Minnesota Department of Natural Resources
Exotic Species Program
500 Lafayette Road
St. Paul, Minnesota 55155-4025

contributing authors and editors*
Susan Balgie*
Wendy Crowell
Steve Enger
Mark Johanson
Gary Montz
Ray Norrgard
Nick Proulx
Jay Rendall*
Luke Skinner
Chip Welling*
Heidi Wolf
David Wright*

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Preface

Each year, by January 15, the Department of Natural Resources (DNR) is required to prepare a report for the Legislature that summarizes the status of management efforts for harmful exotic species (aquatic plants and wild animals) under its jurisdiction. Minnesota Statutes, Chapter 84D.02, Subd. 3, specifies the type of information this report must include: expenditures; progress in, and the effectiveness of, management activities conducted in the state, including educational efforts and watercraft inspections; information on the participation of others in control efforts; management efforts in other states; and an assessment of future management needs. Additional sections have been added to this report to provide a thorough account of the activities of DNR's Exotic Species Program and other groups related to harmful exotic species of aquatic plants and wild animals.

Table of Contents

Table of Contents (Continued)

List of Tables

List of Figures

List of Figures (Continued)

Page

Harmful Exotic Species of Aquatic Plants and Wild Animals in Minnesota: Annual Report for 2002 Summary

The Problem
Harmful exotic species can cause serious problems in Minnesota. For more than 100 years, Minnesota waters have endured negative impacts caused by the common carp and curly-leaf pondweed. More recently, Eurasian watermilfoil and purple loosestrife have displaced native plants, degraded valuable habitat for fish and wildlife, and limited water recreation in many lakes and wetlands in Minnesota. Zebra mussels, currently found in only a few lakes and rivers, can block water intakes used by industry and so increase operating costs. They also can eliminate populations of native mussels. Exotic fish species such as the round goby, found in the Duluth/Superior harbor, can displace native fishes and alter food sources for game fish.

In addition, many harmful exotic species have not yet reached our state or become established here. For example, European frog-bit, which produces problematic mats at the water's surface, is present in southeastern Michigan and other states to the east, but has not been discovered in Minnesota. Two species of exotic Asian carp occur in the Mississippi River as far upstream as northern Iowa. Both of these, the silver and bighead carp, have attracted attention because they can leap up to five feet into the air, sometimes landing in boats or hitting the people in them. Both carp may indirectly harm native fish and mussels by feeding on plankton they require.

The Response
To address the problems caused by harmful exotic species, the Minnesota Legislature in 1991 directed the Department of Natural Resources (DNR) to establish the Exotic Species Program. The program is responsible for monitoring and management of harmful exotic species of aquatic plants and wild animals. Other harmful exotic species are managed either by other divisions within the DNR or other state agencies. For example, exotic insects that can harm trees, such as the gypsy moth, are managed on a cooperative basis by the DNR's Division of Forestry and the Minnesota Department of Agriculture (MDA). The MDA also manages other harmful exotic species of insects and terrestrial plants that are important agricultural pests.

The three primary goals of the Exotic Species Program are:

1. Prevent introductions of new harmful exotic species into Minnesota;
2. Prevent the spread of harmful exotic species within Minnesota; and
3. Reduce the impacts caused by harmful exotic species to Minnesota's ecology, society, and economy.

1. Prevent introductions of new harmful exotic species into Minnesota
The best way to manage a harmful exotic is to prevent its establishment, when possible. Prevention methods include risk assessment, education, and regulation. Risk

assessment involves efforts to determine the problems that an exotic might cause if it were to become established in Minnesota and the pathways by which the exotic might reach our state. Education involves outreach to people who might inadvertently bring an exotic to Minnesota and is intended to explain the risk and steps they can take to prevent accidental introductions. Lastly, regulations have been established to prevent activities or practices that carry a high risk of introduction of harmful exotics. Minnesota has adopted a comprehensive set of regulations (Minnesota Statutes Chapter 84D and Minnesota Rules Chapter 6216) focused on harmful exotic species that includes sections focused on preventing new introductions. The statutes direct the DNR to assign exotic species to one of four regulatory classes: prohibited, regulated, unlisted, or unregulated.

During 2002, the Exotic Species Program focused on the risk that the commercial trade in plants and animals could bring harmful exotics into Minnesota. Certain harmful exotic aquatic plants linked to trade in water gardens or aquarium plants have become established in Minnesota and other states. For example, three quarters of the exotic aquatic plants in southern New England waters were cultivated for commercial trade.

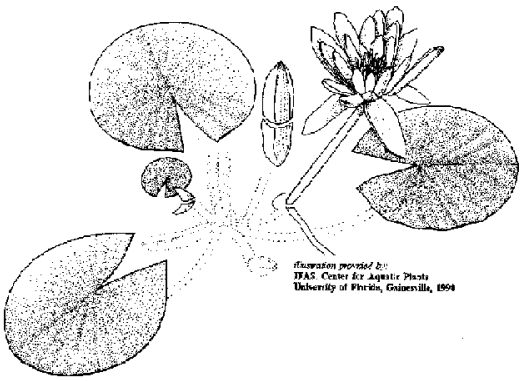

Figure 1a. Purchases of ornamental aquatic plants can result in the accidental introductions of other, more harmful exotic plants in the shipment.

A study completed in 2002 by the University of Minnesota with funding from the Exotic Species Program and Minnesota Sea Grant found that 90 percent of shipments of aquatic plants purchased from vendors across the U.S. were contaminated with plants and animals that were not ordered (Figure 1a). In a few cases, they were prohibited exotics such as hydrilla and purple loosestrife. This research can guide our efforts to work with the horticultural industry to reduce potential introductions of exotic plants into Minnesota.

2. Prevent the spread of harmful exotic species within Minnesota

Efforts to prevent the spread of harmful exotic species within Minnesota are focused on people and their habits. The primary means of spread for harmful exotic aquatic plants such as Eurasian watermilfoil and animals such as zebra mussels is unintentional

transport on trailered watercraft. In response, each year the DNR has hired up to 40 seasonal watercraft inspectors to work at public water accesses, primarily on infested water bodies, where they inspect boats and inform owners about the problems caused by exotics and actions that boaters can take to prevent spread. In 2002, the DNR inspected 45,000 watercraft.

During 2002, the Exotic Species Program worked to increase the public's awareness of exotic species and the problems they cause. These efforts included several methods that have been shown to be very effective:

- radio and television via paid advertising and public service announcements available from the DNR website,
- newspapers via press releases and media contacts,
- information in fishing and boating regulation booklets, and
- informational signs at public water accesses.

The DNR, Minnesota Sea Grant, and others also have produced and distributed an assortment of printed materials, provided information on web sites, attended sport shows and other major events, and provided training to lake association members.

The DNR's Division of Enforcement also is involved in efforts to prevent further spread of harmful exotics. In Minnesota, it is illegal to transport Eurasian watermilfoil as well as most other aquatic plants and prohibited harmful exotic species such as zebra mussels on trailered watercraft, seaplanes, etc. It also is illegal to take bait or water from water bodies that are infested with certain harmful exotic species. These regulations are enforced by conservation officers of the Division of Enforcement.

Surveys of Minnesota boaters attest to the effectiveness of efforts by the DNR's Exotic Species Program. The percentage of respondents to a recent survey who said they took action to prevent the spread of harmful exotics increased from 70 percent in 1994 to over 90 percent in 2000-2001. Also, the proportion of Minnesota boaters who said they were very likely to take action is considerably higher than levels in other states where less money has been invested and less comprehensive efforts made to reach boaters (Figure 1b).

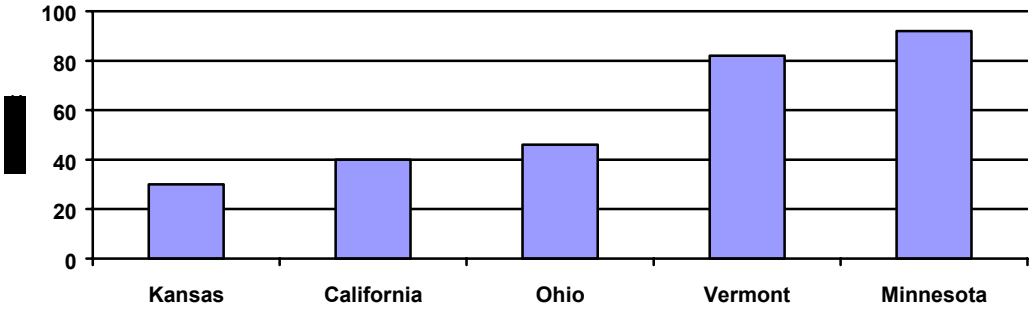

Figure 1b. Percentage of respondents to a 2000-2001 survey of boaters in five states who said they took action to prevent the spread of harmful exotic species.

As a result of these efforts, which have been underway for more than ten years, the DNR believes that the distribution of exotic species such as Eurasian watermilfoil and zebra mussels is much less than it would have been in the absence of a comprehensive program. Consider the examples of Michigan and Wisconsin, where the support for efforts to inform boaters and other users of lakes was less than that in Minnesota during the 1990s. In those other two states, zebra mussels appear to have spread to more inland water bodies than in Minnesota (Figure 1b). It also should be noted that there are more water accesses from which boaters might accidentally transport zebra mussels in Michigan and Wisconsin than in Minnesota.

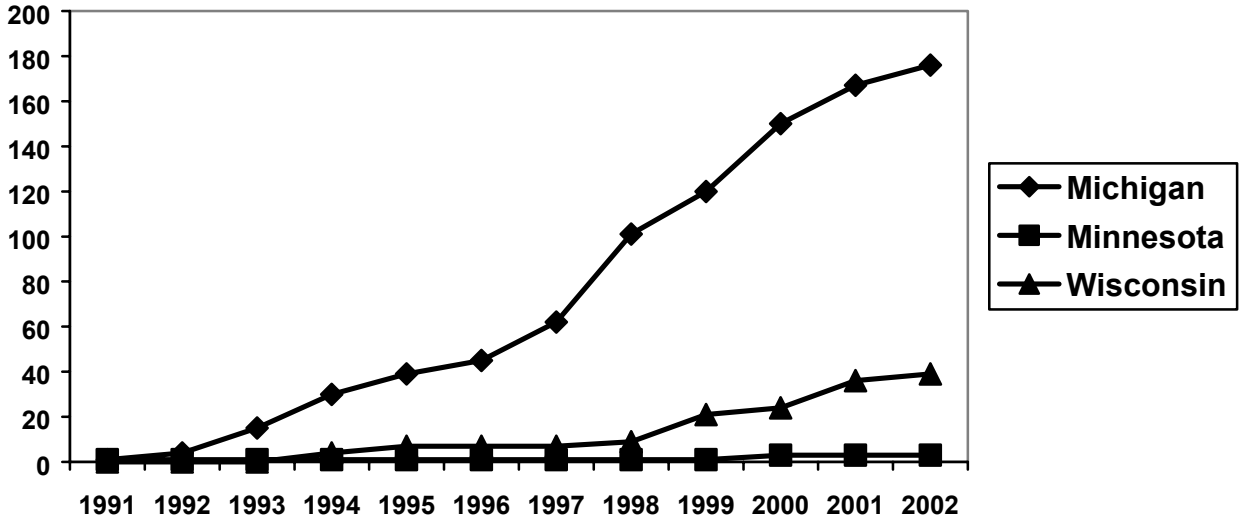

Figure 1c. Number of inland lakes and rivers where zebra mussels have been discovered by year.

Lakeshore residents who participate in the Zebra Mussel Monitoring program assist the Exotic Species Program in its efforts to prevent the spread of zebra mussels. More than 200 people from across Minnesota have taken part in the program during the last two years.

3. Reduce the impacts caused by harmful exotic species

To reduce the harmful effects of exotic species, the Exotic Species Program focused primarily on management of aquatic plants. In the case of purple loosestrife, the Exotic Species Program uses both herbicides and biological control (the use of insects that eat purple loosestrife) to manage this invasive plant. Since 1992, more than seven million leaf-eating beetles (Figure 1d) have been released in 800 purple loosestrife infestations statewide. Severe defoliation of the exotic plant by the beetles was observed on more than 20 percent of sites monitored in 2002. These efforts have been supported in large measure with funding appropriated by the Minnesota Legislature as recommended by the Legislative Commission on Minnesota Resources (LCMR) and cooperation from local and county government to rear and release the beetles statewide.

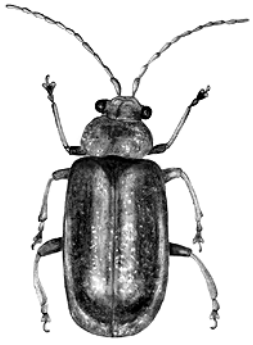

Figure 1d. A beetle (*Galerucella* spp.) that feeds on leaves of purple loosestrife (actual size is approximately ¼ inch long).

To reduce the problems caused by Eurasian watermilfoil, the Exotic Species Program works closely with owners of lakeshore, lake associations, local units of government, and others. Much of this management involves use of herbicides and mechanical harvesting. In 2002, state funds were spent on management of Eurasian watermilfoil on 37 Minnesota lakes. This included whole-lake treatment of three lakes as part of a continuing evaluation by the DNR of the potential to selectively control Eurasian watermilfoil with fluridone herbicide. In addition, efforts by researchers at the University of Minnesota to evaluate the potential to use insects for biological control of Eurasian watermilfoil continued with funding appropriated by the Minnesota Legislature as recommended by the LCMR.

Curly-leaf pondweed is a harmful exotic aquatic plant that occurs in hundreds of Minnesota lakes. It can cause problems by matting at the water's surface and is associated with undesirable algal blooms. In 2002, researchers at Minnesota State University-Mankato continued studies supported with funding from the Exotic Species Program intended to determine the best time of year to manage curly-leaf pondweed. Also during 2002, the DNR continued to assist the U.S. Army Corps of Engineers in a study of the potential to improve control of this harmful exotic by early-season treatment with contact herbicide.

Some efforts of the DNR to reduce the harmful effects of exotics are focused on management of fish, for example, common carp. Water levels were drawn down on several shallow lakes by the Division of Wildlife to eliminate carp and restore aquatic vegetation, which benefits waterfowl. On other lakes, fish barriers were installed to prevent the movement of carp into uninfested water bodies. Current research on carp includes work by the University of Minnesota to identify pheromones that may attract or repel the fish. This research is being done in cooperation with the Division of Wildlife.

Coordination among groups that manage harmful exotic species

Much of the success of the Exotic Species Program in dealing with harmful exotic species results from cooperation among various organizations. Management of Eurasian watermilfoil and purple loosestrife involves cooperation with local lake associations and local units of government as described above. Efforts to prevent introductions of new exotics into Minnesota often involve the participation of Exotic Species Program staff in state organizations such as the Minnesota Invasive Species Advisory Committee and regional organizations such as the Great Lakes Panel on Aquatic Nuisance Species and the Mississippi Interstate Cooperative Resources Association. Involvement with these groups promotes partnerships, develops uniform messages in educational products, and ensures sharing of information about new and existing harmful exotic species.

Revenue and expenditures

Base funding for the Exotic Species Program is derived from a $5 surcharge on the registration of watercraft in Minnesota, which generates approximately $1.2 million per year. Additional short-term revenue is received from federal sources such as the U.S. Fish and Wildlife Service and the U.S. Environmental Protection Agency, and from the Minnesota Legislature as recommended by the LCMR. The majority of the expenditures for management of harmful exotic species in Minnesota goes towards watercraft inspections, enforcement, and exotic species control (Figure 1e).

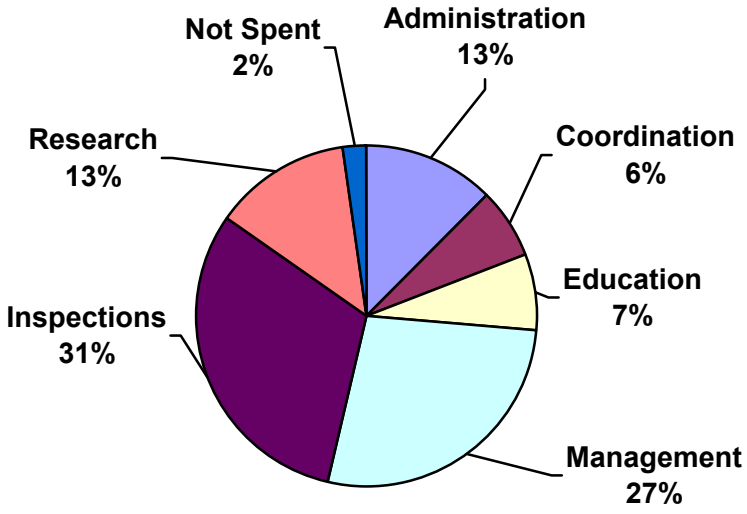

Figure 1e. Classification by major categories of expenditures by the DNR Exotic Species Program of $1.3 million during fiscal year 2002.

Plans for the future

Protecting Minnesota's natural resources from future damage due to harmful exotic species is paramount. Preventing new introductions of exotic species into Minnesota is

a primary goal. This will be accomplished through research, public awareness, and enforcement of regulations. The Exotic Species Program will develop fair and effective approaches to prevention of new introductions by working cooperatively with the public, business interests, other agencies, and states.

Efforts to prevent the spread of harmful exotic species within Minnesota will also continue through inspections of watercraft, education, and enforcement. The DNR cannot accomplish this task alone. The Exotic Species Program will seek to expand cooperative efforts with local communities and other law enforcement organizations.

Finally, the Exotic Species Program will continue to develop and refine management for existing harmful exotics, such as better use of herbicides and implementation of biological control with the assistance of expert researchers, both inside and outside Minnesota. This will include efforts to seek biological control for European buckthorn and garlic mustard, two terrestrial harmful exotic plants. The Exotic Species Program will continue to provide technical assistance to landowners through personal contact and information developed by program staff.

Introduction

Administration of State Harmful Exotic Species Control Programs

The Minnesota Department of Natural Resources (DNR) and the Minnesota Department of Agriculture (MDA) administer prevention and control programs for harmful exotic species (invasive species) in the State of Minnesota. The DNR's Exotic Species Program within the Division of Ecological Services is responsible for programs covering exotic aquatic plant and wild animal species. DNR's Division of Forestry, working in cooperation with the MDA, is charged with surveying and controlling forest pests, including exotic organisms such as gypsy moth and several bark beetles. A separate annual report is prepared by the DNR Forest Health Protection Team. MDA is responsible for the state's noxious weed and seed regulations that apply primarily to terrestrial plants. Information about control, prevention, and regulatory programs for several terrestrial invasive species, plant pests, and noxious weeds may be obtained from the MDA. University of Minnesota Sea Grant Extension has an Exotic Species Information Center in Duluth. The center promotes education to prevent the spread of exotic aquatic species in the state.

Overview of DNR's Exotic Species Program

Minnesota's Exotic Species Program was established in 1991 and was the first program of its kind in the nation. This comprehensive exotic species program was preceded by single species programs. In 1987, the DNR was designated the lead agency for control of purple loosestrife, an invasive plant of particular concern for the state's wetlands. In 1989, DNR was officially assigned a coordinating role for Eurasian watermilfoil control (Minnesota Statutes 84D.02, Subd. 2).

Many species fall under the DNR's current statewide responsibility to develop and coordinate a statewide program to prevent the spread of *harmful exotic species of wild animals and aquatic plants*. Examples include harmful exotic species that are present in Minnesota, such as Eurasian watermilfoil, purple loosestrife, zebra mussel, and ruffe (see Table 2a). The DNR Exotic Species Program also attempts to prevent the introductions of harmful species that have the potential to move into Minnesota such as hydrilla, water chestnut, and Asian carp. To do so, the program must identify potentially harmful species in other areas of North America and the world, predict pathways of spread, and develop and implement solutions that reduce the potential for introduction and spread. Prevention efforts are often undertaken with other states or agencies with similar concerns.

Program Staff and Other DNR Support

Most activities of the Exotic Species Program are conducted or directed by a seven person staff from DNR's Division of Ecological Services. Up to 40 seasonal intern watercraft inspectors are hired each year to inspect boats at public water accesses. Current program staff, their principal areas of responsibility and activity, and their phone numbers are listed in Appendix A. Staff from the DNR divisions of Fisheries, Wildlife, Enforcement, or Trails and Waterways, as well as the Bureau of Information, Education, and Licensing contribute significantly to the implementation and coordination of exotic species activities.

Table 2a. DNR's Exotic Species Program efforts that address specific harmful exotic species.

Exotic Species of Aquatic Plants and Wild Animals in Minnesota	Efforts of DNR's Exotic Species Program						
	A = Public information and education B = Watercraft inspections to prevent spread C = Population surveys and monitoring D = Control to reduce nuisance E = Control to reduce populations/escapes F = Research on biology and management G = Regulations						
	A	**B**	**C**	**D**	**E**	**F**	**G**
Aquatic Plants							
Flowering rush (*Butomus umbellatus*)	✔	✔	✔	✔	✔	✔	✔
Purple loosestrife (*Lythrum salicaria*)	✔		✔		✔	✔	✔
Eurasian watermilfoil (*Myriophyllum spicatum*)	✔	✔	✔	✔	✔	✔	✔
Other Non-native aquatic plants	✔		✔				✔
Curly-leaf pondweed (*Potamogeton crispus*)	✔	✔	**F**	**APM**		✔	✔
Animals							
Common carp (*Cyprinus carpio*)			**F**		**F/W**	**W**	✔
Ruffe (*Gymnocephalus cernuus*)	✔	✔	**F/O**		**NIF**	✔	✔
Round goby (*Neogrobius melanstromus*)	✔	✔	**F/O**		**NIF**		✔
Spiny waterflea (*Bythotrephes cederstroemii*)	✔	✔	**F**				✔
Zebra mussel (*Dreissena polymorpha*)	✔	✔	✔			✔	✔
Rusty crayfish (*Orconetes nusticus*)	✔						✔
Mute swan (*Cygnus olor*)			✔		✔		✔

APM - Individuals or groups apply for aquatic plant management permits
F - DNR Division of Fisheries monitors this species
F/O - DNR Division of Fisheries and other agencies monitor this species
F/W - DNR Division of Fisheries and/or Division of Wildlife occasionally manage this species at priority site
NIF - Inland waters will be addressed as outlined in a Nonindiginous Fish Plan
W - DNR Division of Wildlife is involved with research on this species.

Divisions of Ecological Services, Fisheries, and Wildlife
Pesticide enforcement specialists from Ecological Services and aquatic plant management specialists in the Division of Fisheries assist with the management of various exotic plants including purple loosestrife, Eurasian watermilfoil, and flowering rush. In addition to these staff, other individuals from the divisions of Fisheries and Wildlife contribute by providing biological expertise, assisting with control efforts, conducting inventory and public awareness activities, and providing additional avenues for public input.

Division of Enforcement
Conservation officers are responsible for enforcing the state regulations regarding harmful exotic species. A regional enforcement supervisor acts as exotic species enforcement coordinator within the Division of Enforcement to assist in scheduling, executing, and reporting on enforcement activities related to harmful exotic species. A chapter describing enforcement activities is included in this report (see Enforcement).

Bureau of Information, Education, and Licensing
Susan Balgie from the Bureau of Information, Education, and Licensing provides support for the Exotic Species Program's public awareness activities (see Education and Public Awareness).

Participation in Statewide, Regional, and National Groups

The DNR Exotic Species Program and other agencies in the state participate in statewide groups such as the Minnesota Invasive Species Advisory Council, the Noxious Weed Potential Evaluation Committee, and the Weed Integrated Pest Management Group.

The DNR Exotic Species Program and others in the state participate in regional or federal activities regarding harmful exotic species. Limitations on out-of-state travel in effect during 2002 and the increasing number of national and regional entities and activities related to invasive species have made it much more difficult to represent Minnesota's interests at the regional and national level.

Minnesota's representative to the Great Lakes Panel on Aquatic Nuisance Species is Jay Rendall, the Exotic Species Program Coordinator, Doug Jensen from Minnesota Sea Grant is the alternate member. Participation on this regional panel helps keep Minnesota informed of regional and federal efforts regarding harmful exotic species and provides a voice for Minnesota interests. The Mississippi Interstate Cooperative Resources Association (MICRA) has an Aquatic Nuisance Species (ANS) Committee and is in the process of convening a Mississippi River Basin Panel on aquatic nuisance species. Jay Rendall is chair of MICRA's ANS committee. Program staff are also involved with the following statewide or regional groups: Gary Montz and Jay Rendall – the St. Croix Zebra Mussel Task Force; Luke Skinner – a Forest Health Technology Enterprise Team (the team discussed garlic mustard in 2002) (see Appendix B).

Expenditures

Introduction

Funding for activities of the Exotic Species Program comes from a variety of state, federal, and local sources. Base funding for the Exotic Species Program is derived from a $5 "exotics" surcharge on the registration of watercraft in Minnesota. Surcharge receipts are deposited in the Water Recreation Account and appropriated by the Legislature. Surcharge receipts currently generate sufficient funds to allow an annual appropriation of approximately $1,200,000 (Table 3a). These "base" funds are used to support core program activities. Funds obtained from other sources are used to support special activities or expand the level of core activities.

Table 3a. Funding (in thousands) received by the Exotic Species Program, fiscal years 2002 and 2003.

Fiscal Year	Water Recreation Acct	Legislative Commission on Minnesota Resources[1]	Federal Grant Reimburse-ments	Other State Agencies	Local Contributions	Total
2002	1,174	45	89	5	9	1,322
2003	1,218	45	26	-	11	1,300

[1] Environment and Natural Resources Trust Fund or the Minnesota Resources Fund or both.

Significant support for exotic species research efforts has also been appropriated by the Minnesota Legislature from the Environment and Natural Resources Trust Fund and the Minnesota Resources Fund as recommended by the Legislative Commission on Minnesota Resources (LCMR). Recommendations by the LCMR are based on results of a competitive grants program. During the FY02/03 biennium, the DNR Exotic Species Program will receive $90,000 from this source for a project entitled, "Biological control of Eurasian watermilfoil and purple loosestrife - continuation."

Funds were also obtained or have been promised from a number of Federal and local sources. Federal funds, from the U.S. Fish and Wildlife Service (USFWS), support the on-going implementation of the St. Croix Interstate Management Plan for aquatic nuisance species, which includes public awareness efforts and monitoring activities conducted by DNR. Federal grants were approved by the USFWS to support an assessment of the risks posed by exotic earthworms and by the U.S. Environmental Protection Agency to support research on the biological control of European buckthorn. Local funds were provided by two groups, Kandiyohi County Lakes Association and the Lake Minnetonka Conservation District, that wanted to increase watercraft inspection efforts in area lakes.

This report covers activities in calendar year 2002, which includes the last half of fiscal year 2002 (FY02; Jan 1 – June 30) and the first half of FY03 (July 1 – Dec 30). To provide a comprehensive review of expenditures that occurred during calendar year

2002, we report both expenditures that were incurred in FY02 and those planned in FY03 (Table 3b). Minnesota statute (M.S. 84D.02 Subd. 6) identifies five expenditure categories that must be reported. Those categories are Administration, Education, Management, Inspections, and Research. A sixth category, Coordination, has been added to cover a variety of program-wide or "big-picture" activities that do not fit easily into the reporting categories required by statute. Expenditures within each category are subdivided to reflect the program activities described below.

Administration
Administration includes the fee assessed by the Division of Ecological Services (about 2% of the base budget) and the DNR (about 0.1% of the base budget) to cover administrative services. It includes general office expenses, e.g., clerical staff time, telephones, postage, office rent. Also included as an administrative expense is staff time spent on activities that are not related directly exotic species work, e.g., training or professional development, and assistance with other division or department projects. Finally, all staff time used for holidays, sickness, or vacations (about 5% of the base budget) is included as an administrative expense.

Coordination
Coordination includes a variety of program-wide activities and expenditures. They include:

State coordination: Preparation of state plans and reports, attendance at public hearings, strategic planning efforts, as well as the general oversight and planning of program activities. Involvement in state coordinating groups such as the Minnesota Invasive Species Council is also included. Expenditures primarily represent staff time spent on these activities.

Coordination with regional and federal activities: Staff time, out-of-state travel, and conference calls to represent the state at meetings, workshops, or hearings related to harmful exotic species. Examples from the last two years include: the Great Lakes Panel on Aquatic Nuisance Species (ANS), the Mississippi Interstate Cooperative Resources Association's ANS Committee, the Council of Great Lakes Governors' Ballast Water Initiative, and the Wisconsin Natural Resources Board hearing on mute swans.

Equipment and Services: Purchase and repair of boats, trailers, computers, and similar items, and computer support services.

Education
Expenditures in this category include staff time, in-state travel expenses, fleet charges, mailings, supplies, printing and advertising costs, and radio and TV time to increase public awareness of exotic species. The costs of developing and producing pamphlets, public service announcements, videos, and similar material are included, as are the costs of developing and maintaining exotic species information on the DNR's website.

Management
Expenditures in this category include staff time, in-state travel expenses, fleet charges, commercial applicator contracts, and supplies to survey the distribution of exotic species in Minnesota and to prepare for, conduct, supervise, and evaluate control activities. When the management activity is focused on a specific harmful exotic species, e.g., Eurasian watermilfoil, purple loosestrife, zebra mussels, detailed expenditure information is shown. Funds provided to local government units and organizations to offset the cost of Eurasian watermilfoil management efforts are also included.

Inspections
Expenditures in this category include the costs that Conservation Officers incur enforcing exotic species rules and laws, the costs of implementing watercraft inspections at public water accesses, and staff time and expenses associated with promulgation of rules, development of legislation, conducting risk assessments, and other efforts to prevent the introduction of additional exotic species into Minnesota.

Research
Expenditures in this category include staff time, travel expenses, fleet charges, supplies, and contracts with the University of Minnesota and other research organizations to conduct research studies. These studies include efforts to develop new or improve existing control methods, better understand the ecology of harmful exotic species, develop better risk assessment tools, and evaluate program success. When research is focused on a specific harmful exotic species, e.g., Eurasian watermilfoil, purple loosestrife, curly-leaf pondweed, detailed expenditure information is shown.

Not Spent
Funds in this category include work that was authorized in FY02, but for which the final bill has not yet been received, and salary savings from the hiring freeze. Funding that was appropriated by the Legislature in FY02, but not spent, is available for FY03.

Fiscal Year 2002 (FY02)

Expenditures on exotic species activities during FY02 (July 1, 2001 – June 30, 2002) totaled $1,304,000 (Table 3b). Expenditures from the “Water Recreation Account”, the primary source of funding, are listed along with spending from other accounts. The Exotic Species Program manages “Other Exotics Accounts” that also support program activities. An example is revenue from the sale of public awareness material, which is deposited in a Publications Account and can be used to fund future public awareness efforts. Grants received from other state or federal funding sources, e.g., LCMR recommended appropriations and the U.S. Fish and Wildlife Service, are also included in this category. In FY02, $140,000 was spent from these accounts. Expenditures from “Other Department Accounts” primarily reflect work by staff in the divisions of Ecological Services, Fisheries, or Wildlife who are not hired as exotic species specialists, but who occasionally work on exotic species issues as part of their DNR positions. In FY02, about $10,000 of exotic species work was coded to the Game and Fish Fund and about $7,000 was coded to the General Fund. This summary may not reflect the contribution of all DNR staff who provide assistance to manage harmful exotic species.

The $1,143,000 of Water Recreation Account expenditures by the Exotic Species Program during FY02 (Table 3b) was less than the $1,174,000 appropriated (Table 3a). All funds were not spent, in part, because of the hiring freeze initiated during the 2002 Legislative Session. During 2002, the Exotic Species Program had a position become vacant and a replacement was not hired. The $31,000 that was not spent will roll forward and be available for spending in FY03.

FY02 expenditures by major category (Figure 3a and Table 3b) were similar to spending levels in recent years. Some year-to-year variation in expenditures is expected and reflects changes in program needs and/or the level of assistance provided by various partners. For example, in FY99 the Exotic Species Program invested a significant amount of time meeting with constituent groups and holding public hearings to develop new rules. Consequently, costs for rule development were particularly high in that year. Costs in the Inspections category are increasing. This increase reflects the higher costs of hiring, training, and deploying watercraft inspectors who contact boaters at public water accesses throughout Minnesota. The Exotic Species Program is expanding the number of access inspections conducted in Greater Minnesota, both on infested and non-infested waters, and this decision has increased travel costs. In addition, more staff time is being devoted to prevention-related activities.

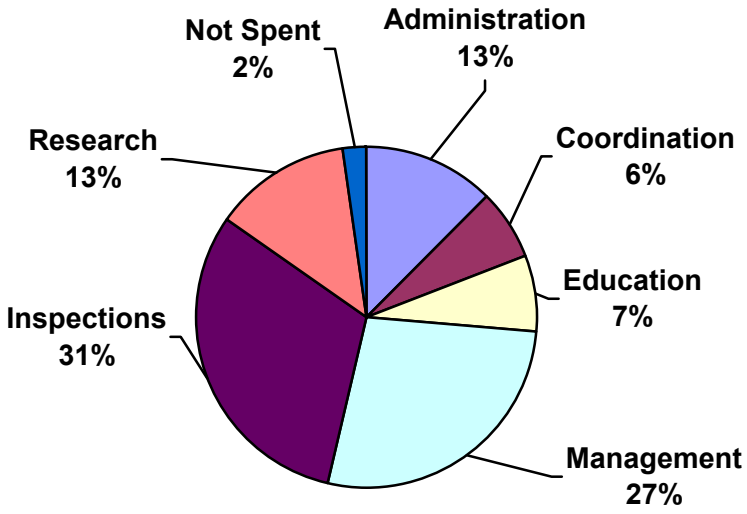

Figure 3a. Exotic species spending in FY02 by major categories.

Fiscal Year 2003 (FY03)

Since this report is due in the middle of FY03, planned expenditures for this year are also reported (Table 3b). Expenditures in most categories are expected to remain relatively constant between FY02 and FY03. The Exotic Species Program believes that the current distribution of funding among major program categories is an appropriate

allocation. Significant investments are being made in each of the four primary focus areas: education, management, inspections, and research. In addition, significant investments are being made to maintain a coordinated statewide and regional response to the threats posed by exotic species. These anticipated spending levels would change if a significant event, e.g., the discovery of a new harmful exotic species in Minnesota or the availability of a new management method, altered exotic species management needs and options.

The following chapters describe in detail the activities that were conducted during 2002 using FY02 and FY03 funds.

Table 3b. Exotic species related expenditures in fiscal year 2002 (FY02) and projected expenditures in FY03 (in thousands of dollars).

Categories of Expenditures	Water Recreation Account		Other Exotic Accounts		Other Dept. Accounts		Totals	
	FY02	FY03	FY02	FY03	FY02	FY03	FY02	FY03
Administration							167	175
Rent, Phones, Postage, Misc.	27	30						
Staff Time	43	40						
Staff Personal leave (Vacation, Holiday, Sick)	61	60						
Clerical	11	15						
Div./Dept. Administrative Support	25	30						
Coordination							89	100
State coordination	63	65			13	15		
Support regional/federal activities	8	10			-	-		
Equipment and services	5	10			-	-		
Education							96	105
Communications plan, workshops, presentations, radio spots, TV, website development	96	105						
Management							363	318
General	14	10	-		3	3		
Eurasian watermilfoil	180	180	62					
Purple loosestrife	84	110	4					
Zebra mussel	12	5						
Curly-leaf pondweed	<1	5						
Flowering rush	4	4						
Nongame Fish	-	1						
Inspections							417	446
Watercraft inspections	357	370						
Enforcement – road and access checks	54	60						
Prevention -- development rules/laws/risk assessments	5	15			<1	1		
Research							172	139
General	2	12	-	-	<1	1		
Eurasian watermilfoil	30	34	23	22				
Purple loosestrife	25	29	22	23				
Zebra mussel	-	-	-	-				
Curly-leaf pondweed	29	18	-	-				
Other exotic plants	7	-	-	-				
Nongame fish	-	-	-	-				
European buckthorn	-	-	32	-				
Total	1,143	1,218	143	45	17	20	1,304	1,283
Not Spent	31							

Emerging Issues

Introduction

There are many aspects of management of harmful exotic species: understanding new threats, monitoring of expanding populations, and development of improved tools for control of harmful exotics that are established in Minnesota. In this chapter we describe three issues in these areas that attracted attention in 2002.

New Species Reported in Minnesota

One new fish species, thought to be red pacu (*Piaractus brachypomus*), was found in the state's waters during 2002. An angler caught a few pacu on Tanner's Lake (Washington County). A red pacu also was caught by a commercial fisherman on the Mississippi River in Peterson Lake near Kellogg (Wabasha County). The fish, examined by DNR Fisheries biologists at Lake City, was about 20 inches and weighing seven pounds. The likely source of these fish is from the release of aquarium fish. Red pacu is in the same family as the piranha, but feeds primarily on seeds, nuts, and other vegetable matter. This species of fish is native to the Amazon basin in South America and is not expected to survive water temperatures that occur during a Minnesota winter, although their introduction into state waters could introduce parasites and disease that endanger native fish.

Approaching Threats: Asian Carp

Issue

Three species of carp native to Asia – silver (*Hypophthalmichthys molitrix*), grass (*Ctenopharyngodon idella*), and bighead (*Hypophthalmichthys nobilis*) – have escaped from captivity and have established populations in North American waters. Another species, the black carp (*Mylopharyngodon piceus*), is used in the aquaculture industry and has escaped from aquaculture ponds in the past, but is not known to have naturalized in North America. Each of these species poses different risks to fish and other aquatic species. The two species that are moving toward or into Minnesota waters of the Mississippi River are the bighead and silver carp. These Asian carp are in Iowa waters of the Mississippi River and are spreading northward. There is also concern about these carp entering the Great Lakes through the Illinois waterways that connect the Mississippi River basin with the Great Lakes.

Bighead carp

The bighead carp (*Hypophthalmichthys nobilis*) is a plankton (microscopic algae) eater. They can get quite large, with individuals reaching over 30 inches and weighing 60 pounds. Their eyes are located on the lower half of the head. The bighead carp was initially introduced into several southern Mississippi River basin states in the 1960s. They were introduced into the Mississippi River when private hatchery ponds were flooded. They quickly began spawning in the Mississippi and populations spread to other rivers. Its distribution in the basin has expanded and, in recent years, populations of this fish in states such as Indiana, Iowa, and Missouri have dramatically increased. Bighead carp in the Mississippi River basin downstream from Minnesota continue to be a concern and are likely to move upstream and threaten fisheries in the Minnesota

River. Iowa DNR received a call from a commercial fisherman who had caught a 13 pound bighead carp in Pool 9 near Lansing, Iowa in May 2002 – just below the Minnesota border.

Netting studies in the Mississippi River conducted by the Illinois DNR have found that bigheads school with paddlefish and may compete with the paddlefish for food. Since bighead eat microscopic food, it is feared they will also compete with young larval native fishes for food (for more information see www.state.ia.us/fish/iafish/minnow/bighead/htm).

A research project entitled, "Bighead Carp in the Upper Mississippi River: Competition with Native Filter-feeding Fishes and Potential Threats to the Great Lakes" was initiated by John H. Chick (University of Illinois, Illinois Natural History Survey) in March 2002 and it will continue until 2004. The objectives of this proposed study are:

1. To determine the extent of dietary overlap between bighead carp and native filter-feedings fishes in the Mississippi and Illinois river systems
2. To use data from the Long Term Resource Monitoring Program to examine whether specific environmental factors correlate with successful reproduction of bighead carp in the Upper Mississippi River System.
3. To test the effectiveness of an electric weir in restricting the spread of bighead carp.

(for more information see www.iisgcp.org/resrch/br/cur/res0401.htm)

Silver carp

The silver carp (*Hypophthalmichthys molitrix*) is present in large numbers in the Mississippi River and is likely to move into Minnesota waters of the Mississippi River soon. The fish was first found in natural waters in Arkansas about 1980, likely the result of escapes from aquaculture facilities. In large numbers the fish has the potential to cause considerable damage to native species because it feeds on plankton required by larval fish and native mussels. The silver carp, like the bighead, has also attracted much attention because of its habitat of jumping several feet out of the water, hitting boaters, or landing in boats.

Black carp

Black carp (*Mylopharyngodon piceus*) are already present in, or are proposed for use in, aquaculture ponds in at least three southern states. Their escape would pose a significant risk to the mollusk and fisheries resources throughout the Mississippi River and its tributaries. The U.S. Fish and Wildlife Service (USFWS) is in final stages of a process to determine if they will list black carp as an injurious wildlife species. On July 30, 2002, a notice was published in the *Federal Register* seeking comments on the proposed listing. On September 30, 2002, the DNR sent comments to the USFWS encouraging it to list the black carp as injurious. If they are listed, they would be illegal to import into the country and to ship between states (see Regulations chapter).

New Management Techniques

Interagency agreement on biological control

In 2002, the DNR and MDA established a memorandum of agreement to address biocontrol research for invasive exotic plants. The agreement establishes that DNR will lead biocontrol research for plant species that invade natural areas and aquatic habitats. When species are a problem in both agriculture and natural areas, DNR and MDA will jointly determine who will take the lead. Research for biocontrol of garlic mustard and European buckthorn are lead by DNR. This research will hopefully aid management of buckthorn and garlic mustard in forests, wildlife management areas, parks, trails, and natural areas throughout Minnesota.

Buckthorn

Common buckthorn (*Rhamnus cathartica*) and glossy buckthorn (*R. frangula*) are European woody species that invade a number of habitat types in the northeast and north-central regions of the United States and Canada. Both species are very adaptable, forming dense thickets that inhibit the growth of native forbs, shrubs, and tree seedlings. Land managers have spent considerable time and money trying to control this invasive shrub using conventional techniques. Their success has been limited and short-term. We believe the best hope for a long-term management strategy may be release of a biological control agent. The Minnesota Department of Natural Resources (DNR) has initiated a research project on biological control of European buckthorn, conducted by the Center for Applied Bioscience International in Switzerland (CABI). The DNR received a two-year grant from the United States Environmental Protection Agency-Great Lake National Program Office and several other contributors to initiate this research. Others including Minnesota Department of Agriculture, Baileys Nursery Foundation, Minnesota Nursery and Landscape Association, and many individuals, have contributed thousands of dollars for the research.

Initial research results suggest that a dozen species of insects show some potential as control agents. Researchers initiated field surveys for potential control agents in the spring of 2002. Surveys and collection trips were carried out by CABI researchers in Germany, Italy, Switzerland, Austria, and Yugoslavia. In total over 60 buckthorn sites were discovered and sampled. To date, some 270 arthropod samples have been collected, 184 on *Rhamnus catharticus* and 70 on *R. frangula*. Beginning in 2003, researchers will rear potential control agents and test whether they feed and/or reproduce on non-target native plants that are closely related to buckthorn. This research is expected to take eight to ten years to complete. If a successful biocontrol agent is discovered, we expect buckthorn populations will be suppressed by: 1) killing buckthorn shrubs outright, 2) stressing or weakening buckthorn plants so that native plant and shrub species can gain a competitive advantage, and/or 3) reducing seed production. In many cases, control or suppression of the pest plant can be long-term.

Garlic mustard

Garlic mustard, *Alliaria petiolata,* is currently one of the most serious invaders of forested areas in southern Ontario and the northeastern and mid-western United States. This biennial exotic plant can cover large areas where it displaces the native woodland ground flora such as spring ephemerals. Few infested sites were known to exist in the

state until recently. In 2001 and 2002, the numbers and sizes of infestations increased significantly. It has become an increasing problem in Minnesota during the past two years. University of Minnesota herbarium records, and reports from citizens and biologists received during 2002 indicate that infestations exist in at least 11 counties: Anoka, Brown, Carver, Cass, Clay, Dakota, Hennepin, Kandiyohi, Nicollet, Pine, and Ramsy. Control of large infestations is difficult and land managers are seeking better control tools.

In 1998, a project to search for natural enemies of garlic mustard was initiated by Dr. Bernd Blossey at Cornell University. Funding was provided by the Departments of Natural Resources in Minnesota, Illinois, Indiana, and Kentucky; Hoosier National Forest; Native Plant Societies of Illinois and Indiana; U.S. Department of Defense and others. In 2002, the DNR and the United States Forest Service-Forest Health Technology Enterprise Team, in cooperation with representatives from many of the initial funding agencies organized an informal working group to develop a 3-5 year plan for continuing the project to develop a biological control program for garlic mustard. In 2002 and 2003, the consortium will cooperatively provide technical and financial assistance to continue the host range testing in Europe, establish laboratory colonies of promising agents in a quarantine facility in the U.S., and establish permanent evaluation plots in several states. This effort will pave the way for the introduction of garlic mustard biocontrol agents in the near future. To date, several species of insects show promise as control agents against garlic mustard. Host specificity testing in near completion and approval for introduction into the United States may happen as soon as 2004.

Education and Public Awareness

Introduction

Issue
Public awareness of harmful exotic species is one of the key ways to limit their introduction and spread. Since 1992, the DNR's Exotic Species Program has made substantial efforts to create and maintain high public awareness and understanding about harmful exotic species. An annual communications plan is developed by the Exotic Species Program to identify activities and priorities.

Goals
Public awareness efforts in Minnesota are designed to:

- Make the public and certain businesses aware of the negative environmental impacts caused by some exotics;
- Help these groups identify and report findings of specific exotic species;
- Outline actions that boaters, anglers, seaplane pilots, waterfowl hunters, water gardeners, riparian landowners, bait dealers, and others must do to reduce the spread of these exotics; and
- Enhance understanding of management options.

Progress in Public Awareness – 2002

Key components of this year's communication efforts included radio and television advertising, public service announcements, printed materials, press releases, media contacts, information on DNR's website, staffing at sports shows and other major events, informational signs at public water accesses, and training.

Radio
Radio was used in 2002 to reach boaters and anglers in several ways. Paid advertising was used on major Twin Cities stations (WCCO-AM, KQRS-FM, KFAN-AM, KEEY-FM, KSTP-AM, and KTCZ-FM) during the weeks preceding the Fishing Opener, Memorial Day, and Fourth of July. These stations were selected for their listener profile which corresponds with those of boat owners. Paid advertising was also used on Minnesota News Network (MNN) this year, reaching an additional 59 affiliate stations throughout Minnesota. In late summer, a special effort was made in the Duluth market and southeastern Minnesota (Rochester and Winona) where there are zebra mussel infestations.

In addition, public service announcements (PSAs) were made available to Minnesota radio stations (a total of 104) along with a cover memo, encouraging program managers to play these announcements. The PSAs are now available in two audio formats from

the DNR's website which makes them readily accessible to station managers at any time and eliminates the need to mail tapes each year (www.dnr.state.mn.us/news/psas/index.html).

Television, video, and informational materials

Paid television advertising was used this year in the Duluth market during July and August (WDIO-TV, an ABC-affiliate station) to remind viewers of the continuing concerns about zebra mussels in the area. Two spots aired during morning and evening newscasts leading into popular outdoors segments including "Sportsman's Notebook," "Gone Fishing'," "Up North," and "Pro's Pointers."

The "2002 Minnesota Fishing Regulations" included a section on harmful exotic aquatic species. Descriptions and illustrations of these harmful exotics were provided along with a summary of exotic species laws, a list of infested waters, and information about how to stop the spread of exotics. More than one million copies of the fishing regulations were printed and distributed.

The "Minnesota Boating Guide" also included a page of information on how to prevent transporting harmful exotic plants and animals. The guide is updated annually and distributed to an estimated 300,000 boaters.

New public awareness materials about harmful exotics were developed and/or distributed by DNR and two of its partners, the Native Plant Society and Minnesota Sea Grant. These new materials included: "Contain those Crawlers", an informational poster about the harmful effects of earthworms on Minnesota's forest floors; "Harmful Exotic Plants," fact sheets designed for aquatic plant sellers and water gardeners; and the video "From Net to Sale" and a poster were mailed to all bait dealers and aquatic farms in Minnesota.

For the first time, information about harmful exotic species will be included in the "Explore Minnesota Fishing Guide," a publication of the Minnesota Office of Tourism produced primarily for distribution at sport shows throughout the Midwest. The guide targets anglers traveling to Minnesota and is scheduled for distribution in early 2003.

DNR website

The DNR's website pages covering harmful exotic species issues were expanded (www.dnr.state.mn.us/ecological_services/exotics.html). The site includes an overview of the Exotic Species Program as well as information on individual programs and staff. A summary of Minnesota's exotic species laws, as well as lists of harmful exotic species and infested waters, and field guides to aquatic plants and aquatic exotic plants and animals are available online. The site also provides a list of publications and resource materials in addition to links to related web pages and sites for other partnering agencies.

Shows and fairs

DNR Exotic Species Program staff participated in the Northwest Sports Show and the Minnesota State Fair to distribute literature and information. At the State Fair, a barrel encrusted with zebra mussels and a tank with Eurasian watermilfoil samples were

exhibited and drew considerable attention. An estimated 750,000 people visit the DNR's exhibits at the Northwest Sports Show and the Minnesota State Fair each year.

Public water accesses
DNR watercraft inspectors completed 20,700 hours of inspection (see Watercraft Inspections and Awareness Events) providing boaters with information and tips on ways to reduce the spread of exotic species. Signs are also posted at public water accesses. The DNR attempts to place "Help Prevent the Spread" and "Stop and Remove" signs at all public water accesses. Additionally, "Exotic Species Alert" signs are placed at accesses to infested waters.

Presentations
Presentations were given to a variety of audiences including: university classes, high schools, conferences, annual meetings, training sessions, and lake associations.

Effectiveness of Public Awareness Efforts

Background
The DNR and Minnesota Sea Grant have conducted several surveys to help assess the effectiveness of public awareness efforts conducted in Minnesota. In 1994, Minnesota Sea Grant conducted a survey of boaters in Minnesota, Wisconsin, and Ohio to evaluate and compare regional differences in educational and awareness programs.

A report (Minnesota Sea Grant, 1994) summarizing the survey results said, "More effort has been expanded and a greater variety of techniques have been used in getting the exotic species message out in Minnesota than in the other two states surveyed. Survey results indicate Minnesota boaters are more knowledgeable about exotic species issues and have already changed their behavior to a greater extent (to prevent the spread of exotics) than boaters in the other two states. This suggests that educational programs are effective."

In 1996, the DNR funded a follow-up survey of boaters in the Minneapolis/St. Paul metro area (DNR, 1996). Also in 1998, a survey of boaters in the Brainerd area was conducted (DNR, 1999). Both these surveys indicate that awareness about exotics has continued to increase. Watercraft inspectors (see Watercraft Inspections Section) also continue to find high levels of public awareness of exotics throughout Minnesota. Information from past surveys and a multi-state Sea Grant survey mailed out in the fall of 2000 will continue to be used to guide development of annual public awareness efforts and maximize their effectiveness.

Effectiveness and boater survey results
A 2000-2001 mail survey coordinated by Minnesota Sea Grant, with cooperation from the DNR Exotic Species Program and conducted through the University of Minnesota Research Center, was sent to 4,000 boaters in five states: Minnesota, Vermont, Ohio, Kansas, and California. Results from Minnesota show that signs at water accesses, information in fishing and boating regulation booklets, articles in newspapers and on TV, as well as regulations and enforcement efforts, are the most effective methods to inform boaters and to encourage them to take precautions. The survey results show that

messages are translating into action. Ninety percent of Minnesota boaters responding to the question in the 2000-2001 survey said they took action (Armson, 2001), an increase over a similar Sea Grant survey in 1994 when 70% of Minnesota boaters said they took action. The survey also showed considerable differences in the percent of boaters' who took action in other states: 82% in Vermont; 46% in Ohio; 40% in California; and 30% in Kansas. These differences are proportional to the level of boater public awareness efforts and the variety of methods used in those states. Comparatively, Minnesota has invested more in public awareness regarding harmful exotic species and results show that this investment is resulting in significant increases in public awareness and preventative actions taken. In another 2000-2001 survey question, 99% of Minnesota boaters said they were very likely or somewhat likely to take precautions.

Angler survey
Minnesota Sea Grant conducted a separate survey of Minnesota anglers (Doug Jensen, Minnesota Sea Grant). The survey found that nearly 97% of Minnesotans believe it is important to prevent the spread of aquatic nuisance species. Yet, while awareness is very high, Minnesota anglers still represent a significant risk for the spread of harmful exotic species — 29% of surveyed anglers dump unwanted live bait into the lake or river after fishing and 25% of anglers who put bait buckets in the water, reuse those minnows on other waters.

Participation of Others in Public Awareness Activities

National "Stop Aquatic Hitchhikers!" Campaign
The national Aquatic Nuisance Species (ANS) Task Force, the U.S. Fish and Wildlife Service, and the U.S. Coast Guard are the primary sponsors of a new "Stop Aquatic Hitchhikers!" campaign. The national campaign was developed in 2001 and implemented in 2002. The campaign includes a variety of marketing tools such as public service announcements, stickers, posters, magazine and newspaper articles, television, and radio programs to make the public aware of this issue. Most material and announcements will include a website address (www.protectyourwaters.net) to direct individuals to visit and learn about how they can become part of the solution in stopping the transport and spread of harmful aquatic hitchhikers.

Minnesota partners
Other agencies and organizations in Minnesota have been cooperatively involved with public awareness activities in the state for several years and continued to conduct public awareness efforts throughout the state.

Educational "traveling trunks" designed for hands-on learning about harmful exotic species are used by teachers and are available from several organizations in the state in addition to the DNR: University of Minnesota Sea Grant and the Bell Museum of Natural History, the National Park Service (for additional information, see www.seagrant.umn.edu/education/ttea.html).

The University of Minnesota Sea Grant Extension Program's Exotic Species Information Center provides research, outreach, and education in collaboration with the DNR.

Since 1991, the Center has served as an important resource on harmful aquatic nuisance species (ANS) for the public and water-related businesses. Center staff regularly communicate with DNR Exotic Species Program staff to help identify program priorities and unmet needs, coordinate activities, leverage funds and resources, and share information and publications.

2002 Highlights of Minnesota Sea Grant's educational activities related to harmful exotic species in Minnesota:

- Minnesota Sea Grant worked with DNR staff on a national effort to evaluate differences in boater awareness and behavior in Minnesota and four other states.

- Minnesota Sea Grant worked with DNR staff on a regional effort to evaluate angler awareness and education related to aquatic nuisance species/harmful exotic species and bait use in Minnesota, Michigan, Illinois, Indiana, and Ohio. Results show that while Minnesota angler awareness was highest, nearly 50% of those who used live bait improperly disposed of it in the water after fishing.

- Minnesota Sea Grant continues to promote youth education programming about harmful exotic species. Youth education traveling trunks, *Aquatic Exotics,* and new lesson plans, compendia, and youth community stewardship project booklets were distributed to Minnesota teachers and students.

- Minnesota Sea Grant and Illinois-Indiana Sea Grant, produced on behalf of the Great Lakes Sea Grant Network, a compact disc (CD), *Exotics to Go!* The CD contains presentations, movie clips, and ANS outreach publications for use by lake associations, agencies, and others to promote awareness, prevent and contain the spread, and mitigate the impacts of ANS.

- Posters for bait shops were produced by Sea Grant in collaboration with the DNR and the bait industry to alert clerks and anglers about preventing the spread of ANS by inspecting and removing suspicious-looking fish, crayfish, or plants from bait tanks. Sea Grant and DNR collaborated to mail a joint cover letter, videotape, poster, and other ANS resource materials to 1,233 licensed minnow dealers/hatchery operators and retail live bait shops across the state. Minnesota and Michigan Sea Grant programs are planning to produce a best management practices fact sheet for hatchery/aquaculture operations based on ANS-HACCP approaches in 2003.

- Minnesota Sea Grant continues to promote and distribute a color poster on key aquatic nuisance species of national concern. Produced in collaboration with the National Oceanic and Atmospheric Administration (NOAA) and the National Sea Grant College Program Office, the poster features sea lamprey, green crab, zebra mussels, purple loosestrife, and nutria. Designed primarily for use in the classroom, it was distributed to teachers and students in Minnesota in 2002.

- Center staff provided presentations about harmful aquatic nuisance species at conferences, workshops, meetings, and festivals in Minnesota. In July,

Minnesota Sea Grant staff gave a presentation at the annual DNR training meeting for watercraft inspectors.

- Minnesota Sea Grant and DNR collaborated to reprint the *Ruffe, Round Goby,* and *Purple Loosestrife WATCH* ID cards. A new *Eurasian Watermilfoil WATCH* ID card was also produced. Each card provides identification features, helps control the spread, and encourages public reports of new infestations. Over 120,000 cards were produce for distribution in Minnesota. Designs for three other cards for spiny and fishhook waterfleas, rusty crayfish, and European frog-bit are underway and will be released in spring of 2003.

- Sea Grant and Extension Service mailed copies of *Biological Control of Purple Loosestrife 4-H* project manuals and leader guides, *Biological Control of Purple Loosestrife: A Guide for Rearing Leaf-Feeding Beetles* as well as WATCH cards and brochures to every 4-H regional extension educator in each Minnesota county.

Center staff provide leadership on state, regional, and national task forces including the Minnesota Invasive Species Advisory Council's Information and Education Committee (chair), Great Lakes Panel on ANS's Information and Education Committee (chair), St. Croix Zebra Mussel Task Force, Great Lakes Sea Grant Network Nonindigenous Species Outreach Committee (chair), the ANS Task Force's Recreation Activities Committee (National Sea Grant representative), and the ANS Task Force's Communication, Outreach and Education Committee.

Future needs for public awareness in Minnesota

- Maintain spending on paid public awareness radio/TV spots to reinforce high awareness of exotic species by watercraft users.
- Continue to make public awareness of zebra mussels in southeast Minnesota near the Mississippi, Zumbro, and St. Croix rivers a priority.
- Work cooperatively with specific industry groups to develop targeted public awareness efforts such as the aquaculture industry, live bait dealers, water garden and horticulture industry, and aquarium trade.
- Use the Minnesota Invasive Species Advisory Committee and other multi-entity groups to enhance interagency communication on the status and progress of exotic species management efforts.
- Expand public awareness activities that are cooperative ventures with lake communities outside the metro area.
- Increase information about harmful exotic species available through the various communication channels such as the DNR web site, publications, and media outlets.
- Continue to work collaboratively with Minnesota Sea Grant staff to pursue research and outreach funding through National Sea Grant and other sources.

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Enforcement

Introduction

Issue

In 1991, the Minnesota Legislature directed the DNR Commissioner to establish a two-year program designed to check trailered boats. Roadchecks were initially designed to inspect boats and trailers for the presence of Eurasian watermilfoil fragments and to educate and inform boaters. As additional harmful exotic species (e.g., zebra mussels) have become established in Minnesota, roadchecks and boat inspections were expanded to detect illegal transportation of those organisms, as well as other aquatic plants.

The DNR supported changes in statute passed during the 1996 legislative session that prohibited the transport of all aquatic vegetation (rather than Eurasian watermilfoil exclusively). This change in law made enforcement simpler. Instead of having to identify Eurasian watermilfoil, which can be difficult, officers and watercraft users only had to ensure that all vegetation was removed before transporting boats and equipment. Passage of the 1996 law prohibiting transport of aquatic plants allowed an increase in exotic species-related enforcement efforts by conservation officers. *Recent court decisions related to roadchecks have affected the DNR's ability to conduct roadchecks for prohibited exotic species (see Progress in Enforcement - 2002).*

In 1999, the Division of Enforcement took steps to better target enforcement efforts. An Exotic Species Enforcement Plan that allocates hours and prioritizes exotic species enforcement needs in each district was initiated. Under the plan, conservation officers' activities include time spent at water accesses doing exotic species-related checks of boats and trailers. Activities in the statewide Exotic Species Enforcement Plan were included as a specific component of the FY01-FY02 annual work plans for all the Division of Enforcement's activities. These annual work plans describe in detail each enforcement district's responsibilities in meeting various responsibilities, including exotic species, and ensures that appropriate work activities and levels are targeted.

Goals

One of the department's goals related to enforcement is to prevent the spread of exotic species within Minnesota. Part of this goal is to lower the percentage of trailered boats transporting prohibited exotic species, aquatic vegetation, and infested water within the state. The second part is to respond quickly when reports are received that harmful exotic wild animals have escaped from captivity.

Progress in Enforcement - 2002

Several types of enforcement activities have occurred to limit the introduction and spread of harmful exotic species including: roadchecks of trailered boats, enforcement at water accesses, and following up on illegally-released exotic animals. In 2002, conservation officers spent 1,716 hours enforcing the exotic species laws and rules. Statewide there were a total of three civil citations and 20 written warnings issued to individuals for violations of exotic species laws and rules. The following paragraphs

summarize the results of three key enforcement activities to meet the goals listed above.

Conducting roadchecks of trailered boats

In 2002, only one major roadcheck was conducted. It was located in Orono at the Maxwell Bay access and occurred on June 8 (Table 6a). Most of the vegetation was found on trailer frames, motors, and anchor ropes. One civil citation, ten written warnings, and four verbal warnings were issued to individuals for violations at the roadcheck. Following the Orono roadcheck, all other roadchecks planned for 2002 were suspended. The reasons for the suspended roadchecks are described below.

> In 1994, the Minnesota Supreme Court decided the case of Ascher v. Commissioner of Public Safety. Ascher held that the police could not conduct sobriety checkpoints. The court's reasoning was that these checkpoints constituted an unlawful invasion of privacy. The court held that law enforcement officials must have reasonable suspicion of a violation before stopping a motorist.
>
> In the years between 1994 and 2002, the Division of Enforcement maintained that the needs for resource protection outweighed individual privacy interests in the roadcheck scenario. Accordingly, we supported the use of game and fish roadchecks and exotic species roadchecks.
>
> Developments in our state's appellate courts during 2002 have signaled that natural resource enforcement measures must comply with the same constitutional rules that govern general police "searches and seizures." These decisions clearly signal that the Ascher case applies to Enforcement's work as well.
>
> The Division of Enforcement has discontinued the use of game and fish roadchecks and exotics roadchecks as a result. Enforcement is hopeful that further litigation or legislative changes will help resolve this situation for the benefit of our natural resources.

An important component of the department's goal to prevent the spread of exotic species in Minnesota is to lower the percentage of boats transporting vegetation. Roadchecks of trailered boats have been a method used to evaluate the success of that effort.

Enforcement at water accesses

<u>Enforcement near the Mississippi River</u>

Conservation officers conducted exotic species enforcement activities along the Mississippi River, focusing on the transportation of zebra mussels and infested waters. Boaters using the Mississippi River south of the Twin Cities must empty bilges, live wells, and bait buckets so that they do not transport zebra mussel infested water from the Mississippi. During the summer of 2002, officers spent about 105 hours of

Table 6a. Summary of trailered watercraft inspected by the DNR during roadchecks conducted between 1991 and 2002.

Year	Number of Roadchecks	Number of Watercraft Inspected	Number of Watercraft with Aquatic Plants	Number of Warnings[1]	Number of Written Citations
2002	1	48	15 (31%)	10 (20.8%)	1 (2.0%)
2001	4	429	68 (15.9%)	66 (15.4%)	1 (0.002%)
2000	4	410	71 (17%)	69 (16.8%)	2 (0.5%)
1999	4	491	101 (21%)	95 (19.3%)	7 (1.4%)
1998	5	645	127 (20%)	117 (18.1%)	3 (0.5%)
1997	7	638	161 (25%)	152 (23.8%)	2 (0.3%)
1996	3	595	138 (23%)	152 (23.8%)	2 (0.3%)
1995	3	202	N/A	9 (4.5%)	-
1994	7	775	N/A	35 (4.5%)	-
1993	37	982	N/A	63 (6.4%)	9 (0.9%)
1992	7	1412	N/A	14 (1.0%)	12 (0.8%)
1991	8	818	N/A	9 (1.1%)	5 (0.6%)
Total	**90**	**7445**	**681**	**791**	**44**

[1] Made assumption that between 1994 and 1996 all offenders were issued warnings

enforcement time along the Mississippi River including accesses near Hastings, Red Wing, Lake City, Kellogg, Winona, and LaCrescent.

Enforcement during the waterfowl hunting season

Conservation officers conducted exotics enforcement activities during the waterfowl hunting season to inform hunters about the laws prohibiting transportation of aquatic vegetation. Hunters must remove vegetation from their boats, decoys, and anchors before leaving the water access. There is an exception for the transport of shooting blinds, and emergent vegetation cut above the water line can be transported. Conservation officers contacted hunters during the waterfowl hunting season at the following accesses along the Mississippi River: Verchota (Winona County), North Lake (Goodhue County), Dresbach (Houston County), Wilcox and Halfmoon (Wabasha County). Additional time was spent in Freeborn County, Otter Tail County, Beltrami County, and Mille Lacs County at several lakes frequented by waterfowl hunters.

Enforcement at Lower St. Croix River

In 2002, the DNR continued to hand out zebra mussel awareness cards to people on the water and at accesses.

Responding to escaped exotic animals

In 2002, the DNR changed its procedures and did not respond to reported escapes of mute swans. This modification reflects changes in federal regulation (see Mute Swan chapter). There were no responses by conservation officers to reported escapes of exotic deer, Eurasian swine, or other exotic wild animals.

Effectiveness of Enforcement

The DNR believes that enforcement plays a critical role in reducing the spread of harmful exotic species, however, it is only part of the larger prevention effort. In order for the regulations on harmful exotic species to be effective in reducing their spread there must be: a balanced mix of public education and awareness efforts, voluntary compliance from the general public, and enforcement of the regulations. One measure of the effectiveness of enforcement efforts targeting trailered boats would be a long-term decrease in the percentage of boats carrying vegetation.

Participation of Others

The Exotic Species Program is interested in increasing the participation of other peace officers to help look for violations and to enforce the state laws related to transport of prohibited exotic species on public roads. The Big Lake Police Department has expressed interest in having its police officers attend exotic species training so they may enforce state exotic species laws. This training will be set up for 2003.

Regulations and Proposed Changes

Introduction

Issue

Minnesota's regulations related to harmful exotic species currently in Minnesota Statutes and Minnesota Rules are generally considered to be comprehensive and some parts are unique. The state statutes related to harmful exotic species are found in Minnesota Statutes, Chapter 84D. The administrative rules related to harmful exotic species are found in Minnesota Rules, Chapter 6216. Current versions of both statutes and rules are available at: www.revisor.leg.state.mn.us/. Summaries of annual changes in the regulations can be found in past DNR annual reports on harmful exotic species.

The DNR is assigned responsibility for designating *infested waters* (see M.S. 84D.03). Water bodies are designated infested if they contain specific harmful exotic species such as Eurasian watermilfoil, zebra mussels, ruffe, round goby, white perch, and spiny water fleas. The current *infested waters* lists are found in Minnesota Rules, Chapter 6216 at: www.revisor.leg.state.mn.us/.

The DNR is also required to adopt rules (per Minnesota Statutes 84D.12) that place exotic species into various regulatory classifications and prescribe how exotic species permits will be issued (per Minnesota Rules 6216.0265). The DNR is authorized to adopt other rules regarding harmful exotic species and infested waters.

Goals

The future needs identified in the 2001 report, included:

- Continue to support efforts to integrate and improve the comprehensiveness, enforceability, and responsiveness of federal laws regarding noxious weeds, injurious wildlife, and other designations related to harmful exotic species. Specifically seek reauthorization of the National Invasive Species Act (NISA) and designations of injurious wildlife such as the black carp.
- Continue to adopt rules that designate additional prohibited, regulated, and unregulated exotic species.

Progress in Regulations - 2002

Federal

At the national level, activity occurred in three key areas: 1) related to reauthorization of NISA, 2) Federal court action related to the Environmental Protection Agency's (EPA) exemption of ballast water from the National Pollution Discharge Elimination System (NPDES) permits process, and 3) U.S. Fish and Wildlife Service (USFWS) designation of injurious wildlife.

<u>Reauthorization of NISA</u>

In August, the National Aquatic Invasive Species Act (NAISA) was introduced in Congress. Congressional hearings were held during spring 2002 related to

implementation of the National Invasive Species Act of 1996 and research priorities for aquatic invasive species. Hearings were held on NAISA in the House of Representatives on November 14, 2002. There was no other Congressional action taken on NAISA before the end of the year. Congressional authors of the reauthorization bill have indicated they will reintroduce the act in the 2003 session and try to have it passed in the first 100 days.

Lawsuit against EPA regarding ballast water

Over three years ago, the Pacific Environmental Advocacy Center filed a lawsuit against the U.S. Environmental Protection Agency (EPA) to repeal its regulation that exempts ballast water from regulation under the Clean Water Act. The Northern District of California federal court ordered the EPA to respond to the plaintiffs' petition to repeal EPA's regulation that exempts ballast water from regulation under the Clean Water Act (Internet source: www.lclark.edu/org/peac/). The lawsuit prevailed in District Court on January 30, 2002, and then prevailed again on April 24, 2002 when EPA moved for reconsideration. The court ordered EPA to respond immediately, but EPA convinced the Ninth Circuit Court of Appeals to stay that order until the government appealed the case. The Ninth Circuit agreed to an expedited briefing schedule that went over the summer, and then heard oral argument in mid-September on the case. A week after oral argument, the Ninth Circuit issued an order informing the parties that it was putting off deciding the matter for 30 days and urging the parties to attempt to mediate/settle the case. Pacific Environmental Advocacy Center and EPA engaged in confidential mediation and extended that 30-day deadline one time (Aaron Courtney, Pacific Environmental Advocacy Center, Lewis and Clark Law School, Portland, Oregon, e-mail to Great Lakes Fishery Commission on November 14, 2002). The Attorneys General from New York, Michigan, Minnesota, and Illinois filed a motion to be allowed into the case as amicus curiae ("friends of the court") on the petitioner's side of the issue. As of December 15, 2002, there has not been a settlement reached.

Designation of injurious wildlife

- The USFWS announced in the *Federal Register* on July 30, 2002, proposed to designate black carp as an injurious wildlife species (U.S. Fish and Wildlife Service 2002a). DNR sent a letter in support of this action to USFWS. The USFWS had not designated black carp as injurious as of December 31, 2002.
- The USFWS added the brushtail possum (*Trichosurus vulpecula*) to the list of injurious live mammals effective July 11, 2002.
- The USFWS designated all snakehead fishes of the family *Channidae* as injurious wildlife on October 4, 2002 (U.S. Fish and Wildlife Service 2002b).

By these actions, the USFWS prohibits the importation into or transportation between the continental United States, the District of Columbia, Hawaii, the Commonwealth of Puerto Rico, or any territory or possession of the United States of any live brushtail possum or snakehead fish. Injurious wildlife can only be imported by permit for scientific, medical, educational, or zoological purposes, or without a permit by federal agencies solely for their own use; permits are also required for the interstate transportation of injurious wildlife currently held in the United States for scientific, medical, educational, or zoological purposes. Designation of injurious wildlife prohibits interstate transportation of

those species currently held in the United States for purposes not listed above. Violations could bring a $5,000 fine or six months in jail.

State statute changes
During 2002, there were changes to the state statutes related to farmed cervidae and game farms. The changes were primarily for purposes of addressing chronic wasting disease, but they are also related to escapes and control of exotic deer. These changes eliminated some conflicting time requirements that made responses to escaped exotic and native cervidae species difficult.

The Agriculture Omnibus bill modified Minnesota Statutes, Chapter 17.452 regarding farmed cervidae as follows:

- The past requirement that owners must report escaped red deer within 72 hours was changed to now require that all escaped farmed cervidae to be reported within 24 hours if not recaptured by the owner; and
- The grace period allowed before escaped farmed cervidae may be destroyed after their escape was changed from 14 days to 24 hours .

The bill also changed the Minnesota Statutes 97A.105 regarding cervidae on game farms:

- Cervidae from game farms may not run at large and the owner must notify the DNR of escapes that are not recaptured within 24 hours.
- Cervidae that are not recaptured may be destroyed by the DNR after 24 hours.

Permanent rulemaking
In 2002, the department continued the rulemaking process to designate additional exotic aquatic plants that could threaten Minnesota's resources as prohibited exotic species or regulated exotic species. The proposed changes to Minnesota Rules are the underlined portions below.

6216.0250 PROHIBITED EXOTIC SPECIES.
[For Subp. 1 and 2, see MR]
<u>Subpart 2A. Federal noxious weed list. For the purpose of this part, the aquatic plants listed in the Code of Federal Regulations, title 7, section 360.200 are also designated as prohibited exotic species.</u>

6216.0260 REGULATED EXOTIC SPECIES.
[For text of Subp. 1, see MR]
Subp. 2. Aquatic plants. The following aquatic plants are designated as regulated exotic species:
[For items A-C, see MR]
<u>D. Yellow iris or yellow flag (*Iris pseudacoris)* Linnaeus</u>

Emergency rulemaking
DNR has begun rulemaking to designate waters found to have Eurasian watermilfoil for the first time in 2002 as infested waters, and to designate the northern snakehead fish

(*Channa argus*) as a prohibited exotic species because of its potential to threaten state resources.

Northern snakehead is an Asian fish also known as Amur, eastern, spotted, eyed or argus snakehead. Its distribution includes China, Korea, and upstream in the Amur River into Russia. It has been reported in Czechoslovakia. Its ability to hibernate and survive cold winter temperatures suggests it could survive in Minnesota and other northern states. It is an aggressive predator consuming fishes and other forms of aquatic life (Howells 2002). It is reported to reach 33 inches in length and weights of 15 pounds. They were imported and sold as aquarium or food fish.

References Cited

U.S. Fish and Wildlife Service. July 2002a. 50 CFR Part 16, RIN 1018-AG70, Injurious Wildlife Species; Black Carp (*Myloparyngoclon piceus*), Federal Register/Vol. 67/No. 146/ Tuesday, July 30, 2002. pp. 49280-49284.

U.S. Fish and Wildlife Service. October 2002b. 50 CFR Part 16, RIN 1018-A136, Injurious Wildlife Species; Snakeheads (family *Channidae*). Federal Register/Vol. 67, No. 193/Friday, October 4, 2002. pp. 62193-62204.

Watercraft Inspections and Awareness Events

Introduction

Issue

The potential for boaters to accidentally move aquatic exotic species from one lake to another is a clear threat to Minnesota's aquatic ecosystems. For this reason, the 1991 Minnesota Legislature mandated that DNR conservation officers conduct inspections of trailered boats on Minnesota highways. The purpose of these inspections was to look for Eurasian watermilfoil, issue citations to violators, and inform the public about the potential spread of harmful aquatic exotic species.

In 1992, the DNR, the Minnesota Lakes Association and angling groups proposed and supported legislation (adopted as M.S. 18.317, Subd. 3A, and recodified as 84D.02 subd. 4) requiring 10,000 hours of inspections of watercraft leaving infested water bodies containing harmful aquatic exotic species such as Eurasian watermilfoil, spiny water fleas, and zebra mussels. Subsequently, a watercraft inspection program was established by the DNR in 1992 to accomplish this mandate. In 1993, legislation was passed increasing the number of inspection hours to 20,000 starting with the 1994 boating season. In 1999, this statute was amended to allow inspections on both infested and uninfested water bodies to fulfill the 20,000 hour requirement.

Goals

The DNR watercraft inspections help meet the goal of presenting the spread of harmful exotic species within Minnesota. The inspections also help to:

- Accomplish 20,000 hours of watercraft inspection as required in state statutes and target about 10% of that effort at uninfested waters.
- Increase public awareness about exotic species and the potential for boaters to transport exotics between water bodies;
- Reduce the percentage of trailered boats carrying harmful exotic species;
- Increase educational efforts with citizen groups.

Progress in Watercraft Inspections – 2002

Accomplish 20,000 hours of watercraft inspection

In 2002, approximately 40 inspectors worked through the summer providing information to the public on watercraft inspections and exotic species. Inspections began in late April and continued though the end of October. Within this 27-week period, 20,700 inspection hours were logged and 45,000 watercraft/trailers were inspected.

During the 27-week inspection season, inspections were conducted at 16 fishing tournaments and continued through October in order to reach waterfowl hunters. Inspectors also distributed more than 5,000 Exotic Alert Tags on vehicles with trailers at access points on infested waters. Inspectors also worked to clear aquatic plant fragments from the public water accesses at which they were stationed.

Inspection efforts were conducted across the state in rough proportion to the number of public water accesses (PWAs) on infested water bodies, with some inclusion of high-use accesses on uninfested water bodies (Figure 8a). The actual distribution of time reflects both the number of PWAs and the level of public use at those accesses. In 2000, the program was broadened to include many uninfested water bodies in an effort to reach more boaters in non-metro locations. In addition, it is important to note that the percent of time the program is spending in each region has shifted considerably from 1999 to 2002 (Figure 8b). A higher percentage of time in 2002 was spent in regions II and IV, reducing the percentage in regions V and VI as well as the number of inspections done in those regions. For this report, the six former DNR regions have been used (Table 8a). An increase in infestations in greater Minnesota in the past years, coupled with a consistent level of inspection efforts, necessitated no decrease in hours spent in region VI, and to some extent region V, to shift efforts to other regions. The necessity of having inspectors on infested water bodies in greater Minnesota has enabled the program to spend time on surrounding uninfested water bodies as well.

Table 8a. Number of watercraft inspections conducted by watercraft inspectors in 1999, 2000, 2001, and 2002. (*Totals are rounded values*).

Year	DNR Region						Total
	1	2	3	4	5	6	
1999	1,600	1,800	7,400	140	5,700	25,000	41,000
2000	2,400	2,900	5,400	540	8,600	32,000	52,000
2001	1,700	2,600	5,700	1,700	3,900	23,000	39,000
2002	660	2,600	7,800	2,400	5,200	26,000	45,000

The watercraft inspection program has primarily focused on water bodies with infestations of harmful exotic species; this was due to the fact that there were relatively few infested water bodies and so it was very efficient. While it is important to contact boaters leaving water bodies infested with harmful exotic species, we feel it is also important to inform boaters on other popular recreation lakes in Minnesota. To allow more flexibility in the program, state statute was amended to include watercraft inspections on uninfested water bodies in the department's 20,000-hour mandate (M.S. 84D.02, Subd. 4). During 2002, inspections on uninfested waters represented about 8% of the total inspections (3,667 inspections) and approximately 12% of the inspection hours (2,509 hours). This is less than the total inspection hours at uninfested lakes during the 2001 season.

To determine which uninfested waters to visit, we used three criteria: 1) lakes or areas with a high level of boater activity, 2) lakes identified on program surveys as frequent destinations for boaters leaving infested water bodies, and 3) lakes with lake associations that desired to hold "Exotic Awareness Events".

Although the program has broadened to include inspections at uninfested waters, the majority of the inspections are still done at infested water bodies. The St. Croix River is of special concern because the lower 25 miles are infested with zebra mussels, discovered in 2000 (see Management of Zebra Mussels). Since this is a relatively new

infestation, it has been very important that watercraft users on the river are aware of the infestation and become educated on how to reduce the risk of transporting zebra mussels to another water body. In 2002, almost 1,000 inspection hours were spent on the St. Croix River and more than 3,000 watercraft were inspected.

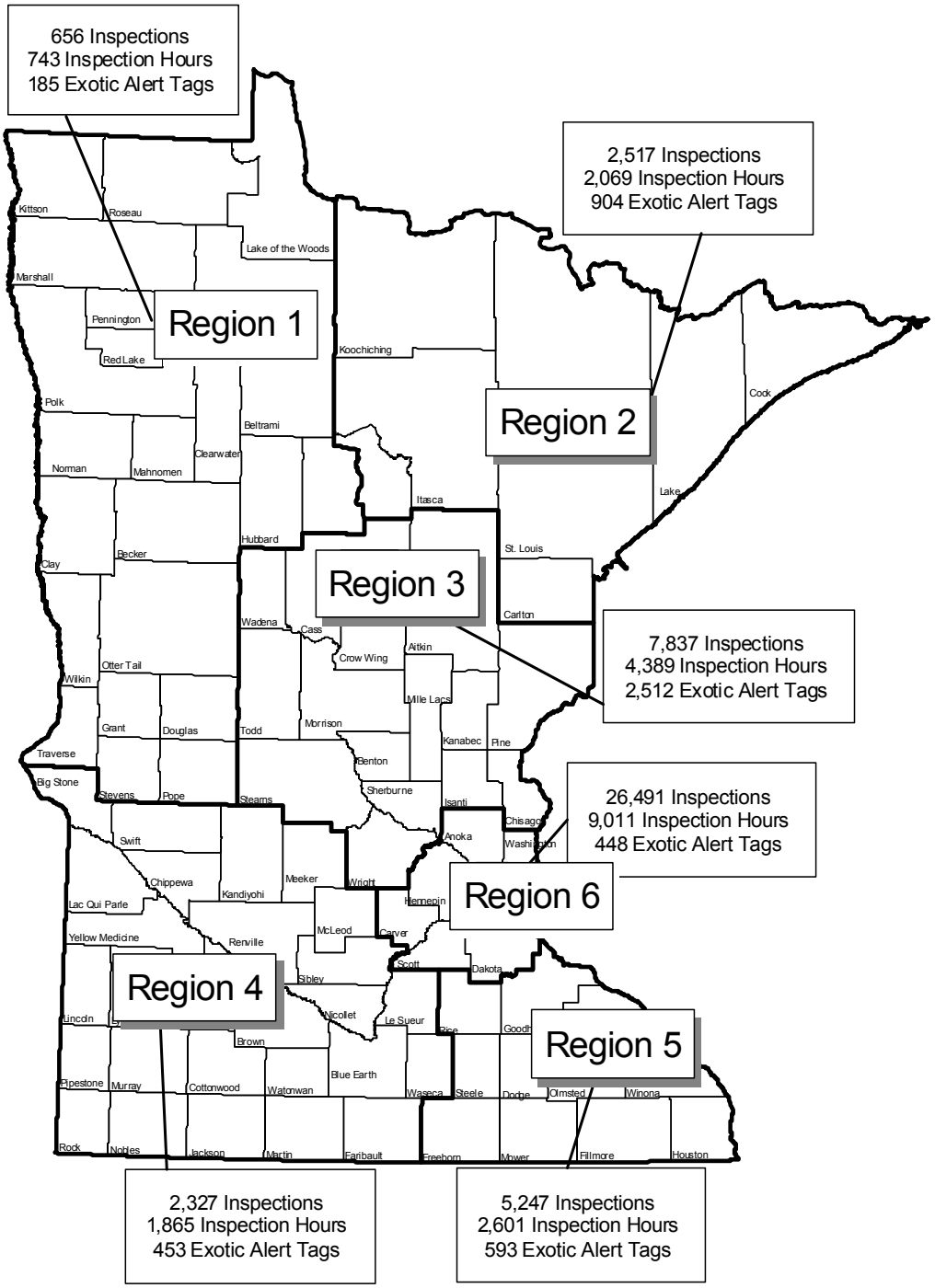

Figure 8a. DNR watercraft inspections at public water accesses in 2002.

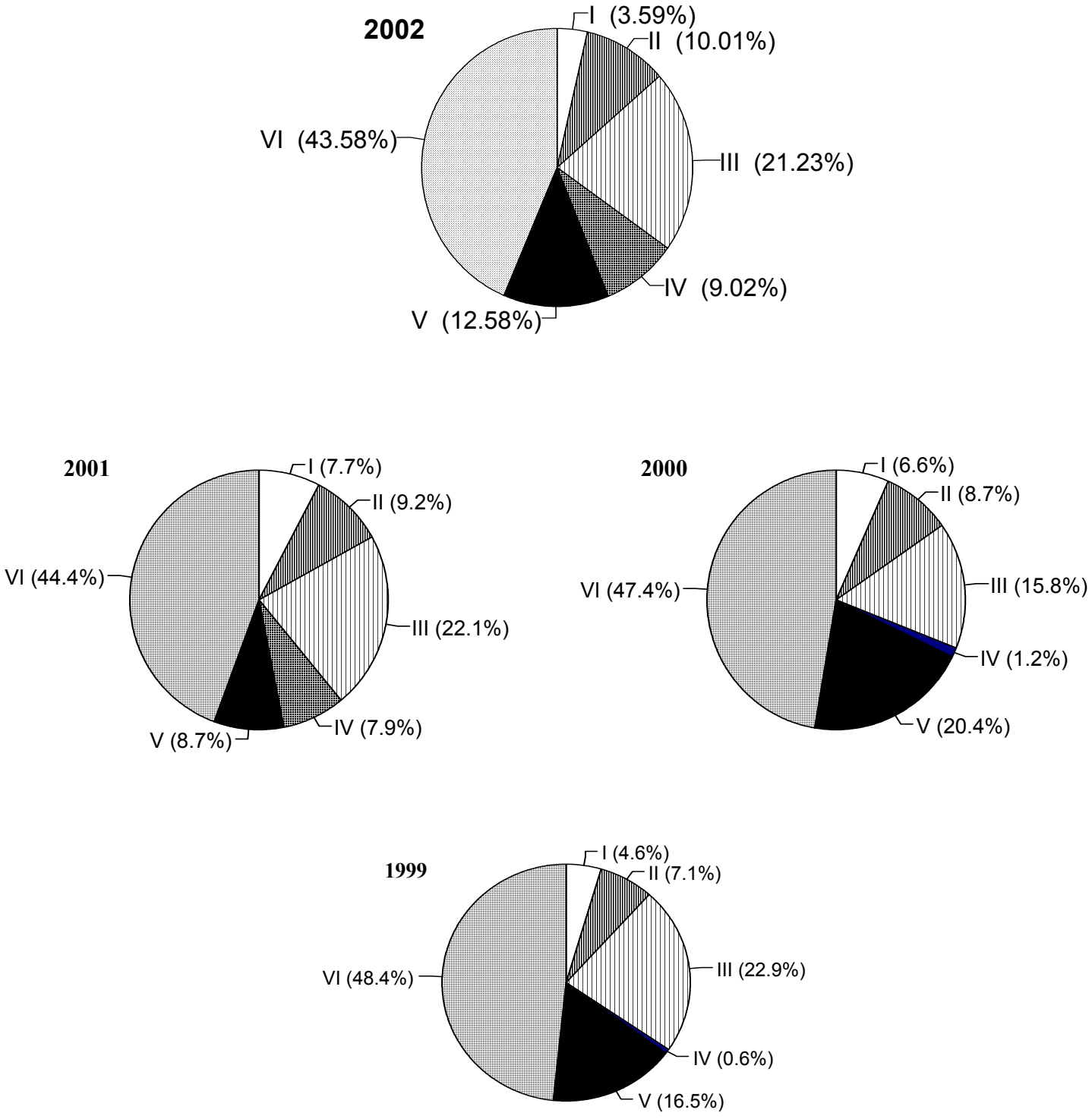

Figure 8b. Percent of the state's total watercraft inspection hours spent in each region in 1999, 2000, 2001, and 2002.

Increase public awareness

Surveys conducted by watercraft inspectors provide important information on the public's awareness of exotic species laws and help identify high risk areas (i.e., accesses where many watercraft pick up plant fragments). According to survey information collected by watercraft inspectors, awareness of exotic species laws remains very high among Minnesota boaters. The percent of watercraft users who responded "yes" when asked if they were aware of the exotic species laws for the state was 93% (Figure 4). Boaters from other states using Minnesota water bodies had a slightly lower response at 86%. The range of percentages for each Minnesota county varied from 91% (in Itasca) to 100% (in multiple counties). Of those who said they were not familiar with the laws, 3% (51 out of 1,621) had vegetation on their watercraft when they entered the access. In contrast, 2% (399 out of 20,651) of the people who said that they were familiar with the laws entered the access with vegetation.

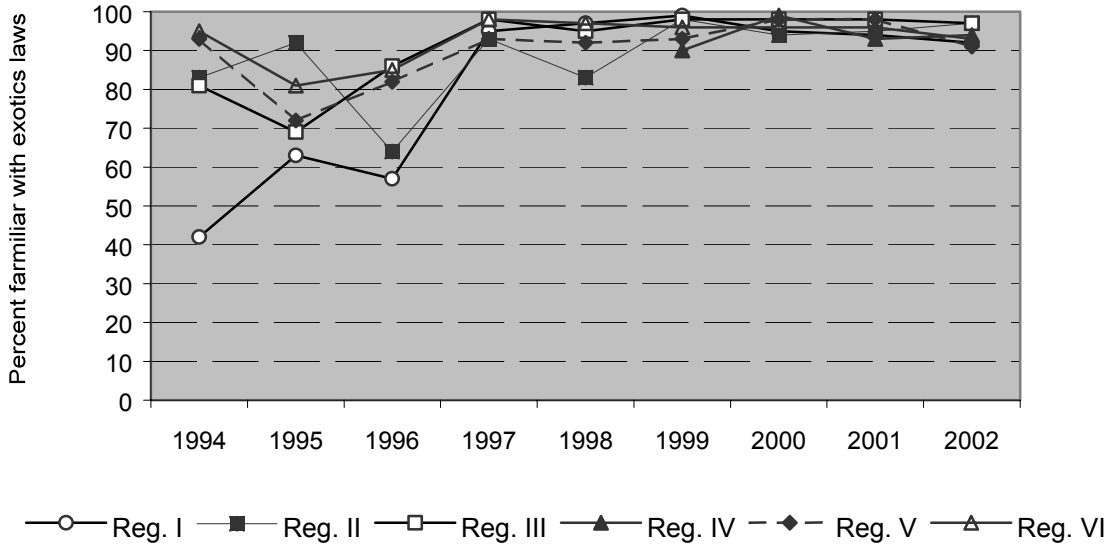

Figure 8c. Surveyed boaters' awareness of exotic species laws by DNR region in Minnesota from 1994 through 2002.

Decals are given to boaters (see Decal Program for Trailered Watercraft at the end of this section) which signifies that they have talked with a watercraft inspector. Of those with no decal, 11% said they were not familiar with the exotics laws. In contrast, of those with a year 2002 decal, 0.1% said they were not familiar with the laws. This suggests that the watercraft inspection program is successful at educating boaters about the exotics laws.

Reduce the percentage of trailered boats carrying exotic species

In 2002, the watercraft inspection program assisted the Division of Enforcement with one roadcheck before changes occurred in the department's ability to conduct roadchecks (see Enforcement).

Increase educational efforts with citizen groups
In 2002, the watercraft inspection program participated in many public awareness activities and worked with several citizen groups in order to educate the public about harmful exotic species. Inspectors answered questions both at the exotic species display at the Minnesota State Fair and at an informational booth for Cannon Valley Trails Day. The watercraft inspection program was also able to work with several citizen groups throughout the season. Inspectors worked side by side with lake association members during two weekend-long awareness events, one at Pike Lake in Duluth and one throughout Kandiyohi County.

The Kandiyohi County Lakes Association also worked cooperatively with the DNR to increase inspection hours in their area. The Kandiyohi County Lakes Association funded 500 hours of inspection within the Kandiyohi County. The DNR provided training, equipment, and supervision while Kandiyohi County Lakes Association paid for salary and travel for one individual who completed 500 inspection hours. This is the second year that the watercraft inspection program has been able to work with the Kandiyohi Lakes Association.

The Watercraft Inspection Program worked cooperatively with the Lake Minnetonka Conservation District (LMCD) for the first time to increase inspection hours on Lake Minnetonka. Inspectors spent an additional 500 hours on three Lake Minnetonka accesses because of the funding provided by the LMCD. The DNR trained, equipped, and supervised inspectors hired with LMCD funding.

Estimate of Risk from Trailered Boats

The percentage of boats/trailers carrying vegetation as they were trailered out of a lake or river varied widely by county. These variations may be caused by several variables including the amount and type of vegetation in the water body, its proximity to the public water access, and the amount of recreational boating traffic. An average of 10% of the watercraft checked by watercraft inspectors were found with vegetation (4,465 watercraft) as they trailered out of the water. This rate demonstrates the clear risk that boaters will transport aquatic vegetation (and harmful exotics) from lake to lake if boats are not properly cleared. The percentage of boats and trailers carrying vegetation as they enter public accesses on infested waters was 0.8%. This is a good indication that the majority of boaters using infested waters are inspecting and cleaning their boats and trailers. During the roadcheck conducted in 2002, the violation rate for transportation of vegetation was 31%, much higher than the percentage of boats entering public waters with vegetation. Enforcement of exotic species laws continues in an effort to reduce the transportation of vegetation and harmful exotics (see Enforcement).

Transportation of Other Exotic Species

Zebra mussels were found in or on five boats being launched into Minnesota waters. Inspectors determined that zebra mussels are being “caught” off the bottom of the lakes or rivers by anglers who often discard them in the bottom of their boats.

The risk of zebra mussels being moved on boat hulls or on plants caught on trailers is well known. Zebra mussels can also be moved by anglers who “catch” them off the bottom and discard them in the bottom of their boats.

Decal Program for Trailered Watercraft

During the 1994 boating season, several boaters expressed frustration over being approached by inspectors several times each week throughout the summer. To respond to boaters' concerns and to reduce the duplication of education efforts, a decal was developed and distributed to boaters whose watercraft had been inspected for exotic species (see decal below). Boaters are instructed to voluntarily affix the decal to the winch post of their trailer. This allows inspectors to identify the boaters who have already spoken with inspectors during the summer. Boaters with a decal are given a brief reminder to drain water and remove vegetation from their boats. The decals have been used for seven years now and have been well received by the public. The 33,000 decals distributed during the 2002 boating season also remind boaters to inspect their boats when inspectors are not present.

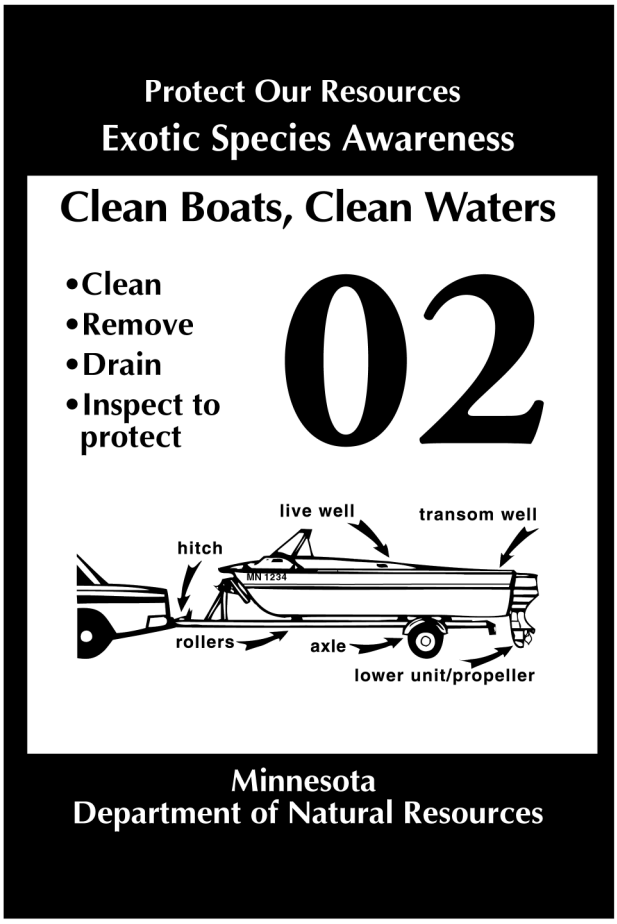

Figure 8d. Decal provided to boaters by DNR watercraft inspectors in 2002.

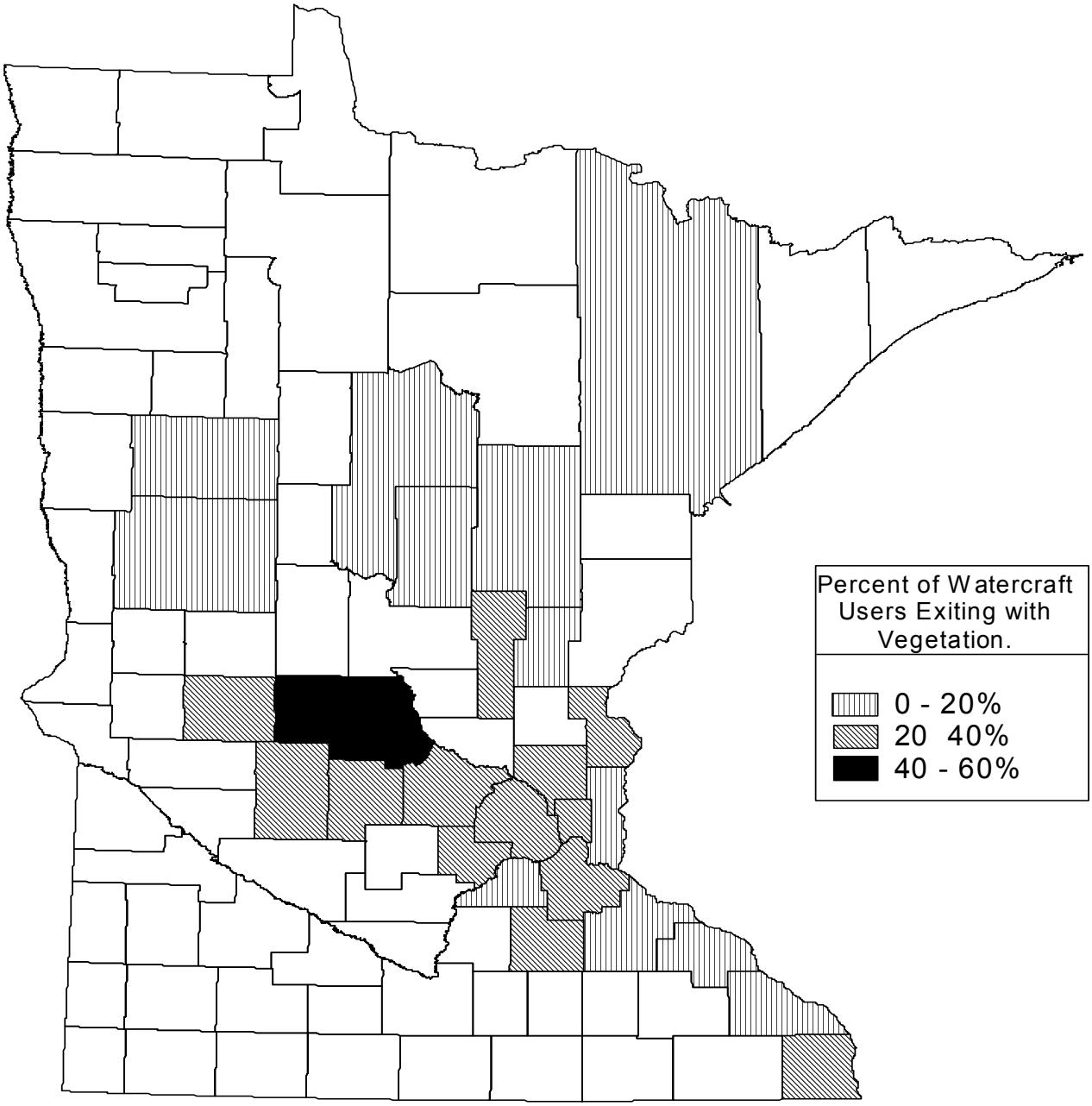

Figure 8e. Percentage of exiting watercraft users inspected with attached vegetation prior to cleaning watercraft (in counties where more than 90 boats were inspected upon leaving an access).

Future needs and recommendations for watercraft inspections

- Conduct a minimum of 20,000 hours of inspections during the 2003 boating season and target about 10% of these inspections at uninfested waters.
- Continue to reduce the percentage of watercraft traveling on Minnesota roads carrying vegetation and other exotic species.
- Continue to refine the time spent on uninfested lakes to maximize the productivity of that time.
- Increase cooperation with citizen groups that would like to help increase awareness in their areas.

Risk Assessment, Risk Management, and Related Research

Introduction

Many harmful exotic species that cause problems in other parts of the United States or other countries do not yet occur in Minnesota. Being proactive, by keeping these species out of Minnesota needs to be a high priority not only for the environment, but the potential increase in management costs. Failure to interrupt pathways and address high risk species often results in introductions that are costly to manage and may become perpetual problems. In reference to the introduction of the snakehead fish, Walter Courtenay, an icthyologist and national expert on exotic fish, said: "The biggest mistake this country has made is that we have not been proactive in preventing these kinds of introduction. We've always been reactive. When you look at the cost of trying to eliminate or control something once it is established here, it is just out of sight."

There are many pathways of introduction and spread of harmful exotic species. In order to interrupt pathways of spread of harmful exotic species, it is necessary to determine the pathways and their level of risk. The Exotic Species Program and others are involved in risk assessments and related research on pathways of spread and species of concern. The risk assessment projects described in this chapter were conducted or completed in 2002.

Exotic Earthworms

Introduction

In 2001, the DNR Exotic Species Program sought and received a small grant from the U.S. Fish and Wildlife Service (USFWS) to conduct a risk assessment on exotic earthworms. The purpose of this risk assessment was to illustrate issues surrounding exotic earthworms within the United States, risks they pose to specific habitats, and recommendations.

People have been introducing exotic earthworms into North America for many years. The first importations of exotic earthworms into the U.S. began around 1500 A.D. when European settlers brought over plant material, some of which contained earthworms (Gates 1974; Reynolds 1994). The work done by G.E. Gates (1966) was instrumental in pointing out the magnitude in which exotic earthworms are currently entering the United States. He identified earthworms that were intercepted by the U.S. Department of Agriculture and found that numerous species from around the world are being continually imported unintentionally. According to Hendrix and Bohlen (2002), this activity is still going on and is probably increasing.

Harmful impacts of exotic earthworms in Minnesota

In Minnesota, as well as other states covered by the most recent glaciation, there are no native terrestrial earthworms. Exotic earthworms that have been introduced into Minnesota have had negative impacts to forests. In the most recently glaciated portions of the United States (Figure 9a), the remaining earthworm-free areas that are most susceptible to negative impacts of exotic earthworms are generally within the northern

deciduous forest habitats. These habitats are described by U.S. Forest Service as follows: "Part of it [forest] consists of mixed stands of a few coniferous species (mainly pine) and a few deciduous species (mainly yellow birch and sugar maple); the rest is a macromosaic of pure deciduous forest in favorable habitats with good soils and pure coniferous forest in less favorable habitats with poor soils." (U.S. Forest Service: Laurentian Mixed Forest, 2002) (Figure 9b). These habitats have developed during the last 10,000 years without earthworm activity and thus created a unique ecology. Earthworms have been and continue to be introduced into these areas, and researchers are now documenting impacts.

The concern with exotic earthworm invasions into forests is the rate at which leaf litter is cycled, and consequently, the change in soil characteristics (Neilsen and Hole 1963; Alban and Berry 1994). Change in the soil structure can have ecological effects beyond its physical characteristics, including altering or completely transforming habitat once occupied by native plants and animals.

Research currently underway in Minnesota is showing a change in forest vegetation. Plant species that depend on a thick layer of organic matter in order to survive, such as the goblin fern (*Botrychium mormo*) and other closely related plants, can be extirpated once earthworms invade (Casson et al., 2001; Gundale, 2002). Preliminary results from research being performed by Hale et al. (2002) shows a decrease in herbaceous plant species and seedling density in previously worm-free deciduous forests in Minnesota.

Further research by Frelich (2002) and Frelich et al. (2002), at the University of Minnesota Center for Hardwood Ecology, is looking at native plant recovery after the invasion of earthworms coupled with grazing pressure by white-tailed deer. Frelich hypothesizes that white-tailed deer grazing inhibits native plant recovery after an earthworm invasion has decreased plant numbers. He also notes that exotic plant species, particularly ones from Europe, have evolved with earthworms and are better suited to survive in earthworm-worked soil and could ultimately dominate worm-invaded areas. Garlic mustard (*Alliaria petiolata*) invasions into hardwood forests appear to be a good example of this.

In human altered and simplified ecosystems, such as urban and agricultural areas north of recent glaciation, earthworms are for the most part beneficial. There are exceptions to this and they include "green" areas within the urban setting (e.g., parks) where researchers have noted impacts similar to the ones mentioned above, altered soil characteristics (physical and chemical), and local extirpation of native plants dependant on a thick layer of organic matter (Nixon, 1995; Frelich, 2002). A lumpy lawn caused by earthworm casting, particularly by the nightcrawler (*Lumbricus terrestris*), is another exception (L. Frelich, Research Associate, University of Minnesota, e-mail, October 2002).

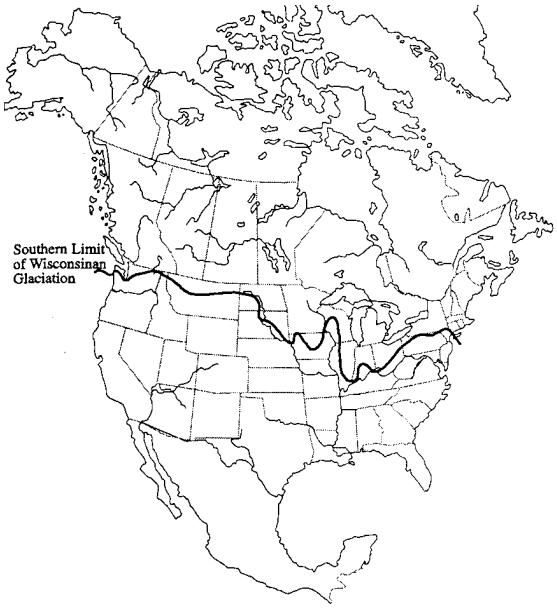

Figure 9a. The southern limit of the Wisconsin glaciation (Reynolds, 1995); shown by solid black line.

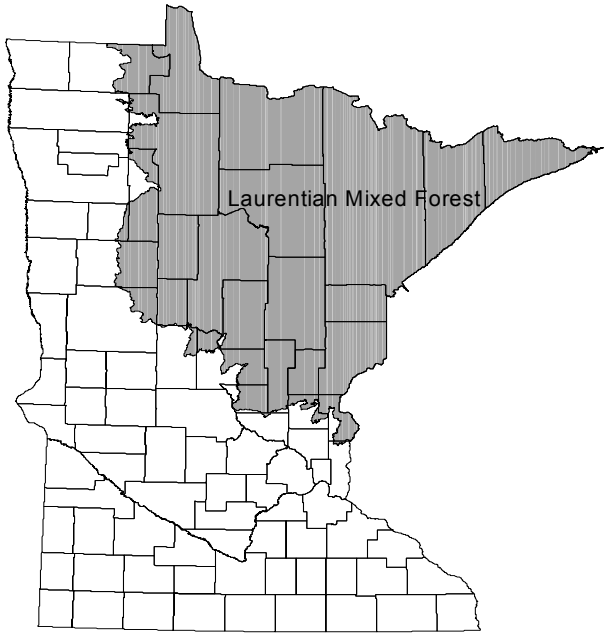

Figure 9b. Laurentian mixed forest in Minnesota.

Earthworm risk assessment activities - 2002

Exotic Earthworm Team

To assist in conducting the risk assessment, the DNR Exotic Species Program assembled an exotic earthworm technical group. The group's purpose was not only to assist with the risk assessment, but also to guide future education, management, and regulatory activities regarding exotic earthworm issues. The group includes scientists from the University of Minnesota, staff from DNR and the MDA, as well as individuals with exotic earthworm expertise and concerns from the Chippewa National Forest, Leech Lake Reservation, and the Minnesota Native Plant Society.

The group met in October 2001 and February 2002. Additional meetings will be held to discuss future statewide educational and regulatory efforts. If additional regulations are recommended for Minnesota, prior to any action, representatives from the bait industry will be included in discussions. The risk assessment began in the spring of 2002 and was completed in November 2002. The assessment includes current regulations, likely pathways of introduction, documented impacts, risks, and recommendations. Copies can be acquired by contacting the Exotic Species Program.

Recommendations

The risk assessment recommended increasing awareness of exotic earthworm impacts through educational efforts and reducing high-risk activities in susceptible habitats that do not contain earthworms.

Aquatic Plant Sales

Issue

Activities such as water gardening, wetland restoration, and shoreline plantings are increasing in popularity. While efforts to restore lakeshores to more natural conditions are recommended, the commercial sale of aquatic plants represents a significant pathway for the introduction of harmful exotic species into Minnesota waters. For example, the harmful exotic species flowering rush *(Butomus umbellatus)* is widely available for sale through aquatic plant catalogs (Galatowitsch and Maki 2002). A DNR review of 30 catalogs and Internet businesses found that 96% of the aquatic plant species available for sale were exotic (Perleberg 1998). The risk that harmful exotics will make their way into natural waters either by accidental escape of cultivated plants or by deliberate introduction of aquarium or water garden plants, poses a threat to Minnesota lakes, rivers, and wetlands.

Goals

The goals of the aquatic plant risk assessment, risk management, and related research are to:

- Identify exotic aquatic plant species that may be harmful to Minnesota resources;
- Identify businesses that sell aquatic plants to Minnesotans; and
- Communicate to both buyers and sellers of aquatic plants which species are potentially harmful and how they can prevent the introduction of those species.

Identify businesses that sell aquatic plants

The DNR and Minnesota Sea Grant funded research at the University of Minnesota to assess the movement of invasive aquatic plants through the horticultural trade. The research was done by Dr. Susan Galatowitsch and her graduate student Kristine Maki. During the summer of 2001, they placed 40 aquatic plant orders from 34 vendors across the U.S. and locally. These orders were placed over the phone and via the Internet. Researchers attempted to order Minnesota *prohibited exotic species* or *federal noxious weeds* 14 times, and all but one order of illegal plants was shipped into the state.

The orders were examined for plant and animal contaminants (species not ordered but unintentionally included in the order), and the plant contaminants were identified. They found 90% of the orders had a plant contaminant, and 80% had an animal contaminant. Duckweed *(Lemna minor)*, a common native plant, was the most common plant contaminant. A small number of orders were contaminated with *federal noxious weeds*. Purple loosestrife *(Lythrum salicaria)* seeds came with one order. Those seeds produced a plant that flowered and produced seed in the greenhouse. Hydrilla (*Hydrilla verticillata*) and giant salvinia (*Salvinia molesta*) contaminated two other orders. Both salvinia and hydrilla reproduced in the greenhouse (Galatowitsch and Maki 2002).

Galatowitsch and Maki (2002) produced a comprehensive database of commercially available exotic aquatic plants from 119 vendors. All vendors in the database sell potentially invasive plants. This database includes information on the commercial availability, life history, and global distribution of 39 exotic aquatic plants regulated by Minnesota or federal law (Galatowitsch and Maki 2002).

Identify exotic aquatic plant species that may be harmful to Minnesota resources
Several species known to be harmful in other areas were treated to determine if they could survive in Minnesota. Galatowitsch and Maki (2002) developed a method for assessment of cold tolerance of submersed aquatic plants and tested it on several exotic plants: *Hydrilla verticillata* (hydrilla), *Pistia stratiotes* (water lettuce), *Egeria densa* (Brazilian elodea), *Cabomba caroliniana* (fanwort) and *Myriophyllum aquaticum* (parrot's feather). Their results indicate that hydrilla will be able to survive and reproduce in many Minnesota lakes, and that parrot's feather would be able to over winter and survive in Minnesota. Their results indicate that water lettuce would likely not survive Minnesota winters. Likewise, Brazilian elodea did not survive the assay conditions, but they caution that the plants they tested may not have had adequate time for building their energy reserves prior to the assay, and a more established *Egeria densa* plant may be able to over winter in Minnesota. They felt the assay results for fanwort were inconclusive, and they suggested testing should be done again with plants with more established root systems (Galatowitsch and Maki 2002). This research was also funded by the DNR and Minnesota Sea Grant.

Communicate to both buyers and sellers of aquatic plants how they can prevent the introduction of harmful exotic species
Exotic Species staff produced two publications aimed at slowing the movement of harmful exotic species through the horticultural trade: *Harmful Exotic Species: What every water gardener and shoreline restorer should know*, and *Harmful Exotic Species: What every aquatic plant seller should know*. These publications give aquatic plant buyers and sellers the information they need to be able to prevent the introduction of harmful exotic species into Minnesota waters.

Minnesota Sea Grant has applied to National Sea Grant for funding for a new initiative "Preventing New Introductions of Invasive Aquatic Plants through Water Gardening and Shoreline Restoration". A pre-proposal for the project received an "excellent" rating, and Minnesota Sea Grant was encouraged to submit a full proposal. This project will examine the potential for the introduction of aquatic nuisance species through the nursery trade both regionally and nationally, develop key messages and materials, evaluate an educational campaign based on those messages; and transfer an outreach program to other states. If funded, the Minnesota DNR will be a collaborator on the project. The project is scheduled to start in June 2003.

Study of Methods and Costs to Screen Milfoil from Diverted Water

Introduction
Water diversion and appropriation from infested waters is a potential pathway of spread for Eurasian watermilfoil and other aquatic exotic species. Consequently, this risk is addressed in Minnesota Rules 6216.0500, Subpart 4.

> Subp. 4. Diversion, appropriation, and transportation of infested waters. Infested waters may not be transported on a public road or off property riparian to infested waters except:

A. in emergencies, such as fire emergencies;

B. as specified in a water appropriation or public waters work permit issued by the commissioner pursuant to Minnesota Statutes, chapter 103G; or

C. under a permit issued pursuant to this part.

Infested waters may not be diverted to other waters without a permit issued pursuant to this part, or as authorized in a public waters work permit or water appropriation permit issued by the commissioner pursuant to Minnesota Statutes, chapter 103G.

Past and potential screening needs

Since the discovery of milfoil in Minnesota during 1987, concerns about the potential transfer of milfoil from an infested lake to an uninfested lake by the diversion of water have developed in at least five or six cases. In at least four cases, pumping systems were designed with various screens or other provisions intended to reduce the risk of inadvertent transfer of milfoil to uninfested receiving waters. Sizes of openings in screens or intakes have ranged from 0.5 to 2 mm.

In 2001, the Saint Paul Regional Water Service (SPRWS) contacted the DNR to inquire about approaches to preventing the spread of milfoil from Centerville Lake in Anoka County (DOW 2.0006), where milfoil was first discovered in 1999, to Deep and Pleasant lakes (DOW 62.0018 and 62.0046, respectively). The SPRWS has a system to pump water from Centerville to Deep, which is connected to Pleasant. The SPRWS may need to appropriate water from Centerville Lake if circumstances prevent the agency from meeting its minimum demand, i.e., base winter consumption, by appropriating water from the normal source, which is the Mississippi River. The possible causes of such difficulty include reduced flow due to drought or unsuitability of water due to contamination.

Screening study

To evaluate a broad range of options and costs for a screen system or other approach to reducing the risk of accidental transfer of milfoil from Centerville Lake to Deep Lake, the DNR established a $3,000 contract with Barr Engineering Company. Barr Engineering described eight possible approaches to this problem. They included various screens and associated structures that ranged in estimated cost from $150,000 to $1.2 million, as well as a zero-cost, “Do Nothing” approach. No particular approach has yet been selected for further consideration or implementation.

Future needs for risk assessment, risk management, and related research

Risk assessment

- Continue to identify exotic species that may be likely to enter Minnesota and evaluate their potential to cause problems if they become established in the wild.
- Develop a database and maintain files at the DNR of literature about exotic aquatic plant and wild animal species to guide regulatory classification.

Risk management

- Educate the public on the emerging exotic earthworm issue.
- Work with industries that might bring prohibited exotic species into Minnesota to reduce the likelihood of those occurrences.

Research

- Identify earthworm-free areas within Minnesota.
- Support current research efforts on exotic earthworms.
- Encourage, fund, and support research to predict which exotic species are likely to naturalize and be harmful in Minnesota.
- Continue to develop and distribute information about regulations regarding selling, buying, and introducing aquatic plants and animals in Minnesota.

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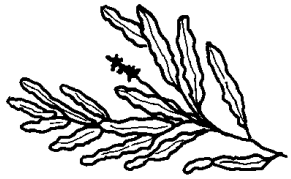
Management of Curly-leaf Pondweed

Introduction



Issue

Curly-leaf pondweed (*Potamogeton crispus* L.) is a perennial, rooted, submersed vascular plant that was first noted in Minnesota about 1910 (Moyle and Hotchkiss 1945). Curly-leaf pondweed is currently known to occur in 65 of the 87 counties in Minnesota (Exotic Species Program 1997). Because curly-leaf grows under the ice, it is often the first plant to appear after ice-out. By late spring it can form dense mats that may interfere with recreation and limit the growth of native aquatic plants (Catling and Dobson 1985). In mid-summer, curly-leaf plants usually die back, which results in rafts of dying plants piling up on shorelines, and often is followed by increases in concentrations of phosphorus (Bouldan et al. 1994) and undesirable algal blooms. Curly-leaf plants usually die back in early summer in response to increasing water temperatures, but they first form vegetative propagules called turions (hardened stem tips). New plants sprout from turions in the fall (Catling and Dobson 1985). Dense mats of curly-leaf can be removed using contact herbicides or mechanical harvesting. However, in order to obtain any long-term control of curly-leaf pondweed, the production of turions must be stopped.

Goals

The DNR has two goals that apply to curly-leaf pondweed management:

- To prevent the spread of curly-leaf pondweed within Minnesota.
- To reduce the impacts caused by curly-leaf pondweed to Minnesota's ecology, society, and economy.

One strategy to attain the second goal is to support and conduct research to improve the management of curly-leaf pondweed, and to communicate research results to the public.

Progress in Management of Curly-leaf Pondweed - 2002

Prevention of spread

Exotic Species Program staff have worked with the general public, with lakeshore residents, and with researchers to support our goals for curly-leaf pondweed. The Exotic Species Program continued to use watercraft inspections, informational materials, and public speaking engagements to further our efforts to prevent the accidental spread of curly-leaf pondweed.

Support research to improve management

Staff have provided technical assistance and financial support to researchers working on curly-leaf pondweed.

U.S. Army Corps of Engineers

Exotic Species Program staff assisted the U.S. Army Corps of Engineers (USACE) in its continuing study to evaluate both the efficacy of contact herbicides to control curly-leaf pondweed at low temperatures, and to reduce the next summer's curly-leaf growth by reducing turion production (Netherland et al. 2000). The USACE has been treating three small lakes in Minnesota every spring since 1999 with endothall see how long it will take to deplete the "bank" of turions in the lake sediments. These treatments have been successful in controlling curly-leaf pondweed during the year of treatment, doing minimal harm to native plants, and reducing turion production. Nevertheless, enough curly-leaf was still present in the treated lakes in the spring of 2002 to warrant treatment. In April 2002, the lakes were again treated. Spring surveys in 2003 will determine if further treatments are needed.

Curly-leaf biology

Dr. John Madsen at Minnesota State University-Mankato (MSU) is conducting research aimed at determining the best time of year to manage curly-leaf pondweed. He and his graduate student are measuring the seasonal variations in biomass and carbohydrate allocation in curly-leaf pondweed populations in Minnesota. Initial results showed that peak biomass occurred with turion formation, which occurred in the sampled lakes from early to late June. Flowering occurred shortly after turion formation. Following turion formation there was a rapid reduction in plant biomass as the plant died back (Woolf and Madsen, 2002). Turion formation occurs at peak biomass and if a goal of treatment is to prevent formation of turions curly-leaf should be treated before it reaches peak biomass. The final report from this study should be available in June, 2003. This research is funded by the Exotic Species Program with $53,000 of program funds over two and a half years.

Effects of fluridone

MSU is midway through a project to determine the effects of fluridone herbicide on curly-leaf pondweed biomass and turion production. They are measuring plant biomass and turion production in two lakes, a treated lake (Eagle) and an untreated reference lake (Parley) in Carver County. Eagle Lake is part of an evaluation of fluridone herbicide by the Minnesota Department of Natural Resources (see the Eurasian watermilfoil chapter for more information about this study). Researchers at MSU sampled biomass and turions in Eagle and Parley in April and June 2002 and will sample them again in April and June 2003. Initial results indicate that the fluridone treatment reduced the amount of curly-leaf pondweed in the lake. The project is funded by the DNR Exotic Species Program with $3,000 of program funds.

Provide technical assistance

Staff have continued to provide information on the best management practices for curly-leaf pondweed control to the public. Based on the USACE research so far the Exotic Species Program recommends using an endothall-based herbicide, such as Aquathol K when water temperatures are 60° F in the spring. These treatments should successfully kill curly-leaf pondweed, reduce or eliminate turion production in the treated areas, and will have less of a negative impact on native aquatic plants than treatments done later in the summer.

Future needs for management of curly-leaf pondweed

- Continue public awareness efforts focused on containing curly-leaf pondweed to where it is already found. Opportunities include our watercraft inspection program, literature, and public speaking engagements.
- Continue to provide information on the best management practices for curly-leaf pondweed control to the public.
- Continue to provide technical assistance and other support to researchers working on curly-leaf control, and the relationships between curly-leaf populations and lake water quality in Minnesota.

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Management of Eurasian Watermilfoil

2002 Highlights

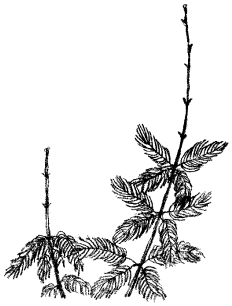
- Eurasian watermilfoil was discovered in eight additional Minnesota water bodies during 2002. There are now 141 Minnesota lakes, rivers, and streams known to contain the exotic submersed aquatic plant.

- The DNR Exotic Species Program revised both the maintenance and high-intensity management approaches to milfoil.

- The DNR Exotic Species Program used state funds for management of milfoil on 37 Minnesota lakes.

- The DNR Exotic Species Program made whole-lake treatments with fluridone on three Minnesota lakes as part of an evaluation of the potential to selectively control milfoil with this herbicide.

Issue



Eurasian watermilfoil (*Myriophyllum spicatum*) is an exotic submerged aquatic plant that was inadvertently introduced to Minnesota. Eurasian watermilfoil, hereafter called milfoil, was first discovered in Lake Minnetonka during the fall of 1987. Because it can limit recreational activities on water bodies and alter aquatic ecosystems by displacing native plants, Minnesota established the Minnesota Department of Natural Resources' (DNR) Exotic Species Program to manage milfoil, as well as certain other harmful exotic species. This report describes the Exotic Species Program's efforts in 2002 to manage milfoil and limit its spread in Minnesota.

Goals

The DNR Exotic Species Program has two primary goals for management of milfoil in Minnesota. They are listed below along with the principal strategies discussed in this chapter.

- Prevent spread of milfoil in Minnesota
  - Monitor distribution of milfoil in Minnesota
- Reduce problems caused by milfoil in Minnesota
  - Provide funding for maintenance management by cooperators
  - Conduct high-intensity management and control at public water accesses
  - Provide technical assistance
  - Support or conduct research on the ecology and management of milfoil

Distribution of Eurasian Watermilfoil in Minnesota

Eurasian watermilfoil is now known to occur in 141 water bodies in Minnesota (Table 11a and Figure 11a). During 2002, the exotic was discovered in eight new lakes. Two of these lakes are located in the seven-county metropolitan area. Four of these lakes are located in counties adjacent in the seven-county metropolitan area. Two of these

lakes are located in counties that are far removed from the Twin Cities. In addition, milfoil was found during 2002 in two counties, Le Sueur and Sherburne, where the exotic had not previously been discovered.

Most Minnesota lakes with milfoil are found in the seven-county metropolitan area (Table 11b). Within this area, the county with the greatest number of lakes with milfoil is Hennepin, where 19% of the lakes have been discovered to have the exotic. In the seven-county metropolitan area, 9% of the lakes have milfoil. On a statewide basis, milfoil has been found to occur in 1% of Minnesota's lakes.

Discovery of new occurrences of Eurasian watermilfoil in Minnesota

Characteristics of some newly discovered occurrences of milfoil suggest that there likely are other water bodies in Minnesota with the exotic that have not yet been discovered. In some cases, milfoil is discovered years after the time when it became established in a lake. For example, in two well-developed recreational lakes in Le Sueur County, widely scattered milfoil was discovered by staff from the DNR Division of Fisheries while engaged in regular surveys of aquatic vegetation. This suggests that the exotic invaded these lakes some years ago. Nevertheless, it was not reported by the local users of the lake, most likely because the milfoil did not become very abundant due to low water clarity, which tends to limit the growth of milfoil in particular and submersed aquatic plants in general.

The number of lakes where aquatic plants are surveyed by the DNR in any given year is a small percentage of the total number of lakes in Minnesota. Consequently, the Exotic Species Program believes there may well be other lakes with milfoil, such as the two discovered in Le Sueur County during 2002, which are unlikely to be detected for some time.

In other lakes, milfoil appears to have been discovered soon after establishment before the exotic becomes widespread when an unusually knowledgeable person noticed the plant. For example, a new occurrence of milfoil in a Crow Wing County lake was reported by an individual who is familiar with the exotic plant because he used to work for a commercial herbicide applicator and had treated milfoil in other lakes. Other users of the lake would have been much less likely than this past-applicator to notice this infestation due to the similarity in appearance between milfoil and many native plants. In addition, the milfoil was not abundant and it was confined to a small part of one bay, making it less likely that users of the lake would notice the exotic.

At the same time, the substantial number of false reports of new occurrences of milfoil suggests that there may not be many undiscovered lakes with the exotic. Many false reports result when other species of submersed vegetation, often forming mats, attract the attention of users of Minnesota lakes. These individuals suspect that the abundant vegetation is milfoil and report the occurrence to the Exotic Species Program. During 2002, as in previous years, most of these reports were found to be occurrences of various native aquatic plants. Nevertheless, we encourage the public to report suspected new occurrences of milfoil to the DNR (see following). Additional evidence that there may not be many undiscovered lakes with milfoil comes from the fact that the Exotic Species Program made brief inspections near public water accesses on a

number of Minnesota lakes and found no new infestations of milfoil in these waters during 2002.

Table 11a. Number of lakes or rivers where Eurasian watermilfoil is known to occur in Minnesota as of December 2002.

Year	Number of lakes in which milfoil was discovered	Running three-year average for number of lakes in which milfoil was discovered	Number of rivers in which milfoil was discovered	Cumulative number of water bodies with milfoil	Cumulative number of counties with milfoil
1987	1	--	0	1	1
1988	8	8	0	9	5
1989	14	11	1	24	8
1990	12	13	1	37	10
1991	14	12	0	51	10
1992	10	10	2	63	12
1993	5	5	0	68	12
1994	2	5	0	70	13
1995	7	5	1	78	13
1996	5	5	0	83	14
1997	5	6	0	88	14
1998	9	7	1	98	16
1999	8	10	0	106	19
2000	14	11	1	121	21
2001	12	11	0	133	22
2002	8	-	0	141	24

Table 11b. Number of lakes known to have Eurasian watermilfoil in the seven counties of the Twin Cities metropolitan area as of December 2002.

County	Number of lakes known to have Eurasian watermilfoil	Number of lakes in county[1]	Percentage of lakes known to have Eurasian watermilfoil
Anoka	6	143	4
Carver	17	128	13
Dakota	6	91	6
Hennepin	38	200	19
Ramsey	16	83	19
Scott	4	144	3
Washington	3	168	2
Total – Metro	90	957	9
Total – State	134[2]	12,000	1

[1]Source: Anonymous (1968).
[2]There also are seven rivers or lakes with Eurasian watermilfoil.

Spread of Eurasian watermilfoil in Minnesota

The rate of spread of milfoil in Minnesota as reflected in the annual discovery of new occurrences of the exotic has changed little over the last three to four years (Table 11a). This observation is based on the running three-year average for number of lakes in which milfoil was discovered, which appears to be stable after experiencing an increase that began in 1998 and reached a plateau in 2000. The locations of the new occurrences of milfoil suggest that most of the spread in recent years likely has resulted from short as opposed to long-distance dispersal (Figure 11a).

Effectiveness of efforts to limit the spread of Eurasian watermilfoil

It is presumed that efforts to inform the public in Minnesota about milfoil and the problems it can cause have reduced the rate of spread of the exotic (Figure 11b). Nevertheless, it is difficult to evaluate the effectiveness of efforts by the DNR to limit the spread of milfoil because it is difficult to know at what rate the exotic might spread and then be discovered in the absence of the Exotic Species Program. One might compare observations of the spread of the exotic in Minnesota to spread in other states that have no program to prevent the spread. But such states also are unlikely to have as much effort directed toward discovery of new occurrences of milfoil by either the public or agency staff as we have in Minnesota. This presumably would lead to a relatively high proportion of occurrences of milfoil being overlooked in other states.

Efforts of users of Minnesota lakes to limit the spread of milfoil in Minnesota appear to be effective. This judgment is based on several observations. First, though approximately 15% of boats leaving lakes have attached vegetation, only 2% of boats entering public accesses on infested lakes have attached vegetation (see chapter on Watercraft Inspections and Awareness Events). This suggests that the majority of boaters using infested waters are cleaning their boats. Second, there was a lack of an increase in the number of new occurrences of milfoil discovered in 2002. Nevertheless, it is possible that the actual number and distribution of water bodies with milfoil is greater than the known distribution of the exotic.

Participation in monitoring of the distribution of milfoil by other state agencies, local units of government, and interested groups

The participation of other divisions of the DNR and outside agencies, citizens, etc. in reporting new occurrences of milfoil remains critical. This assistance is very important because Exotic Species Program staff are able to visit a limited number of lakes each year. Efforts by others to search for milfoil and report suspected occurrences of the exotic greatly increase the likelihood that new occurrences are discovered. The program investigates likely reports of new infestations as soon as possible for two reasons. First, it is important to determine whether milfoil actually is present in the lake. Second, if the exotic is present, then it is important to minimize the risk of spread to uninfested waters by notification of the users of the lake. It is hoped that, once people who use a lake are aware of the presence of milfoil, they will be especially careful to not transport vegetation from the lake on their boats, trailers, or other equipment.

Reports of suspected occurrences of milfoil that turn out to be mistaken also have value. In the course of responding to such reports, staff of the Exotic Species Program discuss identification of the exotic Eurasian watermilfoil with the observer and so

increase the number of people who in the future are likely to be able to distinguish the exotic from various native plant species that are similar in appearance.

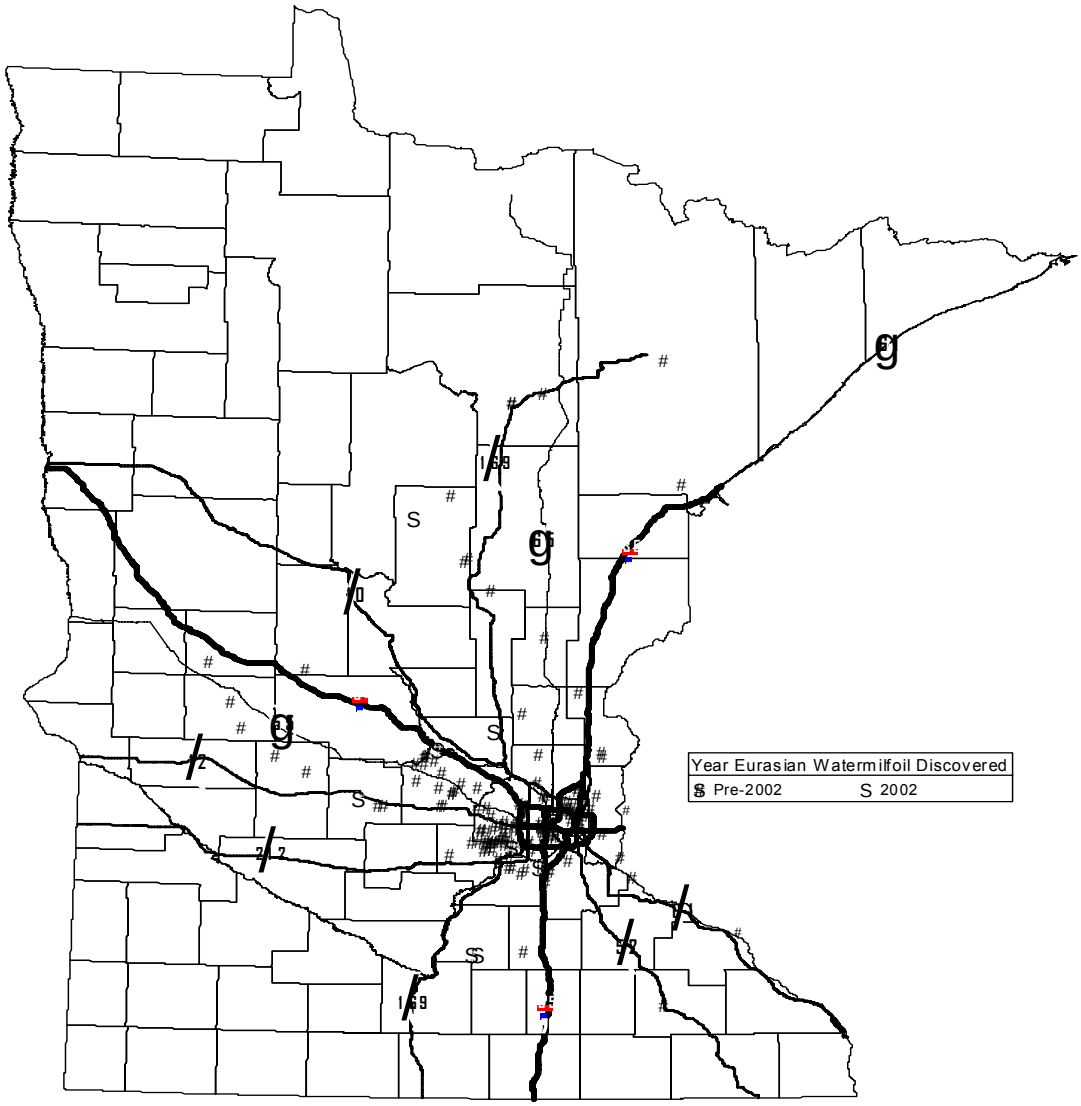


Figure 11a. Distribution of water bodies with Eurasian watermilfoil in Minnesota as of October 2002.

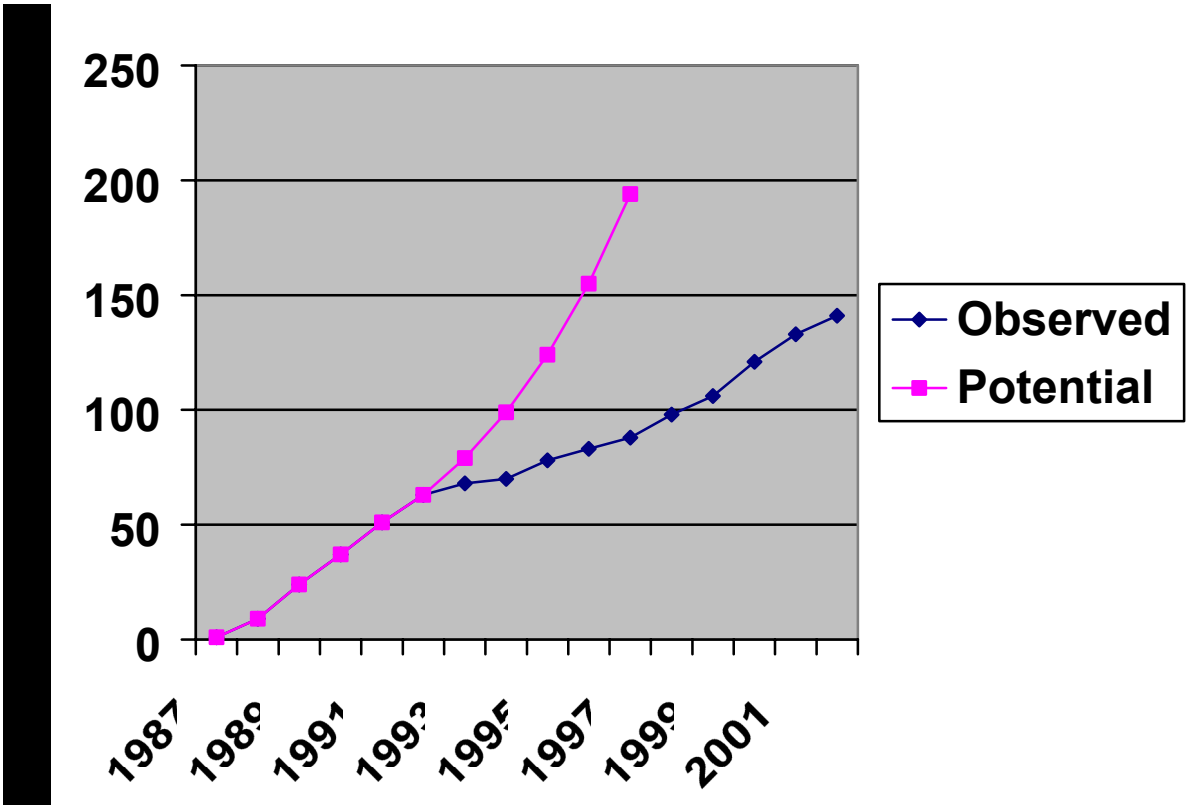


Figure 11b. Observed and possible worst-case scenario rate of spread of Eurasian watermilfoil in Minnesota.

Progress in Management of Eurasian Watermilfoil - 2002

The DNR's approach to management of milfoil was revised for 2002. To understand the revised approach, it is helpful to review the history of the DNR's management of milfoil because our approach to this exotic has evolved over the years. This history was described in a recent report by the DNR (Exotic Species Program 2002) and is briefly summarized below.

History of Minnesota's approach to management of Eurasian watermilfoil

Very soon after the discovery of milfoil in Lake Minnetonka in 1987, the exotic plant became abundant and caused severe problems in the lake. This caused much concern among the users of this and other Minnesota lakes. In response to this concern, the DNR began to spend state dollars to control the plant in 1989. The objectives of the early efforts were to eradicate the plant, or at least control the expansion of milfoil within infested lakes, and to prevent its spread to uninfested bodies of water. Initially, the DNR took the lead in management of milfoil in individual lakes by attempting to find and control all milfoil growing in them. In most cases, control involved herbicide treatments that were made by commercial applicators working under contract to the state.

By 1993, the DNR was able to initiate management on only a third of the lakes with the exotic due to limitations on staff time and funding. In addition, Minnesota's experience in attempting to eradicate milfoil provided increasing amounts of evidence that this is not a realistic goal. In order to make funding and technical assistance available to cooperators on lakes that DNR biologists were unable to visit, the "maintenance management" class was created in 1994. Cooperators are people who either take the lead or participate with the DNR in control of milfoil on individual lakes. Cooperators usually are members of lake associations; they also may be employees of local units of government. In many cases, they receive funds from the DNR to support control of milfoil in public-use areas, most commonly by treatment with herbicides. For lakes assigned to this class, the DNR offered funding to local cooperators, who were expected to take the lead in assessment and control of the milfoil. The goals of maintenance management are to: 1) manage nuisances caused by milfoil, but not necessarily reduce the abundance of the plant lake-wide, and 2) slow the spread of the exotic to other lakes. On lakes in the maintenance management class that receive funds from the DNR, the most common activity is application of herbicide, followed by mechanical harvesting and survey or planning.

The DNR continued to take the lead in assessment of the milfoil and directing control on seven to 14 lakes per year in a second class: "high-intensity management." The goals of high-intensity management are to: 1) limit the spread of the plant within a lake, 2) reduce the abundance of milfoil within a lake, and 3) slow the spread of the exotic to other lakes. High-intensity management usually involves efforts to find all milfoil in a lake and have it treated with herbicide. High-intensity management usually is undertaken by the Exotic Species Program on lakes that either have small, recently discovered populations of milfoil or are located in areas of Minnesota where there are few if any other lakes with milfoil. On lakes in the high-intensity class, the DNR takes the lead in management and pays all costs.

Lessons from management of Eurasian watermilfoil in Minnesota

Over the last 13 years, the DNR and various cooperators have spent much time and effort on a number of lakes in attempting to find and control the exotic. In these efforts we have used various herbicides, most commonly 2,4-D, which was the subject of an article by Crowell (1999). Other herbicides used include triclopyr and fluridone. In addition, control also was done by hand-pulling and mechanical harvesting. These efforts were described in a recent report by the Exotic Species Program (2002). Regarding control of milfoil, we have learned much about what we can and cannot do with current management tools:

1) We can reduce the abundance of the plant in a site or area, which means we can reduce, at least temporarily, the nuisance caused by matted milfoil, but

2) We cannot eliminate or eradicate the plant from lakes, and

3) We cannot reliably prevent spread of the plant within most lakes.

We identified four main reasons why the milfoil program needed to be revised:

1) In most lakes in the high-intensity management class, control undertaken by the DNR is not stopping the spread of milfoil within these lakes.

2) Under the current maintenance management program, a significant number of eligible cooperators have not requested the funds that are available for management of milfoil on the lakes where they live.

3) In some cases, cooperators on lakes in the maintenance management class are proposing control that is not effective, such as fall treatments of areas without matted milfoil.

4) Milfoil continues to spread to more Minnesota lakes while funding and staff available to manage the plant remain constant.

Consultations with people involved with management of Eurasian watermilfoil in Minnesota

As part of the review of the DNR's approach to management of milfoil, the Exotic Species Program consulted people in three groups: past and present staff of the Exotic Species Program, staff in the Division of Fisheries, and people outside the DNR. These efforts began with distribution of a questionnaire that consisted of three questions:

1) What was the most effective milfoil management in which you have taken part?

2) What was the least effective milfoil management in which you have taken part?

3) What are the two or three most important changes you would make to the program?

The activities that were most frequently identified by respondents are described here. Six people who either work in the Exotic Species Program now or have worked for it in the past responded to the questionnaire during July-September 2001. They reported that the most effective management was treatment of newly discovered, small populations of milfoil in shallow and sheltered sites where application of 2,4-D was quite effective. There were only a limited number of cases of this sort. The next most effective activity was participation by staff of the Exotic Species Program in public meetings to discuss milfoil management with lake residents. Staff of the Exotic Species Program reported that the least effective management were most applications of 2,4-D, particularly those in sites that were exposed and where water depths were greater than five feet. The next least effective activity was attempting to locate all milfoil in a lake. The most important changes that staff of the Exotic Species Program would make to the program would be to reduce or eliminate herbicide applications initiated by the DNR, i.e., high-intensity management by the agency. The next most important changes that staff of the Exotic Species Program would make would be to make the maintenance management program a competitive grant process, and to increase the emphasis on the DNR's role as technical advisors.

In November 2001, the questionnaire was distributed to 22 people in the Division of Fisheries who are involved in management of aquatic plants and 15 of them responded. The responses from Fisheries included comments on all aspects of the DNR's management of milfoil, ranging from public education to prevent further spread, to control by different methods, to research into the ecology of the exotic. Though no one or two activities were identified as most effective by a majority of respondents, it appeared that the most effective activities were those designed to limit the spread of milfoil, such as production of educational materials and inspections of watercraft. Other activities identified as most effective by staff from Fisheries included some herbicide treatments and research on potential biological control of milfoil. The activity most frequently identified by staff in Fisheries – though by only four of 15 respondents – as least effective was control of milfoil by use of herbicides. Staff in Fisheries suggested that the most important direction for the program to take would be to maintain or increase efforts to educate citizens to prevent further spread of milfoil. The next most important activity that staff in Fisheries identified was continued research on the ecology and management of milfoil.

In February 2002, the questionnaire was distributed to approximately 80 people outside the DNR. These people primarily were cooperators. Responses were received from 32 individuals, all of which have been reviewed. For this report, we summarized responses from only the first 12 lake residents because we have not yet been able to tabulate all responses.

Lake residents reported that the most effective management was use of various herbicides to control milfoil. The activity most frequently identified by lake residents as least effective was also control of milfoil by use of herbicides. The most important changes that lake residents would make to the program would be to improve the efficacy of control of milfoil by use of herbicides. These recommendations included whole-lake treatments with fluridone herbicide. The next most important changes that they would make would be to maintain or increase the financial support from the DNR for control of milfoil.

<u>Revision of Minnesota's approach to management of Eurasian watermilfoil</u>
After review of the responses to the questionnaire, the Exotic Species Program revised the "Announcement of availability of funds from the Minnesota Department of Natural Resources for management of Eurasian watermilfoil in 2002" in late March. The revised version was sent to the 32 respondents along with an invitation to a meeting in early April to discuss the proposed changes to the program. The meeting was attended by seven lake residents, four commercial pesticide applicators, and representatives of two fishing groups. Since there appeared to be no major problems in the proposed revisions to the program, it was implemented in the 2002 open water season.

Based on the results of the review of the program, we made the following changes. We reduced the number of lakes assigned to the high intensity management class where the DNR attempts to limit the spread of milfoil within the lake. In addition, we went from a system of offering financial assistance to all lakes in the maintenance management class to a competitive grant system.

Classification of water bodies for management of Eurasian watermilfoil

In the spring of 2002, the Exotic Species Program classified the 133 bodies of water known to have milfoil on the basis of information available in 2001 (Table 11b). One hundred lakes were determined to be eligible for management with state funds because they have public water accesses and are protected waters that are regulated by the State of Minnesota (Minnesota Statutes 103G.005, Subd. 15). Another 26 lakes were determined to be ineligible for management with state funds because they either do not have public water accesses or are not protected waters. Lastly, seven water bodies with milfoil are rivers or streams. In flowing waters such as rivers, control of milfoil or other submersed aquatic plants is not usually attempted because: 1) users of these waters in Minnesota rarely encounter problems caused by milfoil like those found in lakes, and 2) use of herbicides in rivers is less reliable than in lakes.

Seven of the eight water bodies that were discovered to have milfoil during 2002 were eligible for management with state funds because they have public water accesses (Table 11c). Of these, one was placed in the high-intensity management class because it had a very limited amount of milfoil and was located in an area of the state with few other milfoil lakes. The other six were classified for maintenance management because the exotic plant was widespread in these lakes. One lake found to have milfoil in 2002 has no public water accesses and consequently is ineligible for management with state funds.

Table 11c. Classification of water bodies in Minnesota with Eurasian watermilfoil during 2002.

Classification	Spring	New in Summer	Fall
Eligible for management with state funds			
Maintenance management	90	6	96
Fluridone evaluation (treated & reference)	6		6
High-intensity management	4	1	5
Ineligible for management with state funds			
Public water but no public access			
Not public water	22	0	22
	4	1	5
Other			
Rivers or streams	7	0	7
Total	133	8	141

Maintenance management of Eurasian watermilfoil

During 2002, state funding and technical assistance were available from the Exotic Species Program to potential cooperators for management of Eurasian watermilfoil on 96 lakes in the maintenance management class (Table 11c). As described above, the goals of maintenance management are to: 1) manage nuisances caused by milfoil, but not necessarily reduce the abundance of the plant in all sites where it grows in a lake, and 2) slow the spread of the exotic to other lakes.

The offer of state funding is described in an announcement that is available to potential cooperators (DNR 2002) and briefly summarized here. These funds are intended to pay for control during spring or early summer of unavoidable nuisances caused by dense and matted milfoil that will benefit a number of homeowners and the general public who use a lake. These funds may not be used for control work that would otherwise be done by private individuals. Typically, control undertaken by private individuals is done immediately adjacent to the owner's shoreline or adjacent to structures such as docks.

This approach is based on the determination that nuisances caused by milfoil are similar to those caused by native plants, though they often are more extensive and severe than those caused by native plants. Minnesota allows control of nuisances caused by dense growths of aquatic plants (M.R. 6280.1000, Subp. 5) that interfere with watercraft use, swimming, or other traditional recreational uses (M.R. 6280.0250, Subp. 2, A, (2)). Nuisances caused by submersed aquatic plants growing in areas of a lake that can be avoided by watercraft, swimmers, or other traditional recreational users are usually not allowed to be controlled. These limits are implemented through prohibitions on control to improve the appearance of undeveloped shoreline or for esthetic purposes alone on developed shoreline (M.R. 6280.0250, Subp. 4, B and C). Also, the area of a lake to which herbicides may be applied to control submersed aquatic plants generally is limited to 15% of the littoral zone (M.R. 6280.0350, Subp. 4, A). The littoral zone is the area in a lake where plants grow and is legally defined as being 15 feet deep or less (M.R. 6280.1000, Subp. 9). Lastly, after August 1 of each year, the DNR does not usually accept applications for permits to control submersed aquatic plants (M.R. 6280.0450, Subp. 2).

Where control of milfoil is necessary, the DNR encourages potential cooperators to do the work in late spring or early summer so that relief from nuisances caused by milfoil is provided during summer, the time of year when recreational use of lakes is usually greatest. Treatments of milfoil after August 1 are discouraged because any relief provided by such control is provided at a time of year when levels of boating are generally lower than they are in spring or summer. In addition, control of milfoil in the fall generally is not likely to eliminate the need to control milfoil during the following spring, when the plants grow back. It is the DNR's experience that most control of aquatic plants, including milfoil, is temporary because the plants grow back from root crowns or other plant parts.

The DNR received applications for state funding to control milfoil from potential cooperators on 32 lakes (Table 11d). Applications were reviewed by the Exotic Species Program in relation to the standards described above. Half of the applications were approved as submitted. Questions about the other half of the applications led to inspections of the milfoil in all but one of these lakes by staff of the Exotic Species Program. These inspections revealed that some sites proposed to be treated with herbicide either did not have dense and matted milfoil or did not constitute an unavoidable nuisance for users of the lake. The results of these inspections and recommended modifications of proposed control projects were reported to the potential cooperators and staff in the Aquatic Plant Management Program who issue permits for control. On six lakes, proposals were modified by reducing the size or number of sites to be treated and subsequently approved. On two lakes, no sites proposed for

treatment met the DNR's criteria and on another lake, sites proposed for control were treated before approval of the application for reimbursement. Consequently, the applications for reimbursement on these three lakes were denied.

Table 11d. Number of Minnesota lakes in the maintenance management class where management of Eurasian watermilfoil was supported with state funds in 2002.

	Number of lakes	Number of lakes
Total number of lakes	96	
Control by cooperator [1, 2]		
Applications received	32	
Applications approved		15
Applications approved after modification		6
Applications denied		3
Applications not pursued		7
Applications received, but it was recommended that work be deferred until 2003		1
Plan by cooperator [1, 3]		
Applications received	11	
Applications approved		9
Applications denied		2
Total approved		27
Control by DNR at PWA [3]		7
Grand Total		32

[1] On three lakes, applications were approved for both control and planning.
[2] On one lake, an application was approved for local control and the DNR controlled milfoil by the public water access (PWA).
[3] On one lake, an application was approved for local planning and the DNR controlled milfoil by the PWA.

Applications for state funding to control milfoil were received from potential cooperators on another eight lakes where projects were not pursued for various reasons. In some cases, applications were submitted early in the year before the milfoil had much time to grow and the exotic subsequently did not cause nuisances that required control with state funds. In two cases, potential cooperators submitted applications for lakes where milfoil did not produce mats in public use areas and so were ineligible for reimbursement by the state. Nevertheless, these potential cooperators treated the non-matting milfoil in attempts to limit the spread of the plant within the lakes using only non-

state funds. On these lakes the DNR issued permits for spot-treatment of milfoil with herbicide as long as potential damage to non-target plants was minimized and the 15% limit was not exceeded.

In one case, a potential cooperator submitted an application for reimbursement for a fall treatment. The potential cooperator did not pursue this plan after staff of the Exotic Species Program inspected the lake and recommended consideration of delaying the proposed treatment until the spring of 2003.

The DNR also received applications for state funding to develop plans for management of milfoil from potential cooperators on 11 lakes (Table 11d) and approved nine of them for lakes where state funds had not previously been used for this purpose. The DNR denied two of these applications because they were submitted by potential cooperators on lakes for which state funds had previously been used to prepare plans.

As a result, the DNR expects to reimburse 19 cooperators on 27 lakes for costs of milfoil management during 2002. In addition, the Exotic Species Program initiated treatment of milfoil in the immediate vicinity of public water accesses operated by the DNR on seven lakes in the maintenance management class (Table 11d). The purpose of this type of control is to reduce the risk that users of the lake inadvertently transport milfoil from the lake to other bodies of water.

High-intensity management of Eurasian watermilfoil

During 2002, the Exotic Species Program conducted high-intensity management of milfoil (see description above) on the five lakes in this class (Table 11e). High-intensity management began with surveys of the lakes by staff of the Exotic Species Program and was followed by application of herbicides by commercial applicators under contract to the DNR on two lakes, Lake Minnewaska in Pope County and Lake Ossawinnamakee in Crow Wing County where it was necessary. Three lakes were not treated because no milfoil plants were found in them. These lakes were McKinney, Ice, and the Gilbert Pit.

McKinney and Ice, which are connected by a stream that runs from the former into the latter, are unique. The lakes are small, i.e., with areas less than 120 acres, and are located in Grand Rapids (Itasca County). Milfoil was discovered in them during 1999. Due to their location in northern Minnesota in an area with no other known occurrences of milfoil, these two lakes represented a potential source of the exotic that might be spread to many uninfested lakes. To reduce the risk of spread, the DNR subjected these lakes to whole-lake treatment in 1999 with fluridone herbicide, the active ingredient in Sonar™ (Welling et al. 1997; see also Exotic Species Program 2000). Inspection of the lakes by the DNR in 2002 found no milfoil, as was the case in the two preceding years. Based on past experience in Minnesota with fluridone treatments on other lakes, it is likely that milfoil will reappear in McKinney and Ice in the future. If that occurs, the value of a second treatment with fluridone will be evaluated

Technical assistance to cooperators and other citizens

Technical assistance was provided by the Exotic Species Program to cooperators and other citizens and managers through various means. Staff of the Exotic Species Program attended numerous meetings of lake associations and local units of government to make presentations and participate in discussions of approaches to management of milfoil. During the course of a season, staff of the Exotic Species Program have many conversations with people over the telephone. In addition, staff of the Exotic Species Program exchange correspondence by regular mail and e-mail with people who need assistance in dealing with milfoil.

Table 11e. Number of lakes, budgets, and expenditures in different classes of management of Eurasian watermilfoil in Minnesota during 2002.

Year	Number of lakes in class	Funds budgeted in spring		Number of lakes in class where control was done	Funds spent
Maintenance Management					
2001	74		149,000	31	71,000
2002	96	Total	95,000	27[1]	57,000
		Control	80,000	21	43,000
		Planning	15,000	9	14,000
Control by DNR at Public Water Access					
2001	--		--	1	600
2002	--		(no separate budget)	7	11,000
Fluridone Treatments					
2001	--		--	--	0
2002	3		40,000	3	70,000
High Intensity Management					
2001	16		--	8	34,000
2002	5		15,000	2	9,000
Totals					
2001	100		--		105,000
2002	107		150,000		147,000

[1]On three lakes, applications were approved for both control and planning.

Effectiveness of management of Eurasian watermilfoil in Minnesota lakes

Perhaps the most interesting outcome related to the DNR's program for management of milfoil in 2002 is the fact that the amount of state funds spent on Minnesota lakes in the maintenance management class was 20% less than the amount spent in 2001 (Table 11e). Further, the amount spent in 2002 was less than the amount available to potential

cooperators. The DNR received applications for state funding to control milfoil from potential cooperators on 32 lakes and funded work on 21 of them (Table 11d). If the remaining 11 proposals had all been funded, an additional $25,000 of state funding would have been spent on control of milfoil, which still would have left $12,000 budgeted, but not spent, for management. Possible explanations for this outcome include: 1. lack of nuisances caused by milfoil that met the criteria for funding by the DNR, 2. lack of awareness of the program among potential cooperators, and 3. the amount of funding available to small lakes may be too little to encourage potential cooperators to participate in the program.

On the 11 lakes where available state funds were not spent, proposals generally did not meet the DNR's criteria as described above, primarily due to a lack of dense milfoil causing unavoidable nuisances. In 2002, the growth of milfoil and also the problems caused by the plant in some, but not all, lakes seemed to be somewhat less than levels observed in some previous years. Reduced water clarity in 2002 might have resulted from high levels of precipitation; this past summer was very wet. The high levels of precipitation in turn would create high levels of overland run-off that would carry nutrients like phosphorous into the lakes. These nutrients can promote the growth of algae, both on plants and in the water column, which can suppress the growth of submerged aquatic plants like milfoil.

We do not know how many additional potential cooperators might have applied to the DNR for funding for maintenance management of milfoil if all of them had been directly contacted and informed about the program. Nevertheless, the DNR's experience is that people often contact the agency if submersed plants become abundant in a lake. This is especially so in cases where lakeshore residents notice matted vegetation in areas where mats had not been seen before. One step the Exotic Species Program plans to take this winter is to try to contact individuals on lakes for which we received no applications in 2002 and ask them why they did not apply for funding. In 2003, the DNR will increase its efforts to notify potential cooperators of the availability of funding from the DNR for control of milfoil. The DNR also plans to pursue an offer from the Minnesota Lakes Association to help inform lake associations of this program in 2003.

It also is possible that the $700 available to smaller lakes, i.e., those with less than 100 littoral acres, is too little money to motivate potential cooperators to apply to the DNR for assistance. In 2003, the DNR plans to increase the minimum amount available to potential cooperators.

Participation in control efforts by other state agencies, local units of government, and interested groups

Cooperation between the Exotic Species Program and organizations outside the DNR such as lake associations, and various local units of government was critical to the success achieved in management of milfoil and the problems it causes in Minnesota. The Exotic Species Program has also received valuable assistance in management of milfoil from staff from DNR's Division of Fisheries and the DNR's Aquatic Plant Management Program in the divisions of Fisheries and Ecological Services.

Research on Eurasian Watermilfoil and Potential Approaches to Management in Minnesota

The Exotic Species Program has supported or conducted a number of research projects to improve management of milfoil. In this section, we briefly summarize the most important or interesting results of recent efforts by researchers.

Potential for biological control of Eurasian watermilfoil

Targeted biological control of single plant species uses organisms, usually insects or disease-causing fungi, to control the undesirable plant. Efforts to evaluate the potential for biological control of milfoil have been supported since 1992 with funding appropriated by the Minnesota Legislature as recommended by the Legislative Commission on Minnesota Resources (LCMR). These investments were made because development of an effective biological control agent could reduce the amount of time and money spent on control of the exotic by the use of herbicides and mechanical harvesting. An ideally effective agent would reproduce on its own and control milfoil before the plant could mat at the water's surface and cause problems. The ideal agent would not harm any plants other than milfoil, or otherwise threaten Minnesota's lakes and rivers.

In 2002, evaluation of potential biological control agents for milfoil by researchers at the University of Minnesota continued to focus on a weevil (*Euhrychiopsis lecontei*), which is a native insect. Current research has three primary objectives. The first is to attempt to detect additional lake-wide milfoil declines and assess populations of the milfoil weevil in a number of Minnesota lakes. Efforts in this area have documented declines in two of five lakes that have been intensively monitored for five to nine years. Preliminary analysis of samples from six new lakes with a range in densities of sunfish showed that densities of sunfish were inversely related to densities of weevils. This tentative finding adds weight to the possibility that predation on weevils by sunfish may limit the ability of the insects to control milfoil.

The second primary objective of this research is to identify and manipulate factors that limit populations of the milfoil weevil. One of the principal activities under this objective in 2002 was open augmentation of populations of weevils. Weevils were stocked in two lakes, one with high numbers of sunfish and another with low numbers of sunfish. Surprisingly, as many or more weevils were found in un-stocked than in stocked areas. Also, densities of weevils were higher in the high sunfish than in the low-sunfish lake. Declines of milfoil were not observed in either lake. Preliminary analyses suggest that milfoil increased more in un-stocked than in stocked plots.

The third primary objective of this research is to identify features of the response of the plant community to milfoil control agents and manipulate factors that may limit the effectiveness of these agents. Preliminary analyses of experiments involving manipulations of plant communities showed few clear and significant effects. Variability among plots appears to be the primary reason for this outcome. More results will be available after current analyses are completed.

Information about the University of Minnesota's research on the potential for biological control of milfoil can be found on its website at

www.fw.umn.edu/research/milfoil/milfoilbc.html. In addition, a thorough review of the current understanding of the potential to use the weevil for control of milfoil was presented by Getsinger et al. (2002).

Experience has shown that development of biological controls may require research conducted over a period of ten years or more. Consequently, the Exotic Species Program's evaluation of the potential for biological control of milfoil is considered to be a long-term effort, the outcome of which cannot be guaranteed.

The research described above was supported by funding provided through the DNR with an appropriation of $45,000 for the FY 2002-2004 period made in 2001 by the Minnesota Legislature as recommended by the LCMR. This appropriation was matched by a commitment of $50,000 from Exotic Species Program funds, which comes from a surcharge on watercraft licenses (see Overview of DNR's Exotic Species Program, Funding). This follows previous appropriations recommended by the LCMR in 1992, 1993, 1995, 1997, and 1999.

Hybrids between the exotic Eurasian and native northern watermilfoil

Since the discovery of Eurasian watermilfoil in Minnesota during 1987 when the exotic was first noticed in Lake Minnetonka, there have been many cases where it has been difficult to distinguish the exotic milfoil from various native milfoil species. Indeed, Eurasian watermilfoil most likely became established in Lake Minnetonka some years before 1987, but was overlooked because the plant is very similar in appearance to the native northern watermilfoil (*Myriophyllum sibiricum*). In the past, researchers on the east coast suspected that plants with characteristics that were intermediate between the exotic Eurasian and native northern watermilfoil were hybrids. In addition, hybrids between the two species were produced under laboratory conditions.

In Minnesota, some people have suspected that the milfoil in certain lakes was a hybrid, but there was no evidence to prove or disprove those suspicions. Staff of the Exotic Species Program have encountered milfoil plants with characteristics that were intermediate between the exotic Eurasian and native northern watermilfoil, which caused difficulty in deciding whether to treat certain areas with herbicide to control it. Now, researchers from the University of Connecticut have used molecular sequence data to demonstrate the existence of naturally-occurring hybrids between Eurasian and northern watermilfoil (Moody and Les 2002). One of the hybrid populations was sampled in White Bear Lake, Ramsey County, where previous work with randomly amplified polymorphic DNA markers showed high levels of genotypic variation (Furnier et al. 1995). In 2002, the DNR committed $4,500 to support further research into the occurrence in Minnesota of hybrids between Eurasian and northern watermilfoil.

Hybridization has been linked to aggressiveness and invasiveness in wetland plants (Galatowitsch et al. 1999). In some cases, hybrids may be more resistant than parental species to herbivory (Whitham et al. 1999; Floate and Whitham 1994; Fritz et al. 1994 cited in Moody and Les 2002). This could affect the usefulness of biocontrol agents. For example, the milfoil weevil (*Euhyrchiopsis lecontei*) has been effective in reducing populations of Eurasian watermilfoil (Creed and Sheldon 1995), but has little effect on northern watermilfoil (Newman et al. 1997). Jester (2000) recognized several

populations of Eurasian watermilfoil where the weevil was present, but appeared to have little effect on the exotic. One of the populations described, Lake Beulah, Wisconsin, has been identified as containing hybrids (Moody and Les 2002).

The potential to use fluridone herbicide to selectively control Eurasian watermilfoil

The potential use of fluridone herbicide, which is formulated as Sonar™ and manufactured by the SePRO Corporation, to control milfoil has been the subject of much discussion in Minnesota because the product is usually applied to whole bays or lakes (see Welling et al. 1997, Exotic Species Program 2001). Operational treatment of whole bays or lakes with herbicide is not allowed in Minnesota because this destroys more vegetation than is necessary to give users access to the lake.

In 2000, new information was made available from studies in Michigan which suggested that application of fluridone at low rates of 5 to 6 ppb may provide more selective control than had previously been observed in Minnesota (Getsinger et al. 2001; Madsen et al. 2002). To address questions about possible harm to native plants, the DNR is conducting an evaluation of the potential to use fluridone herbicide to selectively control Eurasian watermilfoil in Minnesota. As part of this evaluation, three Minnesota lakes were subjected to whole-lake treatments with fluridone in 2002.

Plans for the treatments made in 2002 were refined with the assistance of staff from the SePRO Corporation, who met with staff of the Exotic Species Program in April. For the 2002 treatments, the target concentrations were 4.6 to 5 ppb fluridone. In two of the three lakes, the initial treatments produced concentrations of fluridone that were within 0.1 ppb of the target of 4.6 ppb. In the third lake, the initial treatment produced a concentration of 9.6 ppb fluridone, which was higher than the target of 5.0 ppb. At the time of the next sampling, the concentration of fluridone had decreased to 5.5 ppb. All three lakes were subjected to a second or “bump” treatment about two weeks after the initial treatment. The second treatments achieved the goal of maintaining a fluridone concentration greater than 2.0 ppb for at least 60 days.

The effect of fluridone on the plant community was determined by examining the distribution of individual species in the lakes. The distribution of individual species was estimated by determining their frequency, which is the percentage of sampling sites at which the plant was present. The presence of plants at sampling sites was determined by use of an aquatic plant grapple and visual observations. Initial results indicated that the treatments reduced the frequency of milfoil to zero in all three treated lakes in August 2002.

In some cases, native plants could be identified to the level of genus, but not species. Consequently, they are reported as “taxa,” which includes both genus and species. In one of the three lakes, the total number of submersed, floating leaf, and free-floating aquatic plant taxa decreased by 55% and the average number of native taxa per sampling site following treatment decreased by 87%. These changes may be related to the apparent absence of a spring period of high water clarity in this lake during 2002, as opposed to the effects of fluridone. In the other two treated lakes, the average number of native aquatic plant taxa per sampling site did not appear to decrease by a large

amount following treatment. In the untreated reference lakes, there were no large changes in the frequency of milfoil, the total number of submersed, floating leaf, and free-floating aquatic plant taxa, or the average number of native aquatic plant taxa per sampling site. Additional results of this evaluation will become available in the future as the Exotic Species Program completes its analysis of the data collected to date.

In January 2002, the Minnesota Lakes Association recommended that the DNR allow operational use of fluridone in 2003. At this time, the DNR is not considering allowing operational whole-lake treatments with fluridone in 2003. It is possible that the results of the 2002 treatments in Minnesota, along with new information from other states, will show that additional whole-lake treatments in Minnesota would be useful to determine whether fluridone is sufficiently selective to be allowed for use in the state.

Until we have complete results from the treatments made during the summer of 2002 to review, the DNR cannot determine whether to allow additional use of fluridone herbicide for whole-lake treatments in Minnesota. Results of the 2002 treatments are likely to be complicated, so interpretation, as well as further study, probably will be required. If the DNR determines that additional treatments after 2002 would be useful, then the agency would consider proposals for treatment in 2004. Treatments could not occur until 2004 because the DNR would require pre-treatment data on the plant communities of candidate lake(s), which would require sampling in 2003. We expect that criteria for potential whole-lake treatments will evolve over time as we learn more about fluridone herbicide.

Additional formulation of 2,4-D available for control of Eurasian watermilfoil
In 2001, an additional formulation of 2,4-D herbicide became available for control of milfoil in Minnesota. DMA 4 IVM is a liquid formulation manufactured by DowAgrosciences LLC. This form of 2,4-D has been manufactured for many years, but previously was not available for control of milfoil in Minnesota due to a provision on the label that restricted its use to waters of the Tennessee Valley Authority.

In September 2002, Waterborne Environmental, Inc. conducted a study in Minnesota to determine the mobility of the herbicide in water and its rate of dissipation when DMA 4 IVM was applied under field conditions. The treatment was done in Green Lake, Chisago County. The study is sponsored by the Industry Task Force II on 2,4-D Research Data.

Triclopyr herbicide now available for control of Eurasian watermilfoil
SePRO Corporation announced that triclopyr herbicide was registered by the U.S. Environmental Protection Agency for use in lakes and other aquatic systems. It will be sold by SePRO as Renovate Aquatic Herbicide, which is licensed from Dow AgroSciences. This herbicide is a liquid formulation that was used in various experimental treatments made in Lake Minnetonka and several other Minnesota lakes during the 1990s.

Future plans and needs for management of Eurasian watermilfoil

Priorities for management of milfoil include:

- Keep the public informed about milfoil and the problems milfoil can cause;
- Reduce the plant's spread by targeting watercraft inspection and enforcement efforts in areas of the state where milfoil is present;
- Monitor the distribution of milfoil in the state with emphasis on verification of reports of new occurrences of milfoil;
- Attempt to control milfoil in Minnesota lakes, especially new populations in areas of the state without other occurrences of milfoil; and
- Revise the Maintenance Management Program by increasing the minimum amount of funds available to an individual lake. Also, work with the Minnesota Lakes Association to inform more lake associations and individuals about the availability of funding for management of milfoil. Continue review of the milfoil program.
- Review information from Minnesota to evaluate the effects of milfoil on native plants and lake ecosystems.
- Continue the evaluation of fluridone.

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Management of Flowering Rush

Introduction

Issue

Flowering rush (*Butomus umbellatus* L.) is a perennial aquatic plant, native to Europe and Asia. It grows along lake and river shores as an emergent plant with three-angled fleshy leaves and may produce an umbel-shaped cluster of pink flowers (Figure 12a). Flowering rush may also grow as a non-flowering submersed plant with limp, ribbon-like leaves.

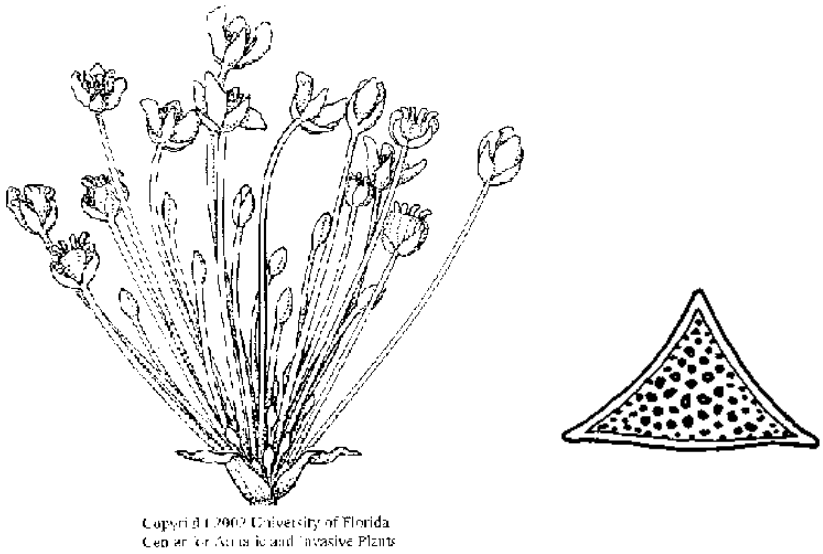

Figure 12a. Flowering rush umbel and cross-section of a leaf.

The plant spreads primarily vegetatively from thick rhizomes (Figure 12b), from small tubers that break off the rhizome, and from small bulblets that form in the inflorescence. Water currents, ice movement (Haber 1997), and muskrats (Gaiser 1949) can easily move these reproductive structures to new locations within a water body.

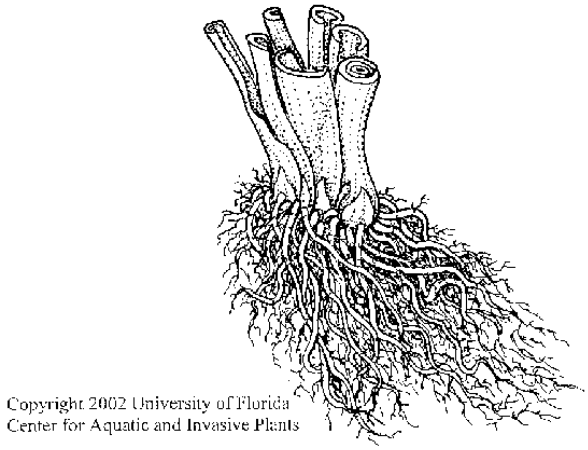

Figure 12b. Flowering rush rhizomes.

Flowering rush was likely brought to North America in the late 1800s in ship ballast and has also been repeatedly introduced as an ornamental plant. As early as 1973, resource managers and researchers have expressed concern that flowering rush may grow more aggressively in North America than in its native Europe and may become an aggressive competitor with native wetland vegetation (Anderson et al. 1974, Staniforth and Frego 1980). Given the invasive qualities of flowering rush, in 1993, it was listed as an undesirable exotic aquatic plant and three years later classified as a prohibited exotic species in Minnesota. A prohibited exotic species is illegal to possess, sell, transport, or release into the wild.

Goals

The DNR has two goals that apply to flowering rush management: 1) To prevent the spread of flowering rush within Minnesota; and 2) To reduce the impacts caused by harmful exotic species to Minnesota's ecology, society, and economy. To attain these goals, the following strategies are used:

- Restrict the sale of flowering rush in Minnesota.
- Monitor current distribution and assess changes.
- Support research to develop and implement better management methods.
- Provide information to concerned citizens on how to best manage flowering rush.

Distribution

Flowering rush was first recorded in Anoka County, Minnesota in 1968 (Moyle 1968) and has since been located in six other counties. Despite its 30-year presence in the state, the distribution of flowering rush remains disjunct (Figure 12c). New introductions are likely the result of intentional planting from horticultural sales. More information about the distribution of flowering rush in the state can be found in the 2000 Exotic Species Annual Report (Exotic Species Program 2001). There were no new discoveries of flowering rush locations in 2002.

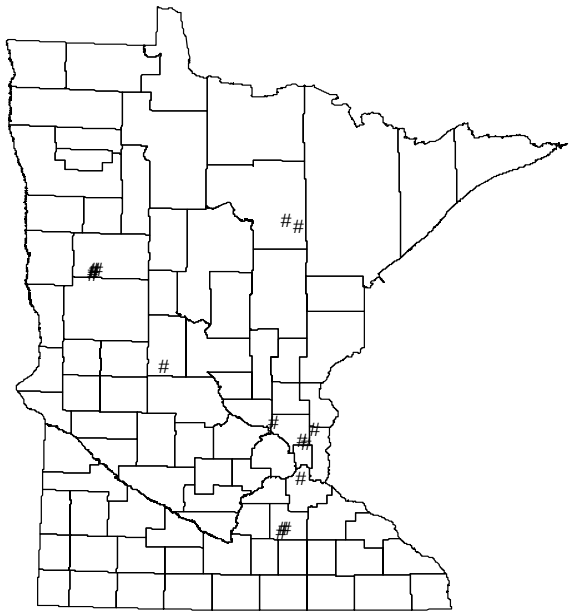

Figure 12c. Minnesota flowering rush locations as of December 2002.

Progress in Management of Flowering Rush – 2002

Prohibit the sale of flowering rush

Flowering rush is a prohibited exotic plant in Minnesota, which means that it is unlawful to possess, purchase, or sell this exotic in Minnesota. Nevertheless, horticultural sales are the most likely means of introducing this plant into a new area. The sale of flowering rush in many large discount stores was stopped following contact from the Exotic Species Program in 1999 (Exotic Species Program 2001). Nevertheless, flowering rush continues to be sold as an ornamental plant and is advertised through the Internet as a desirable, hardy plant for water gardens. In the future, Exotic Species Program staff will be actively seeking out aquatic plant sellers as well as purchasers in order to relay our concerns and educate them on the potential negative impacts of such activities.

Monitor current distribution and assess changes

Exotic Species Program staff surveyed Detroit Lake in the spring and late summer for flowering rush distribution. The goals of these surveys are to document spread of flowering rush and to monitor the effects of management. Flowering rush was found at 6% of the sites during the spring survey and 7% in late summer. In response to missing peak biomass, these surveys, in 2003, will occur mid-summer. The Pelican River Watershed District (PRWD) met with Exotic Species Program staff to discuss concerns regarding the expansion of flowering rush into other lakes in the area. Currently, the PRWD mechanically harvests flowering rush and other aquatic plants to reduce the nuisances for lake residents and users. The PRWD is interested in other management tools to complement harvesting activities.

Support research to develop and implement better management methods

The Forest Lake (Anoka County) infestation is the only known location in Minnesota to produce fertile seeds, according to recent studies done by Eckert et al. (1999). These seeds may pose an increased risk of spread to neighboring waters. In an effort to reduce this risk, the Exotic Species Program staff removed the umbels (flowers) in late summer. Of particular note, the flowering rush within Forest Lake has increased its range significantly. Observations from Exotic Species Program staff estimate that the rush has expanded approximately one-half mile down the shoreline from the original location.

Provide information to concerned citizens on how to best manage flowering rush

Hand-cutting appears to be the most successful method to seasonally reduce dense stands of emergent flowering rush. The Exotic Species Program again coordinated and assisted with a flowering rush hand-cutting project at a public swimming beach in Twin Lakes (Itasca County) for a fifth year. Flowering rush impedes fishing and swimming activities at this beach and fishing pier. This beach was cut in spring of 1998 and 1999, and in the spring and fall of 2000. In 2002, the beach was cut only once and, based on observations by the caretaker of the beach, cutting was not necessary this fall. Cutting will continue next spring and will be coordinated by Exotic Species Program staff.

Effectiveness of Management

Flowering rush often grows in stands with native vegetation, making it difficult to control this exotic without harming the native plants. Mechanical control by cutting appears the most effective method of reducing dense stands of flowering rush. Cutting is most effective if done early and repeated several times during the growing season (Hroudova 1989). Disadvantages of cutting include that it is not selective, is labor intensive, and does not eliminate the exotic. Digging flowering rush may increase its spread if the entire rhizome is not removed. Herbicide applications, particularly in water, have been ineffective because herbicide is quickly washed away from the plant. When new herbicides come on the market that are selective for flowering rush, can remain on the targeted plant for adequate contact time, and are registered for aquatic use, they will be reviewed as potential management tools.

Participation by Other Groups

Others involved in flowering rush management in Minnesota in 2002 include: DNR Fisheries and Wildlife, Pelican River Watershed District (PRWD), Greenway Township in Itasca County, and Queen's University, Ontario.

Future needs for management of flowering rush

- Continue efforts to prevent introductions of flowering rush in Minnesota. Inform the public, nursery industry, and other businesses selling flowering rush of the problems associated with this plant and the existing laws against its possession and sale in Minnesota.
- Encourage research on the distribution, reproductive biology, and potential impacts of flowering rush in Minnesota.
- Continue to investigate new methods of controlling flowering rush and to evaluate the results of ongoing flowering rush management within the state.

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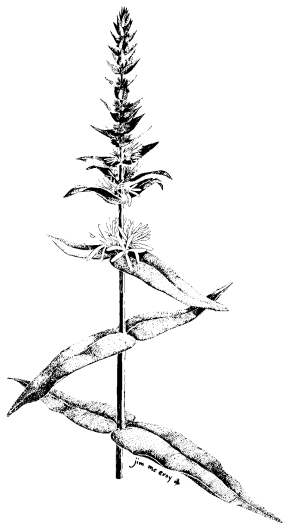
Management of Purple Loosestrife

Introduction

Issue



Purple loosestrife (*Lythrum salicaria*, *L. virgatum* and their hybrids) is a wetland plant from Europe and Asia that invades marshes and lakeshores, replacing cattails and other wetland plants. The Department of Natural Resources (DNR) and other agencies manage purple loosestrife because it harms ecosystems and reduces biodiversity by displacing native plants and habitat for wildlife. The Purple Loosestrife Program was established in the DNR in 1987. State statutes direct the DNR to coordinate a control program to curb the growth of purple loosestrife (see M.S. 84D.02, Subd. 2) and a significant amount of progress has been made toward the development of a sound approach to manage this harmful exotic. Management efforts utilize chemical and biological control techniques in an integrated approach. The Purple Loosestrife Program works closely with federal and state agencies, local units of government, and other stakeholder groups involved in purple loosestrife management.

Goals

The primary goal of the program is to reduce the harmful impact purple loosestrife is having on our wetland and lakeshore habitats. Management efforts to attain this goal include:

- Monitor distribution of purple loosestrife in Minnesota;
- Manage purple loosestrife with biological and chemical control methods;
- Monitor and evaluate management success;
- Support research to improve our understanding of the ecology and management of purple loosestrife.

Distribution

In 1987, the DNR began to inventory sites in Minnesota where purple loosestrife was established. DNR area wildlife managers, county agricultural inspectors, local weed inspectors, personnel of the Minnesota Department of Transportation (MnDOT), and the general public report purple loosestrife sites to the DNR. The DNR maintains a computerized list or database of sites that includes the location, type of site, and number of loosestrife plants present (see Figure 13a). In 2002, 21 new purple loosestrife infestations were identified in Minnesota. There are now 2,165 purple loosestrife infestations recorded statewide (Table 13a). Of those sites, the majority (70%) are lakes, rivers, or wetlands. Inventory totals indicate that Minnesota presently has over 63,000 acres infested with purple loosestrife.

Progress in Management of Purple Loosestrife - 2002

Chemical control of purple loosestrife

Initial attempts by the DNR to control purple loosestrife relied on the use of herbicides. The most effective herbicide was found to be Rodeo™, a formulation of glyphosate, which is a broad spectrum herbicide that is also toxic to desirable, native plants. To allow maximum survival of native plants, Rodeo™ is applied by backpack sprayer as a "spot-treatment" to individual loosestrife plants. A second herbicide, 2,4-D, or 2,4-dichlorophenoxyacetic acid, is less frequently used. 2,4-D is more selective than Rodeo™ because it affects primarily broad-leaved or dicotyledonous plants but it is less effective than Rodeo™.

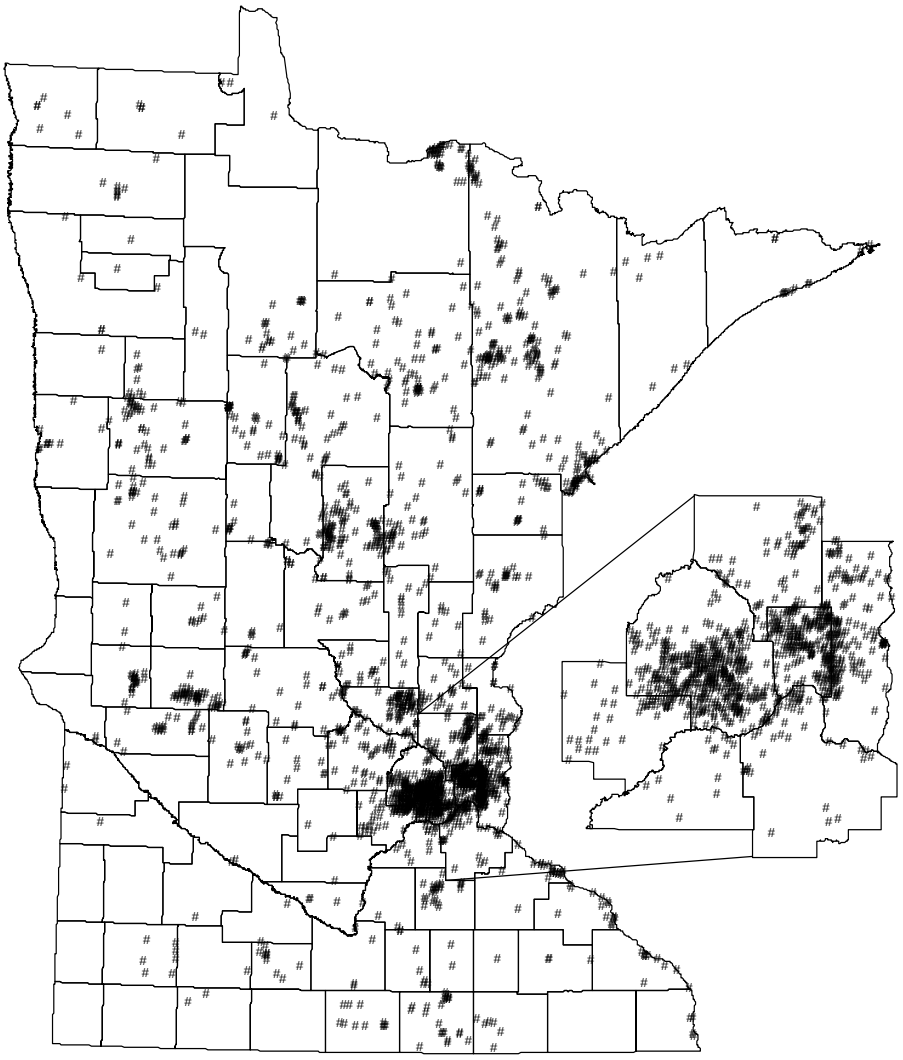


Figure 13a. Purple loosestrife infestations in Minnesota as of December 2002.

Table 13a. Purple loosestrife infestations in Minnesota recorded by the Minnesota Department of Natural Resources in 2001 and 2002.

Site Type	Total sites 2001	New sites 2002	Total sites 2002
Lake	641	11	652
River	199	0	199
Wetland	680	5	685
Roadsides and ditches	465	3	468
Other[1]	159	2	161
Total	**2,144**	**21**	**2,165**

[1]Includes gardens and other miscellaneous sites.

Beginning in 1991, a prioritization plan was developed for selecting control sites in public waters and wetlands where herbicide would be used for purple loosestrife control. This was done because there are insufficient resources to apply herbicides to all known purple loosestrife sites in Minnesota. In addition, DNR personnel observed that herbicide treatments do not result in long lasting reductions of loosestrife when applied to large populations that have been established for a number of years. This is due partly to the plant's ability to reestablish from an extensive purple loosestrife seed bank. Research done by the University of Minnesota, under contract to the DNR, demonstrated that long-established stands of loosestrife develop very large and persistent seed banks. Herbicide treatments which kill the existing loosestrife populations only create space for additional seeds to sprout. Consequently, small and recently established populations of loosestrife, which are likely to have small seed banks, are given the highest priority for treatment. In addition, because seeds of this species are dispersed by water movements, the DNR tries to keep loosestrife from infesting downstream lakes. Sites located in the upper reaches of watersheds with little loosestrife are treated before those located in watersheds with large amounts of loosestrife. Implementation of the prioritization scheme in 1991 resulted in fewer large sites (> 1,000 plants) being treated. Only one site had greater than 1,000 plants and was treated in 2002.

Between 1990 and 2002, herbicides were applied to an average of 130 sites per year. This summary includes applications made by DNR personnel, commercial applicators working under contract to DNR, and various cooperators; it is not a complete listing of all herbicide applications made in Minnesota. During the summer of 2002, the DNR or licensed contractors visited 55 purple loosestrife stands for herbicide control work (Figure 13b). At 19 sites, workers found no loosestrife plants to treat, which is usually due to misidentification of purple loosestrife by persons reporting the infestations. A

total of 36 sites were treated with herbicides. Most of the sites were very small; 87% had less than 100 plants. In total, all sites visited used 0.7 gallons of Rodeo™, 2.3 gallons of 2,4-D, took 305 worker hours, and cost $18,800.

Effectiveness of chemical control

Effectiveness of control efforts are based on short-term and long-term objectives. Control or eradication of small infestations statewide with herbicides is the primary short-term objective. Each year, a small number of purple loosestrife infestations (two in 2002) are eradicated with herbicides. This is critical because these infestations are in watersheds that have very few infestations of loosestrife. This effort helps prevent the spread of purple loosestrife into uninfested wetlands and lakeshores.

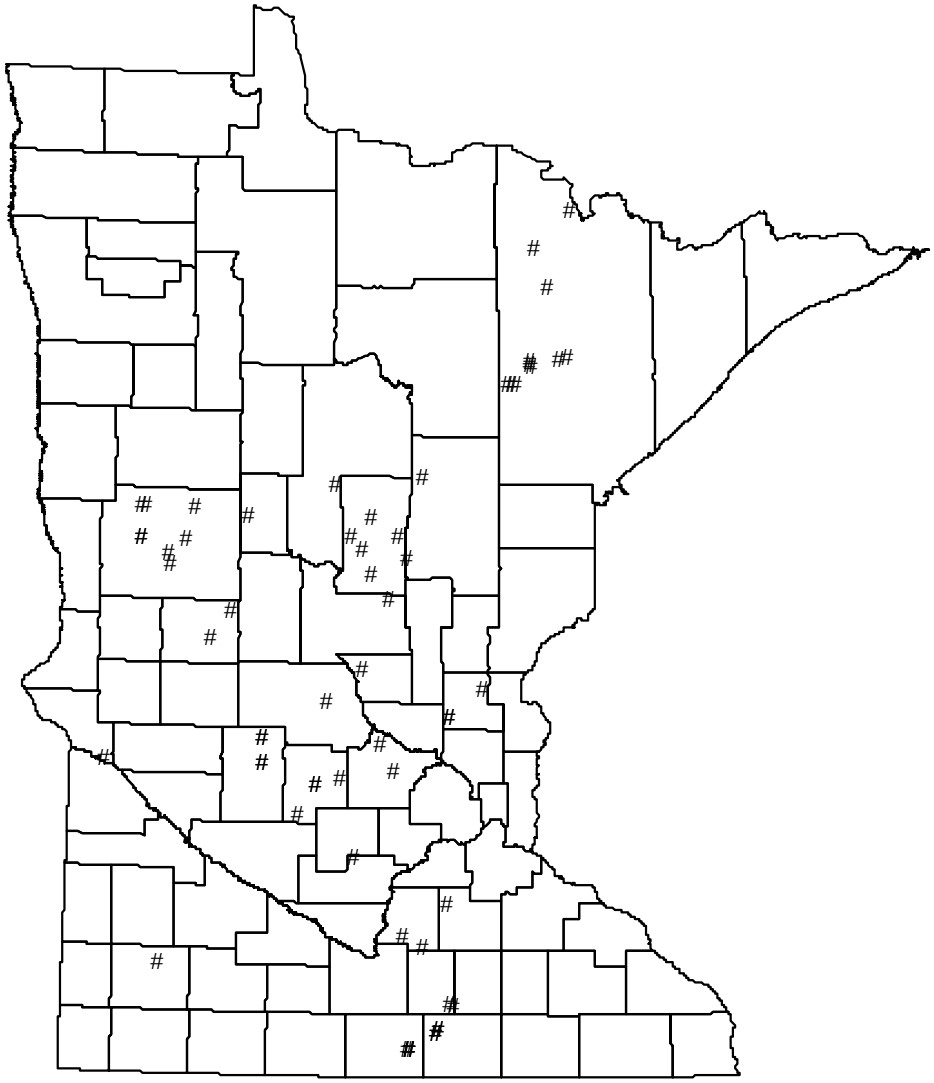


Figure 13b. Locations where the Purple Loosestrife Program funded chemical control in 2002.

Biological control of purple loosestrife

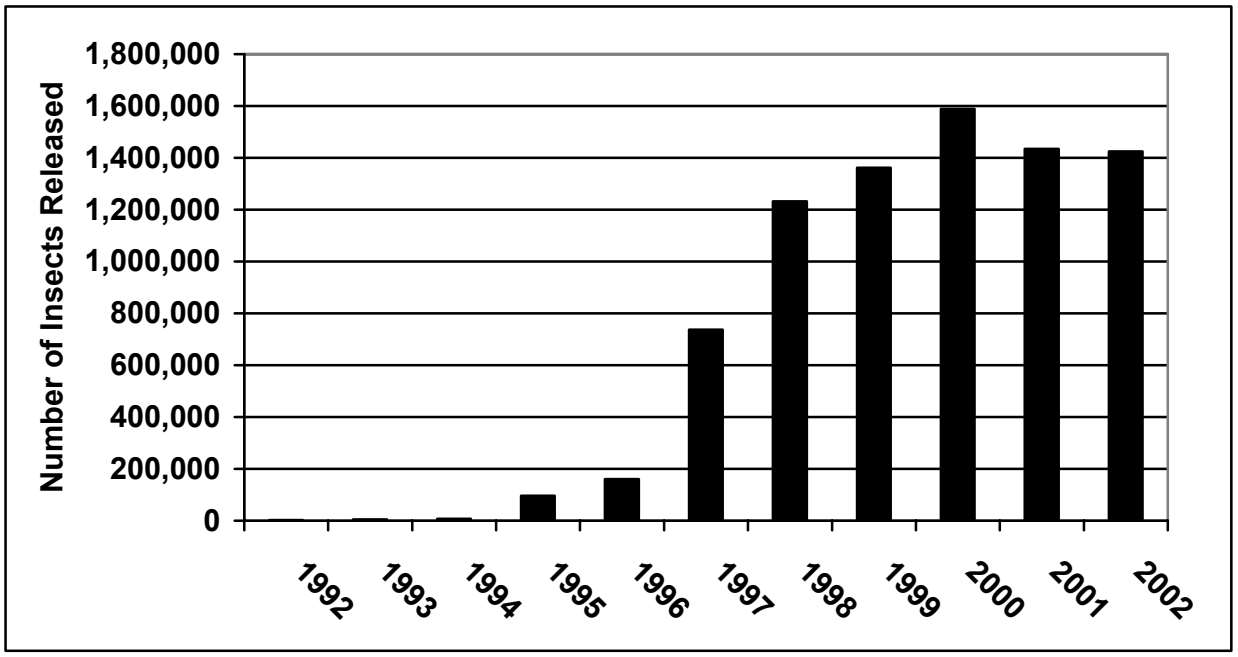
Insects for biological control of purple loosestrife were first released at one site by DNR staff in 1992. This initial release occurred after years of testing to make sure the insects were specific to purple loosestrife, would not damage native plants or agricultural crops, and approved for release by the United States Department of Agriculture (USDA). To date, four species of insects, two leaf-eating beetles, *Galerucella calmariensis* and *G. pusilla*; a root-boring weevil, *Hylobius transversovittatus*; and a flower-feeding weevil, *Nanophyes marmoratus*, have been released as potential biological controls for loosestrife in Minnesota.

Leaf-Eating Beetles: In 1997, the DNR initiated an insect rearing program providing county agricultural inspectors, Minnesota Department of Agriculture field staff, and DNR area wildlife managers with a "starter kit" for rearing their own leaf-eating beetles. From 1997-2002, rearing efforts were increased by recruiting additional partners, such as nature centers, lake associations, schools, 4-H, and garden clubs (Table 13b). This cooperative effort has had a significant effect on the total number of insects released (Figure 13c).

Table 13b. List of cooperators in Minnesota during 2002 that were participating in purple loosestrife control efforts and the type of participation.

Government/Organization	Type of Cooperation
Counties: Anoka, Becker, Beltrami, Carlton, Carver, Cass, Chisago, Crow Wing, Dakota, Douglas, Freeborn, Goodhue, Hennepin, Hubbard, Isanti, Itasca, Kanabec, Kandiyohi, McLeod, Mille Lacs, Morrison, Mower, Otter Tail, Pope, Ramsey, Rice, Scott, Sherburne, St. Louis, Stearns, Stevens, Swift, Todd, Wadena, Washington, Watonwan, Wright	Counties where insects were reared and released by county agricultural inspectors, Minnesota Department of Agriculture field staff, MnDOT field staff, DNR area wildlife managers, 4-H clubs, lake associations, and schools.
MN Department of Agriculture	Partner with DNR in statewide biological control efforts including releasing and monitoring insects.
University of Minnesota	Partner with DNR in statewide biological control efforts, including rearing, releasing, and monitoring of insects.
Leech Lake Indian Reservation, Dept. of Resource Management	Partner with DNR in biological control efforts, including rearing, releasing, and monitoring of insects on or near the Reservation.
USFWS, MN Valley National Wildlife Refuge (NWR); Sherburne NWR; Upper Mississippi NWR	Partner with DNR in biological control efforts, including rearing, releasing, and monitoring of insects.
Cornell University, Ithaca NY	Working under contract to the DNR to develop an artificial diet for rearing the root-boring weevil. Rear and distribute weevils nationwide.

Table 13c. Number of insects released to control purple loosestrife by year.



A starter kit is composed of pots, potting soil, insect cages, leaf-eating beetles, and other materials necessary to rear 20,000 leaf-eating beetles (*Galerucella* spp.). The insects were then released on high priority areas. All insect rearing was completed outdoors for ease of production and to produce hardier insects. In total, 64 cooperators in 33 counties reared an estimated 1.4 million leaf-eating beetles and released them on more than 125 sites. As of December 2002, insects have been released at more than 822 sites statewide (see Figure 13c, Table 13c).

Biological control insects released between 1992 and 2001 have established reproducing populations at more than 90% of the sites. Insect populations increased significantly at many locations with pronounced damage to loosestrife plants. In the summer of 2002, 234 insect release sites were visited to assess the insect establishment and level of control achieved. At 45% (105 sites graded A or B) of the sites surveyed, the insect populations are rapidly increasing and causing significant damage to the loosestrife infestations. At 21% of all visited sites, the loosestrife was severely defoliated (Grade A) (Figure 13e).

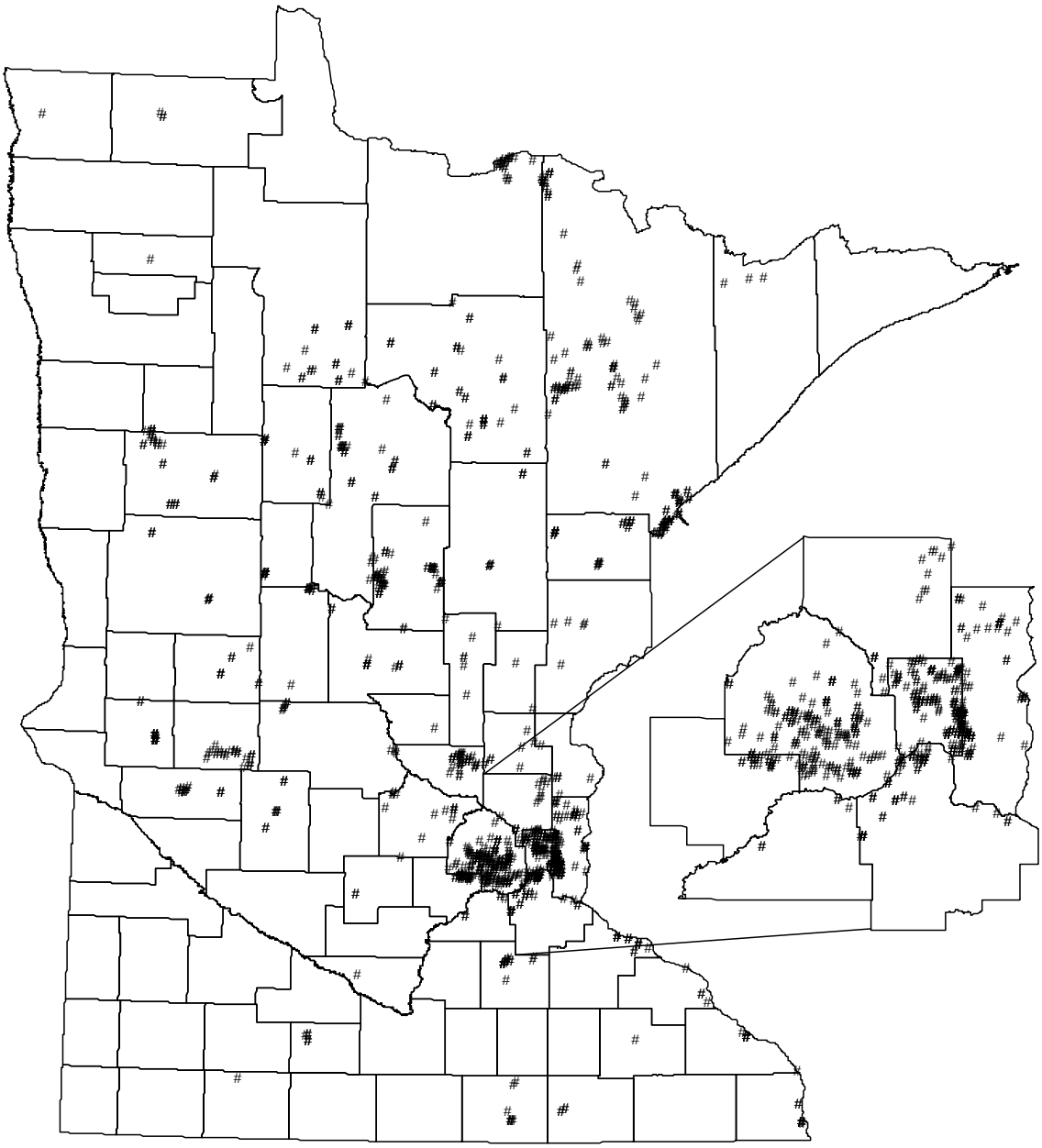


Figure 13c. Locations of insects released to control purple loosestrife in Minnesota.

Table 13d. Summary of number of insects released in each region to control purple loosestrife.

Minnesota DNR Regions	Number of Release Sites	Number of Insects Released
I – Northwest	119	1,200,000
II – Northeast	184	1,400,000
III – Central	461	4,700,000
IV – South	58	700,000
Totals	**822**	**8,000,000**

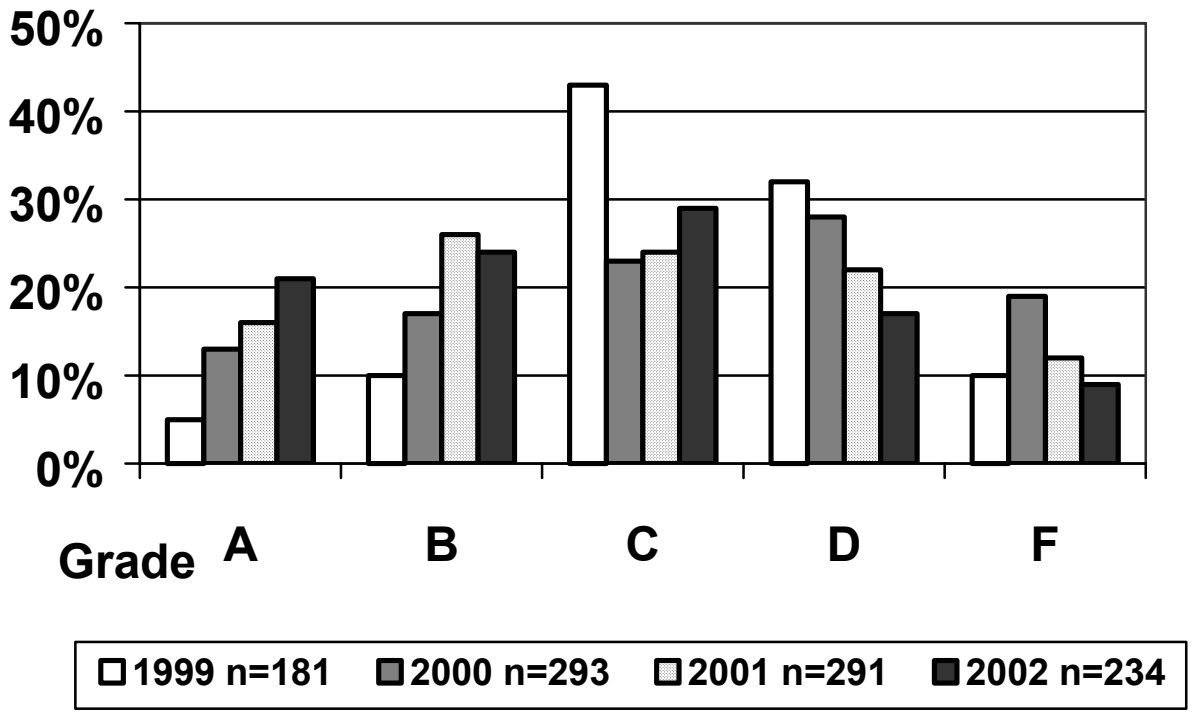


Figure 13d. Sites graded for insect establishment and control.
A = severe defoliation, B = moderate to severe defoliation, C = damage near release point with insects visible, D = no damage, few insects visible, F = no insects or damage present.

With the success of insect establishment in the field, organized rearing efforts are anticipated to come to an end in the next several years. Resource managers will be

able to collect insects from established release sites and redistribute to new infestations. The collect and move method will reduce the effort and costs needed to further distribute leaf-eating beetles in Minnesota. In 2000-2002, insects were collected and redistributed to 79 locations statewide.

Root-Boring Weevils: Initially, only a small number of root-boring weevils were brought to Minnesota. As of December 2002, there are 12,000 weevils comprising 30 releases, at 23 different sites. In 2002, no weevils were made available for release, but in the future, Minnesota will be receiving additional weevils for introduction. Several sites were visited to assess the insects' establishment. At two locations weevil larvae were observed feeding in the roots. Evaluation of weevil establishment and control success will be increased in 2003 and beyond.

Effectiveness of biological control

A long-term objective is to utilize biological controls to reduce the abundance or importance of loosestrife in wetland habitats throughout Minnesota. Biological control, if effective, will reduce the impact of loosestrife on wetland flora and fauna. The DNR's goal is to reduce the abundance of loosestrife in wetlands where it is the dominant plant by at least 70% within 15-20 years. Purple loosestrife will not be eradicated from most wetlands where it presently occurs, but its abundance can be significantly reduced so that it is only a small component of the plant community, not a dominant one. Assessment in 2002 demonstrated that *Galerucella* introductions have caused severe defoliation of loosestrife populations on >20% of sites visited (Figure 13d). The DNR will continue to track these wetlands to assess how loosestrife abundance changes over time and to determine what combinations of biological control agents provided the desired level of control.

Research on Insects as Biological Control Agents

During 2001, funding from the Minnesota Legislature, as recommended by the Legislative Commission on Minnesota's Resources (LCMR), was used to monitor impacts to loosestrife populations by the insects used as purple loosestrife biological control agents. In particular, the leaf-eating beetles*, Galerucella* spp., were monitored at several locations to assess their impacts on loosestrife seed production, seed germination, and carbohydrate stores in roots. The study has shown that *Galerucella* feeding on shoot tips resulted in dramatically fewer seed capsules and shorter inflorescences compared with control plants. The study also showed that *Galerucella* feeding, with complete defoliation, does not immediately kill a plant. More than two years of successive *Galerucella* feeding is required to kill purple loosestrife plants, even when high amounts of defoliation occur. Nevertheless, *Galerucella* feeding on shoot tips does result in shorter loosestrife plants and reduces seed production. This will reduce the competitiveness of purple loosestrife in wetlands and should help to increase abundance of native plant species. This research is complete with a final report provided June 30, 2002.

In 2001, a study began monitoring the landscape movements of *Galerucella* spp. The main objectives are to track the beetles within a wetland as well as wetland to wetland movement. The study will ultimately provide information on the beetle's ability to disperse and establish in new locations and how long this may take to occur. Early

indications are that the loosestrife-eating beetles can move up to ten miles from where they were originally released. This usually happens once the insect population has increased dramatically.

Management of Purple Loosestrife in Other States

To date, more than 30 states and four federal agencies (states include: Alabama, California, Connecticut, Delaware, Iowa, Idaho, Illinois, Indiana, Maryland, Maine, Michigan, Minnesota, Montana, Nebraska, New Hampshire, New Jersey, New York, Ohio, Oregon, Pennsylvania, Rhode Island, South Dakota, Tennessee, Utah, Vermont, Washington, and Wisconsin) have implemented biological control against purple loosestrife. In 2002, the United States Department of Agriculture's Animal Plant Health Inspection Service (USDA) reared and distributed 348,000 *Galerucella* spp. beetles to 16 states (Connecticut, Delaware, Iowa, Indiana, Kansas, Kentucky, Massachussets, Maryland, Maine, Michigan, Montana, North Dakota, Nebraska, Pennsylvania, South Dakota, and West Virginia). The USDA lab has begun to rear the root-mining weevil with the hopes of distributing this species to states in the future.

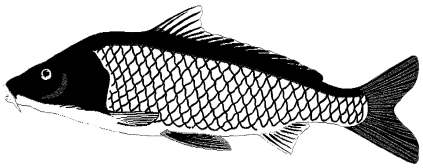
Future needs for management of purple loosestrife

- Continue research on biological control of purple loosestrife, including the development of release strategies. Implementation strategies are needed for actual distribution in the field and subsequent monitoring of the insects.
- Continue DNR funding of herbicide control efforts on small, high-priority infestations.
- Continue to assess effectiveness of management efforts including chemical and biological control.
- Continue to develop new in-state partners (e.g., county agriculture inspectors, MnDOT, DNR area wildlife managers, nature centers) to expand scale of management efforts.

Management of Common Carp

Introduction

Issue



Common carp (*Cyprinus carpio*) were intentionally introduced into Minnesota waters before 1900. They remained relatively unnoticed as a threat to environmental quality until after the drought of the 1930s. The drought had set the stage for an explosion of aquatic vegetation and invertebrates. The early wetland drainage efforts had provided connections into many wetlands and shallow lakes previously inaccessible. With the recovery of precipitation and subsequent increase in water levels in wetlands, lakes, and streams, the common carp found an abundance of food and spawning habitat. As early as the 1940s, carp had noticeably damaged aquatic habitat in famous waterfowl lakes such as Heron Lake in southwestern Minnesota. By the 1960s, common carp were recognized as a major factor in the deterioration of aquatic habitat across southern Minnesota.

The role of common carp in causing habitat deterioration is primarily related to their search for invertebrates in aquatic vegetation and bottom sediments. Their feeding activity disrupts shallowly rooted plants and suspends bottom sediments in the water column. The sediments release phosphorus that increase the growth of phytoplankton. As water clarity is reduced, remaining aquatic plants find it difficult to survive. As the rooted plants disappear, more bottom soils are exposed to wave action and further suspension. The cycle continues until the water body is devoid of rooted aquatic plants and phytoplankton thrives in the suspended nutrients. Habitat for most native gamefish and aquatic wildlife such as waterfowl is devastated. Since carp do not require clear water to feed and reproduce, they eliminate competition from fish that do, including those that prey on carp fry and young of the year.

Common carp are a carrier of a new disease in the state, spring viremia of carp. All C*yprinids* (minnows) and northern pike are susceptible to the disease.

Goals

The DNR has two goals related to management of common carp:

- Prevent the spread of carp into waters within Minnesota where they do not currently exist or have been successfully removed.
- Remove common carp from high-priority waterfowl waters, such as shallow lakes and wetlands where they are present.

Distribution

Carp currently occur in the majority of waters across the southern half of Minnesota (see Figure 14a).

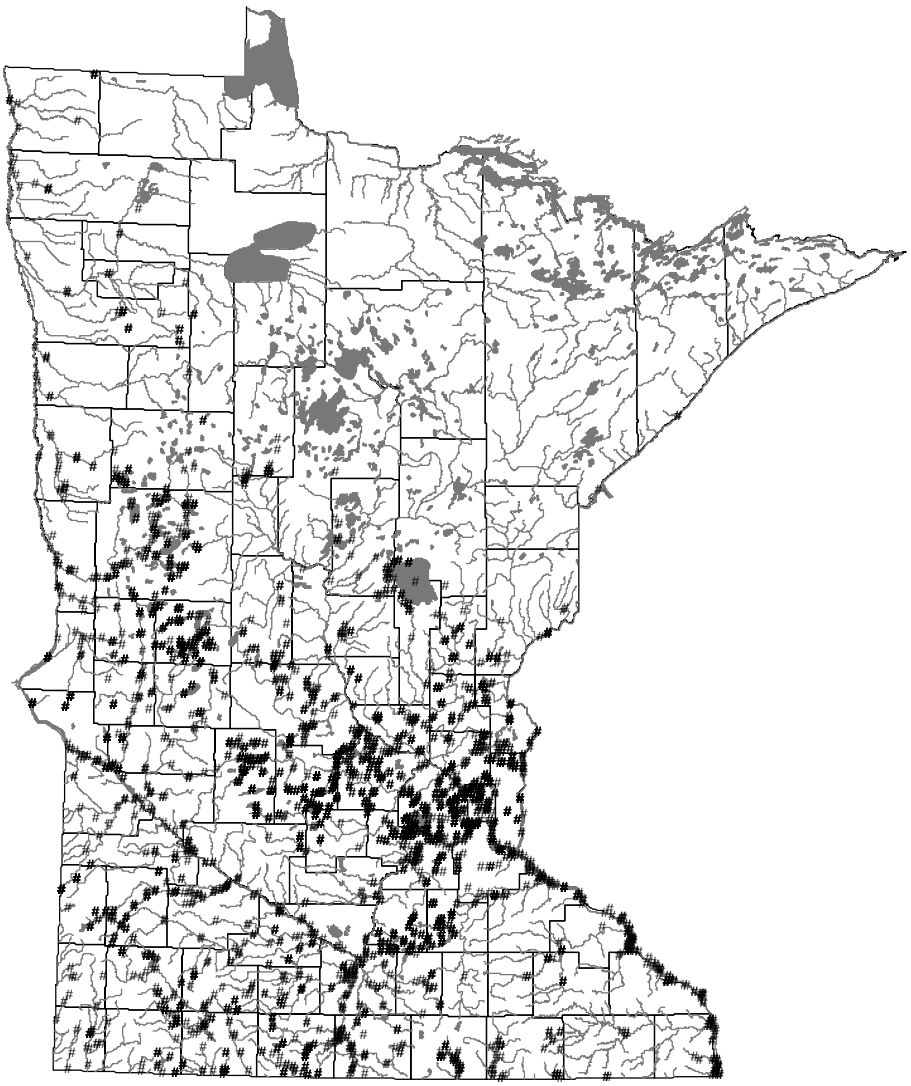


Figure 14a. Distribution of common carp in Minnesota as of December 2002.

Progress in Management of Common Carp - 2002

Several activities occur to inventory common carp infested waters, limit their spread, and remove carp from waters where they exist. Those activities (described below) are primarily conducted by staff of the divisions of Wildlife and Fisheries.

Evaluation of habitat conditions on shallow lakes

Habitat evaluation surveys were conducted on 48 shallow lakes by the Division of Wildlife. These surveys evaluate water clarity, chemistry, and depth along with occurrence and density of rooted aquatic plants.

Evaluation of fish populations

Fish population surveys were proposed at 385 managed fishing lakes by the Division of Fisheries. The results of those surveys will be available in June 2003.

Establish and maintain fish barriers
Fish barriers are used to limit the movement of common carp between connected waters. One new fish barrier was constructed, one was repaired, and 13 fish barriers were maintained by the Division of Wildlife in 2002.

Remove carp from priority lakes
Water level drawdowns were conducted by the Division of Wildlife on several shallow lakes to eliminate carp and restore aquatic vegetation. Examples include: Mud Lake (Traverse County), Rice Lake (Faribault County), Heron Lake (Jackson County), and Bear Lake (Freeborn County).

Research
Research to identify pheromones to attract or repel carp is currently being conducted at the University of Minnesota in cooperation with the DNR Division of Wildlife. A proposal entitled "Developing Pheromones for Use in Carp Control" was submitted to the Legislative Commission on Minnesota Resources (LCMR) to continue this research. It was recommended for $100,000 of funding in FY 2004-2005. The LCMR funding recommendations will be considered for appropriations by the Legislature during its 2003 session. The findings from the pheromone research will be used to develop an integrated approach to carp management.

Effectiveness
Carp management has been only moderately effective in all types of waters within Minnesota. Although in shallow waters, where removal of carp has been successful, the aquatic habitat has responded immediately the next spring with improved water clarity and abundant native rooted aquatic plants.

Participation of Others
Participation of others varies depending on the individual management project for common carp. During 2002, participation on common carp management projects included Ducks Unlimited, Minnesota Waterfowl Association, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, Division of Wildlife, Division of Fisheries, and local lake associations.

Future needs for management of common carp

- Continue support for funding of research related to the application of pheromones, induce winterkill to remove carp, develop and evaluate new fish barrier designs, and make additional refinements of chemical applications to remove carp.
- Continue to seek and provide funding for management to accelerate the removal and blocking of carp from high-priority affected waters.
- Monitor the new disease, spring viremia of carp, to determine how widespread it is in Minnesota and consider new limitations on live carp shipments.

Management of Mute Swans

Introduction

Issue

Mute swans (*Cygnus olor*) are native to Europe and Asia and were brought to the United States from the mid-1800s through the early 1900s (Lever 1987, Ciaranca et al. 1997). Ciaranca et al. (1997) reported that all North American populations of mute swans originated from release or escape of individuals from captive flocks.

In Michigan, Ontario, Wisconsin, and eastern states from Maine to South Carolina, mute swan populations have naturalized and are expanding rapidly causing concern for native species and their habitat (Allin et al. 1987; Ciaranca et al. 1997). For example, Lever (1987) reported that around the Chesapeake Bay one or two pairs escaped captivity during a storm in 1962. By 2000, the Maryland mute swan population had grown to about 4,000 individuals.

Some people have been interested in possessing and releasing mute swans to compete with Canada geese, but this management approach has not been proven to work. Others are interested in having mute swans for ornamental purposes.

Mute swans are currently regulated in part by the Minnesota game farm statutes in Minnesota Statutes 97A.105 and they are designated as a *regulated exotic species* in Minnesota Rules 6216.0260. It is illegal to release mute swans into the wild under the game farm and regulated exotic species statutes.

Goals

- The Department of Natural Resource's (DNR) goal for mute swan management is to avoid the establishment of naturalized populations of mute swans in Minnesota.

Distribution

Unconfined mute swans were reported in Minnesota in 2002 and in previous years. They have occasionally escaped or been released from golf courses, individuals who live on lakes, apartment complexes, and in park settings in Minnesota. There have been documented wild nesting pairs in some locations of the state, although there are no known populations established in the wild in Minnesota that cannot be attributed to an individual who allowed them to be unconfined.

Table 15a. Unconfined mute swans reported in Minnesota counties during 2002.

County	Number of swans	Month(s) Reported
Hennepin	1	October
Olmstead	7	June – October
Ramsey	1	November
Wabasha	1	April
Washington	11	October (3), December (8)
Total for all counties	21	

Progress in Mute Swan Management - 2002

Monitoring mute swans in the wild

Monitoring mute swans in the wild is a strategy necessary to help DNR respond to birds that may establish naturalized populations (see population management below). During 2002, the DNR recorded and investigated six reports of wild or escaped mute swans in the state. A total of 21 birds were reported in the wild in five different counties (see Table 15a). Sources of the reports include: conservation officers that flew over lakes, birders, calls from the public, and other DNR staff who observed unconfined birds.

Preventing introductions

The DNR Exotic Species Program sent letters to two owners of mute swans who did not confine their swans in past years. Beginning in 2002, the U.S. Fish and Wildlife Service (USFWS) requires federal permits for possession, sale, and purchase of mute swans because they are now considered migratory waterfowl.

Population management

Federal involvement in mute swan management

The DNR's ability to respond to mute swans in the wild during 2002 changed because on December 28, 2001, a ruling by the U.S. Circuit City of Appeals for the District of Columbia, which has jurisdiction over federal agencies, found that mute swans are covered by the international Migratory Bird Treaty Act. As a result of the ruling, control of mute swans by states or others will require a depredation permit from the USFWS.

Interagency mute swan management team

The DNR has established a mute swan team that includes representatives from the DNR Division of Wildlife, DNR Nongame Wildlife Program, DNR Exotic Species Program, DNR Division of Enforcement, USFWS, and Wisconsin DNR. The team met on July 30, 2002 and discussed the removal of mute swans from the wild. A depredation permit application for the USFWS is being prepared by DNR to enable the state to respond to unconfined mute swans in 2003.

Management in Other States

State wildlife agencies have conducted varying levels of mute swan population control dependent upon population size and distribution, available resources, and socio-political concerns.

The State of Wisconsin's Natural Resources Board considered a policy to control mute swans in the wild at their meeting in February 2002. Many people, representing agencies, organizations, or themselves, testified on the policy and provided many reasons why Wisconsin DNR should adopt a policy to control the increasing mute swan population in Wisconsin. Two individuals testified against the policy. Jay Rendall, Exotic Species Program Coordinator from Minnesota DNR testified at the hearing and encouraged Wisconsin to adopt the policy because despite Minnesota laws, mute swans in Wisconsin would likely spread to Minnesota. The board voted to adopt a policy and Wisconsin DNR began control of mute swans in the state during 2002.

Future needs for management of mute swans

- Verify occurrences of mute swans in the state and take appropriate actions to have the birds confined under game farm licenses or remove the birds from the wild.
- Develop and distribute informational materials about mute swans and related state and federal laws.
- Obtain a depredation permit from the USFWS to control unconfined mute swans.

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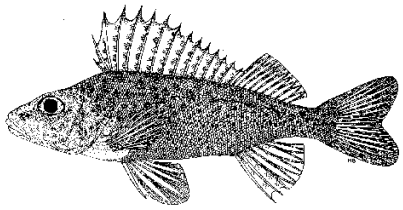
Management of Ruffe

Introduction

Issue



The ruffe (*Gymnocephalus cernuus*) a Eurasian fish of the perch family, was introduced into Minnesota in the mid-1980s. Its likely source of introduction was from ballast water discharge by transoceanic ships. Since the discovery of the ruffe in the St. Louis River near Duluth in 1987, many agencies from Minnesota, Wisconsin, and Ontario as well as the U.S. Fish and Wildlife Service (USFWS) and U.S. Geological Survey, Biological Resources Division (USGS-BRD) have been studying this exotic fish to better understand its impacts on North American fish communities.

Many fish management agencies and sportfishing interests are concerned about potential impacts of ruffe to North American fisheries. The rapid increase in the ruffe population in the Duluth/Superior area, the replacement of fish biomass by ruffe, and the potential spread of ruffe to inland waters are some of the concerns. Several research studies have tried to determine the impacts of ruffe on the ecosystem. Ruffe consume a significant amount of benthic macroinvertebrate energy according to one study conducted by the University of Minnesota-Duluth (Schuldt et al. 1999). Separate research from the same experiment, showed significant declines in the growth of yellow perch, *Perca flavescents*, while in the presence of ruffe (Henson 1999). In contrast, statistical analysis performed by the U.S. Geological Survey (USGS) showed no significant relationship between an increasing ruffe population and declining native fish populations in the St. Louis River, MN/WI (Bronte et al. 1997). From these studies, the relationships of ruffe and native fish species is not clear. In the Duluth harbor, there are declining trends in some fish populations concurrent with the establishment population of ruffe, but they may be due to other factors.

Goals

In order to prevent harm to the nation's and state's fisheries, national and state goals have been established.

- The national goal, drafted in 1995 and revised in 1996 by a national Ruffe Control Committee of the national Aquatic Nuisance Species Task Force, is to *prevent or delay the spread of ruffe in the Great Lakes and inland waters* (Ruffe Control Committee 1996).
- The state goal, applicable to all harmful exotic species, is to *prevent the spread of harmful exotic species within Minnesota*. For ruffe, this means preventing spread from Lake Superior and the St. Louis River to inland waters.

Distribution

Ruffe are found in Minnesota waters of Lake Superior and the St. Louis River. No ruffe have been discovered in inland waters of Minnesota. The DNR does not conduct special surveillance surveys for ruffe in Minnesota inland waters. Angler reports and routine lake surveys by the DNR Division of Fisheries will be the primary methods of detecting movement of ruffe populations to inland waters. A map showing the

distribution of ruffe in North America is available on line at: www.nas.er.usgs.gov/fishes/images/ruffe_map.gif.

In 2002, ruffe surveillance continued in all the Great Lakes. Ruffe were discovered in Lake Michigan for the first time. On August 21, a total of three ruffe were found in the vicinity of Little Bay de Noch of Green Bay (near Escanaba, MI). The USFWS captured one adult and two juvenile ruffe. This was a significant range expansion of 100 miles from Ontonogan, MI. The ruffe also extended their range in Lake Superior. On September 4, ruffe were found in the Keweenaw waterway.

The USFWS Ashland Fishery Resources Office surveys several Wisconsin and Michigan tributaries and nearshore waters of Lake Superior for ruffe. The Ontario Ministry of Natural Resources conducts surveillance in Canadian waters of Lake Superior. The USGS-Lake Superior Biological Station has the lead role in ruffe population investigations in the Great Lakes and their tributaries. USGS-Lake Superior Biological Station has been conducting bottom trawling in the St. Louis River and estuary since 1988 as part of a long-term effort to monitor abundance of ruffe and native species (U.S. Fish and Wildlife Service 2001). Ruffe in the St. Louis River Estuary, increased to nearly 2,000/ha in 1995, but slowly declined since 1995 to about 1,000/ha in 2001 (Evrard and Gorman 2001).

Progress in Management of Ruffe - 2002

Two principle strategies are being used to prevent the spread of ruffe to inland waters: education and regulations.

Educational activities

Educational efforts conducted by the DNR and other cooperating agencies in past years, to achieve the goal of preventing the spread of ruffe to inland waters, were continued in 2002. Information about the ruffe has been included in brochures and in the state fishing regulations synopsis. Advisory signs remain posted in Wisconsin and Minnesota to alert boaters and anglers of the presence of ruffe in the St. Louis River estuary and DNR's watercraft inspectors continue to inform boaters and anglers at public access points in Minnesota's ruffe infested waters about ruffe and the precautions they should take. Minnesota Sea Grant produced new *Ruffe Watch* identification cards in 2002. The cards will be distributed by DNR, Minnesota Sea Grant, and other appropriate agencies in Minnesota.

Regulations

State regulations continue to be a strategy used in 2002 to help prevent the spread of ruffe within Minnesota. Ruffe are designated as prohibited exotic species and may not be transported, possessed, introduced, purchased, sold, or imported in Minnesota. The harvest of live bait from ruffe infested waters is prohibited in the state.

Effectiveness of Ruffe Management

Regulations, inspections, and other public awareness efforts to prevent the establishment of ruffe in inland waters appears, to date, to have been effective.

Management in Other States

The Lake Superior waters of Wisconsin, Ontario, and Michigan, and Michigan waters of Lake Huron contain the only known populations of ruffe in North America. Wisconsin DNR has established regulations to prohibit possession of ruffe and harvest of live bait in Lake Superior and its tributaries up to the first fish barriers. Angling regulations, similar to Minnesota's, in the St. Louis River estuary were also used in an attempt to increase predation on ruffe by native fish. Wisconsin DNR has also prepared a plan to respond to nonindigenous fish introductions in inland lakes. This plan will help provide a decision making process in the event ruffe are found in inland waters in Wisconsin. To date, no state, federal, or Indian entity has used chemical control to manage ruffe in tributaries along the south shore of Lake Superior. Chemical control of ruffe had been proposed for Wisconsin or Michigan waters. Laboratory tests show that ruffe are vulnerable to available fish toxicants, but most information indicates that treatments would not be effective in preventing the spread of ruffe in open systems like the Great Lakes.

Participation of Others in Ruffe Management

The USGS-Biological Resources Division has been involved in ruffe research and a USFWS biologist is the chairperson of the national Ruffe Control Committee. Employees of provinces, tribes, and other Great Lakes states have been involved in the development of reports and plans regarding ruffe.

Future needs for management of ruffe

- Support national and regional efforts to reduce the potential for ruffe to enter the Mississippi River via outlets from Lake Michigan such as: 1) the Dispersal Barrier Demonstration Project by the U.S. Army Corps of Engineers and 2) long-term solutions.
- Invest in and/or support research to develop environmentally sound control methods by the USFWS and others.
- Support continued biological assessment efforts so that the impact of ruffe on native communities can be ascertained.
- Expand efforts to increase public awareness of ruffe in areas of Minnesota where introduction of ruffe may occur.

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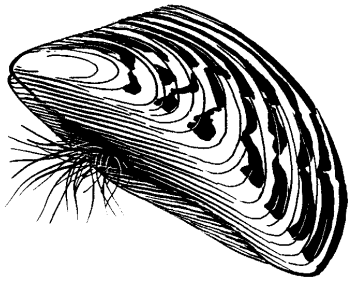
Management of Zebra Mussels

Introduction

Issue



The zebra mussel (*Dreissena polymorpha*) is a small striped exotic mussel that was brought to North America in the ballast waters of trans-Atlantic freighters in the late 1980s. Unlike our native mussels, zebra mussels secrete sticky threads that are used to firmly attach to any hard surface in the water. This ability to attach of these mussels in large clumps can create numerous problems, such as clogging intake pipes for industry or killing native mussels. Attachment of the adults to recreational boats or aquatic vegetation (which may be transported by boaters) can serve to move zebra mussels to other waters. Zebra mussels have a microscopic free living larval stage (veliger) which may float in the water column for two to three weeks. This larval stage ensures widespread distribution in lakes, and downstream of any established zebra mussel populations in rivers. Additionally, this microscopic life stage may also be moved to other water bodies in any water (such as bait buckets) transported overland. The high reproductive capacity and free-living veligers of the zebra mussel allows for rapid dispersal within a water body. Zebra mussels feed by filtering algae and other small particles out of the water. These same small food particles are the food base for zooplankton and larval fish in our lakes and rivers. Hundreds of thousands of zebra mussels may filter so much of this food that it could interfere in the aquatic food chain, reducing the food availability for larval fish and impacting fish populations.

Goals

- Prevent the spread of zebra mussels to uninfested waters within Minnesota.
- Reduce the impacts of zebra mussels to Minnesota's ecology, society, and economy.

One strategy to attain the second goal is to support research to track impacts and assess potential control methods.

Distribution

Zebra mussels occur in the Mississippi River from St. Paul down to the Iowa border, the lower 25 miles of the St. Croix River, the Duluth Harbor, Lake Zumbro, and the Zumbro River downstream of Lake Zumbro (Figure 17a). This distribution did not change in 2002.

Progress in Management of Zebra Mussels - 2002

Reducing impacts

Samples of veligers were collected from Lake Zumbro to determine how long the larval stage is present in the lake in 2002. Monitoring indicated that this season veligers could

be found in the water from June through mid-September, suggesting that the reproduction of zebra mussels was extensive this season. A paper co-authored by DNR staff on winter drawdown impacts on zebra mussels in lakes was presented at the International Aquatic Nuisance Species Conference. Sampling confirmed zebra mussels scattered throughout the length of the Zumbro River downstream of the lake to the confluence with the Mississippi River. The Volunteer Zebra Mussel Monitoring Program continued with mailing of report forms and results from the previous year to all lakeshore residents who had participated. Reports to date from approximately 180 volunteers monitoring their lakeshore areas have not found any zebra mussels in any other waters of the state.

The National Park Service monitors for zebra mussels using slides on settling plate samplers in the federal zone of the St. Croix River, above the infested section of the river. Samples taken by the National Park Service were analyzed in the aquatic invertebrate laboratory by DNR biologists. No zebra mussels were found on the slides, suggesting that this exotic has not been moved upstream within these waters and continues to be confined to the lower 25 miles of the St. Croix.

Prevention of spread
No new infestations were reported from any waters in the state. Watercraft inspectors continued increased efforts in the lower 25 miles of the St. Croix River and at Lake Zumbro, the two newest areas of infestation in Minnesota.

Research
Recent studies have suggested that a specific bacteria may kill zebra mussels. The bacteria occurs in North America, and is not another exotic species. Researchers have suggested the mass culture could produce large quantities of the organism, which could be poured into waters containing zebra mussels. The zebra mussels would eat these bacteria and die. Small-scale trials have been done but hurdles remain to see if this might be an effective control method. Mass-production of such a control has not yet been developed. More extensive testing on a variety of aquatic animals (such as gamefish) would need to be done to determine the safety of such a control. Finally, questions remain about costs for lakewide treatments as well as other ecological concerns.

Effectiveness of Management
The occurrence of zebra mussels in only one inland lake (Lake Zumbro) in Minnesota suggests that efforts to slow the spread of this exotic have succeeded. Despite the occurrence of this exotic in Minnesota waters (Mississippi River, Duluth Harbor) for over a decade, movement into inland state waters has been extremely limited. In comparison, Wisconsin has over 30 inland water bodies with zebra mussels, while Michigan has over 170 infested inland waters. These states do not have statutes such as Minnesota preventing movement of aquatic plants, which recent research has suggested is the primary avenue for overland transport leading to new infestations.

Participation of Others
Funding for an interstate management plan for coordinated actions against the zebra mussel for the St. Croix River was continued by USFWS. The Minnesota DNR,

Wisconsin DNR, and the Great Lakes Indian Fish and Wildlife Commission received funding assistance for zebra mussel activities on the St. Croix River outlined in the management plan.

Monitoring efforts for zebra mussels continued by lakeshore residents throughout Minnesota. Over the past two years, approximately 225 people annually have participated in the Volunteer Zebra Mussel Monitoring program, checking lakes across the state for zebra mussels. These efforts provide a much more extensive examination of Minnesota waters for this exotic than could be conducted by the Exotic Species Program alone.

Future needs for management of zebra mussels

- Continue monitoring zebra mussel populations in various Minnesota waters.
- Continue the Volunteer Zebra Mussel Monitoring program.

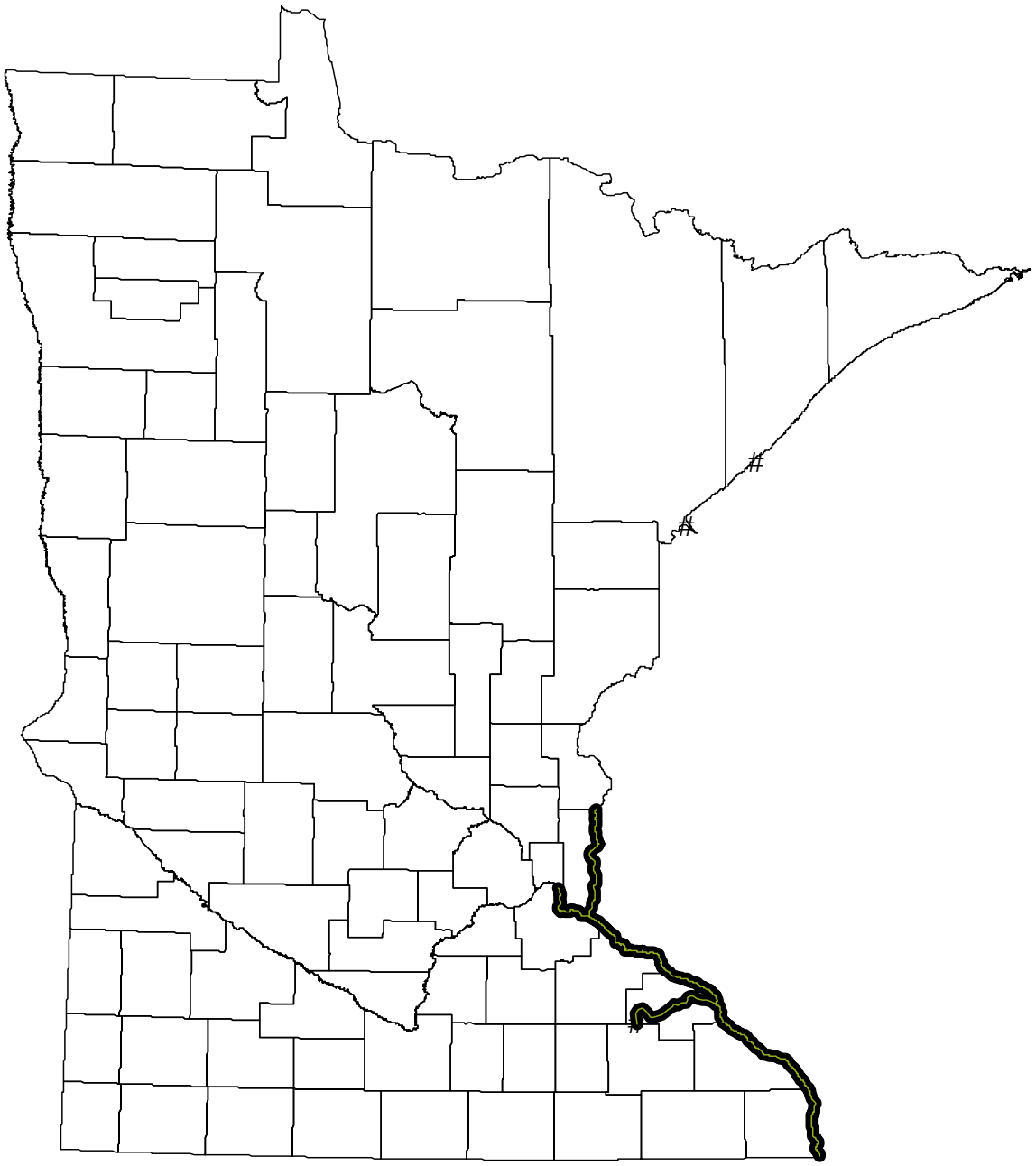


Figure 17a. Zebra mussel locations in Minnesota as of fall 2002.

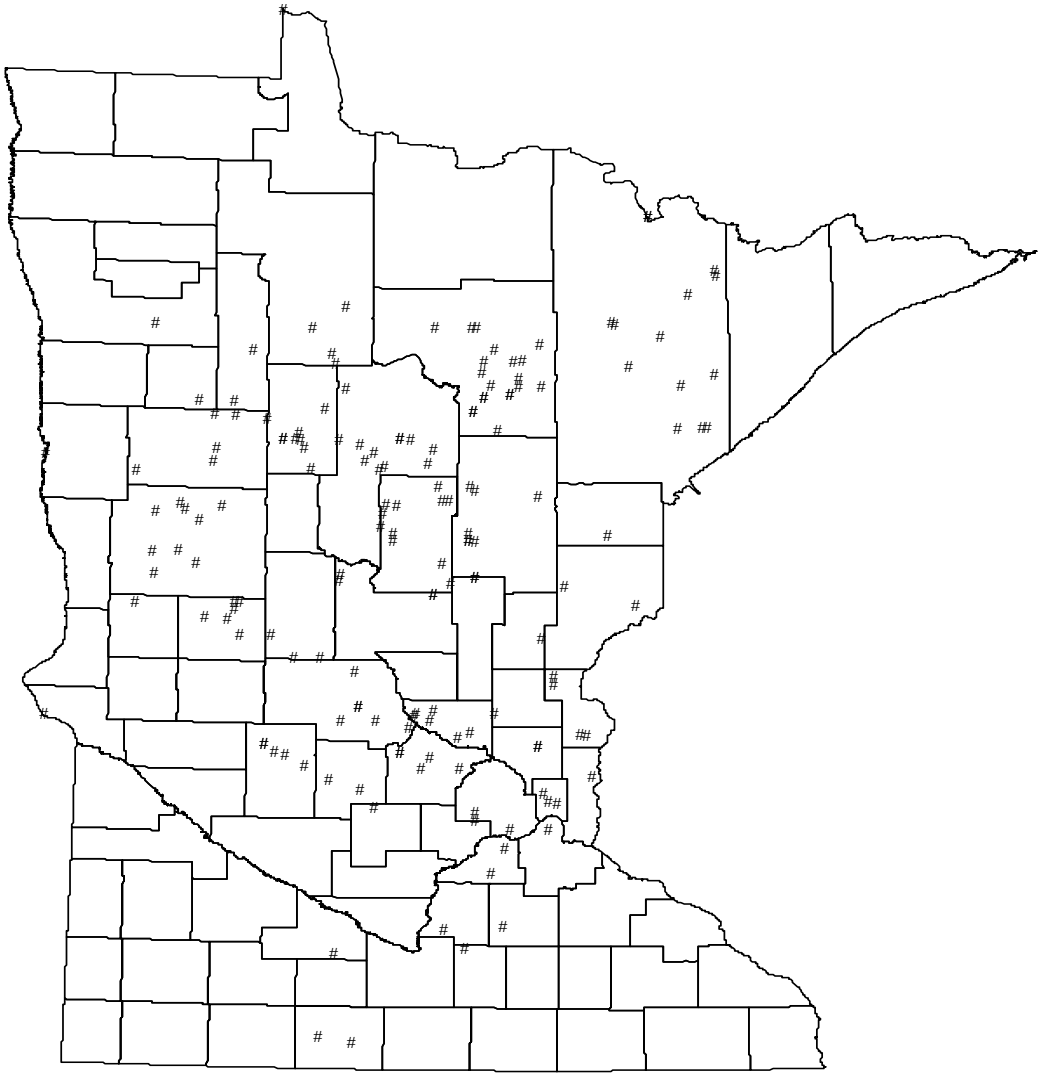


Figure 17b. Location of 2001 zebra mussel citizen volunteer monitors.

Other Harmful Exotic Species in Minnesota

Introduction

Numerous harmful exotic species exist in the state. The previous chapter described species and activities where there was ongoing management of the species. The species described in this chapter all exist in the state, but there were not efforts to manage them in the wild. They are included because they are or have been on interest within the state.

Eurasian Collared-dove

The Eurasian collared-dove (*Streptopelia decaocto*), a bird native to the Indian Subcontinent and Turkey, was first described as a new exotic bird species in the state in the annual report for 1999. They were observed in Big Stone, Brown, Carver, Dakota, Freeborn, Houston (nest with two eggs was observed), Lyon, Kandiyohi, Martin, Pipestone, Renville, Rock, Roseau (the first reported sighting in a northern county), and Yellow Medicine counties during 1999, 2000, and 2001. They were observed in one additional county in 2002 – Blue Earth County where they were heard calling from the Amboy Municipal water tower on September 14. They are likely to be in other Minnesota counties and to continue spreading throughout the state. In July, nesting collared-doves were observed on top of the sub-power station at the city park on the corner of Lincoln and Pine Streets in Caledonia (Houston County). The doves were observed there through September.

The DNR is not attempting to eliminate or control the population of Eurasian collared-doves in Minnesota. There are several reasons: it would be difficult to prevent their continued introduction from adjoining states, the birds look similar to mourning doves, and there is not a regional or national effort to stop their spread.

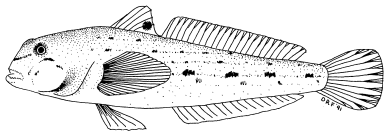
Eurasian Swine

The Eurasian swine, or Eurasian wild pigs (*Sus scrofa* subspecies and *Sus scrofa* hybrids), have been a concern in the state for many years because of their potential to escape from captivity, establish naturalized herds, and cause damage to the state's resources (Minnesota Department of Agriculture (MDA) 1993).

Captive Eurasian swine have escaped Minnesota in the past. No reports to the DNR have been received in 2002. They are currently regulated as *restricted exotic species* and *prohibited exotic species* under Minnesota Statutes 17.457 and 84D.05. The restricted species statutes prohibits importation, possession, propagation, transportation, or release of Eurasian swine, except the commissioner of agriculture may issue permits for a person to possess and raise a restricted species for commercial purposes if the person was in possession of the Eurasian swine on March 1, 1993.

Round and Tubenose Goby

The round (*Neogobius melanostomus*) and tubenose (*Proterochinus marmoratus*) gobies are bottom dwelling fish from Europe and native to the Black and Caspian seas. The gobies were discovered in Michigan waters in 1990, likely the result of ballast water exchange from transoceanic vessels.



In 1995, the round goby was discovered in the Duluth/Superior Harbor. Since then, the population has increased to an estimated 161,000 fish in the St. Louis River (Lori Evrard, U.S. Geological Survey, November 7, 2002). The round goby has documented negative impacts on mottled sculpin reproduction and suspected impacts on other native bottom dwelling fish, such as darters and sturgeon. The round goby has expanded its range throughout the Great Lakes, Detroit River, Lake Superior watershed and the Illinois waterway. It is likely that the fish will migrate from the Illinois River into the Mississippi River and up to Minnesota.

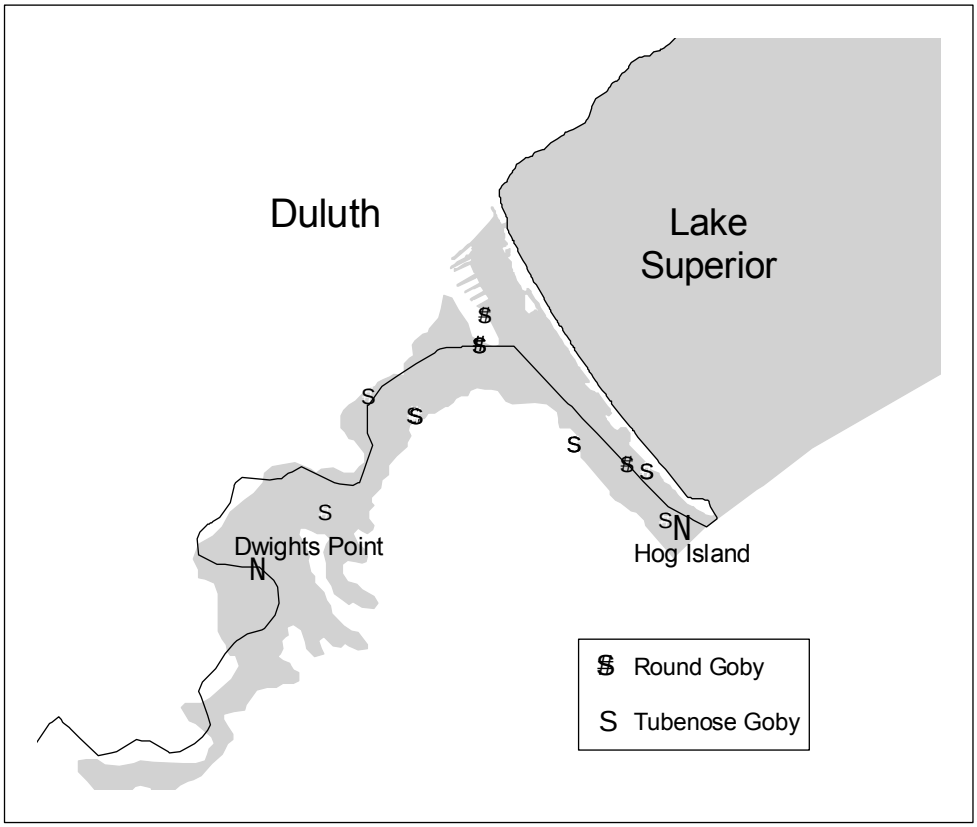
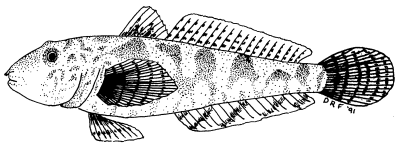


Figure 18a. Locations of round and tubenose goby in Minnesota as of December 2002.



The tubenose goby was first discovered in the St. Louis River harbor in 2001. In 2002, the tubenose has extended its range and numbers. Ten specimens were captured by Wisconsin DNR between Dwight's Point downstream to Hog Island (Dennis Pratt, Wisconsin DNR, November 11, 2002) (Figure 18a).

Unlike the round goby, tubenose gobies do not seem to exhibit the same invasiveness. Evidence of this would be the decline of the population just a few years after their original discovery in the Saint Clair River area.

Rusty Crayfish

The rusty crayfish (*Orconectes rusticus*) is an exotic species in our state that is native to the eastern and mid-eastern United States. It has been spread across the Midwest through human activities, likely through release from bait by anglers. This exotic can out-compete native crayfish and may interbreed with our native species. It can displace native crayfish, reduce or eliminate aquatic vegetation, and may interfere with some fish populations in certain lakes. There are currently no environmentally-safe and effective control methods once the rusty crayfish become established in permanent lakes or rivers. Researchers in Wisconsin have begun examining management of crayfish predators (specific fish species) to try and manage numbers of this exotic in some of their lakes; however, this research is still preliminary. With the lack of any safe or even effective control methods, the Exotic Species Program does not conduct any active management of rusty crayfish.

Rusty crayfish have been reported in 42 lakes and eight rivers in the state, scattered from northeast to south-central Minnesota. Fisheries staff encounter rusty crayfish in their lake sampling gear and report findings to the Ecological Services Division. For 2002, Fisheries staff reported three new lakes with this exotic. Many lakes in St. Louis and Lake counties are connected, and it has been shown that the rusty crayfish will move between interconnected water bodies. Judging from the widespread reported distribution, it is highly likely that rusty crayfish are present, but unrecorded in more waters in the state.

Nonnative Water Lilies

Colorful, hardy water lilies (*Nymphaea* spp.) are popular with water gardeners. Sold under names like Amanda Uber, Laydekeri Lilacea, and Esmerelda, these non-native hybrids of *Nymphaea* sp. come in a wide variety of shapes and colors. Because they are hardy in Minnesota, if planted in natural waters they will survive and spread. A few populations of hybrid water lilies have been found in Minnesota waters. In at least one water, Portage Lake in Park Rapids, the pink water lilies were found to be widespread. Because escaped hybrid lilies can spread in natural waters they have been designated as a *regulated exotic species* by law. This means that they cannot legally be placed into a free-living state (into public waters), or into ponds connected to public waters, but they can be sold and used in private water gardens. During 2002, a DNR Fisheries Lake Survey crew located pink water lilies on Oscar Lake in Douglas County. There had not been a permit issued to place the exotic water lilies in the lake, so DNR Exotic Species Program asked the landowner, who placed them in the lake, to remove them. DNR Exotic Species Program staff will be providing information to sellers and purchasers of aquatic plants, including pink water lilies, to increase awareness about the limitations on where these plants can be planted.

Yellow Iris

Yellow Iris (*Iris pseudacorus*) is a common ornamental plant used in gardens (Ramey 2001) and watergardens, and is often promoted for naturalizing on lakeshores. During

2001, Exotic Species Program staff evaluated the risks posed by yellow iris (*Iris pseudacorus*). Yellow iris is a commonly sold emergent plant and has been found naturalized in several lakeshores in Minnesota. Yellow iris can grow much like *Typha* spp. (cattail) species; a monoculture of densely packed plants with extensive rhizomes (Sutherland 1990). Because of the risks posed by yellow iris, the DNR has proposed that this species be listed as a *regulated exotic species* by law (see Regulations). The proposed classification will aid public understanding that the plant cannot be placed into a free-living state (into protected waters) but will allow the continued sale and use of the plant in water gardens and terrestrial settings. DNR Exotic Species Program staff will be providing information to sellers and purchasers of aquatic plants, including yellow iris, to increase awareness about the limitations on where these plants can be planted.

References Cited

Minnesota Department of Agriculture. 1993. Summary of a Survey on the Status of Wild Hogs in the United States. Unpublished report.

Ramey V., B. Peichal. 2001. Non-native plants in the United States, Iris pseudacorus L. Center for Aquatic and Invasive Plants, University of Florida and Sea Grant, University of Minnesota. www.aquat1.ifas.ufl.edu/seagrant/iripse2.html.

Sutherland, W.J. 1990. Biological Flora of the British Isles, No. 169. *Iris pseudacorus*. Journal of Ecology 78:833-848.

Appendix A - Exotic Species Program Staff

Title / Area of Responsibility	Name	Phone	E-mail
Exotic Species Program Coordinator - rulemaking, legislation, state representative on regional aquatic nuisance species committees or panels and federal exotic species issues, education and public awareness	Jay Rendall	651-297-1464	jay.rendall@dnr.state.mn.us
Purple Loosestrife Coordinator - technical assistance for management of purple loosestrife, and biocontrol of other invasive species	Luke Skinner	651-297-3763	luke.skinner@dnr.state.mn.us
Eurasian Watermilfoil Coordinator - technical and financial assistance for management of milfoil, and technical assistance for other exotic aquatic plants	Chip Welling	651-297-8021	chip.welling@dnr.state.mn.us
Exotic Species Biologist - technical assistance for management of milfoil, curly-leaf pondweed and other exotic aquatic plants	Wendy Crowell	651-282-2508	wendy.crowell@dnr.state.mn.us
Exotic Species Biologist - technical assistance for management of milfoil, flowering rush, and other exotic aquatic plants	Nick Proulx	651-284-3589	nick.proulx@dnr.state.mn.us
Exotic Species Biologist - exotic species issues in northern portions of the state	vacant	218-828-6132	
Watercraft Inspections - awareness events at water accesses	Heidi Wolf	612-297-4891 651-284-3586	heidi.wolf@dnr.state.mn.us
Aquatic Invertebrate Biologist - zebra mussels, rusty crayfish, and other exotic aquatic invertebrates	Gary Montz	612-297-4888	gary.montz@dnr.state.mn.us
Conservation Officer - statewide enforcement of exotic species regulations	Mark Johanson	651-772-7906	mark.johanson@dnr.state.mn.us
General Information		651-296-2835	

Appendix B - Other State Contacts for Exotic Species Prevention and Control Programs and Interagency Groups

Department of Natural Resources - Forest Pest Program

DNR's Division of Forestry, working in cooperation with the Minnesota Department of Agriculture, is charged with surveying and controlling forest pests, including exotic organisms such as gypsy moth and several bark beetles (an annual report is prepared by the DNR Forest Health Protection Team on those issues).

Forestry Division Contacts

Metro Forest Health Specialist	Susan Burks	651-772-7927
Forestry Section Manager	Olin Phillips	651-296-5971

U of Minnesota Sea Grant - Exotic Species Information Center

The Exotic Species Information Center at the University of Minnesota Sea Grant Program provides research, outreach, and education in collaboration with the DNR's Exotic Species Program. The Center has served as an important resource on aquatic nuisance species (ANS) and provides information to the public to prevent and slow their spread.

Center Coordinator - Duluth	Doug Jensen	218-726-8712

Minnesota Department of Agriculture - Invasive Species Programs

The Minnesota Department of Agriculture is responsible for the state's noxious weed and seed laws that apply primarily to terrestrial plants that harm agricultural crops, pastures, and roadsides. Information about control, prevention, and regulatory programs for harmful terrestrial exotic plants may be obtained from the Minnesota Department of Agriculture. MDA also has an Invasive Species Program that addresses species such as Japanese beetle, gypsy moth, long-horned beetle, Grecian foxglove, and Eurasian buckthorn. MDA prepares an annual report for these programs.

Agronomy and Plant Protection Division Contacts

Weed and Seed Unit	Chuck Dale	651-296-6123
Shade Tree and Invasive Species Unit	Anne Selness	651-296-8448
Terrestrial Invasive Species Program	Peter Dzuik	651-296-3343

Ag Development Division Contacts

Weed Biological Control	Tony Cortilet	651-282-6808
Integrated Pest Management Coordinator	Jean Ciborowski	651-297-3217

Interagency Invasive Species Groups

There are several invasive species committees or work groups to facilitate coordination between the involved agencies.

Minnesota Noxious Weed Potential Evaluation Committee - Chuck Dale, Chair, MDA - Weed and Seed Unit, Agronomy and Plant Protection Division, 651-296-6123.

Weed Integrated Pest Management Committee - Jean Ciborowski, MDA - Integrated Pest Management Coordinator, Ag Development Division, 651-297-3217

Gypsy Moth Program Advisory Committee - Anne Selness, MDA - Shade Tree and Invasive Species Unit, Agronomy and Plant Protection Division, 651-296-8448

St. Croix River Zebra Mussel Task Force - Includes these primary members and other less active members: Minnesota Department of Natural Resources, Wisconsin Department of Natural Resources, Great Lakes Indian Fish and Wildlife Commission, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and the National Park Service.

Minnesota Invasive Species Advisory Council - Co-chairs: Anne Selness, MDA - Shade Tree and Invasive Species Unit, Agronomy and Plant Protection Division, 651-296-844 and Jay Rendall, DNR Exotic Species Program, Ecological Services Division, 651-297-1464