, Eurasian watermilfoil is but one of several major problem species that have challenged water managers and water users around the U.S. and Canada.

The workshop brought together leading experts in aquatic plant control and management from around North America, with Minnesotans interested in controlling the Eurasian watermilfoil problems in the state. During the course of the three days, more than 60 people took part in intense discussions and strategy development.

By design, everyone worked hard in a process that stressed participation, divergent experiences and viewpoints, and consensus building. Much of the time was spent in small work groups where strategies were crafted. One group focused its attention on methods of monitoring bodies of water, another discussed techniques for control of infestations, and the final group addressed methods for preventing the spread of this exotic plant. The results of this conference undoubtedly comprise the most comprehensive assessment of the state of the art in Eurasian watermilfoil management to be found anywhere.

The Foundation expresses its deep appreciation to all the participants in this very successful session, especially to those who came from other parts of the continent to share their experiences. Special recognition is due to the Minnesota Department of Natural Resources, the Workshop co-sponsor, for their critical support. Behind every successful event of this kind are the people who really make it happen. A thank you is due the Planning Committee for organizing the conference and inviting the participants. Thanks are also due to Tom Jorgens, Ron Nickerson and Brian Stenquist for their excellent work in facilitating the events over the three days. A final special thanks is due to Marty Jessen, George Orning and Laura Ayers Dorn for their many efforts to make this event a resounding success.

The Freshwater Foundation wishes to convey special appreciation to the G. Heilman Brewing Company (through Schmidt Beer); the F.R. Bigelow Foundation, the Wayzata Lions Club and the Riverway Company for financial support of its Eurasian watermilfoil Program. The Foundation also thanks the Minnesota Department of Natural Resources for its financial support of this workshop.

THE EURASIAN WATERMILFOIL WORKSHOP REPORT

OVERVIEW OF THE WORKSHOP

Eurasian watermilfoil is a recent unwelcome visitor to Minnesota which has quickly become one of the major problems affecting the lakes and other water bodies in the state. Eurasian watermilfoil grows at an extremely fast pace and can create dramatic changes in water bodies where conditions are right for its spread. While this prolific exotic plant is new to Minnesota, it is no stranger to many parts of the U.S. and Canada, or to the people who work to control it in those places where it has become established.

The mounting concern about this problem in Minnesota led the Freshwater Foundation to convene a conference to look for present and future solutions. The workshop was set on the shores of Lake Minnetonka, the largest lake in the Minneapolis-St Paul Metropolitan Area and one of the State's most important recreational resources. Eurasian watermilfoil (EWM) was found there in 1987 and has spread to encompass large areas of the Lake in just three years. More than two dozen other lakes in or near the Twin Cities have EWM infestations and many people are concerned this problem could become widespread in this "Land of 10,000 Lakes".

Experts from around North America came together with Minnesotans involved in various aspects of lake and river management to devise strategies for meeting this challenge. The broad cross section of professionals included the chiefs of aquatic weed control programs, academic and research experts, federal, state, provincial and local water resources managers, and experts in biological, chemical and mechanical control technologies. Minnesotans participating in the workshop included state and local water resource managers, fisheries managers, researchers, aquatic plant management experts, business people, lake association representatives and concerned citizens.

The workshop began with a sharing session. Experts from Oklahoma, Washington, Massachusetts, Mississippi and Florida discussed the situation across the North American continent and reviewed contemporary management strategies. In turn, Minnesota experts discussed the state's water resources and their experience with EWM. Armed with those overviews, the participants went to work in small groups to design model strategies for 1) **Prevention of the Spread of EWM**; 2) **Monitoring and Assessment of EWM infestations**; and 3) **Control of EWM infestations.**

The result of their work fills the remainder of this report.

WORKSHOP RESOLUTION

The Workshop Adopted the following resolution on March 1, 1990

WHEREAS, Eurasian watermilfoil *(Myriophyllum spicatum)* has become a major noxious aquatic weed in northern temperate latitudes, and;

WHEREAS, Eurasian watermilfoil has out-competed most native flora when introduced into a waterbody, and;

WHEREAS, Eurasian watermilfoil has aggressively spread throughout waterbodies after introduction, and;

WHEREAS, Eurasian watermilfoil has become established at nuisance densities in waterbodies covering a range of trophic conditions, and;

WHEREAS, Eurasian watermilfoil in high densities has adverse economic impacts through its interference with recreation, flood control, water supply and delivery, navigation, fisheries and wildlife habitat, and;

WHEREAS, established populations of Eurasian watermilfoil will not necessarily decline in response to reduction of nutrient inputs, and;

WHEREAS, existing and excessive populations of Eurasian watermilfoil accelerate material deposition, and;

WHEREAS, existing populations of Eurasian watermilfoil also pose a threat to uninfested waters. . .

THEREFORE, the Eurasian watermilfoil Workshop strongly recommends eradication and control through well-coordinated programs conducted by appropriate governmental agencies which utilize the approaches and methodologies recommended by this workshop.

PART A

STRATEGIC FINDINGS OF THE WORKSHOP

STATEMENT OF THE PROBLEM

"Eurasian watermilfoil is present in Minnesota, other states and provinces in the Northern Region. It has the demonstrated potential to cause changes in aquatic ecology, which can have significant detrimental effects on water quality, recreation, economy and lifestyle."

GOAL OF EWM MANAGEMENT

"To minimize the detrimental effects of Eurasian watermilfoil on water quality, recreation, economy and lifestyle."

EXPERIENCE REVEALS THAT THERE ARE THREE KEYS TO SUCCESS

The conferees noted three key elements of all successful management programs:

- People Power - A critical combination of skilled professionals, trained support people and volunteers.
- Will Power - The commitment to design and implement the necessary measures.
- Funding - Commitment of funding that is both adequate and sustained.

THE ESSENTIAL ELEMENTS OF STRATEGY

1. ORGANIZATION

- **Legislation establishing a EWM control program**
- **A lead agency, coordinating a multi-agency strategy, with citizen and technical input**
- **Coordinated planning for a focused, effective program**
- **Implementation with a multi-agency coordinated approach**

2. INFORMATION/EDUCATION

- The key to any effective strategy
- Good data is critical to program effectiveness
- Continuing need to develop better control methods

3. TARGETING

- Assume resources are limited
- Focus approach to use resources most effectively
- Emphasize most valuable and most endangered water bodies
- Use monitoring program to ensure containment
- Treat pioneer stands and established stands differently

4. DECISION STRATEGY

- Decisions must be tailored to the specifics of each case. This is especially important in selecting tactics to control an infestation in a particular lake or river.
- Zone strategies are those that apply to a broad geographic, climatic, or other region exhibiting common characteristics (e.g. The Northern Lakes Region).
- Place strategies are those that apply to a particular portion of that region (e.g. the State of Minnesota).
- Case strategies are those that apply to a particular water body (e.g. Lake Minnetonka).

Figure 1

CURRENT EWM MANAGEMENT APPROACHES

PREVENTION	ASSESSMENT	CONTROL
EDUCATION AND AWARENESS - Develop Public Awareness Program - Develop Training & Education - System of Citizen & Agency Participation in Monitoring REGULATION AND CONTROL - Law to Identify & Regulate Nuisance Species - Enforcement - Eradication of Localized Pioneer Infestations (timely action) - Target High Risk Waterbodies	Develop Lead Agency (identification/ strategy/co-ordination) Detection - Training - Surveying Priority Setting (waterbody risk assessment) - By Waterbody Uses - By Waterbody Characteristics - By Location Monitoring New Infestations Monitoring Established Infestations Research for Better Decision Making	MANAGEMENT METHODS - Mechanical Harvesting - Herbicides - 2,4-D - Sonar - Endothall - Diquat - Komeen ERADICATION METHODS - Mechanical - Diver Dredge - Diver Manual - Chemical Herbicides - 2,4-D - Sonar - Bottom Barriers

Figure 2

DIRECTIONS FOR THE FUTURE

PREVENTION	ASSESSMENT	CONTROL
The problem may become more accepted - a complacent public There may be more exotic species to deal with Shift of concern from spread to new waterbodies to spread within waterbodies Research/monitor/ eradication will be essential to improve predicting capability and evaluate programs More state and federal involvement in funding and management	Cost/benefit analysis of treatment Better predict critical areas (relation between waterbody parameters and weed growth needs) Refine remote sensing techniques Assemble/integrate waterbody data bases through pilot waterbody programs	NEW PRODUCTS - Chemical (e.g.,Renovate) - Mechanical (e.g.,Aquadock) - Biological (e.g., MT) VISIONS - Combine current technologies in integrated approaches between the various methods - Chemical (e.g., species selectives) - Mechanical (e.g., rotovating) - Biological (e.g.,pathogens) - Other (e.g.,sediment amendments) - Great Ideas (e.g., EWM eating walleye) - "No Grass Carp!" OBSTACLES - Knowledge - Funding/Costs - Clarification of purpose

PART B
FINDINGS OF WORKSHOP WORKGROUPS

The Conferees convened in three work groups based upon their expertise and interest. The three groups were charged with assessing the contemporary state of the art in EWM management and looking ahead to the evolution of strategies and techniques. In particular, they were asked to focus on the three most important systems in each area. The groups convened in the following areas:

Workgroup 1 - Prevention of the Spread of EWM

Workgroup 2 - Assessment and Monitoring of EWM

Workgroup 3 - Control of Infestations of EWM

1. PREVENTING THE SPREAD OF EURASIAN WATERMILFOIL

◦ Current Best Management Approaches

• Education and Awareness

- **A public awareness program** must be developed to enlist the support and active cooperation of the public participating in water based recreation. The campaign should define EWM as a serious problem, encourage the appropriate actions by water users, and promote making others aware of the problem. Suggested techniques are:

  > **Posters, pamphlets, newsletters, public service announcements, slide shows, electronic bulletin boards, information sent with boat, fishing and hunting licenses or registrations, signs (at boat ramps, on highways and at tourist centers) and displays at fairs.**

- **Training and education** about EWM is an effective strategy component to prevent the spread of this plant. Government personnel, lakeshore associations, homeowners associations, children (with education kits) and school curriculums are places to concentrate efforts.

- **Citizen and agency participation** in monitoring for EWM is a good technique for increasing support and broadening the base of people involved in containment. Groups that have been used are Soil and Water Conservation Districts, associations, advisory councils, Departments of Natural Resources, and water planning boards.

- <u>Regulation and Control</u>

  - **Eradication of localized "pioneer" infestations** should be a very high priority in the management program. A quick eradication response to small, new infestations has been shown to be a very effective and efficient way to contain EWM. The experience in other states and provinces points to the importance of developing a quick response team that can get to the scene of a new infestation with the appropriate tools to assess the situation and implement eradication measures.

  - **Legislation** defining EWM as a nuisance species and making it illegal to transport, propagate, possess or sell nuisance species is a basic requirement for any program. A strong law will help prevent new introductions, create a supportive environment for enforcement and build credibility for public education programs.

  - **Enforcement** of the law is fundamental to preventing the spread of EWM and to clearly demonstrating that this problem is being taken very seriously. Good enforcement not only contains the spread of EWM directly, but helps enlist wider support from the public.

  - **Targeting of high risk waterbodies** has been shown to be an important component of the effective prevention programs around the U.S. and in British Columbia. Targeting strategies can be based on the characteristics of water bodies, on the type and extent of use, and on locational factors. Targeting leads to the most efficient use of scarce resources.

- Future Directions in Preventing the Spread of EWM

  - **Public awareness and education**

    The need may diminish at some point in the future as the EWM problem becomes increasingly familiar.

  - **Other exotic species**

    Other "exotics" may present problems in addition to those of EWM.

  - **Shifting concern toward spread within waterbodies**

    Future concerns may shift toward preventing the spread of EWM within a waterbody, rather than the spread between waterbodies.

  - **Research to develop future monitoring and eradication methods**

    Research to develop the monitoring and eradication methods to be employed in the future needs to get underway. An emphasis on better predictive capability and evaluation methods should produce results.

  - **More state and federal involvement in funding and management**

    A larger role from federal and state governments will be needed to promote research, ensure improved control and provide adequate financial support.

2. ASSESSMENT & MONITORING OF EURASIAN WATERMILFOIL

- Current Best Management Approaches

  - **Development of a coordinating agency to focus responsibility**

    All successful programs have focused responsibility for EWM, Hydrilla or other "exotic" aquatics with a lead coordinating agency. Responsibility for positive identification of suspect plants must be established by the lead agency to create a clearinghouse for verification. The lead agency should be given primary responsibility for strategy, planning and coordination with other agencies involved in the issue.

- **Detection requires a good training and surveying system**

  Detection of new EWM infestations in waterbodies is essential to containment and has two key elements, training and surveying.

  Effective detection requires a well trained core of specialists, a broader group trained to look for EWM in the course of their activities, and a water using public aware of EWM and cooperating by reporting suspicious plants. Among the training techniques used effectively are workshops, publications, videos and manuals, with training provided by universities, agencies, and foundations.

  The surveying network can include associations, soil and water districts, watersheds, local governments, commercial applicators, extension, educational institutions, service clubs, and volunteers.

- **Priority setting through waterbody risk assessment**

  Detailed surveying to identify EWM is expensive, time consuming and difficult, making it very important to effectively target these efforts to lakes and rivers believed to be at the most risk of infestation. The three factors suggested by the group for screening include the use, the physical characteristics and the location of a waterbody. The assessment of risk requires an integrated data base with parameters on the recreational and residential use of the lake, on the physical, biological and chemical properties of the lake, and on the geographical location within watersheds and in proximity to known infestations.

- **Monitoring of new outbreaks and of established infestations**

  Monitoring of both new outbreaks and of established infestations are key elements of a containment strategy.

  With new outbreaks, the group recommends general mapping of occurrence, a detailed survey of the size, density and basin location of the infestation, and an intensification of surveying in the surrounding region.

  For established infestations, the group identified several techniques that may be used separately or in combination. These techniques range from searching outlets, beaches or grids for plant fragments, to diver reconnaissance of bottom areas, to aerial and satellite imagery.

◦ Future Directions in Assessment and Monitoring

Research to develop more effective techniques of monitoring and assessing EWM is critical to better management in the future. Areas suggested for exploration include:

- **Cost/benefit assessment of treatment programs.**

  The costs and benefits of various treatment regimes need to be quantified to promote increasingly effective use of scarce resources in the effort to contain EWM.

- **Integrated data bases to link parameters and plant growth rates.**

  There is very little hard, consistent data that ties physical, chemical, use, and other critical parameters to the susceptibility of a waterbody to EWM infestation or to the spread of EWM within the waterbody once it becomes established. There is a pressing need to know where EWM is most likely to become established and how rapidly it will spread once established. Much of the requisite data exists in various data bases, but it has not been integrated and enhanced to focus on answering these questions.

- **Techniques to predict critical areas for infestation.**

  Better techniques to identify EWM vulnerability in an efficient manner are needed in order to deploy resources effectively. In addition, better techniques to survey suspected EWM infestations are needed in order to promote early detection and effective treatment.

- **Refined remote sensing techniques.**

  Current work with remote sensing technologies indicate they hold great promise as a method of monitoring. However, most of the techniques lack the level of precision that would be desirable in broad applications. Research and development efforts are needed to refine current techniques and to develop better ones for the future.

3. CONTROL OF EURASIAN WATERMILFOIL INFESTATIONS

○ Current Best Management Approaches

• Understanding "control" parameters

- Definitions and goals of eradication and management must be resolved to provide direction when choosing methods of dealing with Eurasian watermilfoil.

- The rationale for control or eradication is that existing sources of Eurasian watermilfoil have a high likelihood of being sources for dispersal.

- The definition of the term 'eradication' can vary depending on the region being considered.

  > In Michigan, eradication can be considered a management program which protects the establishment native species and severely reduces the infestation of Eurasian watermilfoil.

  > In California, eradication can be considered to be a program which results in no "exotic" plant parts in the water system within three years after treatment.

• The following control methods for pioneer and established EWM infestations were discussed by the workgroup:

- Mechanical harvesting
- mechanical rotovating
- mechanical shallow tillage
- hydroraking
- dredging
- diver operated suction dredging
- scuba removal by hand
- Floating weed fragment barriers
- ultra sound
- contact herbicides
  - Endothall
  - Diquat
  - Komeen

- systemic herbicides
- 2, 4-D
- Sonar
- bottom barriers
  - texel
  - bottom line
  - aquascreen
- drawdown
- sediment alterations
- grass carp
- bacteria/fungi
- allelopathy
- herbivorous insect

- **Recommended techniques to control established infestations**

  - Mechanical harvesting

  - Herbicide treatment
    - 2, 4-D
    - Sonar
    - Endothall
    - Diquat
    - Komeen

- **Recommended eradication techniques for pioneer infestations**

  - Mechanical
    - diver dredge
    - diver manual

  - Chemical
    - 2, 4-D
    - Sonar

  - Bottom Barriers

◦ Future Directions in the Control of EWM

- **Some Problems That Must be Addressed**

  - There is a lack of institutional arrangements to deal with moving knowledge into action. The technology is in fair shape at this point, but institutional systems are not geared to deal with the problem.

- Removing obstacles to hastening biological control of EWM.

- Clarification of the objectives of Minnesota EWM management programs. Depending on the whether the objective is eradication or control, the methods and need for new technology will vary considerably.

- **New products and systems for EWM**
  - New chemical herbicides soon to be on the market include *Mariner, Arsenal, and Renovate.*

  - New mechanical methods include *Aquadock* and the use of integrated approaches.

  - Biological control methods show considerable promise for the future long term control of EWM. A promising fungal pathogen, known as MT or *microleptidiscus terrestrias* is gaining attention.

- **Visions for the future - areas for development**

  - Combinations of current technologies in integrated approaches.

  - Systemic herbicides that are species specific.

  - Mechanical technologies, such as *Rotarium.*

  - Biological methods using pathogens directed to EWM.

  - Other techniques, such as sediment amendments

  - Herbivorous insects that are specific to EWM

APPENDICES

The following appendices contain summaries of the recommendations of the Control workgroup relating to specific management tools that are available for use today to eradicate and or control EWM.

Appendix A

Current Eurasian Watermilfoil Eradication Methods

These methods are recommended for use to eradicate EWM in the northern lakes region, including Minnesota. The correct method or combination of methods for a particular case is dependent on the specific conditions of that case. Specific applications should follow a careful assessment of the circumstances and well defined decision rules.

Appendix B

Current Eurasian Watermilfoil Control Methods

These methods are recommended for the control of EWM to minimize its impact on waterbodies with EWM infestations in the northern lakes region, including Minnesota. The best method or combination for control in a specific case depends on the circumstances of that waterbody. Therefore, specific applications should follow a careful assessment of the characteristics of the individual waterbody and should proceed within well defined decision parameters.

Appendix A
CURRENT EWM ERADICATION METHODS

I. Diver-Operated Suction Dredging

A. PROCEDURE

1. Small dredge operated by a SCUBA diver to selectively remove aquatic plants

B. EFFECTIVENESS

1. 90% immediate removal of plants (plus some sediment)
2. If done properly, repeated application results in eradication

C. CRITERIA FOR USE

1. When population is too large for "Scuba Removal by Hand"
2. Characteristics of substrate are important

D. RELATIVE COST

1. Wide ranging price (up to $10,000/acre depending plant numbers)

E. ADVANTAGE

1. Removes roots and plants to any depth
2. Can be selective

F. DISADVANTAGES

1. Slow and labor intensive
2. Expensive
3. Small scale
4. Short term increases in turbidity
5. Requires a permit, resulting in 30-90 day wait
6. Moderately hazardous because it involves diving

II. Scuba Removal by Hand

A. PROCEDURE

B. EFFECTIVENESS

C. CRITERIA FOR USE

1. Site less than 1 acre, or
2. Widespread infestation at low densities

D. RELATIVE COST

1. Variable but relatively expensive (for example average diver costs $30/hr/diver)

E. ADVANTAGES

1. Site specific
2. Species specific
3. Highly effective
4. Its fun to do
5. Minimizes dispersal
6. Minimizes destruction of native plants
7. Provides opportunities for volunteer labor from diving groups

F. DISADVANTAGES

1. Can do for only small number of plants
2. Labor intensive
3. Limited by what diver can see
4. High cost
5. Moderately hazardous because it involves diving

III. 2,4-D Herbicide

A. PROCEDURE

1. A systemic herbicide available in liquid and pellet form applied early or later in season from boat or helicopter, surface or subsurface (note: in upper Midwest, Wisconsin is only state that allows application in liquid form)

B. EFFECTIVENESS

1. Under favorable conditions susceptible species may see 95-100% decrease in biomass
2. If applied when EWM plants are young and vigorously growing (early in season) may result inmore complete kill of targeted plant-as opposed to treating mature plants later in growing season
3. Weeds decompose over 2-3 week period

C. RELATIVE COST

1. Self application: Cost of chemicals (approx. $170-$300/acre)
2. Contract application: high cost for initial acre, reduced costs for additional acres

D. CRITERIA FOR USE

1. Can be used for small (<10 Acre) and large (>10 acre) infestations

E. ADVANTAGES

1. Will kill roots
2. Selective for milfoil - some other species not as susceptible
3. Possible full season control with successive annual treatments
4. Has some characteristics of contact herbicide (i.e. Knockdown)

F. DISADVANTAGES

1. Label restrictions: delay irrigation and potable use for up to 3 weeks post treatment
2. Public perception: Controversial because of alleged human health risks

IV. Sonar Herbicide

A. PROCEDURE

1. A systemic herbicide available in liquid and granular form applied to surface or bottom of lake in early spring as soon as plants begin to grow

B. EFFECTIVENESS

1. Under favorable conditions, susceptible species may see 85-100% decrease in biomass 1-3 months
2. Control may last for full season (plus), but yearly application probable

C. CRITERIA FOR USE

1. Must treat a large enough area (>10 acres) to be effective and comply with label restrictions.

D. RELATIVE COST

1. Self application: cost of chemicals (approx. $170-$300/acre)
2. Contract: high cost for initial acre, reduced cost for more acres

E. ADVANTAGES

1. Slow acting, so direct and indirect impacts on the environment are minimized
2. Provides longer control than some other herbicides
3. Selective control possible by adjusting application rates/timing
4. Fewer water use restrictions
5. More readily acceptable to regulators and citizens

F. DISADVANTAGES

1. May take 3 months to be effective
2. Label restrictions: Can't apply within 1/4 mile of intake of potable water

V. **Bottom Barriers** (e.g. a. Texel, b. Aquascreen, c. Bottom line)

A. PROCEDURE

1. Synthetic barrier material laid on the bottom of the lake
2. Kills plants by cutting off sunlight and by plant compression
3. May be installed with or without Scuba divers depending on water depth and size of installation

B. EFFECTIVENESS

1. Immediate 100% decrease in plants
2. Unmaintained barrier may in some cases provide 2-3 plus years
3. Maintained barrier may provide 7 plus years of control

C. CRITERIA FOR USE

1. Use on concentrated isolated patches

D. RELATIVE COST

1. Texel - 15 cents/square foot, Aquascreen - 35 cents/square foot Bottomline - 75 cents/square foot (includes staking system)
2. Installation costs add 25 cents/50 cents/sq. foot

E. ADVANTAGES

1. Immediate control of entire water column
2. Useful for individual homeowners
3. May be used in areas not accessible by harvester, rotovator, etc.
4. May be reused after pioneer population eradicated

F. DISADVANTAGES

1. Not feasible for large scale
2. Not species specific
3. While in place, the barrier takes the lake bed out of production

Appendix B
Current EWM Control Methods

I. Mechanical Harvesting

A. PROCEDURE

1. Plant stems and leaves cut and collected, then removed from the lake
2. Machines can cut 5-8 feet below water surface and up to 16.5 foot wide swaths

B. EFFECTIVENESS

1. Immediately removes weeds down to maximum cut depth
2. Regrowth in 30-60 days(in shallow areas less than 30 days)

C. CRITERIA FOR USE

D. RELATIVE COST

1. Contract harvesting: Aprox. $150-$400/acre/cut
2. Machine costs vary depending on equipment needs

E. ADVANTAGES

1. Can be used for large scale maintenance/management
2. Immediate creation of open water areas
3 Potential for nutrient removal
4. Fewer regulatory constraints
5. Potential for private use of harvested weeds (e.g. gardening/ farming)
6 Potential for opening plants to pathogen

F. DISADVANTAGES

1. Potential for off site dispersal of milfoil
2. Non target impacts: e.g. removal of herbivores, fish, other plants
3. Multiple cuttings required
4. Disposal of weeds necessary
5. Constant machine maintenance
6. Potential for shoreline litter

II. 2,4-D Herbicide

A. PROCEDURES

1. A systemic herbicide available in liquid and pellet form applied early or later in season from boat or helicopter,surface or subsurface.(note: in upper Midwest, Wisconsin is only state that allows application in liquid form)

B. EFFECTIVENESS

1. Under favorable conditions susceptible species may see 95-100% decrease in biomass
2. If applied when EWM plants are young and vigorously growing (early in season) may result in more complete kill of target plant - as opposed to treating mature plants later in growing season
3. Weeds decompose over 2-3 week period

C. RELATIVE COST

1. Self application: cost of chemicals (approx. $170-$300 Acre)
2. Contract application: High cost for initial acre, reduced cost for additonal acres

D. CRITERIA FOR USE

1. Can be used for small (<10 acre) and large (>10 acre) infestations

E. ADVANTAGES

1. May kill roots
2. Selective for milfoil - some other species not as susceptable
3. Possible full season control with successive annual treatments
4. Has some characteristics of contact herbicide (i.e. knockdown)

F. DISADVANTAGES

1. Label restrictions: Delay irrigation & potable use for up to 3 weeks post treatment
2. Controversial because of alleged human health risks

III. Sonar Herbicide

A. PROCEDURE

1. A systemic herbicide available in liquid and granular form, it is applied to surface or bottom of lake in early spring as soon as plants begin to grow.

B. EFFECTIVENESS

1. Under favorable conditions, susceptible species may see 85-100% decrease in biomass in 1-3 months.
2. Control may last for full season (plus) but year applications probable.

C. CRITERIA FOR USE

1. Must treat a large enough area (more than 10 acres) to comply with label restrictions.

D. RELATIVE COST

1. Self application: cost of chemicals (approx. $170-$300/acre)
2. Contract: high cost for initial acre, reduced cost for additional acres

E. ADVANTAGES

1. Slow acting, so direct and indirect impacts on the environment are minimized
2. Provides longer control than some other herbicides
3. Selective control possible through adjusting application rates/timing
4. Fewer water use restrictions
5. More readily acceptable to regulators and citizens concerned with public health

F. DISADVANTAGES

1. May take 3 months to be effective
   Label restrictions: Can't apply within 1/4 mile of intake of potable water

IV. Endothall Herbicide

A. PROCEDURES

1. A contact herbicide available in liquid and granular form applied to the surface or bottom of the lake

B. EFFECTIVENESS

1. Under favorable conditions, susceptible species will see 50-100% decrease in biomass after several weeks
2. Regrowth potential within 30 days

C. CRITERIA FOR USE

1. Short exposure time
2. Rapid knockdown

D. RELATIVE COST

1. Cost of chemicals (aprox. $170-$300/acre) plus applicators cost

E. ADVANTAGES

1. Fast acting herbicide
2. More readily acceptable to regulators and citizens concerned with public health

F. DISADVANTAGES

1. Label restrictions: Swimming 24 hrs, potable water for 7 to 14 days, fish consumption 3 days, irrigation 7 days
2. Retreatment within same season probable
3. Doesn't kill roots
4. Possibility for temporary algae blooms

V Diquat Herbicide

A. PROCEDURES

1. Contact herbicide available in liquid form that is applied to the surface or bottom of the lake.

B. EFFECTIVENESS

1. Under favorable conditions, susceptible species will see a 95-100% decline in biomass after 2 weeks.
2. Control for a season - possible under favorable conditons

C. CRITERIA FOR USE

1. Very short exposure time
2. Very rapid knockdown

D. RELATIVE COSTS

1. Chemical costs ($170-$300/acre) plus applicator cost

E. ADVANTAGES

1. Fast acting
2. Use for spot treatments and when short exposure time is expected

F. DISADVANTAGES

1. Can't use in turbid waters
2. Water use restrictions: swimming 24 hrs, potable 14 days
3. Less species specifically
4. In Minnesota, it must be applied by a commercial applicator
5. Label restrictions: No swimming for 24 hrs, potable water 14 days
6. Possiblility for temporary algae blooms with large scale treatments

VI. **Komeen Herbicide** (Chelated Copper)

A. PROCEDURES

1. A contact herbicide available in liquid form that is applied to the surface or bottom of the lake.

B. EFFECTIVENESS

1. Under favorable conditions, susceptible species will see a 95-100% decline in biomass after 2 weeks.
2. Control for a season - possible, under favorable conditions

C. CRITERIA FOR USE

1. Short exposure time
2. Rapid knockdown

D. RELATIVE COST

1. Chemical costs ($170-$300/acre) plus applicator costs

E. ADVANTAGES

1. Fast acting
2. Use for spot treatments and when short exposure time is expected

F. DISADVANTAGES

1. Marginal effectiveness on anything but young plants
2. Not specific, least selective
3. In Minnesota, it must be applied by a commercial applicator

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