Invasive Species of Aquatic Plants and Wild Animals in Minnesota

Annual Report 2006

for the year ending December 31

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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 invasive species (aquatic plants and wild animals) under its jurisdiction. Minnesota Statutes, Chapter 84D.02, Subd. 6, specify 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, and an assessment of future management needs. Additional sections have been added to this report to provide a thorough account of DNR's Invasive Species Program activities and other activities related to invasive species of aquatic plants and wild animals.

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Summary

Hot topics in 2006

New Curly-leaf Pondweed Grant Program Initiated

In 2006, the DNR established a grant program entitled "Pilot projects to control curly-leaf pondweed or Eurasian watermilfoil on a lake-wide basis for ecological benefits." The purpose of this program is to allow a limited number of well-planned and well-monitored projects to go forward in order to determine if ecological benefits can be obtained by lake-wide control of these invasive species. Lake-wide treatments are those that attempt to treat all, or almost all, of the target plants in a lake. Ecological benefits include increases in the frequency or abundance of native aquatic plants and, in the case of curly-leaf pondweed, may include reductions in levels of phosphorus and algae, which should increase water clarity.

Grants totaling $125,000 were awarded for ten lakes under this program. Of the total, $115,000 helped fund control projects on seven lakes, and $10,000 was provided for the collection of pre-treatment aquatic plant survey data on three lakes. In 2006, only curly-leaf pondweed control projects were funded. Comments from lake residents and DNR staff observations indicate that the treatments were successful in controlling curly-leaf pondweed. The DNR and its cooperators will continue to carefully monitor these projects to determine if they result in ecological benefits for the treated lakes. In 2007, $200,000 will be available for control projects or the collection of pre-treatment data.

New Zealand Mud Snail Discovered in Duluth-Superior Harbor

During routine surveys in the Duluth-Superior Harbor, researchers with the U.S. Geological Survey confirmed the presence of numerous New Zealand mud snails in separate locations. This is the first occurrence of this tiny (less than ¼") invasive snail in Minnesota waters. First discovered in western states, it has rapidly spread to many rivers and streams in western North America. This invasive can reach high densities in optimum habitats, and may crowd out preferred food or prey for fish such as trout. While fish can eat these snails, they often pass undigested providing little or no food for the predators. Due to their small size and ability to survive out of water, the possibility of spread of New Zealand mud snails to other Minnesota waters is a major concern. Of particular worry is the chance that this invasive may move into trout streams along the North Shore or be moved into the southeast area of the state. Precautions for anglers and boaters as well as other public information were produced and distributed.

Movement of Zebra Mussels in Water and on Equipment a Big Concern

Transport of Boatlift. The transport of a boatlift from a zebra mussel infested water highlighted another possible pathway of spread and resulted in an enforcement action. In October, a boatlift was transported from Lake Ossawinnamakee to North Long Lake in the Brainerd lakes area. The lift was not cleaned prior to transport and had many visible zebra mussels attached (Figure 1). The local DNR conservation officer

interviewed the owner of the lift and subsequently issued a citation for transporting zebra mussels.

While the lift had not yet been placed in the water at North Long Lake, this highlights the need to clean all equipment and objects that rest in our waters prior to any movement. Boatlifts, docks, rafts, and swim platforms–all these may harbor invasive species. Owners should clean off all equipment prior to moving it anywhere away from their property.

Figure 1. Zebra mussels attached to boatlift removed from Lake Ossawinnamakee.

Transport of Water. In July, a truck owned by a local paving business had its tank filled with lake water from Lake Ossawinnamakee (zebra mussel and milfoil infested waters). DNR staff observed the action and reported it to the local DNR conservation officer, who followed up with the company to inform them of the illegal action. The truck was pulled from service and sanitized before reuse. In September, a sewer service truck from the Aitkin area attempted to remove water from Lake Mille Lacs by placing a hose from the truck in the lake. This imminent transport of infested water was halted when a DNR watercraft inspector informed the truck driver that it was not legal to take water from Lake Mille Lacs without a permit. The Invasive Species Program followed up with the company to inform them that state regulations prohibit transport of water from infested waters. During the discussion, the company indicated that this procedure is fairly common for that type of business.

These two situations highlight the need for all citizens working or recreating in our lakes and rivers to take precautions to prevent the movement of invasive species.

Status of Invasive Species of Aquatic Plants and Wild Animals in Minnesota: 2006

Aquatic Plants

- **Eurasian watermilfoil** was discovered in 13 additional Minnesota water bodies. There are now 190 Minnesota lakes, rivers, and streams known to contain the invasive submersed aquatic plant.
- **Purple loosestrife** has been documented in more than 2,328 locations statewide. Management efforts are being carried out on nearly half of these locations with biological control or herbicide applications.
- **Curly-leaf pondweed** is known to occur in 740 Minnesota lakes in 68 counties.
- **Flowering rush** is currently found in 16 lakes. The most problematic area of the state is near Detroit Lakes where the Pelican River Watershed District is leading ongoing management efforts.

Wild Animals

- **Asian carp** (bighead, grass, silver, or black carp). A single grass carp (*Ctenopharyngodon idella*) was caught in the St. Croix River by a commercial fisherman. No reproducing populations are known to exist in Minnesota waters.
- **Zebra mussels** are found in four inland lakes, isolated areas of Lake Superior, the Mississippi River from the Pine River in Crow Wing County to the Iowa border, the St. Croix River from Stillwater downstream, Pelican Brook and the Zumbro River downstream of Lake Zumbro (Figure 2).
- **New Zealand mud snails** (see Hot Topics).
- **Spiny waterflea** has been documented in Lake Superior and six inland lakes in northern Minnesota. The latest infestations were reported from Rainy Lake and Namakan Lake on the northern border of Minnesota in 2006.
- **Chinese and banded mystery snails** are being reported in many Minnesota waters particularly in the Twin Cities area and the northern half of the state.
- **Round goby.** First discovered in 1998, the round goby is currently found in the St. Louis River estuary. The **tubenose goby** was first discovered in 2001 and its population has increased, but at a slower rate than round gobies.
- **Mute swans.** Four mute swans were removed from the wild at Big Carnelian Lake in Washington County and two were removed from a marsh near Cokato in Wright County.

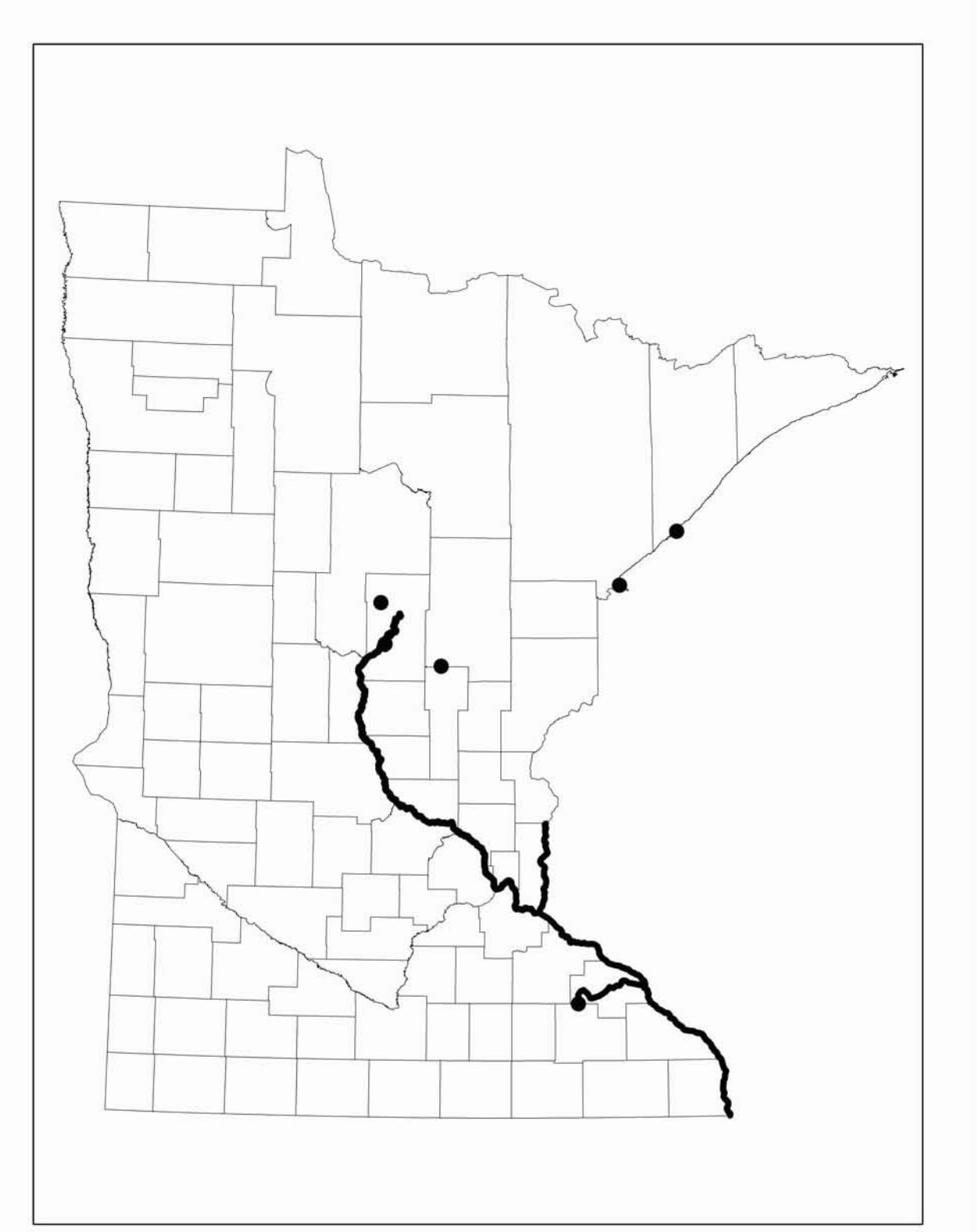

Figure 2. Zebra mussel locations in Minnesota as of November 2006.

The Problem
Invasive species have the potential to cause serious problems in Minnesota. Evidence from numerous locations in North America and from around the world demonstrates that these non-native species are a threat to the state's natural resources and local economies that depend on natural resources.

The Response
To address the problems caused by invasive species, the 1991 Minnesota Legislature directed the DNR to establish the Invasive Species Program and to implement actions to monitor and manage invasive species of aquatic plants and wild animals.

The three primary goals of the DNR Invasive Species Program are to:
1. Prevent introductions of new invasive species into Minnesota;
2. Prevent the spread of invasive species within Minnesota;
3. Reduce the impacts caused by invasive species to Minnesota's ecology, society, and economy.

1. Prevent introductions of new invasive species into Minnesota

Regulations. Regulations help to prevent activities or practices that carry a high risk of introduction. Based on the risk assessments, DNR staff from the Division of Ecological Services continued rulemaking that designates new infested waters and new regulated and prohibited invasive species.

Education. Education efforts explain the risks posed by invasive species and steps that people and businesses can take to prevent new introductions. Several education efforts were undertaken to communicate the "Stop Aquatic Hitchhikers!" message to the public including billboards, exhibits at Cabela's Owatonna store, and the Minnesota State Fair.

2. Prevent the spread of invasive species within Minnesota

Efforts to prevent the spread of invasive species within Minnesota are focused on people and their habits. Once an invasive species becomes established in Minnesota's lakes and rivers, a primary means for its spread is the unintentional transport on boats, trailers, and other water-related recreational equipment.

Watercraft inspections. Forty-five watercraft inspectors worked through the summer providing information to the public on watercraft inspections and invasive species. Inspections began in late April and continued though mid-October. Within this 25-week period, watercraft inspectors logged 25,000 inspection hours. A total of 41,000 watercraft/trailers were inspected. During the inspection season, inspections were conducted at 46 fishing tournaments and continued through October in order to reach waterfowl hunters. Inspectors distributed more than 6,600 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.
The Invasive Species Program also worked cooperatively with nine lake associations and citizen groups to increase inspection hours in their areas. These citizen groups funded additional hours of inspection at their accesses while the Invasive Species

Program provided training, equipment, and supervision. The Lake Minnetonka Conservation District (LMCD) worked with the Invasive Species Program for a fifth year. Inspectors spent an additional 2,160 hours on five Lake Minnetonka accesses because of the funding provided by the LMCD.

Enforcement. Conservation officers spent 2,494 hours enforcing the invasive species laws and rules. Statewide, there were 18 civil citations, three summons, and 15 written warnings issued to individuals for violation of invasive species laws and rules. One citation was issued for transporting zebra mussels on a boatlift, while other enforcement occurred related to transport of water from infested waters in trucks. Officers spent many hours educating the public on the regulations and handing out informational pamphlets. Officers also made presentations at resort and lake association meetings.

Education. Providing information to the public about the actions they can take to help stop the spread of aquatic invasive species is a key component of this effort. New informational signs about the discovery of zebra mussels in Lake Mille Lacs were installed at all public water accesses and at six resorts on the lake. The signs explain what boaters can do to make sure they don't transport any invasive species. The DNR, in partnership with the USFWS and Cabela's, established a new multimedia exhibit on aquatic invasive species at the Cabela's store in Owatonna.

Developing best management practices. DNR staff from the divisions of Ecological Services and Fish and Wildlife continued to work with Fisheries staff to evaluate the risks posed by Fisheries activities, and to propose additional precautions to prevent the spread of invasive species through those activities.

3. Reduce the impacts caused by invasive species

Current efforts to reduce the harmful effects of invasive species are primarily focused on the management of aquatic plants.

Curly-leaf pondweed. The Invasive Species Program supported efforts to manage curly-leaf pondweed by 1) providing technical assistance to individuals and groups working to manage nuisance curly-leaf growth, including participating in the development of several lake vegetation management plans; 2) providing funding for curly-leaf pondweed management pilot projects (see Hot Topics); and 3) assisting with research of new methods of curly-leaf pondweed management.

Eurasian watermilfoil. To reduce the problems caused by Eurasian watermilfoil (milfoil), the Invasive Species Program worked closely with lakeshore owners, lake associations, local units of government, and others to manage milfoil with herbicides and mechanical harvesting. The amount of funding offered to cooperators for control of milfoil was increased. Cooperators received $82,000 to manage milfoil on 23 lakes statewide. The DNR also treated milfoil in the immediate vicinity of five public water accesses to 1) reduce the risk that users of the lake inadvertently transport milfoil from the lake to other bodies of water; and 2) improve access to the lake.

Purple loosestrife. Both herbicides and biological control methods (the use of insects that eat purple loosestrife) are being used to manage this invasive plant. Since 1992, 8.8 million leaf-eating beetles have been released in 800 of the 2,300 known purple loosestrife infestations. Severe defoliation of purple loosestrife by the beetles was observed on more than 20% of sites monitored in 2006. These efforts have been supported by cooperators from local, county, and state entities that rear and release the beetles statewide.

Coordination and cooperation among groups that manage invasive species

The successes achieved in preventing and managing invasive species result from cooperation among various organizations. Management of curly-leaf pondweed, milfoil, and purple loosestrife involves cooperation with local lake associations and local units of government. Efforts to prevent introductions of new invasive species into Minnesota often involve the participation of DNR staff in state and regional groups such as the Minnesota Invasive Species Advisory Council (MISAC) and the Mississippi River Basin Panel on Aquatic Nuisance Species. Involvement with these groups promotes partnerships, develops uniform messages in educational products, and ensures sharing of information about new and existing invasive species. In 2006, MISAC's members such as DNR and the Minnesota Department of Agriculture, continued the development of a statewide invasive species management plan. The plan will be available for public comment in January 2007, and finalized in June 2007.

Revenue and Expenditures

The primary funding source for the Invasive Species Program is a $5 surcharge on watercraft registered in Minnesota. The surcharge, coupled with additional funding appropriations from the Water Recreation Account, generated approximately $1.9 million in funds for the 2006 fiscal year. Most of the funding (71%) was spent on education, watercraft inspections, enforcement, and management/control efforts (Figure 3).

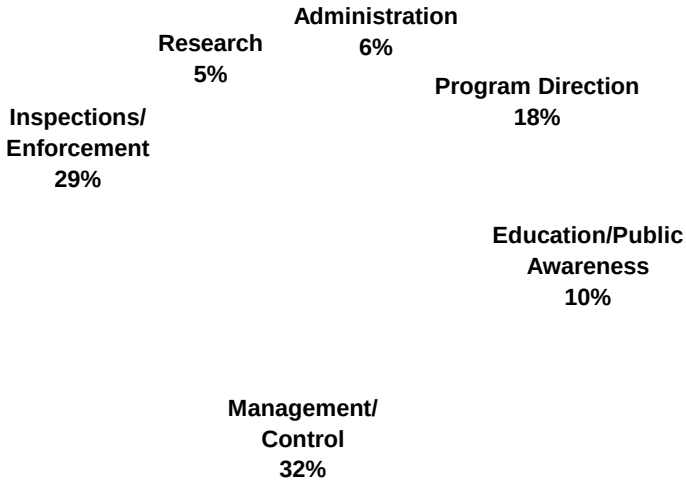

Figure 3. Invasive Species Program spending in FY06 by major categories.

The 2006 Legislature increased invasive species funding by providing $550,000 from the General Fund, allowing substantial increases in a number of invasive species activities including: 1) expand grants to help groups manage invasive aquatic plants; 2) expand enforcement efforts by DNR conservation officers; 3) expand DNR's ability to monitor and manage invasive terrestrial plants on state lands and minimize the movement of invasive species associated with DNR activities; 4) expand DNR's efforts to identify activities that have a high risk of moving invasive species and work with the groups/businesses involved to reduce risk; and 5) expand public awareness efforts.

Additional funding, primarily for research projects, was received from the U.S. Fish and Wildlife Service, U.S. Forest Service, and the Minnesota Legislature as recommended by the Legislative Commission on Minnesota Resources.

Plans for the future

Continued investment in a comprehensive program to protect Minnesota's natural resources from future damage due to invasive species is paramount. The DNR plans to continue working with other agencies and groups that are members of MISAC to develop and implement comprehensive strategies and actions that will enable Minnesota to better address the multitude of invasive species issues.

Introduction

Overview of DNR's Invasive Species Program

Minnesota's Invasive Species Program was established in 1991. The Minnesota Department of Natural Resources (DNR) has responsibility to develop and coordinate a statewide program to prevent the spread of invasive species of wild animals and aquatic plants. Single species programs preceded this comprehensive program. 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, the DNR was officially assigned a coordinating role for Eurasian watermilfoil control (Minnesota Statutes 84D.02, Subd. 2).

The DNR Invasive Species Program addresses many invasive species that are present in Minnesota such as Eurasian watermilfoil, purple loosestrife, zebra mussels, and spiny waterfleas (see Table 1). The program also attempts to prevent the introductions of invasive species that have the potential to move into Minnesota such as hydrilla, water chestnut, and Asian carp. To do so, the Program identifies potentially invasive species in other areas of North America and the world, predicts pathways of spread, and develops and implements solutions that reduce the potential for introduction and spread (see Risk Assessment and Risk Management). Prevention efforts are often undertaken with other states, agencies, and partners with similar concerns.

Most activities of the Invasive Species Program are conducted or directed by staff from DNR's Division of Ecological Services. The Division hires an additional 40 or more students during the summer to inspect boats at public water accesses and help implement management activities. Staff from the DNR divisions of Fish and Wildlife and Enforcement, as well as the Bureau of Information and Education, also contribute significantly to the implementation and coordination of invasive species activities. In total, the equivalent of over 20 full-time positions are focused on invasive species work.

In recent years, the Program has begun to address terrestrial plant species on DNR managed lands. Within DNR, our goal is to enhance the ability of field staff to effectively manage terrestrial invasive plants on DNR managed lands. Key strategies include: 1) coordinate inventories of public lands for invasive species; 2) gather, maintain, and share knowledge of integrated pest management (chemical, mechanical, and biological control) for invasive terrestrial plants; 3) fund management efforts on state managed lands; and 4) develop or improve management practices through research (i.e., biological control).

Other State Invasive Species Control Programs

The DNR and the Minnesota Department of Agriculture (MDA) administer prevention and control programs for other invasive species in Minnesota. The DNR's Division of Forestry, working in cooperation with the MDA, is charged with surveying and controlling forest pests, including non-native organisms such as bark beetles. Once an invasive forest pest becomes established in the state, DNR Forestry becomes responsible for management of the species. The DNR's Forest Health Protection Team prepares a separate annual report.

Table 1. Invasive Species Program efforts that address specific invasive species.

A = public information and education B = watercraft inspections to prevent spread
C = population surveys and monitoring D = technical assistance for control by others
E = control to reduce populations, escapes, and nuisance conditions
F = research on biology and management G = regulations

Invasive Species of Aquatic Plants and Wild Animals in Minnesota	Efforts of DNR's Invasive Species Program						
	A	B	C	D	E	F	G
Aquatic Plants							
Curly-leaf pondweed (*Potamogeton crispus*)	X	X	X	X	X	X	X
Eurasian watermilfoil (*Myriophyllum spicatum*)	X	X	X	X	X	X	X
Flowering rush (*Butomus umbellatus*)	X	X	X	X	X	X	X
Other non-native aquatic plants	X		X	X	X	X	X
Purple loosestrife (*Lythrum salicaria*)	X		X	X	X	X	X
Animals							
Common carp (*Cyprinus carpio*)			F		F/W	F/W	X
Mystery snails (*Bellamya [=Cipangopaludina] chinensis; B. japonica; and Viviparus georgianus*)			E				X
Mute swan (*Cygnus olor*)			X		X		X
New Zealand mudsnails (*Potamopyrghs antipodarum*)	X	X	X				X
Round goby (*Neogrobius melanstromus*)	X	X	F/O		NIF		X
Ruffe (*Gymnocephalus cernuus*)	X	X	F/O		NIF		X
Rusty crayfish (*Orconetes rusticus*)	X						X
Spiny waterflea (*Bythotrephes longimanus*)	X	X	F				X
Zebra mussel (*Dreissena polymorpha*)	X	X	X			X	X

E - DNR Ecological Services staff in addition to those in the Invasive Species Program monitor these species
F - DNR Fisheries monitors these species
F/O - DNR Fisheries and other agencies monitor these species
F/W - DNR Fisheries and/or Wildlife occasionally manage this species at priority sites
NIF - Inland waters will be addressed as outlined in a Nonindigenous Fish (NIF) plan
W - DNR Wildlife is involved with research on this species

The MDA is the lead regulatory agency to address terrestrial invasive species, i.e., noxious weeds, gypsy moth, emerald ash borer, sudden oak death, under authority in Minnesota Statutes, Chapter 18G,H, J and Chapters 18 and 21. 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 Invasive Species Information Center in Duluth. The Center promotes education and outreach to prevent the spread of aquatic invasive species in the state.

Other DNR Support
Staff from the DNR divisions of Fish and Wildlife and Enforcement, and the Bureau of Information and Education contribute significantly to the implementation and coordination of invasive species activities.

Divisions of Ecological Services and Fish and Wildlife
Pesticide enforcement specialists from Ecological Services and Aquatic Plant Management Specialists in DNR Fisheries assist with the management of various invasive plants including purple loosestrife, Eurasian watermilfoil, and flowering rush. In addition to these staff, other individuals from the Division of Fish and Wildlife and the Division of Ecological Services 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 invasive species of aquatic plants and wild animals. A regional enforcement supervisor acts as invasive species enforcement coordinator within the Division of Enforcement to assist in scheduling, executing, and reporting on enforcement activities related to invasive species. A chapter describing enforcement activities is included in this report (see Enforcement).

Bureau of Information and Education
Susan Balgie and other staff from the Bureau of Information and Education provide support for the Invasive Species Program's public awareness activities (see Education and Public Awareness).

Participation in Statewide, Regional, and National Groups
The DNR Invasive Species Program and other agencies in the state participate in statewide groups such as the Minnesota Invasive Species Advisory Council, the County Agricultural Inspectors Advisory Committee, and the Weed Integrated Pest Management Group.

The DNR Invasive Species Program and others in the state participate in regional and federal activities regarding harmful invasive species. 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 was not active in the Great Lakes Panel on Aquatic Nuisance Species during 2006.

Participation on the Mississippi River Basin Panel on aquatic nuisance species helps keep Minnesota informed of regional and federal efforts regarding invasive species and provides a voice for Minnesota interests. Jay Rendall was selected to chair the new panel during its initial year in 2003 and was the Immediate Past Chair in 2006.

Program staff are also involved with the following statewide or regional groups:

- Gary Montz and Jay Rendall - St. Croix River Zebra Mussel Task Force (see Appendix B);
- Luke Skinner - national garlic mustard biocontrol working group; Midwest Invasive Plant Network;
- Jay Rendall - Council of Great Lakes Governor's Aquatic Invasive Species Task Force; and
- Jay Rendall - national Asian carp work group that drafted a national Asian Carp Management and Control Plan, which was out for public comment in 2006.

Development of a Statewide Invasive Species Management Plan

Several state, federal, and private entities continued efforts to draft a state invasive species plan for aquatic and terrestrial invasive species in 2006. The draft has been revised based on the input at a full-day workshop, "A Workshop to Develop a Comprehensive State Plan on Invasive Species for Minnesota," held on October 24, 2005. While the MDA and DNR are mandated to have invasive species response plans, several other agencies and organizations are interested in helping implement the plan and are reviewing the plan framework to determine which of the actions they can help implement. A combined plan will provide a common structure for coordinating and guiding invasive species detection and response efforts, and encourage input from partners. Benefits of a combined plan include increased access to funding, stronger partnerships among interested parties, reduced duplication of effort, and development of a common vocabulary. A new draft plan will be distributed for public comment in January 2007. Finalization of the plan is scheduled for April 2007.

Expenditures

Funding Sources

Funding for activities conducted by the Invasive Species Program comes from a variety of state, federal, and local sources.

State Funds

The primary funding source is a $5 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 2). The 2003 Legislature, at the Department's request, expanded funding for the Invasive Species Program by appropriating additional funding from the Water Recreation Account. This funding was from the "regular" watercraft license receipts (Table 2). Funding was increased by $380,000 in FY04 and by $440,000 beginning in FY05. The 2005 Legislature provided an additional $154,000 per year of watercraft license funding in FY06 to allow the Department to expand its grant program focused on the management of invasive aquatic plants. Funding was expanded again by the 2006 Legislature; $550,000 from the general fund was appropriated.

Table 2. State and local funding (in thousands of dollars) received by the Invasive Species Program, fiscal years 2003, 2004, 2005, 2006, and 2007.

Fiscal Year	Water Recreation Account		General Fund	Legislative Commission on Minnesota Resources[1]	Local Contributions	Total
	Surcharge[2]	Regular				
2003	1,191	0		45	11	1,247
2004	1,202	380		55	19	1,656
2005	1,201	440		54	17	1,712
2006	1,201	594		100	42	1,937
2007	1,201	594	550	100	53	2,498

[1] State appropriations, as recommended by the LCMR, from the Environment and Natural Resources Trust Fund or the Minnesota Resources Fund or both.
[2] Includes funds appropriated directly to the Division of Enforcement for invasive species work.

Over the last decade, significant support for invasive species research has 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) (Table 2).

Recommendations by the LCMR are based on results of a competitive process. During the FY04/05 biennium, funding was provided for a project focused on European buckthorn and spotted knapweed, two high-priority terrestrial invasive plants. This

project is a joint effort by DNR and the Minnesota Department of Agriculture. LCMR recommended additional funding for garlic mustard and buckthorn biocontrol research during the FY06/07 biennium.

Federal Funds

The DNR seeks funding from federal sources for a variety of program activities. Recent projects that have been funded are shown in Table 3. For example, funds from the U.S. Fish and Wildlife Service (USFWS) support the implementation of the St. Croix Interstate Management Plan for aquatic invasive species. A portion of DNR's public awareness efforts and zebra mussel monitoring dives on the St. Croix River are paid from these funds. Two grants have been approved by the U.S. Environmental Protection Agency (USEPA) to support research on the biological control of European buckthorn. Funding from the U.S. Forest Service (USFS) was also obtained to initiate a garlic mustard biological control project. These federally funded projects often operate on timelines that are different from the state's fiscal year.

Table 3. Recent proposals submitted by the Invasive Species Program that received federal funding.

Category	Federal Fiscal Year[1] Grant Awarded	Calendar Year(s) Used	Grant Amount (1000s of $)	Source
Implement St. Croix management plan for aquatic nuisance species				
	2004	2005	71	USFWS
	2005	2006	73	USFWS
	2006	2007	46	USFWS
Research on biological control of European buckthorn				
	2003	2004-05	50	USEPA
Research on biological control of garlic mustard				
	2003-06	2004-07	225	USFS
	2006	2006	10	USFWS
Terrestrial invasive plant management				
	2005	2005-07	200	USFWS

[1] The federal fiscal year begins on October 1 and ends on September 30.

Local Funds
Local groups work with the DNR to manage invasive aquatic species and, in some cases, provide funds to expand planned efforts (Table 2). During 2006, nine local groups provided funding so that the number of watercraft inspections on specific lakes could be increased. See Watercraft Inspections and Awareness Events for a more detailed account of these cooperative efforts.

Timeframe
This report covers activities in calendar year 2006, which includes the last half of the Minnesota fiscal year 2006 (FY06), January 1-June 30, 2006, and the first half of fiscal year 2007 (FY07), July 1-December 31, 2006. To provide a comprehensive review of expenditures and to meet the report's January 15, 2007 due date, we report on expenditures that were incurred in FY06 (July 1, 2005-June 30, 2006).

Cost Accounting
The DNR has a detailed cost accounting system that is used to track how funds are spent. All staff time and expenditures are coded. The coding allows us to sort work/expenditures by the type of activity being undertaken (e.g., management activities, public awareness efforts) and/or by what invasive species the work is focused on.

Minnesota Statute (M.S. 84D.02 Subd. 6) identifies five expenditure categories that must be reported. Those categories are Administration, Education/Public Awareness, Management/Control, Inspections/Enforcement, and Research. A sixth category, Program Direction, 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 in the following chapters.

Administration
Administration includes *Support Costs* assessed by the Division of Ecological Services for general office supplies, office rent, telephones, postage, workers' compensation fees, computer support fees, and the state accounting system fees. *Clerical* costs and *Administrative Support* costs that fund administrative staff that work for the divisions of Fish and Wildlife and Ecological Services are shown separately. Administration also includes a prorated portion of the salary of division staff that serve on regional management teams. Two categories of expenses, "other work" and "staff leave time," listed as an Administrative expense in previous Annual Reports have been changed. "Other work" (time staff spent in training, supervising, and providing assistance to other Division or Department projects) has been moved to the Program Direction category. "Staff leave time" (time used for holidays, sick leave, and vacation) has been apportioned across all categories based on the proportion of staff time invested in that category. Those costs are listed in Table 4 associated with the "Other" heading.

Program Direction
This category includes a variety of activities and expenditures. *State coordination* includes general program planning, preparation of state plans and reports (including this document), and general invasive species coordination with a wide variety of groups. This category includes the work of program staff as well as various managers in the Division of Ecological Services who periodically work on invasive species issues. For

example, program staff and managers meet with groups such as Minnesota Waters and the Lake Minnetonka Conservation District to discuss state activities and to coordinate efforts. Program staff are also members of state-level coordinating groups, such as the Minnesota Invasive Species Advisory Council, which are included here. Expenditures primarily represent staff time spent on these activities. *Regional and federal coordination* includes staff time and out-of-state travel expenses to work with regional and federal partners on invasive aquatic species issues. Examples from 2006 include: a Mississippi River Basin Panel on Aquatic Nuisance Species (ANS) meeting, participation on conference calls associated with the Council of Great Lakes Governors' ANS Initiative, and a regional workshop focused on Promoting Regional ANS Cooperation and Coordination. "Training, supervising, related work" represents a variety of work activities that staff participate in to improve their skills, direct co-workers, or help on other projects. Finally, *Equipment and Services* includes fleet costs not assigned to a specific activity and the cost to purchase and repair boats, trailers, computers, and similar items.

Education/Public Awareness
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 invasive aquatic 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 invasive species information on the DNR's Web site.

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

Inspections/Enforcement
Expenditures in this category include the costs that conservation officers incur enforcing invasive 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 invasive 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 to improve existing control methods, better understanding of the ecology of invasive species, better risk assessment tools, and to evaluate program success. When research is focused on a specific invasive species, such as Eurasian watermilfoil, purple loosestrife, or curly-leaf pondweed, detailed expenditure information for that species is shown.

Fiscal Year 2006 (FY06)

Expenditures on aquatic non-native invasive species activities during FY06 (July 1, 2005-June 30, 2006) totaled $1,996,000 (Table 4). Expenditures from the Water Recreation Account, the largest single source of funding, are listed along with spending from other accounts. For this report, spending from the "Surcharge" and "Regular" portions of the Water Recreation Account have been combined into a single column. The Invasive Species Program manages other accounts that also support program activities. An example is revenue from the sale of public awareness material. This revenue is deposited in a "Publications Account" and is used to fund future public awareness efforts. Grants received from various state or federal funding sources, such as LCMR recommended appropriations and the USFWS, are other examples. As is shown in Table 4, most program activities focused on the management of non-native, invasive terrestrial plants are funded by grants from other organizations.

The final expenditure category reflects work by non-Program staff in the divisions of Ecological Services, Fish and Wildlife, and Enforcement who occasionally do invasive species work as part of their regular DNR jobs. In FY06, major expenditures in this category included $31,000 to the Division of Enforcement (reflecting enforcement efforts that were not covered by Invasive Species Program funds) and $2,000 of invasive species work coded to the Game and Fish Fund (primarily reflecting the work of aquatic plant management specialists in DNR Fisheries). This summary may not reflect the contribution of all DNR staff that provide assistance to manage non-native invasive aquatic plant and wild animal species.

The $1,633,000 of "Water Recreation Account" expenditures by the Invasive Species Program during FY06 (Table 4) were less than the $1,795,000 appropriated by the Legislature. A substantial portion of those unspent funds have already been committed for invasive species management or research efforts, but final payment had not been made at the time this report was written. Funds that were appropriated for FY06 and were not spent will "roll forward" and be available to spend in FY07. Figure 4 provides a broad outline of how the $1,633,000 was spent; a detailed breakdown of spending by category is shown in Table 4.

The Management/Control category ($544,000) and Inspections/ Enforcement category ($465,000) represent two largest segments of the budget; these two categories accounted for 62% of Water Recreation Account funds expended in FY06. The focus on those two categories, plus Education/Public Awareness which represents an additional 10% of FY06 spending, reflects the priority the Department places on efforts to prevent the spread of invasive species and to help manage the problems those species cause.

Eurasian watermilfoil and curly-leaf pondweed are the two invasive species that received the most focus based on dollars spent. FY06 spending targeted specifically at Eurasian watermilfoil was $172,000; $150,000 was spent on curly-leaf pondweed. Other invasive species that received substantial funding included zebra mussels ($82,000) and purple loosestrife ($68,000). Spending on management or research efforts focused on zebra mussels and curly-leaf pondweed has increased substantially in recent years. Individual chapters of this report provide details on the activities accomplished with those funds.

The Program Direction category increased significantly as a proportion of the budget between FY05 and FY06; from 11% to 18%. The rapid increase reflected a fundamental change in how the Division of Ecological Services tracks expenditures. Prior to FY06, work division managers (e.g. the Division Director or Assistant Director), planners, or IT staff invested in invasive species activities was "donated", and the invasive species budget was not charged for their time. Beginning in FY06, the Division instituted a new cost-accounting system that was designed to enhance budget integrity; all work efforts are now coded to specific accounts that reflect the type of work that is being done.

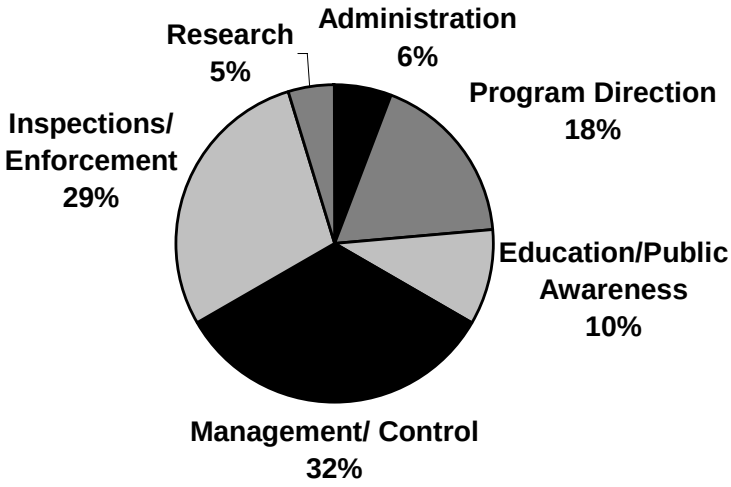

Figure 4. Invasive Species Program spending (Water Recreation Account only) in FY06 by major categories.

Fiscal Year 2007 (FY07)

Since this report is due in the middle of FY07, projected expenditures for that fiscal year are not reported. A comprehensive review of FY07 expenditures will be provided in the 2007 Annual Report.

New Funding: The 2006 Legislature expanded invasive species funding ($550,000 from the General Fund was appropriated; see Table 2) that will allow substantial increases in a number of invasive species activities. The Department intends to expand activities focused on both aquatic and terrestrial species. Specific target areas include:

1) expand grants to help groups manage invasive aquatic plants;
2) expand enforcement efforts by DNR conservation officers;
3) expand DNR's ability to monitor and manage invasive terrestrial plants growing on state lands and minimize the movement of invasive species associated with DNR activities;
4) expand DNR efforts to identify activities that have a high risk of moving invasive species and work with the groups/businesses involved to reduce risk; and

5) expand public awareness efforts.

These new efforts will be described in detail in next year's report.

The following chapters describe in detail the activities that were conducted during calendar year 2006 with FY06 and FY07 funds.

Table 4. Invasive species related expenditures in fiscal year 2006 (FY06) (in thousands of dollars).

Categories of Expenditures	Water Recreation Account FY06	Other Funding Sources FY06
Administration		
Division Support Costs	35	
Regional Representation	13	
Clerical	6	
Administrative Support	42	
Subtotal	**96**	
Program Direction		
State coordination	167	
Support regional/federal activities	13	
Training, supervision, related work	82	
Equipment and services	15	
Other	14	
Subtotal	**291**	
Education/Public Awareness		
Radio spots, TV, Web site development	147	[1]50
Other	12	
Subtotal	**159**	**50**
Management/Control		
General	72	[1]2
Eurasian watermilfoil	138	[1]3
Purple loosestrife	58	
Zebra mussel	82	
Curly-leaf pondweed	135	
Flowering rush	1	
Other aquatic invasive species	4	
Terrestrial invasive species	<1	[1]64
Other	53	
Subtotal	**544**	**69**
Inspections/Enforcement		
Watercraft inspections	363	[1]17
Enforcement - access checks	53	[1]31
Prevention - laws/risk assessments	22	
Other	27	
Subtotal	**465**	**48**
Research		
General	3	--
Eurasian watermilfoil	34	--
Purple loosestrife	10	--
Zebra mussel	--	--
Curly-leaf pondweed	15	--
Flowering rush	--	--
Other aquatic species	6	--
Terrestrial Invasive Plants	--	[2, 3]196
Other	10	--
Subtotal	**78**	**196**
Total	**1633**	**363**

[1]Other DNR funding, [2]LCMR funding, [3]Federal funding
*Subtotals are rounded to the nearest thousand

Education and Public Awareness

2006 Highlights

- Television advertising was expanded in the Twin Cities and southeastern Minnesota/western Wisconsin
- New "Stop Aquatic Hitchhikers!" radio and television ads were created and distributed
- New communication media were used to implement the "Stop Aquatic Hitchhikers!" campaign: displays at travel information centers, billboards, and lawn banners.

Introduction

Issue

Public awareness of invasive species is one of the key strategies used to limit their introduction and spread. Since 1992, the DNR's Invasive Species Program has made substantial efforts to create and maintain a high level of public awareness and understanding about invasive species. An annual communications plan is developed by Program staff 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 invasives;
- Help these groups identify and report findings of specific invasive species;
- Outline actions that boaters, anglers, seaplane pilots, waterfowl hunters, aquarium owners, water gardeners, riparian landowners, bait dealers, and others must do to reduce the spread of these invasives; and
- Enhance understanding of management options.

Progress in Public Awareness - 2006

Similar to previous years, key components of this year's communication efforts included radio and television advertising, public service announcements, printed materials, press releases, media contacts, newspaper ads, information on DNR's Web site, staffing at sports shows and other major events, educational displays and exhibits, informational signs at public water accesses, and training. New methods and messages were also used in 2006 to broaden exposure and provide variety.

Radio

Radio was used in 2006 to reach boaters and anglers in several ways. Paid advertising was used on major stations in the Twin Cities and Brainerd during the weeks preceding the Fishing Opener, Memorial Day, and Fourth of July. The stations were selected for their listener profiles which correspond with those of boat owners. Paid advertising also was used on Minnesota News Network (MNN), reaching an additional 73-affiliate stations throughout greater Minnesota in July.

In late summer, a special effort was made in the Duluth market, Brainerd Lakes area, and southeastern Minnesota (Rochester and Winona) where zebra mussel infestations occur.

In addition, public service announcements (PSAs) were made available to Minnesota radio stations along with communication encouraging program managers to play these announcements. A new PSA for waterfowl hunters was created by Winkleman Productions for Minnesota, Iowa, and Wisconsin as part of a three-state "Stop Aquatic Hitchhikers!" project. The PSA was distributed in the state this fall by DNR.

All the current PSAs are available in two audio formats from the DNR's Web site, making them readily accessible to station managers at any time and eliminating the need to mail tapes each year (www.dnr.state.mn.us/news/psas/index.html).

Television

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 invasive species in the area. A new television spot was created for this market and aired during morning and evening newscasts leading into popular outdoors segments including "Sportsman's Notebook," "Gone Fishing'," "Up North," and "Pro's Pointers." The new spot featured a DNR conservation officer alerting boaters and anglers about the threat of zebra mussels, round gobies, and New Zealand mudsnails and the steps they could take to help prevent the spread of these invasives.

A second version of the spot was created to air in other markets where zebra mussels and Eurasian watermilfoil are a primary concern. This version was shown during late summer and early fall on "Minnesota Bound," a long-running half-hour program that appeals to both outdoor enthusiasts and general audiences. The ad was also placed on the ABC-affiliate station in LaCrosse, Wisconsin, to reach viewers in southeastern Minnesota/southwestern Wisconsin.

In addition, spots concerning zebra mussels and Eurasian watermilfoil were aired on metro area cable stations to coincide with outdoor programs and Twins baseball coverage.

Newspapers and informational materials

A newspaper advertising campaign was completed in 2006. The ad design incorporated the "Stop Aquatic Hitchhikers!" national campaign logo and listed four simple steps that boaters and anglers could take to help stop the spread of aquatic invasive species. The ad ran in the outdoor or recreation sections of daily newspapers in targeted areas of the state including Brainerd, Duluth, Rochester, Twin Cities, and Winona in spring and summer. The ads also ran in several specialty newspapers reaching boaters, campers, anglers, outdoor enthusiasts, and tourists. Newspaper coverage continued in the Mille Lacs and Aitkin newspapers to keep attention on the recent discovery of zebra mussels in the area. A special aquatic invasive species section, with information provided by the Invasive Species Program, was included in the annual *Mille Lacs Fishing Digest* to help inform users of that lake about new regulations that apply at zebra mussel infested waters.

Distribution of the *Help Stop Aquatic Hitchhikers* brochure continued this year. The publication provides simple steps that recreationists can take to help stop the spread of aquatic hitchhikers. Distribution efforts are ongoing to sport and outdoors shows, special events, and information kiosks. The brochure was also distributed to ten travel information centers located at Albert Lea, Beaver Creek, Dresbach, Fisher's Landing, Grand Portage, Moorhead, St. Cloud, St. Croix, Thompson Hill (Duluth), and Worthington. The centers are staffed year-round, with the exception of the Fisher's Landing and Grand Portage facilities, which are open May-October. An estimated 3,000,000 visitors stopped at the centers.

The 2006 *Minnesota Fishing Regulations* included a section on invasive aquatic species. Descriptions and illustrations of several invasive species were provided along with a summary of invasive species laws and other pertinent information. 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 the accidental transport of invasive plants and animals. The guide is updated annually and was distributed this year to more than 300,000 boaters.

Information about invasive species was included in the 2006 edition of the *Explore Minnesota Fishing Guide*, a publication of Explore Minnesota Tourism. The guide targets anglers traveling to Minnesota and is widely distributed throughout the Midwest at major outdoor sports shows including those held in Chicago, Milwaukee, Kansas City, Omaha, Des Moines, Sioux Falls, and Fargo. It is also distributed at travel information centers across Minnesota and some Minnesota outdoor retailers.

A new information card was produced that provides references to state laws that apply at zebra mussel infested waters. Two versions of the card were developed: one version was produced specifically for distribution in the Mille Lacs Lake area and the other was produced for statewide distribution. Watercraft inspectors, conservation officers, and other groups helped to distribute the cards to the public.

Billboards

DNR partnered with Wildlife Forever, U.S. Forest Service, U.S. Fish and Wildlife Service (USFWS), and Minnesota Sea Grant to develop and post billboards with the "Stop Aquatic Hitchhikers!" message on key state travel routes to and from lake areas. One of the most apparent was on I-35 at the point where I-35E and I-35W merge just south of Forest Lake. This billboard was posted for the entire summer. Twelve other billboards were posted for one-month periods during July and August on key highways including 210, 169, 94, and 71.

News releases

News releases alerting the public about invasive species in the state were distributed throughout the year to all major media outlets in Minnesota. In addition, several interviews with Minnesota media resulted in expanded television, radio, and print coverage this year, helping to raise awareness about these issues. Major daily and weekly newspapers ran articles generated from the news releases and several of these articles were syndicated to other newspapers around the country.

DNR Web site
The DNR's Web site pages covering invasive species and related information are updated regularly (www.dnr.state.mn.us/ecological_services/invasives/index.html). In addition to profiles of many invasive species, the site includes an overview of the Invasive Species Program as well as information on individual programs and staff. A summary of Minnesota's invasive species laws, lists of invasive species and infested waters, as well as field guides to aquatic plants and aquatic invasive 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
Invasive Species Program staff participated at the Minnesota State Fair and other events to distribute literature and information. DNR watercraft inspectors staffed the display throughout the State Fair providing a venue for visitors to ask specific questions about invasive species while visiting the exhibit. The display was updated in 2006 to include a new three-sided kiosk with information for water gardeners and aquarium owners, tips for preventing the transport of nuisance species, and updates on new areas of concern. An estimated 800,000 people visit the DNR's exhibits at the Minnesota State Fair each year.

Special exhibits
Underwater Adventures
DNR and Underwater Adventures are partnering on new informational exhibits at Underwater Adventures located at the Mall of America. One of the topics is invasive species. In 2006, a large silver carp replica and a "Habitattitude" message were placed at the koi pond. Staff from DNR, USFWS, and Sea Grant also began discussions about potential aquatic invasive species related messages and exhibits in Underwater Adventures.

Cabela's
An educational exhibit and supporting Traveler Information System (TIS) was established at the Cabela's store in Owatonna. The DNR worked with the USFWS, Pacific States Marine Fisheries Commission, and Minnesota Department of Transportation on this project.

Two major elements comprise the project design: a TIS in the vicinity of the store and an in-store exhibit.

A TIS is a low frequency radio transmission that allows motorists within approximately a 3- to 5-mile radius of the signal to tune in to AM radio station 1610 for public service announcements about aquatic invasive species. The TIS was installed at Cabela's in 2005 and is currently operating, but some performance is below expectations. The DNR is working with the vendor to determine if it is possible to improve the broadcast quality. Two roadside signs on Interstate 35 advertise the station and frequency.

An aquatic invasive species exhibit was fabricated and installed in Cabela's in December 2005. The exhibit features three major components: a habitat diorama of aquatic invasive species, including painted depictions or replicate mounts of zebra mussels, silver and bighead carp, snakehead, goby, ruffe, spiny waterflea, sea lamprey

on lake trout, Eurasian watermilfoil, curly-leaf pondweed, and water chestnut seeds; a large plasma screen TV displaying DVD footage of invasive species information and imagery; and an interactive computer kiosk with a field guide of aquatic invasive species, what we can do to prevent their spread, and what agencies are doing to address the problems. New video programming for the large screen TV was completed in 2006. Final content for the computer kiosk about aquatic invasive species, how people can help, and the partners who developed or supported the exhibit was also completed in 2006.

Boat washing program
The DNR worked on a collaborative effort with Minnesota Waters (formerly Minnesota Lakes Association), Minnesota Bass Federation, Minnesota Sea Grant, and other local partners in the Brainerd lakes area for the second consecutive year. The region is a popular vacation and fishing destination and the risk of spreading aquatic invasive species from one body of water to another is extremely high. Patterned after a similar effort in South Dakota, the project was designed to encourage boaters to wash and dry their boats before entering or upon leaving a body of water.

Area car wash owners were contacted to find out if they would be willing to participate in the program and promote their facilities as boat and trailer wash stations. The facilities also had to meet specific criteria required by the DNR to ensure that they were suitable for washing boats and recreational equipment.

A collateral piece listing the participating car wash facilities along with a location map was produced and distributed to local convenience stores, bait shops, travel information centers, and sporting goods retailers. The publication explained why it is important to wash boats and trailers and provided step-by-step instructions for removing invasive species from recreational equipment.

Public water accesses
DNR watercraft inspectors completed more than 25,000 hours of inspection (see Watercraft Inspections and Awareness Events) providing boaters with information and tips on ways to reduce the spread of invasive species. 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, service and professional organizations, 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.

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 invasives has continued to increase. In 2006, watercraft inspectors (see Watercraft Inspections and Awareness Events) continued to find high levels of public awareness of invasives by boaters throughout Minnesota. Information from past surveys was 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 Invasive 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 news stories 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 survey said they took action (Armson 2001), an increase over a similar Minnesota 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 invasive species and results show that this investment is resulting in significant increases in public awareness and preventive actions taken. In another 2000-2001 survey question, 99% of Minnesota boaters said they were very likely or somewhat likely to take precautions.

A new survey of boaters was initiated in 2006 as part of the three-state “Stop Aquatic Hitchhikers!” campaign and will be continued in 2007.

Participation of Others in Public Awareness Activities

“Stop Aquatic Hitchhikers!” Campaign

A three-state project and other projects are building upon efforts to extend and evaluate the national “Stop Aquatic Hitchhikers!” *c*ampaign along key invasion corridors in Minnesota, Wisconsin, and Iowa. A federal grant from the National Oceanic and Atmospheric Administration/Sea Grant and funds from other federal and state sources have enabled several collaborators including the Minnesota, Iowa, and Wisconsin DNRs, Wisconsin Sea Grant, Cabela’s, Wildlife Forever, Crystal Pierz Marine, Minnesota Arrowhead Association, Minnesota Waters (formerly the Minnesota Lakes Association and Minnesota Rivers Council) to implement a multi-media campaign. The campaign features the “Stop Aquatic Hitchhikers!” logo and prevention messages on highway signs, billboards, display panels at rest areas, television, radio, and newspaper ads, kiosks at retail outlets, gas pump toppers, lawn banners, windshield tags, and stickers. A face-to-face and self-administered survey during 2006-2007 will evaluate whether the campaign changed boater awareness and behaviors.

National "Habitattitude" Campaign

*"*Habitattitude*"* is a national public education campaign launched in fall 2004 to prevent the release of unwanted aquarium fish and plants into the environment by aquarists and water gardeners. The government-industry-academia coalition was formed in partnership with the Pet Industry Joint Advisory Council, the USFWS, and the National Oceanic and Atmospheric Administration's Great Lakes Sea Grant Network, led by Minnesota Sea Grant. The campaign's logo and "don't release" message are appearing on fish bags, new aquaria, brochures and other print media, news releases, newsletters, and ads in hobbyist magazines across the country. The campaign's Web site www.habitattitude.net provides resources to campaign partners and consumers. The DNR became a partner on the campaign in late 2005. The Invasive Species Program and MinnAqua Program are two DNR entities that will be involved in campaign efforts in Minnesota. Others, such as Minnesota Sea Grant and Region 3 of the USFWS, will be implementing the campaign in the state.

In Minnesota, Sea Grant has worked to broaden the campaign partnership. Joining Sea Grant and the USFWS are the Minnesota DNR, the Minnesota Pollution Control Agency, the University of Minnesota Extension Service, the Minnesota Nursery and Landscape Association (MNLA), the Great Lakes Aquarium, the Lake Superior Zoo, and the City of Duluth's Environmental Advisory Council. In 2006, DNR, Sea Grant, and USFWS have been discussing ways to integrate "Habitattitude" into Underwater Adventures at the Mall of America. DNR developed a display that includes the campaign brand and prevention message at the koi pond. DNR and USFWS are also working with the Minnesota Zoo to incorporate "Habitattitude" and other invasive species messages into its facility.

In 2006, Sea Grant promoted the campaign via 76 presentations, displays, and events, and distributed materials that reached more than 5,285 people. A guest article was featured in *From Shore to Shore* (Jan-Feb, 2006), the University of Minnesota Extension Service's Shoreland Education Team newsletter. Sea Grant led production of a new *Get Habitattitude* bookmark, co-sponsored by the DNR, USFWS, Underwater Adventures, and MNLA, for distribution at the 2006 Minnesota State Fair and other events and locations. In collaboration with Sea Grant, the DNR also produced a new display banner and launched new Web pages for Minnesota partners and consumers (**www.dnr.state.mn.us/Habitattitude/**).

Results of a 2005 consumer survey suggest that public education can prevent the release of unwanted aquarium fish and plants, resulting in environmental protection. A follow-up campaign survey is planned for 2007.

Minnesota partners

Other agencies and organizations in Minnesota have been cooperatively involved with public awareness activities in the state for more than a decade and continue to conduct public awareness efforts throughout the state.

The Minnesota Invasive Species Advisory Council (MISAC) produced a 2007 invasive species wall calendar highlighting 12 non-native invasive species that are potential threats in Minnesota. The publication contains information about each of the featured species such as keys to identification, means of spread, and impacts. This was the

third year MISAC produced the calendar, which was distributed to natural resource, agricultural, highway, and other professionals in the state. The project was a cooperative effort of MISAC members to raise awareness of all types of invasive species and to direct the recipients to the Council's Web site at www.mda.state.mn.us/misac/ where they can obtain further information about invasive species. The DNR is a member and co-chair of MISAC.

Teachers throughout Minnesota can reserve educational "traveling trunks" that include hands-on activities for classroom instruction. The trunks contain a wide range of tools designed to teach youth about aquatic invasive species (AIS). In addition to the DNR, educators can obtain the trunks from several organizations including the University of Minnesota Sea Grant, Bell Museum of Natural History, Great Lakes Aquarium, and National Park Service. For a more detailed description of the trunks, visit: www.seagrant.umn.edu/education/ttea.html. The trunks were updated last year.

The University of Minnesota Sea Grant Program is a leader in public education campaigns, outreach, and research. The tools and expertise Sea Grant provides help people learn how to prevent the spread and minimize the impacts of AIS. The Program serves as a liaison between interest groups and business, and government agencies and task forces. Sea Grant often partners with the DNR to co-develop programs and materials to avoid duplication of effort, save money, resources, and time, and to integrate our expertise to effectively address AIS issues in Minnesota and beyond.

2006 Highlights of Minnesota Sea Grant's educational activities related to aquatic invasive species in Minnesota:

- Minnesota Sea Grant co-leads "Habitattitude," a national public education campaign for aquarists and water gardeners (see National "Habitattitude" Campaign earlier in this chapter).

- On behalf of the Great Lakes Sea Grant Network, Minnesota Sea Grant continues to promote the successful Aquatic Invasive Species-Hazard Analysis and Critical Control Point Curriculum (AIS-HACCP, has-sip) training, which is aimed at preventing the spread of AIS or providing AIS-free certification for aquaculturists, wild baitfish harvesters, hatchery operators, fisheries managers, and conservation officers. AIS-HACCP is being adopted by a variety of organizations, tribes, and agencies in Minnesota, the Great Lakes, and beyond. In 2006, three workshops sponsored by the network were attended by Great Lakes audiences.

- Sea Grant along with the Water Resources Center and the University of Minnesota Extension Service's Shoreland Education Team sponsored workshops on aquatic invasive species control and management, reaching an estimated 275 people across Minnesota.

- Sea Grant continues to lead a project designed to reduce the potential for water gardening and shoreland restoration to introduce and spread invasive plants or animals in Minnesota. Sea Grant surveyed nursery professionals and water

gardeners and developed educational messages and materials. Posters, tip cards, and plant sticks and tags were distributed to nurseries and garden centers in Minnesota.

- Sea Grant continues to educate youths about AIS by promoting and distributing lesson plans, traveling resource kits, and curricula to teachers and educators. Presentations were given at “River Quest," and “River Watch Congress." Sea Grant continues to partner with the Great Lakes Aquarium by sponsoring “Partners In Education," a program that trains University of Minnesota, Duluth undergraduate education students. With content based in part on AIS, the program reached an estimated 1,500 students from dozens of classrooms in 2006.

- Sea Grant coordinated a reprint of 473,000 *AIS WATCH ID* cards for six partners across the Great Lakes region.

- Sea Grant responded to the spring announcement of the New Zealand mudsnail infestation in the Duluth-Superior Harbor by working together with the U.S. Environmental Protection Agency, Minnesota and Wisconsin DNRs, and Wisconsin Sea Grant to issue a news release and to produce 90,000 new *New Zealand Mudsnail WATCH ID* cards for distribution in Minnesota and Wisconsin.

- Sea Grant staff provided 118 presentations about harmful AIS at 71 conferences, workshops, meetings, guest lectures, and other events reaching more than 8,600 people in 2006. Sea Grant also facilitated a session featuring the “Stop Aquatic Hitchhikers!” campaign called “AIS—What Can We Do to Stop the Spread?” at the 2006 Lakes and Rivers Conference, Duluth. Booths co-hosted by Sea Grant and the DNR include the 2006 Minnesota Green Expo (Minneapolis), Midwest Flyfishing Expo (Bloomington), and Duluth Outdoor Sports Show, and the Lakes and Rivers Conference (Duluth).

- Sea Grant staff participate on state, regional, and national task forces including the Minnesota Invasive Species Advisory Council (MISAC) Communication and Outreach Committee (chair), Great Lakes Panel on ANS (alternate Minnesota representative), St. Croix River AIS Task Force, 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 invasive species by watercraft users.
- Continue to make public awareness of zebra mussels in Minnesota near Brainerd, Lake Superior, 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 MISAC and other multi-entity groups to enhance interagency communication on the status and progress of invasive species management efforts.
- Expand public awareness activities that are cooperative ventures with lake communities outside the metro area.
- Increase information about invasive species available through 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 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 invasive 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 less complicated. 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.

In 1999, the Division of Enforcement took steps to better focus enforcement efforts. An Invasive Species Enforcement Plan that allocated hours and prioritized invasive species enforcement needs in each district was initiated.

Activities in the statewide Invasive Species Enforcement Plan were included as a specific component of the FY05-FY07 annual work plans for all Enforcement Division activities. These annual work plans describe in detail each enforcement district's responsibilities in meeting various responsibilities, including invasive species, and ensures that appropriate work activities and levels are accomplished. Funding levels were increased in November 2006 to address the Division exceeding hourly goals for the last several years. Additional funding was added to the Division to be spent on enforcement efforts to prevent the spread of invasive species. District work plans will be updated for the remainder of FY07, FY08-09.

Goals

One of the Department's goals related to enforcement is to prevent the spread of invasive species within Minnesota. Part of this goal is to lower the percentage of trailered boats transporting prohibited invasive species, aquatic vegetation, and infested water within the state. The second part is to respond quickly when reports are received that potentially invasive wild animals have escaped from captivity or are found in the wild from unknown sources. The Division also responds to complaints of illegal water appropriation and movement of equipment from infested waters.

Progress in Enforcement Efforts - 2006

Several types of enforcement activities have occurred to limit the introduction and spread of invasive species including: educational work and presentations, checks of trailered boats at water accesses, monitoring commercial bait harvest equipment, investigating complaints concerning water appropriation or equipment transfer from infested waters, and follow up on illegally-released non-native animals. In 2006,

conservation officers spent 2,494 hours enforcing the invasive species laws and rules. Statewide, there were 18 civil citations, three summons, and 15 written warnings issued to individuals for violation of invasive species laws and rules. Officers spent many hours educating the public on the regulations and handing out informational pamphlets. Officers also made presentations at resort and lake association meetings.

The following paragraphs summarize some of the key enforcement initiatives that have been used to meet the goals listed above.

Roadchecks

Roadchecks of trailered boats were not conducted in 2006. Beginning in mid-summer of 2002, roadchecks were suspended. The history behind suspending roadchecks is 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 invasive species roadchecks.

- Developments in our state's appellate courts during 2002 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 discontinued the use of game and fish roadchecks and invasives 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. The Division is currently pursuing reinstituting roadchecks based on current case law.

Enforcement at water accesses

<u>Enforcement near infested waters</u>

Conservation officers increased efforts in the Mille Lacs area based on the presence of zebra mussels and high numbers of boats that are used on the lake. Officers also continued to conduct invasive species enforcement activities along the Mississippi River, focusing on the transportation of zebra mussels and infested water. Those boating on infested waters must empty bilges, live wells, and bait buckets so that they do not transport zebra mussels. During the summer of 2006, officers spent time enforcing invasive species regulations along the Mississippi and St. Croix rivers (including accesses near, Hastings, Red Wing, Lake City, Kellogg, Winona, and LaCrescent), Mille Lacs Lake and lakes in the Brainerd Lakes area. There was also an increase in minnow dealer checks in the Mille Lacs area and training/meetings were

held near Mille Lacs and in St. Cloud with officers and bait dealers regarding special permits to harvest bait in infested waters.

Efforts also focused on educating the public on the laws relating to transporting water from infested waters in live wells and bait buckets. Cards with information about laws related to zebra mussel infested waters were handed out to the public again this year. Time was spent educating the public at accesses at infested waters.

Boatlifts and Trucks

Transport of Boatlift
The transport of a boatlift from a zebra mussel infested water highlighted another possible pathway of spread and resulted in an enforcement action. In October, a boatlift was transported from Lake Ossawinnamakee to Sullivan's Resort on North Long Lake. The lift was not cleaned prior to transport and had many visible zebra mussels attached (see photo). The local conservation officer interviewed the lift owner who was subsequently issued a citation for transporting zebra mussels.

While the lift had not yet been placed into water at North Long Lake, this highlights the need to clean all equipment and objects that rest in our waters prior to any movement. Boat lifts, docks, rafts, swim platforms–all these may harbor invasive species. Owners should clean off all equipment prior to moving the equipment anywhere off of their property.

Figure 1. Zebra mussels attached to boatlift removed from Lake Ossawinnamakee.

Transport of Water by Trucks

A couple situations occurred in 2006 related to the transport of water from infested waters, which indicated the need for increased awareness of state laws that apply to that activity and enforcement action. In July, a truck owned by a local paving business had filled with lake water at Lake Ossawinnamakee. DNR staff observed the action and reported this to a conservation officer, who followed up with the company to inform them of the illegal action. The truck was pulled from service and sanitized before reuse. In September, a sewer service truck from the Aitkin area attempted to remove water from Lake Mille Lacs by placing a hose from the truck into the lake. This imminent transport of infested water was halted when a DNR watercraft inspector informed the truck driver that it was not legal to take water from Lake Mille Lacs without a permit. The Invasive Species Program followed up with the company to inform them that state regulation prohibits transport of water from infested waters. During the discussion, the company indicated that this procedure is fairly common for that type of business. During the summer of 2006, a conservation officer who had written several warnings and citations to boaters for not draining water commented that people may not notice the signs about infested water at the water accesses and suggested that the signs should be in a florescent color to get the public's attention.

Enforcement during the waterfowl hunting season

Conservation officers conducted invasives related 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 accesses statewide.

Responding to escaped animals

In 2006, there were five responses involving mute swans in the wild (see Management of Mute Swans). There were reports to conservation officers of escapes of non-native deer and elk and other non-native wild animals. An elk herd was recaptured in the Brainerd area with two bulls having to be destroyed as the owner could not capture them. In the Pine River area, a hunter shot an escaped deer before the owner could capture the animal.

Goals for 2007

The DNR believes that enforcement plays a critical role in reducing the spread of invasive species, however, it is only part of the larger prevention effort. Increased funding will be used to increase enforcement efforts to historical levels, and increase efforts in areas of infestations. In order for the regulations on invasive 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. Enforcement will be increased near infested waters, specifically those infested with zebra mussels and milfoil. The Enforcement Division also has a representative on the Terrestrial Invasives Species work group.

Regulations and Proposed Changes

Introduction

Issue

Minnesota's regulations related to invasive species of aquatic plants and wild animals currently in Minnesota Statutes and Minnesota Rules are generally considered to be comprehensive by entities outside of Minnesota that have reviewed invasive species regulations. The state statutes related to these invasive species are found in Minnesota Statutes, Chapter 84D. The administrative rules related to invasive 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 invasive (harmful exotic) species.

It is the DNR's responsibility to designate *infested waters* (see M.S. 84D.03). Water bodies are designated infested if they contain specific invasive species such as Eurasian watermilfoil, zebra mussels, ruffe, round goby, white perch, and spiny waterfleas. The current *infested waters* lists are found in Minnesota Rules, Chapter 6216 at www.revisor.leg.state.mn.us/arule/6216.

The DNR is also required to adopt rules (per Minnesota Statutes 84D.12) that place non-native aquatic plant and wild animal species into various regulatory classifications and prescribe how invasive species permits will be issued (per Minnesota Rules 6216.0265). The DNR is authorized to adopt other rules regarding infested waters and invasive species of aquatic plants and wild animals.

Goals

- 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 invasive 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, or use other means, which may be allowed in the future, that designate additional prohibited invasive species, regulated invasive species, and unregulated non-native species.

Progress in Regulations - 2006

Federal

At the national level, the following are key regulatory areas: 1) reauthorization of the National Invasive Species Act (NISA); 2) national ballast water regulations; and 3) potential designation of injurious wildlife. Progress, or lack of progress, during 2006 on these areas is described below:

- The National Invasive Species Act of 1996 was not reauthorized in 2006.

- The U.S. District Court for the Northern District of California ruled that it would vacate a federal regulation that exempts ballast water discharges from vessels from Clean Water Act (CWA) permit requirements on September 30, 2008. The ruling follows its 2005 decision that found that ballast water discharges are not exempt from CWA permit requirements. The Environmental Protection Agency is appealing those two rulings by a federal district court. The notice of appeal was filed on Nov. 16, 2006. In the notice, EPA tells the U.S. District Court for the Northern District of California that it "hereby appeals" to the U.S. Court of Appeals for the Ninth Circuit to review two rulings regarding Clean Water Act regulation of ballast water discharges by EPA.

- The U.S. Fish and Wildlife Service (USFWS) is continuing to review information related to a proposal to designate black carp, silver carp, and bighead carp as an injurious wildlife species under the Lacey Act. A *Federal Register* notice published on September 5, 2006 stated:

  "*The U.S. Fish and Wildlife Service proposes to add all forms (diploid and triploid) of live silver carp (Hypophthalmichthys molitrix), gametes, eggs, and hybrids; and all forms (diploid and triploid) of live largescale silver carp (Hypophthalmichthys harmandi), gametes, eggs, and hybrids to the list of injurious fish, mollusks, and crustaceans under the Lacey Act. This listing would have the effect of prohibiting the importation and interstate transportation of any live animal, gamete, viable egg, or hybrid of the silver carp and largescale silver carp, without a permit in limited circumstances. The best available information indicates that this action is necessary to protect the interests of human beings, and wildlife and wildlife resources, from the purposeful or accidental introduction and subsequent establishment of silver carp and largescale silver carp populations in ecosystems of the United States."*

  The USFWS had not designated black carp, silver carp, and bighead carp as injurious wildlife as of December 31, 2006.

State statute changes

The DNR proposed technical statutory changes for consideration during the 2006 Legislative Session. The Legislature acted on those recommendations and passed H.F. 3200 that included the following modifications:

- the definition of "invasive species" was changed by removing the clause "can naturalize and";

- the definitions of "prohibited invasive species" and "regulated invasive species" were changed to clarify that non-native species are being classified as types of invasive species;

- curly-leaf pondweed was added as species for which the Department must have a program to curb the spread and control the growth, similar to the purple loosestrife and Eurasian watermilfoil programs within the Invasive Species Program; and

- the definition of "transport" was changed, so that it does not include the transport of *infested water* within a water of the state or to a connected water of the state where the species being transported is already present.

Emergency rulemaking
In 2006, DNR adopted emergency rules to designate waters found to have zebra mussels, Eurasian watermilfoil, and spiny waterfleas as infested waters. The newly designated waters were published in the *State Register* on April 3, 2006.

Permanent rulemaking
Development of proposed permanent rules that was ongoing in 2005 continued in 2006. The proposed rules will designate infested waters that have previously been designated in emergency rule, but have not yet been designated in permanent rules. The proposed rules also will designate northern snakehead fish (*Channa argus*) and New Zealand mudsnail (*Potamopyrgus antipodarum*) as additional prohibited invasive species. Chinese water spinach (*Ipomoea aquatica*) is proposed for redesignation as a *regulated invasive species*. The tubenose goby (*Proterorhinus marmoratus*) and brittle naiad *(Najas minor*) will be proposed for designation as *prohibited invasive species*. Brazilian waterweed (*Egeria densa*) is proposed for designation as a *regulated invasive species*.

Future needs for Regulations and Proposed Changes

- Support the reauthorization of NISA and designations of injurious wildlife such as the silver and black carp.
- Use species evaluations and current literature to propose appropriate designations that will protect Minnesota's environment from the introduction of invasive species.
- Work with staff at the Minnesota Pollution Control Agency who regulate wastewater to inform licensees about laws regarding transport of water from infested waters and also contact marinas statewide regarding invasive species laws.
- Consider changing the signing at water accesses regarding the transport of infested water to improve visibility.

Watercraft Inspections and Awareness Events

Introduction

Issue

The potential for boaters to accidentally move aquatic invasive 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 invasive species.

In 1992, the DNR, 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 aquatic invasive species such as Eurasian watermilfoil, spiny waterflea, 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. Effective June 1, 2004, the 20,000-hour requirement was lowered to 10,000 hours.

Goals

Watercraft inspections help to achieve the second goal of the Invasive Species Program: preventing the spread of invasive species within Minnesota. The inspectors also help to:

- Complete up to 20,000 hours of watercraft inspection at public water accesses across the state;
- Increase public awareness about invasive species and the potential for boaters to transport invasive species between water bodies;
- Reduce the percentage of trailered boats carrying invasive species;
- Increase educational efforts with citizen groups.

Progress in Watercraft Inspections - 2006

Complete required hours of watercraft inspection

In 2006, approximately 45 watercraft inspectors worked through the summer providing information to the public on watercraft inspections and invasive species. Inspections began in late April and continued though mid-October. Within this 25-week period, watercraft inspectors logged 25,000 inspection hours. A total of 41,000 watercraft/ trailers were inspected.

During the inspection season, inspections were conducted at 46 fishing tournaments and continued through October in order to reach waterfowl hunters. Inspectors distributed more than 6,600 Invasive 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 (PWAs) at which they were stationed.

Inspection efforts were conducted across the state in rough proportion to the number of PWAs on infested water bodies, (Table 5 and Figure 5). The actual distribution of time reflects both the number of PWAs and the intensity of public use at those accesses. The percent of time that the program is spending in each region has stayed relatively stable from 2001 to 2006 with an increase in time in Region 2 between 2004 and 2006, (Figure 6). This change could be attributed to the new infestations in greater Minnesota in the past years. There has also been a decrease in Region 4 between 2005 and 2006.

Table 5. Number of watercraft inspections conducted by watercraft inspectors in 2002, 2003, 2004, 2005 and 2006. (*Totals are rounded values*).

Year	DNR Region				Total
	1	2	3	4	
2001	1,700	4,000	27,200	5,800	39,000
2002	660	3,100	32,300	7,700	44,000
2003	760	5,600	29,700	5,500	42,000
2004	1,200	6,800	35,600	6,800	50,000
2005	1,500	8,300	39,500	5,800	55,000
2006	1,900	9,900	25,600	3,200	41,000

The watercraft inspection program has primarily focused on water bodies with infestations of aquatic invasive species. This approach was used because 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 aquatic invasive 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 order to meet the Department's 20,000-hour mandate (M.S. 84D.02, Subd. 4). During 2006, inspections on uninfested waters represented about 21%of the total inspections (8,890 inspections) and approximately 25% of the inspection hours (6,426 hours). Due to an increased number of cooperative contracts for additional inspections at several uninfested water bodies, both the number of hours and inspections at uninfested waters have increased in 2006.

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 "Invasive Species Awareness Events."

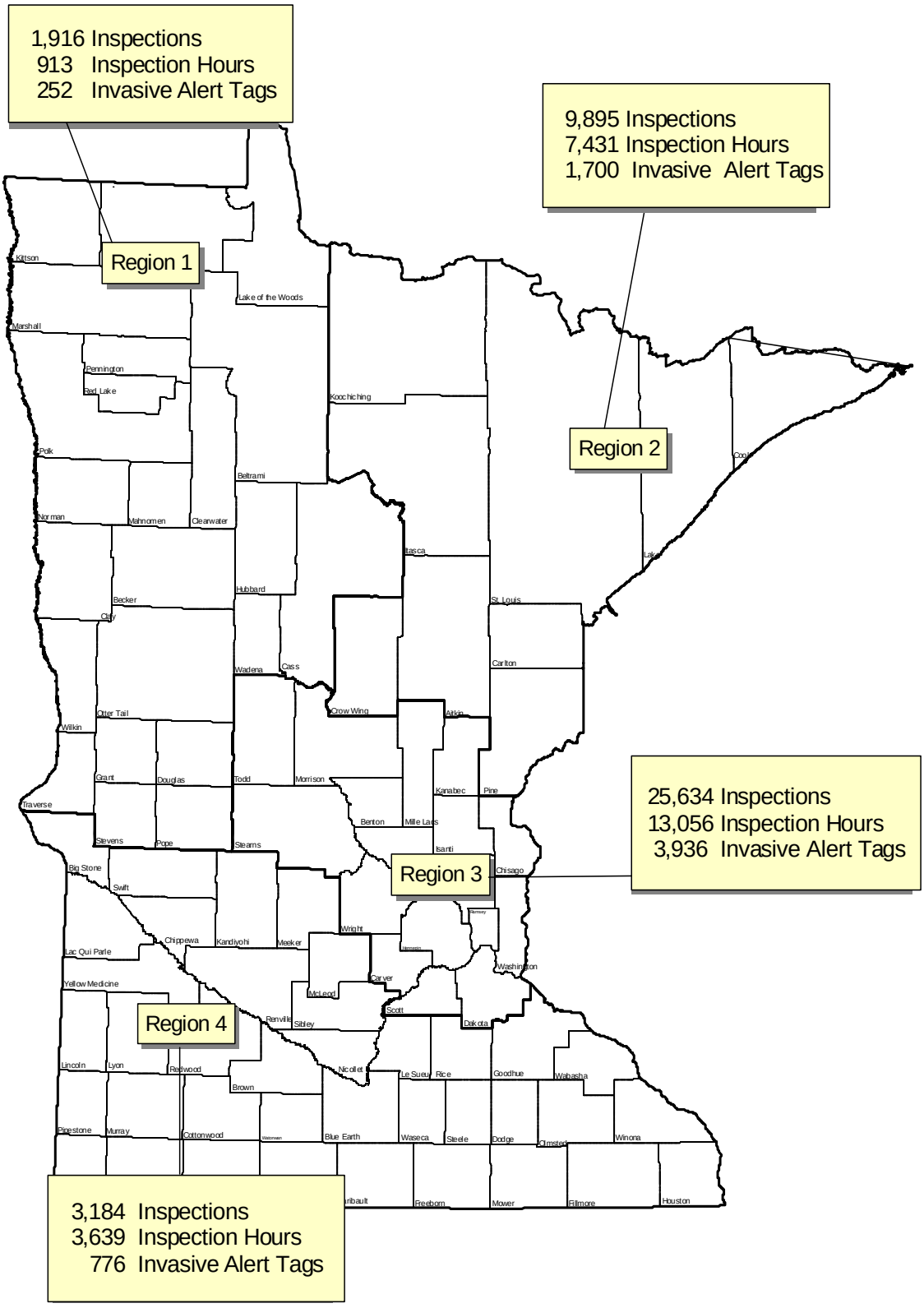

Figure 5. DNR watercraft inspections at public water accesses in 2006.

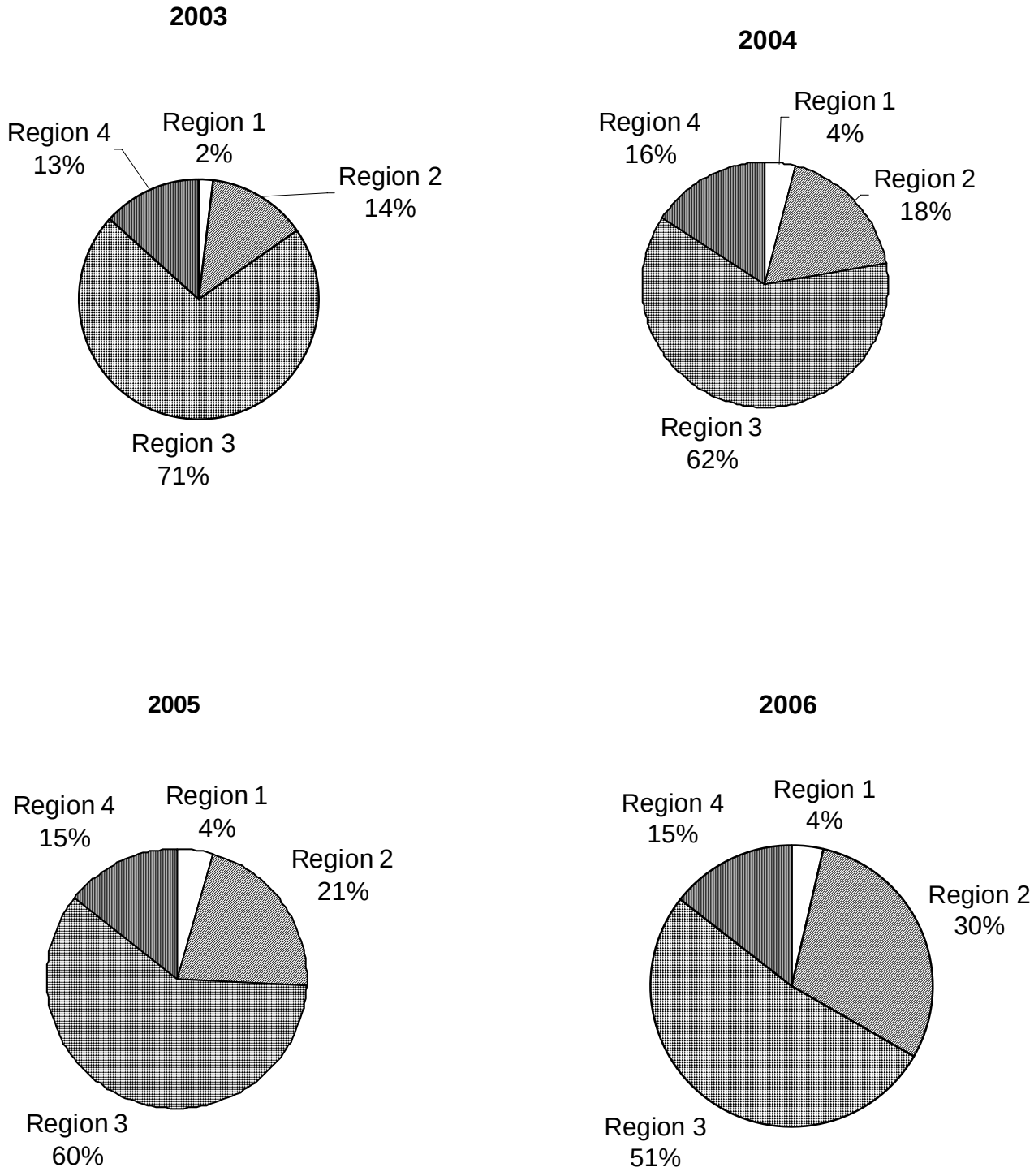

Figure 6. Percent of the state's total watercraft inspection hours spent in each region in 2003, 2004, 2005, and 2006.

Although the program has broadened to include inspections at uninfested waters, the majority of the inspections are still done at infested water bodies. With the population of zebra mussels in Lake Ossawinnamakee increasing since their discovery in 2003 (see Management of Zebra Mussels), it has remained very important to maintain a high level of public awareness effort in the Brainerd area.

In August of 2005, four zebra mussels were discovered in Lake Mille Lacs. In response to this discovery additional watercraft inspectors were sent to Lake Mille Lacs and new informational signs about the discovery of zebra mussels in Lake Mille Lacs were installed at all public water accesses and at six resorts on the lake. The signs explain what boaters can do to make sure they don't transport any invasive species. The Watercraft Inspection Program also set a goal of increasing the number of hours spent at Lake Mille Lacs by 30% in 2006. This goal was achieved and 1,167 hours of inspection were done at accesses on Lake Mille Lacs. During this time, 3,617 boats were inspected.

Increase public awareness

Each boater contacted by a watercraft inspector is asked a standard series of questions. These surveys provide important information on the public's awareness of invasive 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 invasive species laws remains very high among Minnesota boaters. The percent of watercraft users who responded "yes" when asked if they were aware of the invasive species laws for the state was 97%. Boaters from other states using Minnesota water bodies had a slightly lower response at 95%. The range of percentages for each Minnesota county where at least 100 inspections had been done varied from 89% (in Washington County) to 100% (in Aitkin, Isanti, Kandiyohi, and Morrison counties). Of those who said they were not familiar with the laws, slightly more than 3% (20 out of 620) had vegetation on their watercraft when they entered the access. In contrast, slightly more than 1% (295 out of 19,248) of the people who said that they were familiar with the laws entered the access with vegetation.

Decals are given to boaters (see Decal Program for Trailered Watercraft) to signify that they have talked with a watercraft inspector. Of those with no decal, 4.3% said they were not familiar with the invasive species laws. In contrast, of those with a year 2006 decal, 18 out of 6,717 boaters or slightly less than three tenths of one percent said they were not familiar with the laws. This suggests that the Watercraft Inspection Program is successful at educating boaters about Minnesota's invasive species laws.

Reduce the percentage of trailered boats carrying invasive species

The Watercraft Inspection Program has been unable to assist with roadchecks due to changes in the law that prevents the Department from conducting them (see Enforcement).

Increase educational efforts with citizen groups

In 2006, the Watercraft Inspection Program participated in many public awareness activities and worked with several citizen groups in order to educate the public about aquatic invasive species. Inspectors answered questions both at the invasive species display at the Minnesota State Fair and Celebrate Lake Pepin Day. The inspectors also

educated citizens at Cannon Valley Trail Days in Welch. The Watercraft Inspection Program was also able to work with several citizen groups throughout the season both through awareness events and participation in lake association meetings. Two volunteer trainings were conducted during the season; one of the trainings was with the Whitefish Area Property Owners Association and the other was held at the Aitkin River and Lakes Fair. Both the Whitefish Area Property Owners and the Big Watab Lake Association worked with inspectors to hold awareness events at their accesses.

The Watercraft Inspection Program also worked cooperatively with nine lake associations and citizen groups to increase inspection hours in their areas. These citizen groups funded additional hours of inspection at their accesses while the Watercraft Inspection Program provided training, equipment, and supervision. The Lake Minnetonka Conservation District (LMCD) worked with the Watercraft Inspection Program for the fifth year. Inspectors spent an additional 2,092 hours on five Lake Minnetonka accesses because of the funding provided by the LMCD. Both Bay and Pike lake associations worked cooperatively with the DNR for the third year. Pike Lake Association's cooperative efforts with the Watercraft Inspection Program increased inspection hours on its lake by 375 hours and Bay Lake Association's cooperative efforts increased inspection hours by 304 hours. The Big Sandy Lake Association worked cooperatively with the DNR for the second year and increased the hours spent at Big Sandy by 181 hours. Five lake associations were new to the cooperative inspection program in 2006. Three of those lake associations are from the west central part of the state: the Otter Tail Lake Association increased its hours by 42, the Pelican Lake Association cooperatively hired for 211hours, and the Big Watab Lake Association increased its hours by 98. The Lower Hay Lake Association is part of the Whitefish Area Property Owners Association in the Brainerd area and increased its hours by 79. Medicine Lake is located in Hennepin County in the west metro and increased its hours by 109. The Watercraft Inspection Program was very pleased with the strong citizen group involvement we experienced this year.

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 (Figure 7). 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 14% of the watercraft checked by watercraft inspectors were found with vegetation.

Transportation of Other Invasive Species

There were no zebra mussels found on boats being launched into Minnesota waters. One watercraft was found to have attached zebra mussels while exiting the St. Louis River in mid-May of 2006. This demonstrates a clear risk of zebra mussels being moved on boat hulls or on plants caught on trailers if boats are not properly cleaned. Anglers who "catch" zebra mussels off the bottom and discard them in the bottom of their boats can also move them. One watercraft also exited the St. Louis River at the end of July with a round goby. In each of these cases, the watercraft owner would have been asked to dispose of the invasive specie before leaving the access.

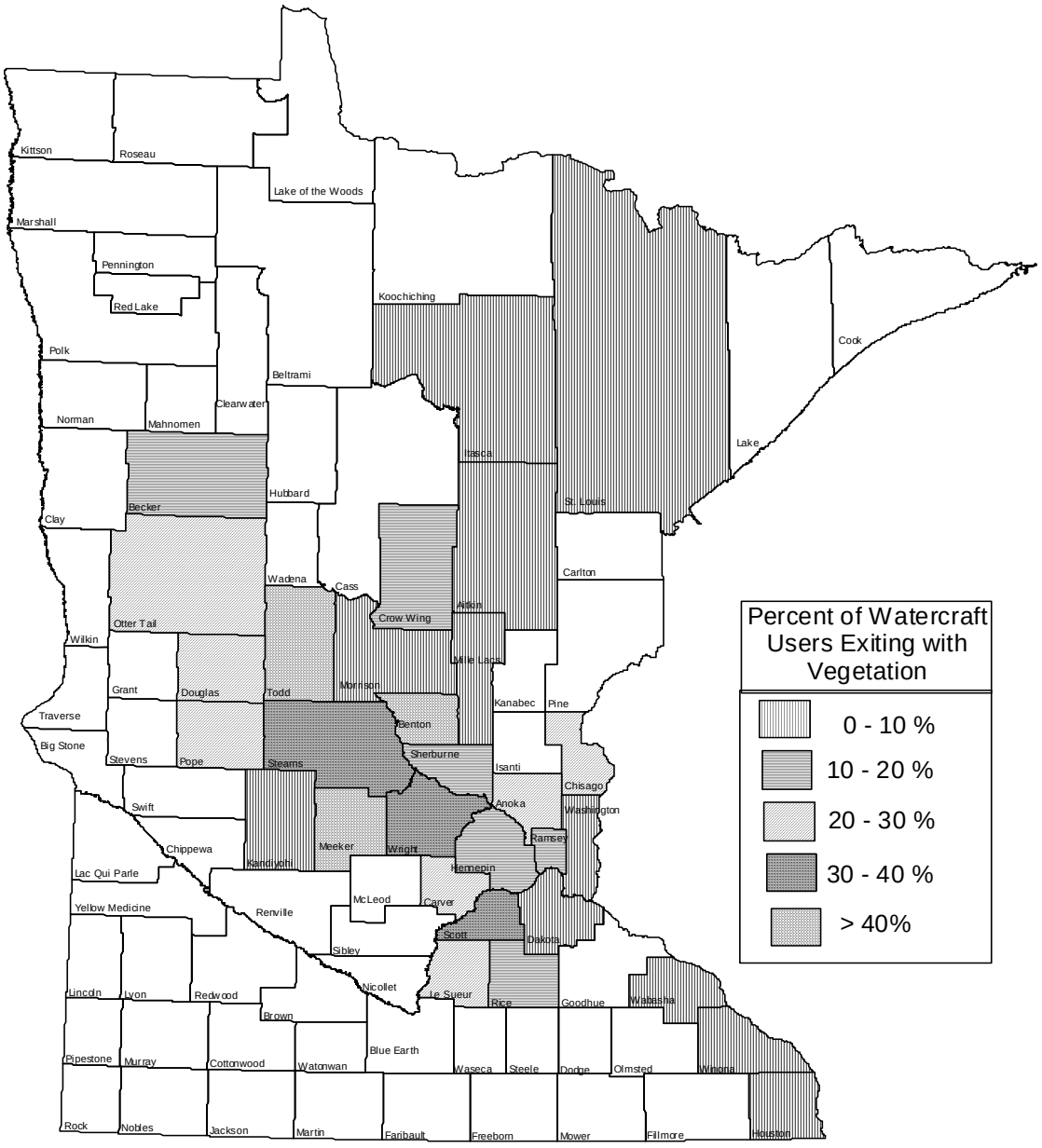

Figure 7. Percentage of exiting watercraft with attached vegetation prior to inspection and cleaning (in counties where more than 100 boats were inspected upon leaving an access).

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 their concerns and to reduce the duplication of education efforts, a decal was developed and distributed to boaters whose watercraft had been inspected for invasive species (Figure 8). 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 11 years now and have been well received by the public. The approximately 27,000 decals distributed during the 2006 boating season also remind boaters to inspect their boats when inspectors are not present.

Future needs and recommendations for watercraft inspections

- Increase cooperation and partnerships with citizen groups that would like to help raise awareness in their areas.
- Expand the number of community events in which we participate in order to educate new audiences about invasive species.

Figure 8. Decal provided to boaters by DNR watercraft inspectors in 2006.

Risk Assessment and Risk Management

2006 Highlights

- DNR staff from Ecological Services drafted Permanent Rules that include new infested waters and new regulated and prohibited species.
- DNR staff from the divisions of Ecological Services and Fish and Wildlife continued to work with DNR Fisheries to evaluate the risks posed by Fisheries activities, and to propose additional precautions to prevent the spread of invasive species through those activities.
- DNR staff from nine divisions began work on an Operational Order to reduce the movement of invasives through DNR activities.

Introduction

Many invasive species that cause problems in other parts of the United States or in other countries do not yet occur in Minnesota but could become established here. Keeping these species out of Minnesota is a high priority not only for the environment, but also for the state's economy. Failure to interrupt pathways that bring these species to Minnesota, and to address high-risk species can result in introductions that are costly to manage and may become perpetual problems.

Risk assessments are a way to determine how non-native species move into the state and to identify which species pose the greatest threat to Minnesota. Risk assessments need to be updated regularly as new information becomes available. In addition, continuing to gather information about a non-native species in the state can help determine whether to implement new and/or different management strategies.

Risk assessments provide the basis for planning and implementing risk management activities. Risk management activities include, but are not limited to: public education, regulation, and management. The results of a risk assessment can be used to recommend that species be classified as prohibited, regulated, unregulated, or unlisted (M.S. 84D.04-.07). For example, the results of the risk assessment of curly-leaf pondweed led the Invasive Species Program to propose the species be classified as a *prohibited invasive*, to support research on new management methods for curly-leaf, and to investigate whether repeated lake-wide treatments of curly-leaf pondweed could provide ecological benefits (See Management of Curly-leaf Pondweed).

Goals

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

- Identify invasive species that may be harmful to Minnesota resources;
- Identify the pathways by which invasive species come to Minnesota;
- Determine the best options to prevent the release and establishment of potentially invasive species and to implement them.

Risk assessment of individual non-native species and risk management recommendations

A risk assessment of a potentially invasive, non-native species includes an assessment of how likely it is to be introduced into the state, the likelihood of its naturalization in the state, the possible adverse effects it may have on native species, outdoor recreation, and other uses of natural resources in Minnesota, and the potential for its control. To date, the Invasive Species Program has completed risk assessments on 48 species (Invasive Species Program, 2005, 2006). These risk assessments have been used to guide risk management activities and are part of a process for deciding on risk management activities not only for species that were evaluated, but also for ones that will be reviewed in the future.

Permanent Rules

During 2006, DNR staff reviewed the risk assessments prepared in previous years and proposed several permanent changes to Minnesota Rules chapter 6216. Invasive Species (http://www.revisor.leg.state.mn.us/arule/6216/). In addition to the changes noted in last year's annual report (Invasive Species Program, 2006), DNR staff proposed that tubenose goby and brittle naiad be listed as prohibited invasive species. DNR staff also proposed that waters that contain brittle naiad and flowering rush be listed as infested waters. These recommendations were based on the review of these species based on the following questions:

1. What are its pathways of spread, and what is the probability it is being introduced to Minnesota?
2. What is the probability it can become established in Minnesota?
3. Could it be harmful to Minnesota's economy, environment, or society?
4. How can it be controlled?
5. How severe are the consequences of establishment?

Risk assessment of pathways of invasive species introduction, spread, and risk management recommendations

Guidelines for DNR Fisheries Operations

Pathway risk assessments are an attempt to predict how invasive, non-native species will enter Minnesota and in what numbers. During 2006, DNR staff reviewed the analysis of risks associated with DNR Fisheries activities (Invasive Species Program, 2006) and developed guidelines to prevent transport of invasive plants by DNR Fisheries. DNR Fisheries staff are now developing a plan to implement those recommendations.

Development of a DNR Operational Order to reduce the spread of invasives

In 2006, an intra-departmental team began efforts to develop an Operational Order (Op Order) to reduce the spread and impact of invasive species by DNR resource management activities. This team has representatives from the DNR divisions of Ecological Services, Enforcement, Fish and Wildlife, Forestry, Lands and Minerals, Parks and Recreation, Trails and Waterways, Waters as well as the Bureau of Management Resources. The scope of the operational order will include all DNR

activities that relate to movement of terrestrial and aquatic invasive species. The purpose of the proposed Op Order is to:

1. Ensure that DNR resource management activities comply with existing statutes and rules governing invasive species;
2. Develop appropriate responsibilities and procedures for the prevention and management of invasive species in relation to DNR resource management activities;
3. Ensure that DNR resource management activities comply with the forest certification CAR concerning invasive species.

It is expected that a working draft of the OP Order will be ready by the open water boating season in 2007. The Op Order will create a reporting mechanism to ensure compliance and necessary updating of the Op Order.

Prevention of spread of invasive species through aquatic plant and pet sales

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 and animals represents a significant pathway for the introduction of invasive species into Minnesota waters. The risk that invasive species will make their way into natural waters, either by accidental escape or by deliberate introduction of aquarium or water garden plants or animals, poses a threat to Minnesota lakes, rivers, and wetlands. In 2006, DNR staff distributed educational materials to help interrupt this pathway of invasive species introduction.

DNR staff distributed educational materials developed by Minnesota Sea Grant and the University of Minnesota Extension Service. Key messages were put onto tip cards, plant sticks, and display posters for water gardening centers. Images of the outreach materials can be seen on the Minnesota Sea Grant Web site: www.seagrant.umn.edu/exotics/ais_wg_materials.html.

Invasive Species Program staff updated and continued to distribute two publications aimed at slowing the movement of invasive species through the water gardening trade: *Invasive Aquatic Plants: What every water gardener and shoreline restorer should know, and Invasive Aquatic Plants: 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 invasive species into Minnesota waters. These materials are available on the DNR Web site: www.dnr.state.mn.us/ecological_services/pubs_aquatics.html

The DNR became a partner in the “Habitatitude” campaign, which focuses on preventing the release of animals and plants purchased at pet stores. The DNR ”Habitatitude” Web site provides alternatives to releasing unwanted pets into the wild and explains the problems, which can be caused by such releases. www.dnr.state.mn.us/habitattitude/index.html.

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

Risk Assessment

- Continue to identify non-native species that may be likely to enter or have already entered Minnesota and evaluate their potential to cause problems if they become established in the wild.
- Continue to identify pathways that could bring non-native species into the state.
- Develop a database and maintain files at the DNR of literature about invasive aquatic plant and wild animal species, and pathways of their introduction to guide risk management activities.

Risk Management

- Determine and carry out appropriate actions to deal with species determined to be harmful to Minnesota. Actions will include education, regulations, monitoring and management, and formulation of public policy.

Research

- Encourage, fund, and support research to predict which non-native species are likely to naturalize and be harmful in Minnesota, and to examine the risks associated with particular pathways of introduction of those species.

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Management of Curly-leaf Pondweed

2006 Highlights

- The DNR established a new grant program to provide funding for pilot projects for lake-wide control of curly-leaf pondweed or Eurasian watermilfoil for ecological benefits. Grants totaling $125,000 were given to ten lakes under this program for lake-wide control of curly-leaf pondweed, or for the collection of pre-treatment data.
- Research supported by the DNR included monitoring of the effects of the lake-wide curly-leaf pondweed treatments, studies of turion distribution, viability, and longevity; and determination of the lowest rate of fluridone herbicide needed to control curly-leaf pondweed and stop turion production.

Introduction

Issue

Curly-leaf pondweed (*Potamogeton crispus*) is a perennial, rooted, submersed vascular plant that was first noted in Minnesota about 1910 (Moyle and Hotchkiss 1945). Curly-leaf pondweed is known to occur in 740 Minnesota lakes in 68 of the 87 counties (Figure 9). Unlike most native plants, curly-leaf pondweed plants remain alive through the winter slowly growing even under thick ice and snow cover (Wehrmeister and Stuckey 1978). Therefore, it is often the first plant to appear after ice-out.

By late spring, curly-leaf pondweed 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 an increase in phosphorus (Bolduan et al. 1994) and undesirable algal blooms. A key question underlying management of curly-leaf pondweed is: to what extent do lakes experience algal blooms due to the presence of curly-leaf pondweed, and to what extent do lakes grow large amounts of curly-leaf pondweed due to an abundance of mid-summer algae and the nutrient regime that supports this condition?

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). In order to obtain long-term control of curly-leaf pondweed, the production of turions must be stopped. It is not clear how many years of turion reduction it will take to produce long-term control of curly-leaf.

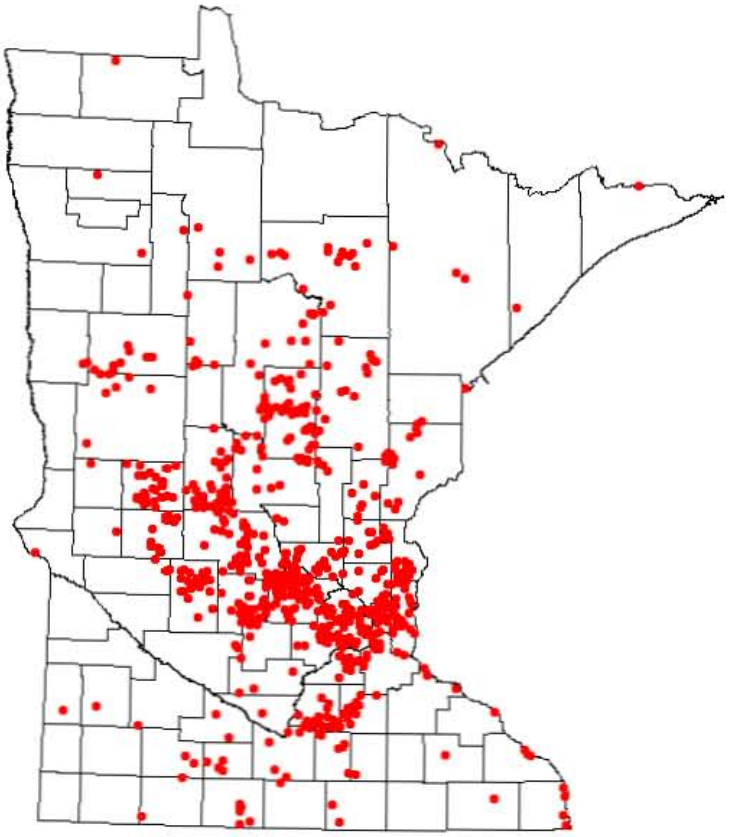

Figure 9. Curly-leaf pondweed locations in Minnesota as of October 2006 (compiled from reports from DNR Fisheries, Wildlife, and Ecological Services staff).

Goals

The DNR has two goals for 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.

The DNR uses both enforcement and public awareness to achieve the first goal. The DNR has two strategies to achieve the second goal. One is to provide technical assistance to people who are managing curly-leaf pondweed. The other is to support and participate in pilot projects and research to improve the management of curly-leaf pondweed.

Prevention of spread

Invasive Species Program staff worked with the general public, lakeshore residents, and researchers to help prevent the spread of curly-leaf pondweed. The Invasive 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. In particular, access inspectors spent time at several lakes, which are

heavily infested with curly-leaf pondweed (See Watercraft Inspections and Awareness Events). DNR conservation officers also helped prevent the spread of curly-leaf pondweed through enforcement of state laws that make it illegal to transfer aquatic plants on public roads (see Enforcement).

Progress in Management of Curly-leaf Pondweed - 2006

Management of nuisances caused by curly-leaf pondweed
Lake residents and lake associations who do routine management of curly-leaf pondweed to reduce nuisance areas using both herbicides and mechanical harvesting undertake the majority of curly-leaf pondweed management done in Minnesota. Past research supported by the DNR indicates that endothall herbicide used at low rates early in the spring is most effective at preventing turion production in the treated areas, and reducing impacts to native plants (Netherland et al. 2000, Poovey et al. 2002, Exotic Species Program 2004). As a result, many of the routine treatments with herbicides are now done with a low rate of endothall herbicide in early spring.

During 2006, DNR staff actively supported efforts to manage nuisance levels of curly-leaf pondweed by providing technical assistance to lake groups working to manage the plant. In addition, the 2006 Legislature directed the DNR to provide some funding to Lake Osakis in Todd County for curly-leaf pondweed management. The DNR plans to provide $30,000 for management of curly-leaf pondweed in Lake Osakis in 2007. Technical assistance included conducting lake vegetation surveys, guidance on the best management practices for controlling curly-leaf pondweed, and assistance in writing Lake Vegetation Management Plans (LVMPs).

Technical Assistance

Surveys of lake vegetation

In 2006, DNR staff conducted three types of lake vegetation surveys in support of curly-leaf pondweed management: point-intercept surveys, surveys of buried turions, and mapping of matted areas of curly-leaf. Point-intercept surveys provide an estimate of the distribution and frequency of occurrence of curly-leaf pondweed and native plants. These surveys were used to describe the distribution and abundance of plant species in surveyed lakes. They were also used, in some cases, to determine if curly-leaf management activities were effective and to see if curly-leaf management caused any damage to native plant communities. DNR staff from the divisions of Ecological Services and Fish and Wildlife conducted point-intercept surveys on 23 lakes with curly-leaf pondweed. Turion surveys were used to determine if successive years of treatment were causing a depletion of curly-leaf pondweed turions in the lake sediments. Mapping was used to determine where curly-leaf pondweed formed dense mats and how those mats were interfering with recreational use of the lake. These efforts served as the basis for evaluation by local residents and the DNR to the extent and severity of the problems caused by curly-leaf pondweed in these lakes, and were used to help determine the best management strategy for the lakes.

Best management practices for controlling curly-leaf pondweed

Staff of the Invasive Species Program continued to provide the public with information on the best management practices for curly-leaf pondweed control through individual contacts and participation in public meetings. In 2006, staff presented talks at the Minnesota Waters Lakes and Rivers Conference in Duluth, and at the Aquatic Plant Management Society meeting in Portland, Oregon. In addition, staff also attended many lake association meetings to discuss the control of curly-leaf pondweed.

The DNR recommends that herbicide treatments of curly-leaf pondweed be done according to the following guidelines:

> Treatments should be done with an endothall based herbicide such as Aquathol K. Treatment of areas more than one acre in size should be done at a low rate, 0.75 to 1.0 ppm endothall with 1.5 ppm used for areas less than one acre in size. Treatments should be done when water temperatures are between 50 and 60 degrees F, and are increasing. While treatment areas can be estimated from surveys in the year before treatment for the purpose of obtaining a permit, actual areas that will be treated should be based on pre-treatment plant surveys conducted in April, in the year of treatment.

These guidelines are based on research that has been done in Minnesota on early-season treatments with endothall (Netherland et al. 2000, Poovey et al. 2002, Invasive Species Program 2006) and guidance from Cerexagri (the manufacturer of endothall based herbicides such as Aquathol K).

Lake vegetation management plans

DNR staff worked with lake groups and local units of government to develop LVMPs. LVMPs contain a description of the condition of the lake and plans to address identified problems. The purpose of an LVMP is to develop agreement on goals for the aquatic plant community, identify issues, design methods to reach those goals, and to design methods to evaluate whether the goals are being reached or not. DNR staff worked on several LVMPs for lakes with curly-leaf pondweed in 2006. Many of the lake vegetation surveys described above were conducted to evaluate the results of curly-leaf management allowed by an LVMP or to help with the development of an LVMP.

Repeated lake-wide treatments of curly-leaf pondweed for ecological benefits: Pilot projects and Research

Lake-wide treatments are those that attempt to treat all, or almost all, of the curly-leaf pondweed in a lake. These treatments usually involve the use of endothall herbicide. Exposure of plants to endothall for approximately 12 to 24 hours can provide high levels of control of curly-leaf pondweed (Netherland et al. 2000, Poovey et al. 2002). Whole-lake treatments are those that apply herbicide to the whole lake. These treatments usually involve the use of fluridone herbicide. Exposure of plants to 4 ppb fluridone for at least 56 days can provide high levels of control of curly-leaf pondweed (Poovey, U.S. Army Engineer Research and Development Center, unpublished data).

In order to provide long-term reduction of curly-leaf pondweed, an infested lake must be treated for several years in a row. This is so that the bank of turions will be depleted.

Even with repeated treatments, it does not appear to be feasible to completely eradicate curly-leaf pondweed from a water body (Invasive Species Program 2006). This may be due to survival of some plants or turions, or germination of seeds (Newman et. al, 2006). Research done by the U.S. Army Engineer Research and Development Center (USAERDC) indicates that at least three years of repeated treatments, and possibly four, are needed to significantly reduce the amount of curly-leaf pondweed in a lake (Invasive Species Program 2006).

The four main goals of repeated lake-wide treatments are:

1. Reduce the interference with lake use caused by curly-leaf pondweed.
2. Reduce the abundance of curly-leaf pondweed for long periods of time.
3. Increase the frequency and abundance of native, submersed aquatic plants.
4. Reduce peaks in concentrations of phosphorous and associated algal blooms.

Ecological benefits include increases in the frequency or abundance of native submersed plants and reductions in levels of phosphorus and algae, which should increase water clarity.

Operational applications of herbicides to whole lakes that are classified as public waters (Minnesota Statutes (M.S. 103G.005) are not allowed in Minnesota (Minnesota Rules Chapter 6280: Aquatic Plant Management) because this destroys more vegetation than is necessary to give riparian owners access to lakes. Unnecessary destruction of vegetation in Minnesota waters is not permitted because plants provide many benefits to lake ecosystems (M.S. 103G.615). For these reasons, application of herbicides to control submersed vegetation in Minnesota lakes is limited to treatment of no more than 15% of the littoral zone. A variance from this limit can be issued by the DNR. Variances have been issued for pilot projects, which control curly-leaf pondweed by whole-lake management, where there is a well-developed plan and a commitment to monitor and report the effects of the treatment on the lake.

Pilot lake-wide treatments funded under a new DNR grant program

DNR staff working with lake residents, lake associations, and local units of government, have participated in several pilot projects in which herbicides were used to control curly-leaf pondweed lake-wide. Seven of these projects were partially funded under a new DNR grant program “Pilot projects to control curly-leaf pondweed or Eurasian watermilfoil on a lake-wide basis for ecological benefits” which was introduced in 2006. (http://www.dnr.state.mn.us/grants/habitat/lakewide.html). Funding under this grant program will be available in 2007.

The DNR established this grant program to provide funding for pilot lake-wide curly-leaf pondweed and Eurasian watermilfoil control projects. The purpose of offering these funds was to allow a limited number of well-planned and well-monitored projects to go forward in order to determine if ecological benefits could be obtained by lake-wide control of curly-leaf pondweed or Eurasian watermilfoil. The effects of funded projects have been and will be carefully monitored in order to determine how and where to use a lake-wide treatment approach in the future. This grant program made $125,000 available for lake-wide control of curly-leaf pondweed or Eurasian watermilfoil in 2006. The maximum amount available to any one project was $30,000.

There were 41 project proposals submitted. Seven projects (Table 6) were selected to receive a grant. Project proposals were ranked by the grant selection committee based on potential benefit to the aquatic environment, possible negative impacts of the proposed treatment, size of the project, the quality of pre-treatment data available, and, in the case of curly-leaf pondweed treatments, the ability of applicants to continue lake-wide treatment in the future without grant funds. In addition, projects were chosen that were located in different parts of Minnesota.

Table 6. Projects granted funding for lake-wide curly-leaf pondweed control in 2006.

County	Lake	Size of Lake (acres/littoral acres)	Acres Treated	Amount Granted ($1000s)	Type of Treatment	Years of lake-wide treatment
Crow Wing	Lower Mission	698/452	240	25	Endothall	1
Hennepin	Medicine	886/399	316	20	Endothall	3
Morrison	Crookneck	168/ 131	18	10	Endothall	1
Scott	Fish	171/ 74	16	10	Endothall	2
Sherburne	Rush *	142/ 142	61	5	Endothall	1
Sherburne	Julia *	142/ 136	27	5	Endothall	1
Hennepin	Weaver	149/ 76	149	10	Fluridone	2
Lincoln	Benton	2600/ 2600	2600	30	Fluridone	2

* Julia and Rush are part of the Briggs Rush Julia chain of lakes. Both lakes had lake-wide treatments for curly-leaf pondweed as part of one treatment plan. They were granted $10,000 towards those treatments.

In 2006, only curly-leaf pondweed control projects were funded. Treatments were done either with fluridone herbicide at 4.0 ppb, or with endothall herbicide at 0.75 -1.0 ppm. All treatments were done in late April or early May, when water temperatures were between 50 and 60 degrees F. Comments from lake residents, aquatic plant surveys, and DNR staff observations indicate that the treatments were successful in controlling curly-leaf pondweed.

In order to be accepted into the grant program, there had to be adequate pre-treatment data available on the lake proposed for treatment. $10,000 of the $125,00 available was set aside for grants for the collection of pre-treatment aquatic plant survey data. Three projects were granted funding for that purpose (Table 7).

Table 7. Projects granted funding for the collection of aquatic plant survey data in 2006.

County	Lake	Size of Lake (acres/ littoral acres)	Amount Granted ($1000s)
Crow Wing	Sebie	169/ 117	3
Meeker	Clear	497/ 441	5
Ramsey	Silver	72/ 71	2

Monitoring of pilot lakes

All of the lakes included in the grant program for pilot lake-wide treatments had previous aquatic vegetation surveys. Several of the lakes included had been studied in previous years by various cooperators. As part of the grant program, all of the included lakes had aquatic vegetation surveys done, as well as water quality monitoring.

Surveys of Aquatic Vegetation

The DNR is providing $119,000 to Dr. Newman at the University of Minnesota to monitor changes in the aquatic plant community of Lower Mission, Weaver, Crookneck, Fish, Julia, and Rush lakes, as well as three untreated reference lakes in 2006, 2007, and 2008. In 2006, lakes were surveyed for plant community characteristics three times per year using the point-intercept method (Madsen1999). Lakes were surveyed in April, May, late June, and late August. Surveys in April or early May were done before or within one week of treatment in 2006 (prior to any treatment effects). Plant biomass samples were collected on each sample date in order to estimate curly-leaf and native plant abundance. Turion density was determined for each lake once per year in early fall using sediment samples.

Staff of the Invasive Species Program conducted point-intercept surveys on Lake Benton in April, June, and August and collected biomass samples in June and sediment turion samples in August. USAERDC researcher John Skogerboe conducted point-intercept surveys of Medicine Lake three times in 2006, and collected biomass samples in August. Dr. Newman and his staff will analyze data from his surveys as well as data collected from Lake Benton and Medicine Lake.

Steve McComas of Blue Water Science used scuba diving to measure stem densities of curly-leaf pondweed prior to herbicide effects and then following herbicide treatment on Medicine, Fish, and Spring lakes.

Water Quality monitoring

Various water quality parameters were measured on the pilot project lakes. Secchi depth readings were taken twice monthly throughout the spring and summer by the cooperators on each lake granted control dollars. Dr. Newman collected a light, temperature, and oxygen profile in each of the lakes he worked on, as well as collecting water samples for phosphorus and chlorophyll a concentrations on each plant sampling date. Table 8 summarizes other water quality measurements taken in 2006.

Table 8. Water quality parameters measured on pilot lake-wide treatment lakes in 2006.

County Lake	**Parameters measured**	**Sampling Schedule**	**Samples collected by**
Crow Wing Lower Mission	Total phosphorus Cholorophyll a pH Temperature/Dissolved oxygen profile Secchi depth	Monthly	Outdoor Corps
Hennepin Medicine	Total phosphorus Cholorophyll a Total nitrogen Soluble reactive phosphorus temperature, dissolved oxygen, pH, and conductivity profiles	Bi-weekly	Three Rivers Park District
Hennepin Weaver	Total phosphorus Cholorophyll a Total nitrogen Temperature, dissolved oxygen, pH, and conductivity	Bi-weekly	Three Rivers Park District
Lincoln Benton	pH, alkalinity Cholorophyll a Total suspended solids	Monthly	Lincoln County Environmental Office
Morrison Crookneck	Total phosphorus Cholorophyll a Secchi Dissolved oxygen/ temperature/ pH, alkalinity	Monthly	Professional Lake Management
Scott Fish	Total phosphorus Chlorophyll a Total nitrogen Temperature, dissolved oxygen, pH, and conductivity profiles	Bi-weekly	Three Rivers Park District
Sherburne Rush and Julia	Total phosphorus Chlorophyll a	Twice/month	Citizens working with DNR staff

Results of repeated lake-wide treatments

The following are some recent results of lake-wide treatments, which have been going on for several years. Results from the 2005 treatment of Weaver Lake were reported in the 2005 annual report (Invasive Species Program 2006). A complete report of results from 2006 treatments should be available in the spring of 2007.

Endothall treatment

Schwanz and Blackhawk lakes, Dakota County

From 2000 through 2003, USAERDC researchers used repeated early spring, whole-lake applications of endothall applied as Aquathol K for control of curly-leaf pondweed in two Dakota County lakes (Invasive Species Program 2005). These treatments were discontinued on Schwanz Lake (13 acres) and Blackhawk Lake (37 acres) after 2003.

In 2004, no treatments were conducted on Schwanz Lake and 12 acres were treated on Blackhawk Lake using Aquathol K. In April of 2005, two acres on Schwanz Lake and six acres on Blackhawk Lake were treated using a granular endothall herbicide, Aquathol Super K. In April 2006, 1.5 acres on Schwanz lake and 5 acres on Blackhawk Lake were again treated with Aquathol Super K. Low levels of curly-leaf pondweed continued to persist in both Schwanz and Blackhawk lakes in June 2006; however, the plants remained below nuisance levels (John Skogerboe, USAERDC, pers. communication). This is the third year following the end of the series of lake-wide treatments where curly-leaf has occurred at low levels.

Medicine Lake, Hennepin County

Medicine Lake was subjected to early-season endothall herbicide treatments in 2004, 2005, and 2006. The purpose of these treatments was to reduce curly-leaf pondweed abundance, to reduce internal phosphorus loading, and to increase native plant abundance (Invasive Species Program 2006). Results from the 2004 and 2005 treatments indicate that the early-season endothall treatments were effective at significantly reducing curly-leaf pondweed stem density and frequency of occurrence in the year of treatment (Vlach and Barten 2006).

The effect of the endothall treatments on other species was mixed. The frequency of Eurasian watermilfoil in the lake increased from 8% in September 2004 to 18% in September 2005. The only substantial increase in a native species was an increase in Canadian waterweed, which increased from 4% in September 2004 to 14% in September 2005. Analysis of water quality data (1995-2005) indicates that average phosphorus concentrations for May through mid-July were lower in 2005 than in previous years. This reduced phosphorus was partially attributed to the control of curly-leaf pondweed. The early season reduction in phosphorus was not enough to result in a significant difference in the annual average total phosphorus concentrations from 1995 through 2005 (Vlach and Barten 2006).

Spring Lake, Scott County

In addition to the projects done under the new grant program, Spring Lake has also been subjected to early spring lake-wide treatments with endothall herbicide in 2004, 2005, and 2006. The Prior Lake-Spring Lake Watershed District organized these treatments in cooperation with the lake association in an effort to limit the internal loading of phosphorus from curly-leaf pondweed. In their permit application of 2004, the District described the many steps that have been taken to improve water quality in Spring Lake. They stated that they were considering an alum application to the lake but there was concern that curly-leaf pondweed growth would interfere with an alum treatment. The District's hope is that after the 2006 treatment, the curly-leaf growth will

be manageable, and it will then be possible to take more aggressive steps to control internal loading and further improve the lake's water quality.

Results from the 2004 and 2005 treatments indicate that the early-season treatments were successful in reducing the frequency of occurrence and abundance of curly-leaf pondweed in the year of treatment (McComas 2005 and 2006). The treatments appeared to have a positive effect on the occurrence of several native plant species. The frequencies of the common native plants found in Spring Lake, coontail, elodea, wild celery, and mud plantain, were higher in August 2005 than in August 2004 (McComas 2005 and 2006).

Water quality samples taken bi-weekly were collected through the Citizen Lake Monitoring Program of the Metropolitan Council. The Prior Lake-Spring Lake Watershed District will summarize this data, along with data from 2006 this winter.

Fluridone treatment

Lake Benton, Lincoln County

Lake Benton is a 2,857-acre lake with a maximum depth of nine feet. It is highly eutrophic. In 2003, the Lake Benton Lake Improvement Association (LBLIA) requested permission from the DNR to treat Lake Benton with a multi-year series of fluridone herbicide treatments to control curly-leaf pondweed and deplete the turion bank in the lake. Subsequently, the DNR met with members of the LBLIA and other interested parties to assess the situation on the lake and consider approaches to management. In 2004, the DNR conducted two surveys of the vegetation in Lake Benton. After additional discussion, the DNR agreed to permit an initial fluridone treatment in 2005 and decided that permitting of treatments in future years would depend on the outcome of the initial treatment. Lake Benton has been subjected to lake-wide fluridone treatments at 4 ppb in 2005 and 2006.

Both the 2005 and the 2006 treatments were successful in reducing the frequency of occurrence and abundance of curly-leaf pondweed in the year of treatment. The effects on native plants were mixed. In June 2006, the distribution of native plants was higher than in June 2005 or 2004. 2006 was also the first time that any native plants were collected in a biomass sample. Nevertheless, Richardson's pondweed, which was observed in Lake Benton in July 2004 has not been observed since then. In general, native plants occur at very low frequencies in Lake Benton. For example, in June 2006, native plants were found at 4% frequency of occurrence. The water clarity of Lake Benton, as measured by Secchi depth, is higher in 2006 compared to 2004 and 2005 (Table 9).

Table 9. May through September Secchi depth in Lake Benton.

Year	Secchi Depth May-Sept. (feet)	Number of samples
2004	1.6	8
2005	1.7	10
2006	4.3	9

Research to improve management of curly-leaf pondweed

Whole-lake management with low rates of endothall combined with 2,4-D for selective control of curly-leaf pondweed and Eurasian watermilfoil

The U.S. Army Engineer Research and Development Center (USAERDC) working in cooperation with Mississippi State University, the DNR, and CerexAgri continued to test the efficacy of early spring applications of endothall in combination with 2,4-D against curly-leaf pondweed and Eurasian watermilfoil in two Minnesota lakes (Invasive Species Program 2006). This effort began in 2003 when study lakes, two to be treated with herbicides and two to serve as untreated reference lakes, were selected and pre-treatment surveys of the vegetation were done. Lakes were treated in 2004 and 2005 (Invasive Species Program 2006). Results from 2006 treatments should be available in early 2007. Results indicate that early spring application of 1 ppm endothall (Aquathol K) combined with 0.5 ppm 2,4-D (DMA 4 IVM) or granular (Aquathol Super K) applied alone at 1.5 mg/L effectively controlled both Eurasian watermilfoil and curly-leaf pondweed for at least one growing season. Native plant data showed that these communities were not adversely affected by the herbicide treatments (Skogerboe and Getsinger 2006). Native plant diversity and abundance did increase in treated lakes during the second and third year post treatment (Skogerboe 2006, unpublished data).

Evaluation of low rates of fluridone to control the growth and reproduction of curly-leaf pondweed

The DNR provided $50,000 to the USAERDC to study the effects of fluridone herbicide on curly-leaf pondweed growth and turion production (Invasive Species Program 2006). The results of the first study indicated that 4 ppb fluridone is the lowest rate that will suppress plant growth and prevent turion formation. In 2006, USAERDC provided results from the second greenhouse study. The second study repeated the work done in the first greenhouse study. The second study indicated that the initial target concentration should be at least 4 ppb, with exposures of at least 56 days. The study also indicated that fluridone treatments should be conducted in early spring when plants are immature. Further work will evaluate the ability of fluridone treated curly-leaf pondweed to withstand varying levels of turbidity (Poovey, USAERDC unpublished data).

Study of turion longevity in curly-leaf pondweed

In 2006, the DNR Invasive Species Program provided $10,000 in funding to Dr. Newman at the University of Minnesota to continue his evaluation of the distribution, viability, and longevity of turions in curly-leaf pondweed (Newman et. al 2006, Invasive Species Program 2006). This is a continuation of work started by DNR staff and Dr. Newman in 2004 (Invasive Species Program 2005). Dr. Newman and his students found a general decrease in density of turions with water depth. Their data showed significant pools of turions occur to depths of three meters. They found most turions in the top 5 cm layer of sediment. Nevertheless, substantial numbers of turions were present in the 5-10 cm layer, and in lakes with softer sediments, turions were found as deep as the 20-30 cm layer. Additionally, considerable variability in turion densities was found between the four lakes sampled, with lakes Rebecca and Sarah having over 20 times more turions than Round Lake (Newman et. al 2006).

Dr. Newman's work indicated that burial in sediment can inhibit turion sprouting, and that a substantial percentage of buried turions can be viable. Experiments examining turion longevity indicated that almost 50% of turions buried in Smiths Bay were viable after two years. Experiments with intact cores also suggested that approximately 50% of buried turions would be expected to sprout when exposed to the proper conditions. This pool of viable turions could provide significant recruitment in future years, depending on the longevity of turions and their ability to move to the sediment surface. In addition, Dr. Newman's researchers observed curly-leaf pondweed growing from seeds and unidentified propagules, in addition to sprouting from turions. These seeds and other propagules also provide an additional source of new curly-leaf pondweed plants in future years (Newman et. al 2006).

Future needs for management of curly-leaf pondweed

- Review available information on the ecology and management of curly-leaf pondweed to identify possible research projects that might be carried out to improve management of this invasive species in Minnesota.
- Continue to provide funding for identified research needs, such as research to determine the distribution, viability, and longevity of curly-leaf turions.
- Continue public awareness efforts focused on containing curly-leaf pondweed. Opportunities include our TV and radio advertising, Watercraft Inspection Program, literature, and public speaking engagements.
- Continue to support the management of curly-leaf pondweed in the state through technical assistance and grants for pilot projects.

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Management of Eurasian Watermilfoil

2006 Highlights

- Eurasian watermilfoil was discovered in 13 additional Minnesota water bodies during 2006. There are now 190 Minnesota lakes, ponds, rivers, and streams known to contain the invasive submersed aquatic plant.
- Cooperators on 24 lakes were reimbursed by the DNR.

Issue

Eurasian watermilfoil (*Myriophyllum spicatum*) is an invasive submerged aquatic plant that was inadvertently introduced to Minnesota. Eurasian watermilfoil, hereinafter called milfoil, was first discovered in Lake Minnetonka during the fall of 1987. Milfoil can limit recreational activities on water bodies and alter aquatic ecosystems by displacing native plants. As a result, Minnesota established the Minnesota Department of Natural Resources (DNR) Invasive Species Program to manage milfoil, as well as certain other invasive species. Milfoil is classified as a *prohibited invasive species*, which means that it may not be bought, sold, or possessed in Minnesota. In this report, we describe the efforts of the Invasive Species Program to manage milfoil and limit its spread in Minnesota during 2006.

Goals

The Invasive Species Program has two primary goals for management of milfoil in Minnesota. They are listed below along with the principal strategies that are pursued to achieve these goals.

1) Prevent spread of milfoil in Minnesota
   a) Monitor distribution of milfoil in Minnesota.
   b) Show boaters how to prevent the spread of milfoil (see Watercraft Inspections and Awareness Events).

2) Reduce problems caused by milfoil in Minnesota
   a) Provide funding for maintenance management by cooperators.
   b) Conduct high-intensity management and control at public water accesses.
   c) Provide technical assistance.
   d) Support or conduct research on the ecology and management of milfoil.

Spread of Eurasian Watermilfoil in Minnesota during 2006

Milfoil was newly discovered in 13 lakes during 2006 (Table 10 and Figure 10). Eight of these lakes are located in the seven-county metropolitan area. Milfoil is now known to occur in 190 water bodies in Minnesota.

The rate of spread of milfoil in Minnesota, as reflected in the annual discovery of new occurrences of the invasive, has changed little over the last three to four years (Table 10). This observation is based on the running three-year average for the number of lakes in which milfoil was discovered.

Table 10. Classification of water bodies in Minnesota with Eurasian watermilfoil during 2006.

Classification	Spring	New in Summer	Fall
Eligible for management with state funds	126	8	134
Ineligible for management with state funds			
Public water but no public access	34	5	39
Not public water	9	0	9
Rivers or streams	8	0	8
Total	177	13	190

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 invasive plant that have not yet been discovered. In some cases, milfoil is discovered years after the time when it became established in a lake. In other lakes, milfoil appears to have been discovered before the invasive became abundant or widespread when it was noticed by a person who was knowledgeable about identification of aquatic plants.

Many false reports of milfoil 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 Invasive Species Program. During 2006, as in previous years, most of these reports were found to be occurrences of various native aquatic plants. It has been extremely useful for citizens to send the DNR samples of suspected Eurasian watermilfoil so the plants can be quickly identified. The DNR encourages the public to report suspected new occurrences of milfoil.

Monitoring the distribution of Eurasian watermilfoil 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 staff in the Invasive Species Program are only able to visit a limited number of lakes each year. Efforts by others to search for milfoil and report suspected occurrences of the invasive 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 invasive is present, then it is important to minimize the risk of spread to uninfested waters by notifying 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.

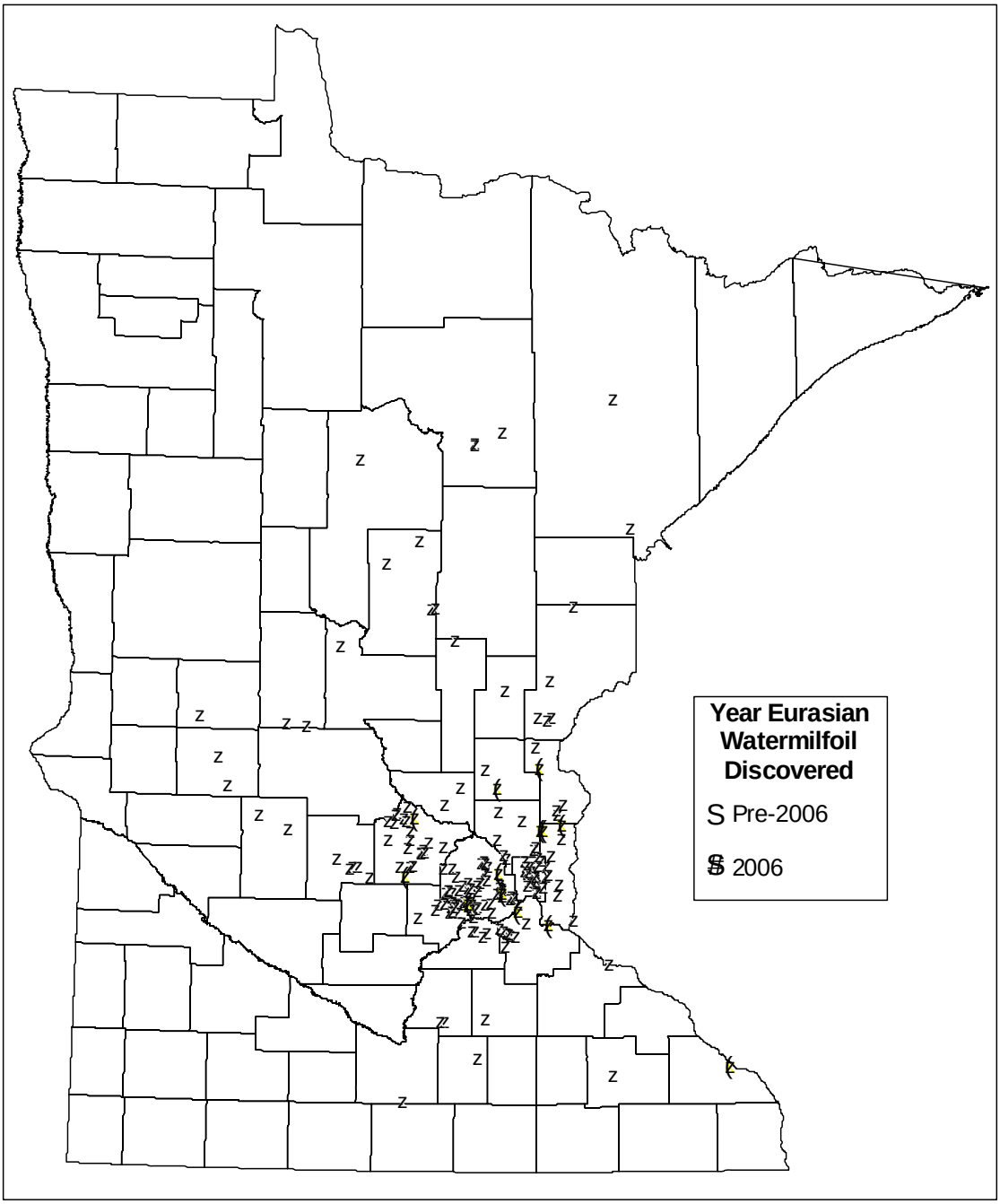

Figure 10. Distribution of water bodies with Eurasian watermilfoil in Minnesota as of November 2006.

Reports of suspected occurrences of milfoil that turn out to be mistaken also have value. In the course of responding to such reports, staff in the Invasive Species Program discuss identification of the non-native Eurasian watermilfoil with the observer and so increase the number of people who in the future are likely to be able to distinguish the invasive from native plant species that are similar in appearance.

Management of Eurasian watermilfoil in Minnesota during 2006

Classification of water bodies for management of Eurasian watermilfoil

In the spring of 2006, the Invasive Species Program classified the 177 bodies of water known to have milfoil (Table 10). One hundred twenty-six 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 (Minnesota Statute 103G.005, Subd. 15).

Some 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, flowing waters such as rivers and streams are not usually considered for management of milfoil with state funds because 1) users of these waters in Minnesota rarely encounter problems caused by milfoil like those found in lakes; and 2) use of herbicides is less reliable in rivers and streams than in lakes.

Eight of the 13 water bodies that were discovered to have milfoil during 2006 were eligible for management with state funds because they have public water accesses (Table 11). Five lakes found to have milfoil in 2006 have no public water access and, consequently, are ineligible for management with state funds.

Management of Eurasian watermilfoil

During 2006, state funding and technical assistance were available from the Invasive Species Program to potential cooperators for management of milfoil. The offer of state funding is described in an announcement that is available to potential local cooperators (DNR 2006a) who are expected to take the lead in control of the milfoil. The offer is briefly summarized here. The most common activity on lakes in the maintenance management class that receive funds from the DNR is application of herbicide, followed by mechanical harvesting and assessment. 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. These funds may also be used for control intended to slow the spread of the invasive to other lakes.

The DNR received applications for state funding to control milfoil from potential cooperators on 27 lakes (Table 11). Applications were reviewed by the Invasive Species Program in relation to the standards described in the announcement that is available to potential cooperators (DNR 2006a). Twenty-three of the applications were approved for funding. Questions about some applications led to inspections of the milfoil in these lakes by staff of the Invasive Species Program. These inspections

revealed that some sites proposed for treatment 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 some lakes, proposals were modified by reducing the size of the area to be treated, and subsequently approved. Applications for reimbursement were not approved for four lakes.

Table 11. Number of Minnesota lakes where management of Eurasian watermilfoil was supported with state funds in 2002-2006.

	Applications received	Applications approved	Applications denied or not pursued
2002	32	21	11
2003	32	23	9
2004	26	18	8
2005	37	27	10
2006	27	23	4

As a result, the DNR expects to reimburse 20 cooperators on 27 lakes for costs of milfoil management during 2006.

Assessment of Eurasian watermilfoil

In addition to control, the DNR also offers funding to support assessments of the potential for Eurasian watermilfoil to produce dense and matted growth that might interfere with watercraft use, swimming, or other traditional recreational uses of a lake. The offer of state funding is described in an announcement that is available to potential local cooperators (DNR 2006b) who are expected to take the lead in assessment of the milfoil. This requires a survey of milfoil in the lake to be done by a contractor, who will then provide a report to the cooperator. During 2006, the DNR received two applications for reimbursement for assessments of milfoil in two lakes. One of the two assessments was completed in 2006; the other likely will be completed in 2007.

Control of Eurasian watermilfoil by the DNR at DNR public water accesses

The Invasive Species Program initiated treatment of milfoil in the immediate vicinity of public water accesses operated by the DNR on five lakes (Table 9). The purposes of this type of control are to: 1) reduce the risk that users of the lake inadvertently transport milfoil from the lake to other bodies of water; and 2) improve access to the lake.

High-intensity management of Eurasian watermilfoil

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 invasive to other lakes. High-intensity management usually involves efforts to find all milfoil in a lake and treat it with herbicide. High-intensity management may be undertaken by the Invasive 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. During 2006, the Invasive Species Program did not identify any lakes where it was considered necessary for the agency to conduct high-intensity management of milfoil (Table 12).

Technical assistance to cooperators and other citizens

Technical assistance was provided by the Invasive Species Program to cooperators and other citizens and managers. Staff of the Invasive 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 Invasive Species Program have many conversations with people over the telephone. In addition, staff of the Invasive Species Program exchange correspondence by regular mail and e-mail with people who need assistance in dealing with milfoil.

Effectiveness of management of Eurasian watermilfoil in Minnesota lakes

Though the number of Minnesota lakes known to have milfoil increased in 2006, the number of lakes from which applications for DNR funding for control were received remained much lower than the number of lakes eligible to apply (Tables 11 and 12). The number of lakes where cooperators received DNR funding for control of milfoil during 2006 decreased by comparison with the previous year (Table 11).

In 2006, potential cooperators used 91% of the funds that were budgeted by the DNR for reimbursement for maintenance management control of milfoil (Table 12). Possible explanations for this outcome include: 1) lack of nuisances caused by milfoil that met the criteria for funding by the DNR; and 2) lack of awareness of the program among potential cooperators.

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

Cooperation between the Invasive 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 in Minnesota. The Invasive Species Program has also received valuable assistance from staff in DNR Fisheries and the Aquatic Plant Management Program in Fisheries and the Division of Ecological Services.

Table 12. Number of lakes, budgets, and expenditures in different classes of management of Eurasian watermilfoil in Minnesota during 2006.

Year	Number of lakes in class in spring	Funds budgeted in spring	Number of lakes in class where control or assessment was done	Funds spent
Maintenance Management Control by Cooperators and Reimbursed by DNR				
2006	126	90,000	23	**82,000**
Assessment by Cooperators and Reimbursed by DNR				
2006	--	18,000	2[1]	**2,000**
Control by DNR at DNR Public Water Access				
2006	--	12,000	5[2]	**11,000**
High-Intensity Management				
2006	0	Contingency	0	**0**
Totals				
2006	--	120,000	30	**95,000**

[1] One of these lakes applied for funding in 2006, but does not plan to do the work until 2007.
[2] One of these lakes also received funding for maintenance management.

Research on Eurasian Watermilfoil and Potential Approaches to Management in Minnesota

The Invasive Species Program has supported or conducted a number of research projects to improve management of milfoil. In this section, we briefly summarize activities or results of recent efforts by researchers working primarily in Minnesota.

Susceptibility of lakes to invasion by Eurasian watermilfoil

In 2006, Ms. Sara Roley, a researcher at the University of Minnesota produced a report on a study intended to identify lakes susceptible to invasion by Eurasian watermilfoil based on simple, broadly available variables. Roley (2006) found relationships between susceptibility of lakes to invasion by milfoil and characteristics including distance to the nearest lake with milfoil, area or size of lakes, Secchi depth, alkalinity, and maximum depth. Roley observed that the results of her analyses were generally consistent with those of previous studies and estimated that 1,900 to 4,300 of Minnesota's 11,000 lakes are susceptible to invasion by milfoil.

Genetics of Eurasian, northern, and hybrid watermilfoils

In 2006, Dr. Michael Moody, a researcher at Indiana University continued to study the genetics of Eurasian, northern, and hybrid watermilfoils. Recent efforts have included comprehensive surveys of milfoil in five Minnesota lakes, which indicated that Eurasian

watermilfoil was not found in lakes where the hybrid was present (Moody and Les, in press). This effort also included an evaluation of the utility of examination of leaf morphology in identification of different milfoil taxa, which showed that hybrids are intermediate between the two parental species. A combination of this approach with molecular analysis can lead to ready identification of hybrids. In 2006, Dr. Moody received a commitment of $5,000 from the Invasive Species Program to continue research on the genetics of Eurasian, northern, and hybrid watermilfoils. The long-term goal of this research is to improve the ability of researchers to identify individual genotypes through development of microsatellite markers for Eurasian watermilfoil and other watermilfoils. Current efforts involve the use of microsatellite markers to identify individual genotypes in samples collected from watermilfoil populations across North America. Prior knowledge of the identity of hybrid populations will clarify interpretation of microsatellite patterns. A microsatellite library has already been developed, with support from the DNR, by a private biotech company (Genetic Identification Service), which provided variable markers. Current efforts involve sampling of several populations to determine microsatellite markers that will be most useful for identifying genotypes both among and within populations (Moody 2006). Preliminary analyses included sampling from within Minnesota populations already examined and from lakes in other states. Preliminary results suggest that sexual reproduction may be occurring in a population of Eurasian watermilfoil in one Minnesota lake. A separate effort by Dr. Newman's group discovered Eurasian watermilfoil seedling emerging from sediment samples in a study of seed banks (see below). More research in this area will help us to better understand the ecology of Eurasian watermilfoil, which is likely to be useful in management of the plant.

Macrophyte seedbanks in lakes with Eurasian watermilfoil

In 2006, Mr. Daliris S. Ramirez-Burgos, an undergraduate student at the University of Minnesota, conducted a study of macrophyte seedbanks in lakes with different densities of Eurasian watermilfoil (Ramirez-Burgos and Newman 2006). They found viable seedbanks in all four lakes sampled. Sporlings of *Chara* spp. were the plants most commonly emerging from samples of sediment. Further work found that six watermilfoil seedlings emerged from samples `of sediment collected from the same lake where it is suspected that sexual reproduction may be occurring in a population of Eurasian watermilfoil (R. Newman, University of Minnesota, pers. communication). Genetic analyses by Dr. Moody determined that the seedlings are Eurasian watermilfoil.

Research on approaches to control of Eurasian watermilfoil

Potential for biological control of Eurasian watermilfoil

During 2006, Dr. Ray Newman, the principal investigator at the University of Minnesota, and his colleagues continued to work towards publishing results from their research on the milfoil weevil (*Euhrychiopsis lecontei*). This research included studies of chemically mediated selection of host plants by the weevil (Marko et al. 2005), performance of weevils on different milfoils (Roley and Newman 2006), and predation on weevils by fish (Ward and Newman 2006). Dr. Newman and several German colleagues published a study of the Eurasian milfoil weevil (Newman et al. 2006). The Eurasian milfoil weevil is closely related to the milfoil weevil, which is native to North America.

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

The DNR conducted an evaluation of the potential to use fluridone herbicide to selectively control milfoil in Minnesota by application of fluridone at low rates of about 5 ppb (Getsinger et al. 2001; Madsen et al. 2003). As part of this evaluation, three Minnesota lakes were subjected to whole-lake treatments with fluridone in 2002. For the 2002 treatments, the target concentrations were 4.6 to 5 ppb fluridone. The lakes selected for this evaluation were eutrophic lakes, which had average Secchi depths less then two meters and few species of submersed plants.

The results of these whole-lake treatments suggest that use of fluridone herbicide, even when applied at low rates, to control milfoil in eutrophic lakes with low plant species richness and dominated by tolerant plant species such as coontail is likely to do more harm than good due to decreases in native plants. In addition, these types of treatments do not appear to permanently eliminate milfoil from the treated lake. In 2005, milfoil was found in two of the treated lakes, Crooked and Shutz, which were inspected (Invasive Species Program, unpublished data). Results for Schutz, one of the treated lakes, and Auburn, one of the untreated reference lakes included in the evaluation, were published by Valley et al. (2006). During 2006, inspection of the third lake treated in 2002 did not discover milfoil.

Additional information from similar treatments made in mesotrophic lakes, where average Secchi depths are greater than three meters and which often have more plant species than are found in eutrophic lakes, suggests that selective control of milfoil with an increase in native plants may be attainable.

For example, Lac Lavon is a mesotrophic lake formed from an abandoned gravel pit. It has been treated with fluridone three times over the past nine years: in 1996, 1998, and 2002 (Crowell et al. 2006). Prior to the 1996 treatment, Lac Lavon averaged 2.3 native taxa per sampling site (May 1996) and in the following year, the average increased to 4.4 native taxa per site. Milfoil subsequently increased in abundance until the next treatment, after which it declined. Following the third treatment in 2002, the frequency of milfoil reached 92% in 2005. Residents and local government officials again treated Lac Lavon with fluridone in 2006.

More research on the effects of fluridone in mesotrophic lakes would appear to be useful. At this time, the DNR is considering allowing additional whole-lake treatments with this herbicide to control milfoil in 2007, assuming that pre-treatment data is available from 2006 for any lakes proposed for treatment with this herbicide.

Potential to apply two herbicides at low rates to control both Eurasian watermilfoil and curly-leaf pondweed

In 2006, the U.S. Army Corps of Engineers continued a study in Minnesota to determine whether early spring treatment with low rates of endothall and 2,4-D herbicides will control both milfoil and curly-leaf pondweed. The researchers also want to determine whether reductions in milfoil and curly-leaf will produce a more diverse and abundant native plant community. Lastly, the project is intended to determine whether the expected shift in vegetation will affect the fish community. The study is being conducted in cooperation with Mississippi State University and the DNR. CerexAgri, an herbicide manufacturer, is providing financial and technical support. Herbicides were applied in spring and monitoring was done during the open water season of 2006. Results on the progress were reported to the DNR through oral presentations during 2006 and in a Technical Note (Skogeboe and Getsinger 2006), in which results from the first two years of the study are reported. Additional written results are expected to be reported to the DNR in the future.

Susceptibility of selected species and hybrids of milfoil to aquatic herbicides

Recent documentation of hybridization of Eurasian (*Myriophyllum spicatum*) and northern watermilfoil (*Myriophyllum sibiricum*) by Moody and Les (2002) has implications for various management strategies including herbicides and biological control. In conjunction with the discovery of hybrid milfoils, there have also been numerous anecdotal reports of reduced activity of the herbicides 2,4-D and fluridone in the upper Midwest. Reduced efficacy of herbicides has been noted at sites that have been managed over time. While this could simply be a matter of yearly variations in initial plant vigor and environmental conditions on the date of treatment, the number of reports from different locations suggests the potential for the development of increased herbicide tolerance by a milfoil biotype.

In 2005, the DNR provided funding to the U.S. Army Engineer Research and Development Center (USAERDC) to support a study of potential variation among different species and genotypes of milfoils in susceptibility to herbicides. Results to date showed no significant differences between the hybrid and Eurasian watermilfoil populations in their responses to herbicide. Complete results of this study and recommendations will be conveyed in a final report from the USAERDC to the DNR.

Future plans and needs for management of Eurasian watermilfoil

- Keep the public informed about milfoil and the problems it 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.
- Continue to improve our understanding of the ecology and management of milfoil.

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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 11). Flowering rush may also grow as a non-flowering submersed plant with limp, ribbon-like leaves.

The plant spreads primarily vegetatively from thick rhizomes (Figure 11), 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.

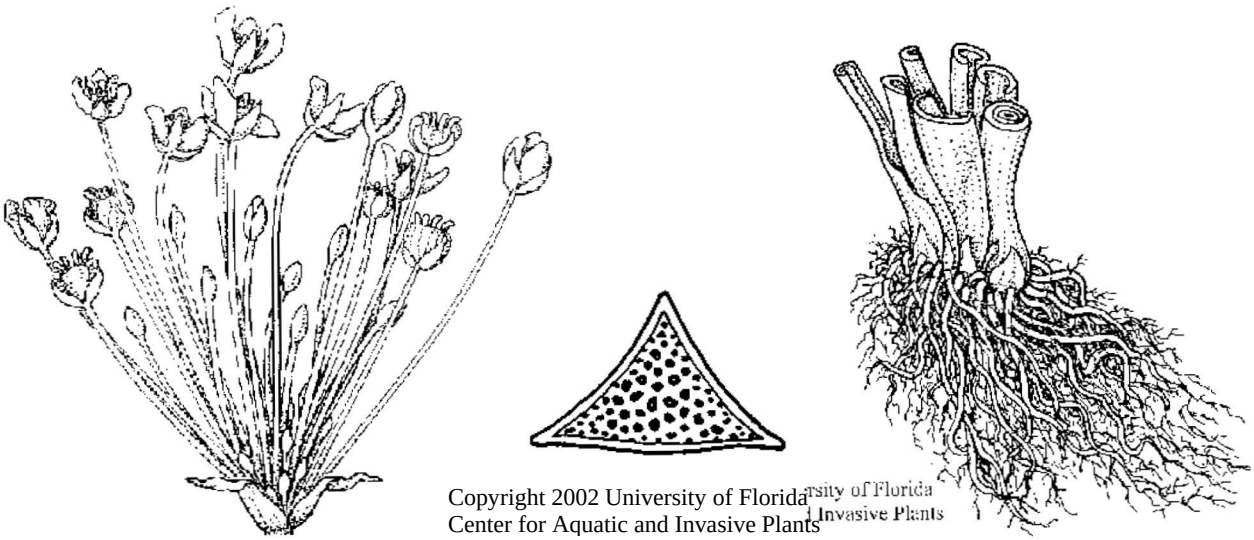

Figure 11. Flowering rush umbel, cross-section of a leaf, and rhizomes.

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 characteristics of flowering rush, it is classified as a *prohibited* invasive species in Minnesota. A prohibited invasive species is illegal to possess, sell, transport, or release into the wild.

Distribution

Flowering rush was first recorded in Anoka County 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 is widely scattered and uncommon (Figure 12). New

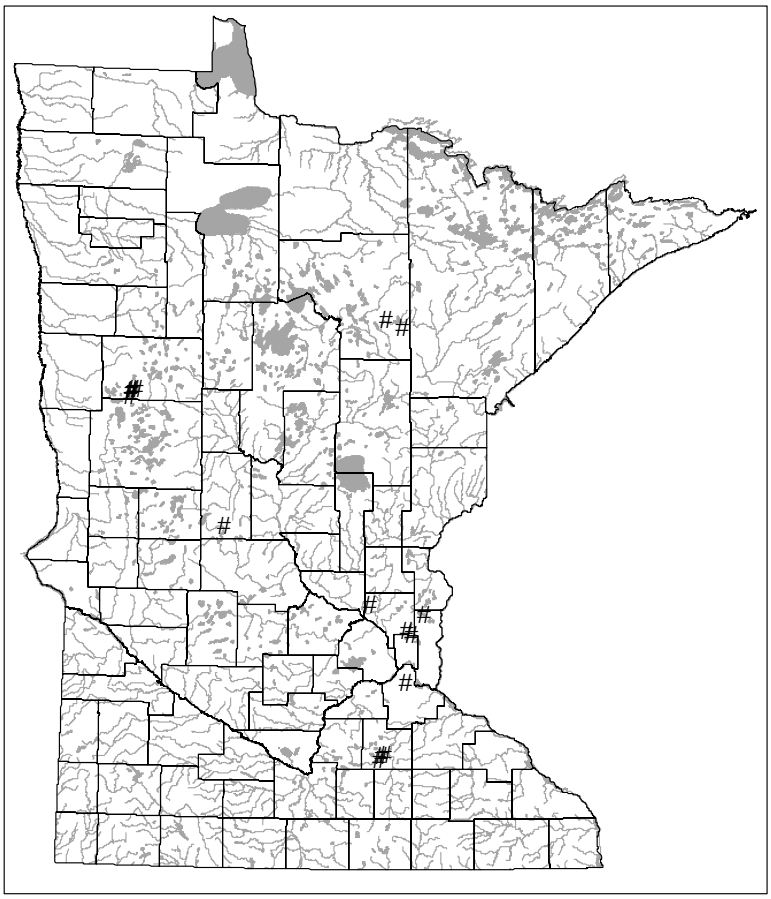

Figure 12. Minnesota flowering rush locations as of November 2006.

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 2006.

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 invasive species to Minnesota's ecology, society, and economy. To attain these goals, the following strategies are used:

- Prohibit 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 those interested in how to best manage flowering rush.

Progress in Management of Flowering Rush - 2006

Prohibit the sale of flowering rush

Flowering rush is a prohibited invasive plant in Minnesota, which means that it is unlawful to possess, purchase, or sell this invasive in Minnesota. Nevertheless, horticultural sales are the most likely means of introducing this plant into a new area. Flowering rush is advertised for sale in catalogs and by Internet companies as a hardy, desirable ornamental water garden plant. An effort to inform aquatic plant sellers and buyers about the potential negative impacts of releasing non-native plants into the wild will continue, utilizing various public education materials and personal contacts.

Monitor current distribution and assess changes

In 2006, Invasive Species Program staff did not monitor flowering rush populations due to an unforeseen shift in staff workload. The 2005 Invasive Species Annual Report (Invasive Species Program 2006) includes discussion regarding previous flowering rush surveys.

Support research to develop and implement better management methods

In 2003 through 2005, the Pelican River Watershed District (PRWD) contracted with a private herbicide applicator to test different aquatically registered herbicides on small plots of flowering rush. Several different herbicides and rates were tried including glyphosate, imazapyr, 2, 4-D (granular and liquid), diquat, and various adjuvants. From this work, imazapyr, trade name Habitat, performed the best. The flowering rush within the imazapyr plots were reduced significantly for at least two years after treatment. As a result, the PRWD has halted its mechanical harvesting program in exchange for spot treating flowering rush stands with imazapyr. In 2006, the PRWD treated 155 acres on three lakes using 58 gallons of Habitat (PRWD report 2006).

In an effort to replicate those results in a different part of Minnesota, imazapyr was applied to three acres of flowering rush on North Twin Lake (Itasca County) along the boat landing and beach area in 2005 and 2006. This is the same area that manual cutting has been used in the past with limited long-term success. The 2005 treatment occurred too late in the year to be fully effective, but did show a slight reduction of flowering rush near the public water access in 2006 (personal comm. Joe Zelenikar, November 7, 2006). In addition, detailed pre-treatment aquatic vegetation sampling was completed to document any non-target impacts of this herbicide.

Provide information to those interested in how to best manage flowering rush

The PRWD annually meets with DNR staff including representatives from the Invasive Species Program to discuss concerns regarding the expansion of flowering rush within and into lakes in the Detroit Lakes area. Currently, the PRWD is spot treating flowering rush stands with imazapyr to reduce the nuisances for lake residents and users. Support of this project, including technical assistance, will continue.

On North Twin Lake in Itasca County, flowering rush is actively managed by Greenway Township. In the past, hand cutting has seasonally reduced the dense stands of flowering rush, but has not provided long-term control for the public water access and the adjacent beach area. As information regarding imazapyr's ability to control flowering rush became available, the Invasive Species Program hired an herbicide

applicator to treat three acres of flowering rush with imazapyr in 2005 and 2006. If these treatments prove to be successful, Greenway Township will save money and staff time on flowering rush management.

Effectiveness of Management

Flowering rush often grows in stands with native vegetation, making it difficult to control this invasive without harming the native plants. Recent herbicide work done by the PRWD and others, is demonstrating that flowering rush can be controlled for at least two years with imazapyr without significantly harming submersed aquatic plants. Given the short time this herbicide has been used on flowering rush, Invasive Species Program staff will continue to evaluate the utility of these treatments.

Mechanical control by cutting can also be an effective method of reducing dense stands of flowering rush, but only seasonally. Cutting is most effective if done early and repeated several times during the growing season (Hroudova 1989). The disadvantages of cutting are that it lacks selectivity, it is labor intensive, and it does not eliminate the invasive. Digging flowering rush may increase its spread if the entire rhizome is not removed, but can be effective at removing small infestations of flowering rush.

Participation by Other Groups

Others involved in flowering rush management in Minnesota in 2006 include: DNR's Division of Fish and Wildlife, PRWD, and Greenway Township in Itasca County.

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

Background

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 DNR and other agencies manage purple loosestrife because it harms ecosystems and reduces biodiversity by displacing native plants and habitat for wildlife (Blossey et al. 2001). 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 (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 invasive.

This management program integrates chemical and biological control approaches and cooperates closely with federal and state agencies, local units of government, and other stakeholder groups involved in purple loosestrife management. The goal of the program is to reduce the impact purple loosestrife is having on our environment. Management efforts include both biological and chemical control methods, monitoring management efforts, and supporting further research.

Statewide Inventory of Purple Loosestrife

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, 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 13). In 2006, 47 new purple loosestrife infestations were identified in Minnesota. There are now over 2,300 purple loosestrife infestations recorded statewide (Table 13). 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 - 2006

Chemical control of purple loosestrife

Initial attempts by the DNR to control purple loosestrife relied mainly on the use of herbicides. The most effective herbicide is Rodeo, a formulation of glyphosate, which is a broad-spectrum herbicide that can kill desirable native plants. To allow maximum survival of native plants, Rodeo is applied by backpack sprayer as a “spot-treatment” to individual loosestrife plants.

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

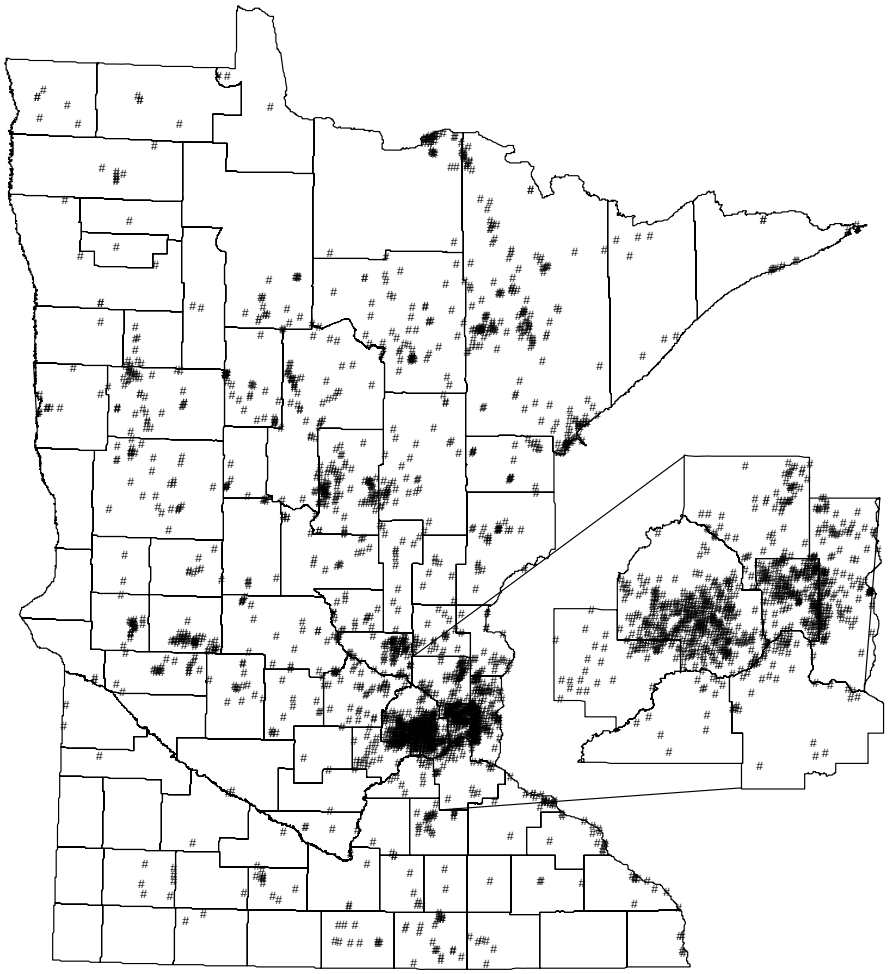


Figure 13. Purple loosestrife infestations in Minnesota as of December 2006.

Table 13. Purple loosestrife infestations in Minnesota recorded by the Minnesota Department of Natural Resources in 2005 and 2006.

Site Type	Total sites 2005	New sites 2006	Total sites 2006
Lake	684	18	702
River	213	6	219
Wetland	722	17	739
Roadsides and ditches	497	6	503
Other[1]	165	0	165
Total	**2281**	**47**	**2328**

[1]Includes gardens and other miscellaneous sites.

to large populations that have been established for a number of years. This is due in part to the plant's ability to re-establish from an extensive purple loosestrife seed bank.

Research by the University of Minnesota, under contract to the DNR, demonstrated that long-established stands of loosestrife develop very large and persistent seed banks (Welling and Becker 1990). Herbicide treatments kill the existing loosestrife population only, creating 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 small loosestrife infestations 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.

Between 1989 and 2006, the number of sites, number of plants, and total cost of treating purple loosestrife with herbicide has generally decreased (Table 14). 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. In 2006, only DNR staff was used to treat purple loosestrife stands statewide. DNR staff visited 95 purple loosestrife stands for herbicide control work (Figure 14, Table 14). At one site, workers found no loosestrife plants to treat. A total of 91 sites were treated with herbicides. Most of the sites were very small: 88% had fewer than 100 plants. Seventeen purple loosestrife plants were hand-pulled from three locations. This work took a total of 674 worker hours, and only 0.43 gallons of Rodeo. Total cost for this effort was $12,400.

Effectiveness of chemical control

Effectiveness of control efforts will be 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 (one in 2006) are controlled for at least one year beyond the year of treatment 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.

Table 14. Historical herbicide applications performed by DNR and applicators contracted by DNR in Minnesota (1989-2006).

Year	Sites visited	Sites with <100 plants treated	Sites with >100 plants treated	No plants located	Total worker hours	Herbicide quantity used/gal	Total treatment costs
1989	166				3,045	471	$102,000
1990	194	74	120	0	3,290	-	$74,900
1991	200	109	58	33	3,420	-	$77,900
1992	227	110	77	40	-	-	-
1993	194	96	79	19	2,300	48	$65,000
1994	188	81	81	26	1,850	30	$52,000
1995	203	102	63	38	2,261	35	$63,000
1996	153	74	56	23	1,396	14	$45,000
1997	132	55	55	22	965	7	$36,000
1998	144	66	51	27	1,193	11	$40,000
1999	131	65	38	28	791	9.5	$26,000
2000	111	38	28	45	518	2.4	$22,800
2001	87	55	17	15	359	1	$19,700
2002	55	32	7	16	305	2.3	$18,800
2003	54	30	7	17	243	0.87	$8,180
2004	60	30	9	20	370	0.58	$9,400
2005	62	48	9	5	296	0.40	$9,000
2006	95	84	10	1	674	0.43	$12,400

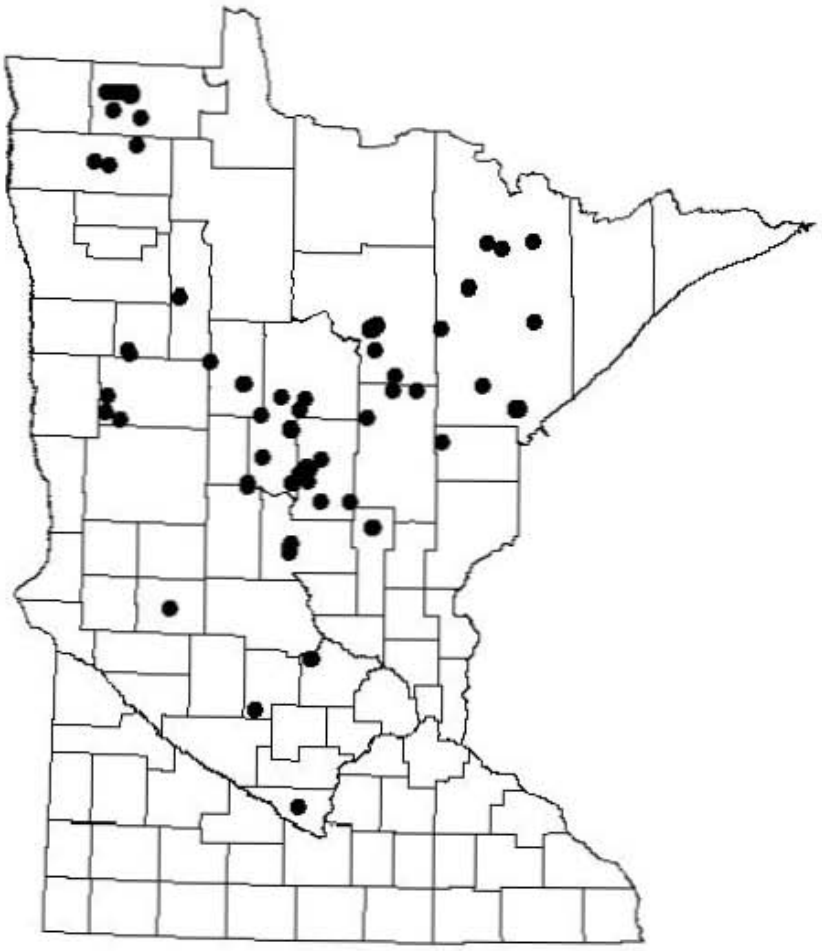


Figure 14. Locations where DNR staff used herbicides to control purple loosestrife in 2006.

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 and would not damage native plants or agricultural crops and after the insects were 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 by providing county agricultural inspectors, MDA field staff, DNR area wildlife managers, Minnesota Sea Grant, nature centers, lake associations, schools, 4-H and garden clubs with a "starter kit" for rearing their own leaf-eating beetles. 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. From 1997 to 2006, this cooperative effort has had a significant effect on total number of insects released (Figure 15).

With the success of insect establishment in the field, organized rearing efforts came to an end in 2004. Resource managers are able to collect insects from established release sites and redistribute them to new infestations. The "collect and move" method has reduced the effort needed to further distribute leaf-eating beetles in Minnesota. In 2006, an estimated 10,160 leaf-eating beetles were collected and released on 19 sites. To date, the leaf-eating beetles have been released on 799 sites statewide (see Figure 16, Table 15).

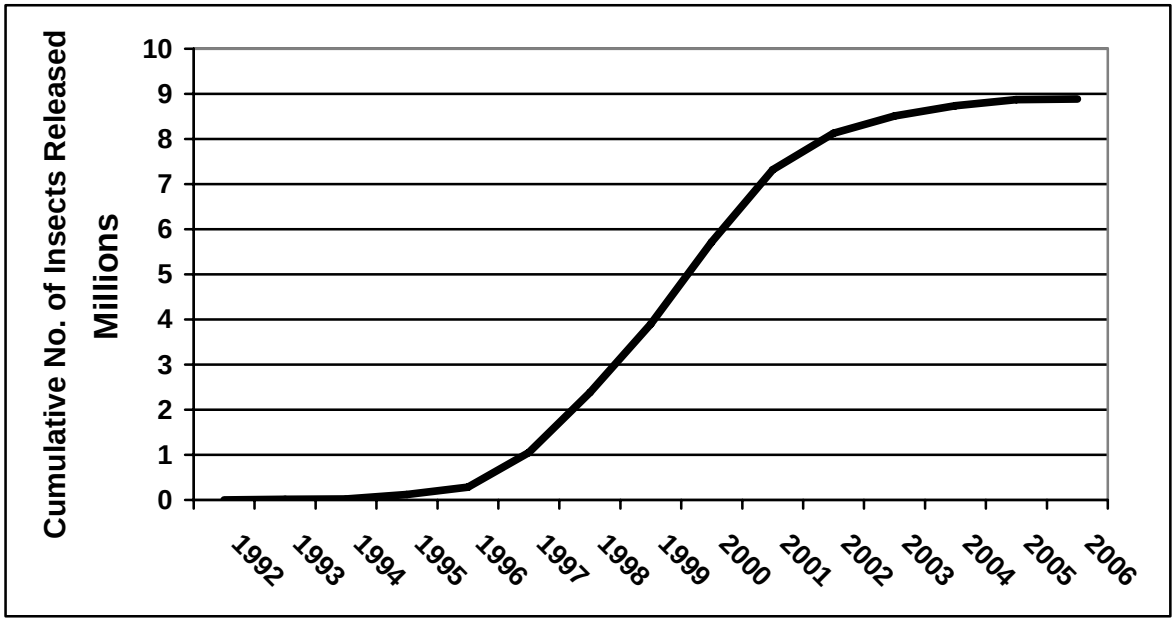


Figure 15. Cumulative number of insects released to control purple loosestrife by year.

Table 15. Summary of number of insects released in each region to control purple loosestrife (1992-2006).

Minnesota DNR Regions	Number of Release Sites	Number of Insects Released
1 – Northwest	129	1,361,556
2 – Northeast	208	1,622,497
3 – Central	401	5,187,821
4 – South	61	705,300
Totals	**799**	**8,877,174**

Biological control insects released between 1992 and 2006 have established reproducing populations at more than 84% of the sites visited. Insect populations increased significantly at many locations with pronounced damage to loosestrife plants. In the summer of 2006, 403 insect release sites were assessed for insect establishment and level of control achieved. At 70% (282 sites) of the sites surveyed, insect populations were increasing and causing damage to the loosestrife infestations. At 17% (70 sites) of all visited sites, the loosestrife was severely defoliated (90-100%) (Figure 17).

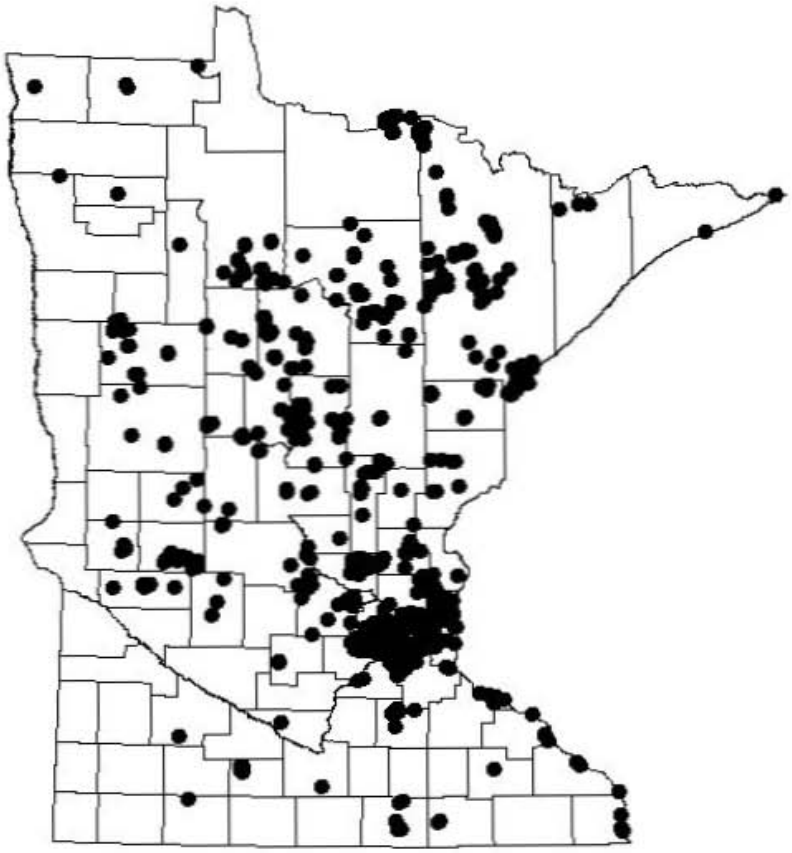


Figure 16. Locations of insects released to control purple loosestrife in Minnesota through 2006.

Effectiveness of biological control

A long-term objective is to utilize biological controls to reduce the abundance/impacts of loosestrife in wetland habitats throughout Minnesota. Biological control, if effective, will reduce the impact loosestrife has 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, and not a dominant one. Assessment efforts in 2006 demonstrated that *Galerucella* introductions have caused moderate to severe defoliation of loosestrife populations on 45% (181 sites) of 403 sites visited in 2006 (Figure 17).

The DNR continues to assess how loosestrife abundance changes over time and to determine what combinations of biological control agents provided the desired level of control. Over the last 11 years (1995-2006), a field study has been conducted within ten purple loosestrife infestations to quantitatively assess the effects of *G. calmariensis and G. pusilla* on purple loosestrife and non-target native plant communities in Minnesota. The overall results to date suggest that *Galerucella* spp. populations initially peaked between three and five years after establishment. At most sites, purple loosestrife density declined (up to 90%) in response to an increase in *Galerucella* spp abundance. *Galerucella* spp. appear to have a strong numerical response to purple loosestrife density which led to multiple "boom and bust" cycles occurring on many of the sites during the 11-year period. Declines in *Galerucella* spp. typically allowed purple loosestrife populations to rebound. Generally, *Galerucella* spp. populations rebounded as loosestrife abundance increased. The number and amplitude of the boom and bust cycles appears to be related, in part, to the density of the initial purple loosestrife infestation. Sites where purple loosestrife approached 100% cover tended to cycle more frequently than sites with a higher plant diversity and abundance. It appears that in more diverse sites, increased plant competition prevented purple loosestrife from attaining pre-release densities. As purple loosestrife populations declined, plant species richness and/or abundance increased within release sites.

Research on Insects as Biological Control Agents

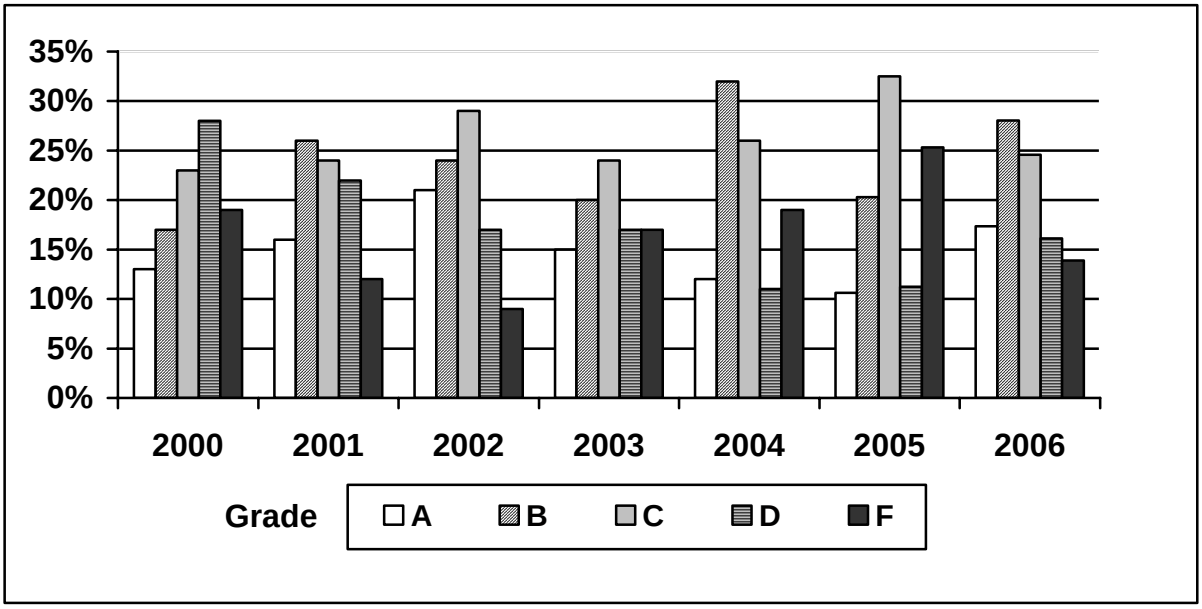
Three research projects at the University of Minnesota are ongoing to 1) evaluate monitoring techniques; 2) monitor agent establishment and control success; and 3) test cold hardiness of leaf-beetles.

Evaluating monitoring techniques. Accurately determining species composition is important in understanding the role each species plays in controlling purple loosestrife. The objective of this study was to test two relative sampling methods, hand collecting and pheromone trapping, for their ability to accurately estimate *Galerucella* spp. species ratios in the field. In 2005 and 2006, experiments were conducted in nine purple loosestrife infestations to test the sampling techniques when over-wintering adults (collected May-June) and F_1 adults (collected July-August) were present. Initial results from 2005 indicated that pheromone traps captured 25% more *G. calmariensis* than hand collections. However, pheromone trap data combined over the two-year period showed no bias toward *G. calmariensis* when compared to hand sampling. *Galerucella* species ratios from pheromone trap sampling were not significantly different between

over-wintered and F_1 adults. As part of a post-release monitoring program, both sampling methods accurately estimate species composition and can provide important information in determining the role each *Galerucella* spp. plays in biological control of purple loosestrife.

Monitoring Galerucella spp. establishment. Post-release monitoring of biological control agents is important in understanding factors that affect their establishment and the successful control of the targeted pest. This is the third year of a statewide survey conducted to assess the establishment of *G. calmariensis* and *G. pusilla* in Minnesota. In 2006, we sampled 112 different purple loosestrife infestations for *Galerucella* species composition and site characteristics. *Galerucella pusilla* is the dominant species in these 112 sampled sites with 48 sites composed of 90% *G. pusilla* or greater. Of these 48 sites, 63% of the sites are 100% *G. pusilla*. Only 36 sites contain at least 90% *G. calmariensis* and 66% of these sites are 100% *G. calmariensis*. A general trend found from this survey is that *G. calmariensis* dominant sites are found mainly in the northern part of the state. This leads us to assess the over-wintering abilities of each species to determine if this could explain the differences in species distribution in Minnesota.

Cold hardiness of Galerucella spp. Insects utilize different cold hardiness strategies for survival at low temperatures during winter conditions. Successful control of purple loosestrife over its extensive northern range, including Minnesota, will depend on the two species' ability to withstand extreme cold temperatures. We investigated the supercooling point (SCP) or the point at which the insect will spontaneously freeze to help understand the limitations on establishment for *Galerucella* spp. So far, the SCP was determined for 85 male and 106 female *G. calmariensis* and 64 male and 49 female *G. pusilla*. The overall mean (± SE) SCP for *G. calmariensis* males and females are 14.37 ± 0.38°C and 14.47 ± 0.29°C respectively. The overall mean SCP for *G. pusilla* males and females are 14.38 ± 0.38°C and 13.2 ± 0.46°C respectively. We are currently determining lethal time at -12, -6, and 0ºC by looking at the survival rates of *Galerucella* spp. at these temperatures at varying durations. These studies will provide insight into the abilities of *G. calmariensis* and *G. pusilla* to withstand cold temperatures and possibly explain differences in distribution between the two species in the state.



A = 90-100% defoliation, B = 50-89% defoliation, C = damage near release point with insects visible, D = no damage, few insects visible, F = no insects or damage present.

Figure 17. Sites graded for insect establishment and control.

Future needs for management of purple loosestrife

- Continue implementation and evaluation of biological control of purple loosestrife.
- Continue DNR funding of herbicide control efforts on small, high-priority infestations.
- Continue to assess effectiveness of overall management strategies.
- Continue to collaborate with county agriculture inspectors, MnDOT, DNR area wildlife managers, nature centers, etc., to expand management efforts.

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Other Invasive Aquatic Plant Species in Minnesota

Introduction

Numerous invasive species of aquatic plants exist in the state. The previous chapters described species for which there were ongoing efforts. The species listed in Table 16 exist in the state, but there are no ongoing efforts by the DNR to manage them in the wild. They are included because they are or have been of interest within the state, and have been described in previous annual reports.

Table 16. Other Invasive Aquatic Plant Species in Minnesota.

Species	Status	Legal Status	Last annual report to include info on this species
Yellow iris *(Iris pseudacorus)*	Commonly sold; public education has focused on preventing people from planting it in natural water bodies.	Regulated	2002
Brittle naiad *(Najas minor)*	One known population in Lac Lavon in Dakota County.	Proposed to be listed as Prohibited	2004
Hardy hybrid water lily (*Nymphaea* spp. hybrid)	Three known wild populations in Minnesota.	Regulated	2004
Water lettuce *(Pistia stratiotes)*	No new infestations found since 2001.	Unlisted	2001
Reed canary-grass *(Phalaris arundinacea)*	Widespread in Minnesota.	Unlisted	2004
Salt cedar (*Tamarix ramosissima)*	One known population that was treated with herbicide and by mechanical methods in 2003-2004. It is believed to have been eradicated from the site.	Unlisted	2004
Introduced subspecies of common reed (*Phragmites australis subsp.australis)*	Only a few known populations in the state; distribution information is lacking.	Unlisted	

Terrestrial Invasive Plant Management

Overview

Terrestrial invasive plant species are non-native plants that can naturalize, threatening natural resources and their use. Invasive plant species out-compete native plants that provide critical habitat needed to support wildlife species. For example, common buckthorn (*Rhamnus cathartica*) and glossy buckthorn (*R. frangula*) are Eurasian 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 (Heidorn 1991, Randall and Marinelli 1996) and have been linked to increased predation in songbird populations (Schmidt and Whelan 1999).

The DNR manages approximately 5.7 million acres or 95% of all the state-owned lands including Scientific and Natural Areas (184,000 acres), State Forests (4 million acres), Wildlife and Aquatic Management Areas (1.3 million acres), State Parks and Trails (244,000 acres). Prevention and management of invasive species is an important conservation action needed to protect and/or restore habitats for wildlife species, especially those species in greatest conservation need. Within the DNR, there is a critical need to expand the amount of awareness, data, tools and resources to reduce impacts caused by invasive plants on state-managed lands. The goal is to improve or enhance the ability of DNR staff to effectively manage terrestrial invasive plants on DNR managed-lands through management, inventory, education, and research.

This work is being funded by a combination of sources that includes state funding (Legislative Commission on Minnesota Resources, Heritage Enhancement and General Fund), and federal funding (U.S. Forest Service and U.S. Fish and Wildlife Service).

Management

Grant Program

The Invasive Species Program initiated a grant program for the management of terrestrial invasive plant species on state-managed lands. A combination of State Wildlife Grant, General Fund and Heritage Enhancement funding totaling $365, 000 was available to DNR land managers from January 2006-June 2007. The overall goal of this project is to improve and/or protect habitats of wildlife species in greatest conservation need that have been degraded by terrestrial invasive species on state-managed lands, including State Parks, Forests, Trails, Wildlife Management Areas and Scientific and Natural Areas.

Management of invasive species is an important conservation action needed to protect and/or restore habitats for wildlife species, especially those species in greatest conservation need. Species in greatest conservation need are defined in Minnesota's Comprehensive Wildlife Conservation Strategy as animals whose populations are rare, declining, or vulnerable to decline, and are below levels desirable to ensure long-term health and stability). Habitats impacted by invasive species include oak savannah, native prairie, grassland, bluffland, and hardwood forest and wetland habitats. Minnesota's Comprehensive Wildlife Conservation Strategy lists management of

invasive species as a Priority Conservation Action for all ecological subsections in the state.

The grants could not be used to substitute for funding activities (current or ongoing) related to invasive species management within each Division. This funding was meant to allow managers to add or start new invasive species projects or expand on existing projects. Eligible projects activities include: 1) invasive plant surveys; and 2) planning and implementation of invasive plant management efforts.

Thirty-nine proposals totaling more than $596,000 were submitted for funding in response to a request for proposal for terrestrial invasive plant management. Thirty-two projects were funded, totaling $365,000, for the management of terrestrial invasive plant species on state-managed lands (Table 17). The funded proposals included 18 proposals for controlling invasive plants, four proposals for invasive plant inventories, and ten proposals to do both (inventories and control).

Table 17. Funded terrestrial invasive plant inventory/management projects FY06-07.

Division/ Section	Number of Projects	Project Type	Subtotal
Fisheries	3	• Buckthorn control (2) • Invasives inventory (1)	**$ 29,600**
Forestry	7	• Buckthorn control (4) • Garlic mustard control (2) • Invasives inventory (1)	**$ 70,500**
Parks	13	• Primarily woody invasives control (Buckthorn, honeysuckle, Siberian elm, cargana); some Canada thistle, spotted knapweed and garlic mustard control • Invasives mapping part of 6 projects	**$ 134,100**
Trails and Waterways	4	• Buckthorn control (2) • Tansy control (1) • Leafy spurge and spotted knapweed control • Canada thistle control (1)	**$ 48,000**
Wildlife	5	• Woody invasives control (2) • Invasives inventory (2)	**$ 83,000**
TOTAL	**32**		**$ 365,200**

The majority of the proposals targeted the control of woody invasive species such as buckthorn, exotic honeysuckles and Siberian elm. Many of the management projects are currently underway but will not be completed until June 30, 2007. Results of the management effort will be provided in the 2007 annual report.

Reducing the Spread and Impact of Invasive Species by DNR Resource Management Activities

Due to the growing threat of invasive species (both terrestrial and aquatic), and the Forest Stewardship Council's Corrective Action Request (CAR) to "implement strategy

to identify areas of greatest concern with respect to invasive species and implementation to control," there is a need to address the spread and impact of invasive species by DNR resource management activities from a department-wide perspective.

Inventory

Using standardized protocols developed by the DNR, more than 10,000 locations of invasive plant species on state-managed lands have already been mapped using GPS/GIS technologies (Figure 18). This includes surveys conducted in 20 state parks, 160 wildlife management areas, and along 160 miles of state trails. Data collected in the field is now being sent directly (via the web) to a central database within DNR where the all-terrestrial invasive plant data is stored and managed. For the first time, this data is now available to DNR staff through quick themes in Arcview. This terrestrial invasive plant data is updated weekly to ensure managers have the latest available information. Managers are now using this information to target and monitor the results of control efforts on these populations.

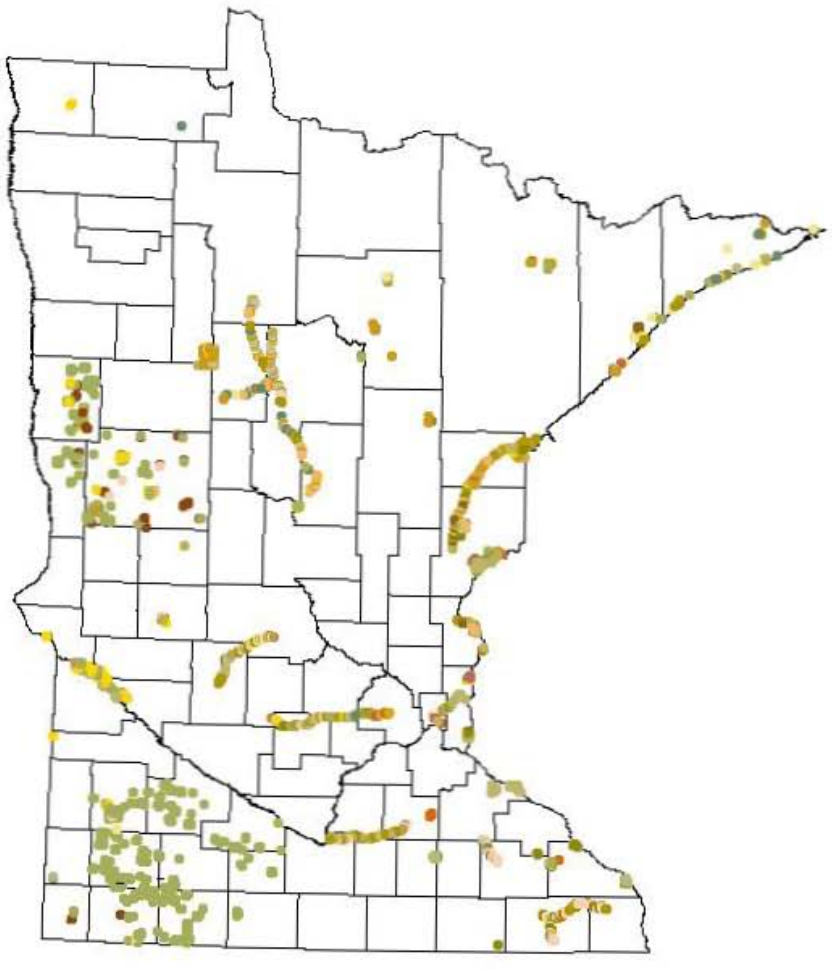

Figure 18. Terrestrial invasive plant inventories (all species), 2006.

Information and Education

Two, one-day workshops entitled "Invasive Plants of Minnesota Forests: information and educational tools for professionals" were held in Grand Rapids and Rochester, Minnesota. The workshops were designed to help foresters and resource managers become invasive species educators for audiences appropriate to their jobs and become familiar with resource materials and organizations. Participants learned how to identify, monitor, prevent, and control the most troublesome invaders of Minnesota's woodlands. These non-native invasive species have ecological implications for forest communities, disrupt tree regeneration, and create problems during and after timber harvests.

Highlights of the workshop included:

- Understand the ecological, economic, and recreational/social impacts of invasives.
- Understand the pathways in which invasives spread.
- Develop basic "four season" identification skills and understand the life history of each species, especially as it pertains to eradication and control methods.
- Become familiar with Best Management Practices (BMPs) for forest invasives to help prevent their spread.

- Become familiar with a variety of management and control methods, including mechanical, prescribed fire, grazing, chemical, biocontrols, various tools, and how an integrated approach can work.
- Make a commitment to "pass it on," and become an "Invasives Educator" for audiences appropriate to your job and become familiar with resources available (materials, people, organizing) to make your workshop happen.

The workshop focused on the most common woodland invasives: common and glossy buckthorn, exotic honeysuckles, garlic mustard, and other invasive plants.

The workshops were funded by a Minnesota DNR Forest Stewardship grant (funding from Forestry and Ecological Services) to the Institute of Agriculture and Trade Policy (IATP). The workshops were planned and carried out in conjunction with the Minnesota DNR Invasive Species Program. Instructors Gigi La Budde of IATP's Community Forestry Resource Center, and Luke Skinner and Ann Pierce, DNR Invasive Species Program, lead the all-day session with both classroom and field components. A total of 75 people participated in both workshops. Nearly half of the participants were DNR staff from Forestry, Wildlife, Parks, and Trails and Waterways. The remaining participants were county foresters, Natural Resources Conservation Service and Soil and Water Conservation District staff, master gardeners, etc.

The next step will be to work with the participants to put on their own workshops or presentations at meetings.

Research

Research in being carried out to improve management practices of plant species that pose a serious threat to natural resources and their use. Research is underway to improve control of Canada thistle, reduce herbicide use, and reduce impacts to native plants. Funds are being provided to support research on biological control methods for garlic mustard and buckthorn.

Canada Thistle Research

The Invasive Species Program helped sponsor a Canada thistle field day to inform resource managers on the results of current research on BMPs for Canada thistle management. The Canada thistle research was carried out under contract with the University of Minnesota. University scientists conducted the research in cooperation with DNR Wildlife staff from the Talcot Area office. Sites used for testing the BMPs included the West Graham Wildlife Management Area and Timber Lake U.S. Fish and Wildlife Service Waterfowl Protection Area. These BMPs were designed to balance the needs of managing wildlife habitat, to benefit desired native prairie species, and to decrease or eliminate the presence of Canada thistle. Clopyralid (Transline formulated product) is used because clopyralid is the most effective product on Canada thistle and offers non-target forb tolerance. To date, data indicate that spot treatment may not be feasible, and mowing two times per season would likely result in inadequate control of Canada thistle. Clopyralid application at labeled rates in the pre-bud stage provided good control. However, early season herbicide applications may harm nesting and survival of desired waterfowl. Waiting until after July 15 resulted in higher levels of Canada thistle. Below label rates of clopyralid, that would provide a greater margin of safety for sensitive forbs, did not control Canada thistle. Fall application of transline

provided good control with minimal impact to native forbs. The current recommendation is to treat Canada thistle in the fall (when feasible).

Buckthorn Biological Control Research

Research in Europe. The DNR has initiated a research project on biological control of European buckthorn, conducted by the Center for Applied Bioscience International in Switzerland (CABI). Minnesota legislature as recommended by the Legislative Commission on Minnesota Resources, from the Environmental Trust Fund and by the DNR to continue this research.

Initial research results suggest that a dozen species of insects show some potential as control agents. Surveys were carried out by CABI researchers in Germany, Italy, Switzerland, Austria, and Yugoslavia (2002-2005). In total, more than 60 buckthorn sites were discovered and sampled. To date, some 270 arthropod samples have been collected, 184 on *Rhamnus cathartica* and 70 on *R. frangula*. Emphasis was put on field surveys of flower and fruit/seed-feeding insects as key Lepidoptera species. Priority will be given to the biological control of *R*. *cathartica*, and no detailed work will be planned for biological control of *F. alnus* at this time. This research is expected to take eight to ten years to complete.

Garlic Mustard Biological Control Research

Summary. Since 1998, a consortium of private, state, and federal sponsors have supported the development of biological control for garlic mustard (*Alliaria petiolata*). Four weevil species attacking seeds, stems, and root crowns of garlic mustard have been selected as the most promising biocontrol agents. Individual and combined impacts of these species can increase rosette mortality and decrease seed output, stem height, and overall performance of garlic mustard. The determination of their host specificity, i.e., restriction to garlic mustard as the only plant allowing complete development without possibility to develop in native North American species, has been the highest priority over the past four years. The focus of this work has been on the root feeder *Ceutorhynchus scrobicollis* followed by the two-stem miners *C. alliariae* and *C. roberti*. The results of these tests show high specificity of all species to garlic mustard. Although three European plant species were also attacked in tests, these species are not recorded as field hosts of the weevils. The implementation of safe garlic mustard biocontrol appears within close reach.

Host specificity testing of the final set of native plant species was completed for *C. scrobicollis*. This included additional native species in several genera now considered closely related to garlic mustard. With testing complete, a petition will be developed for submission to USDA-APHIS and state agencies to allow field release in the United States. The petition will be developed during the late summer and fall, with a target date of January 1, 2007 for submission. Development of the petition will be a collaborative effort between researchers and managers participating in garlic mustard biological control development. This includes collaborators from CABI Bioscience, Cornell University, University of Minnesota, Michigan Sate University, USDA-Forest Service and Minnesota Department of Natural Resources.

In anticipation of receiving approval, work has been ongoing to develop mass rearing methods for *C. scrobicollis.* Researchers at the University of Minnesota are testing methods to rear *C. scrobicollis* outdoors as well as within the quarantine facility.

Garlic mustard biological control implementation in Minnesota. A second garlic mustard project was initiated in 2005 to establish permanent plots to monitor garlic mustard populations in anticipation of biological control insect release. To find potential sites, it was necessary to locate garlic mustard populations of the appropriate size in areas where management would not be applied. The established plots then have their species composition and garlic mustard abundance recorded in 2005 and 2006. Garlic mustard monitoring plots were established in 12 sites in central and southeastern Minnesota. In addition to setting up monitoring sites, a research plan for garlic mustard was developed. Current research on garlic mustard was reviewed and research objectives and experiments related to impacts and control of garlic mustard were developed. Funding for this effort was recommended by the Legislative Commission on Minnesota Resources from the Minnesota Environment and Natural Resources Trust Fund.

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Management of Asian Carp

Introduction

Four non-native species of carp, collectively known as Asian carp, have been imported for commercial aquaculture use in the Mississippi River basin and appear to have significant potential to harm aquatic ecosystems in Minnesota. The species are: bighead carp (*Hypophthalmichthys nobilis*), silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*), and black carp (*Mylopharyngodon piceus*). All four species have escaped from captivity and all but the black carp are known to have established populations in the Upper Mississippi River Basin (UMRB). Monitoring has documented that these populations are expanding their geographic range and are moving up the Mississippi River towards Minnesota (a single bighead carp was caught in Lake Pepin in 2003 and a large grass carp was caught in the St. Croix River in 2006). There is also concern that these fish could enter the Great Lakes through the Illinois waterways that connect the Mississippi River basin with the Great Lakes Basin.

Resource managers throughout the UMRB are concerned about Asian carp and their associated impacts on natural resources and human safety. The natural ranges of these fish species in Asia and risk assessments suggest that they will thrive in the UMRB. Asian carp are already the most abundant large fish in parts of the Missouri River and are present in large numbers in parts of the Mississippi River and its tributaries. Each of these species has unique characteristics and poses different threats to fish and other aquatic species. Taken together they appear capable of having profound effects on aquatic resources and recreational opportunities.

At present, no populations of Asian carp are known to have established in Minnesota. One Asian carp was reported caught in the state border waters in 2006. A commercial fisherman caught a grass carp in the St. Croix River in spring 2006. The closest known populations are in Iowa waters of the Mississippi River and its tributaries. Monitoring has documented that these populations continue to move upstream. Asian carp can move up to seven miles a day (Anderson, 2004) and 150 miles in a season (Chapman 2004), so there appears to be a diminishing window of opportunity to limit the spread of these species throughout the UMRB.

Bighead carp

The bighead carp are a planktivorous fish (they eat microscopic organisms) and are native to China. They prefer zooplankton (microscopic animals), but will supplement their diet with phytoplankton (microscopic plants) and detritus. They can get quite large, with individuals reaching over 30 inches in length and weighing up to 110 pounds. A unique feature that distinguishes the bighead carp from our native fishes is the placement of the eyes, which are located below the mouth. Bighead carp feed on the same food items as many of our native species and they will directly compete with the commercially harvested bigmouth buffalo, the threatened paddlefish, young-of-the-year of many fish species, and freshwater mussels.

Silver carp

Silver carp are large fish reaching 60 pounds and are native to eastern Asia. They were imported into the U.S. and stocked in private waters in other states to control

algae/phytoplankton. The fish was first found in natural waters in Arkansas around 1980, likely the result of escapes from private aquaculture facilities. This fish has the potential to cause considerable damage to native species because it feeds on plankton required by larval fish, gizzard shad and other plankton eating fish, and native mussels. The silver carp has also attracted attention because of its habit of jumping out of the water in response to passing boats (Figure 19). Because of their size and the height the fish reach, this behavior creates a serious hazard to boaters. Silver carp have not yet been documented in Minnesota waters, although a few anglers have observed jumping fish in the Mississippi River between Minneapolis and Red Wing and believe they may have been silver carp.

Figure 19. Silver carp in Illinois jumping in response to a power boat (Photo: C. Young, State Journal Register).

Grass carp

Grass carp are also large fish reaching up to 70 pounds and native to eastern Asia (Figure 20). Wild populations are now present in many natural waters in the United States. These fish have been and continue to be widely stocked to control aquatic vegetation. According to fisheries biologists in Midwest states, reproducing populations of grass carp are found in tributaries of the Mississippi River south of Minnesota. Grass carp have not become established in Minnesota waters, but individual fish have been caught in state border waters (St. Croix River in 2006, Mississippi River below the Twin Cities, and Okamanpeedan Lake on the Minnesota-Iowa border). They have been

sampled periodically by DNR Fisheries staff in the Mississippi River—the northern-most record at Wabasha, Minnesota, in 1994, and the earliest record in Lake Winona in 1977.

Figure 20. Grass carp caught in the St. Croix River in 2006.

Black carp

Black carp are native to eastern Asia. This species was first brought into the United States in the early 1970s as a "contaminant" in imported grass carp stocks for a private fish farm in Arkansas. In the early 1980s, black carp were imported as a food fish and to control the spread of yellow grub *Clinostomum margaritum* in aquaculture ponds (Source: http://nas.er.usgs.gov/queries/SpSimpleSearch.asp). Their establishment in the wild would pose a significant risk to the mollusk and fisheries resources throughout the Mississippi River and its tributaries.

A risk assessment on black carp (Nico et al. 2005) reports that black carp have been found in the wild in other states more than previously reported. On several separate occasions black carp have been captured in open waters of the nation: Illinois (2003 and 2004), Louisiana (2004), and Arkansas (2005). Despite these occurrences, it is not known with certainty if they are reproducing in the wild. There are no reports of larval or juvenile black carp, but it is possible they have reproduced and may have been misidentified or overlooked. Nico (et al. 2005) state, “the continued captures of adult black carp in Louisiana and other parts of the Mississippi River basin provide strong evidence that the species is reproducing and is already firmly established.”

Nico (et al. 2005) report that in terms of overall habitat suitability, the Mississippi River is suitable for black carp populations, perhaps even better than some rivers in its native

range. The upper Mississippi is less suitable because of the existence of many navigation locks and dams that restrict fish movement. He points out that habitat restoration and increasing connectivity, which benefits native fishes, also favors black carp survival.

Management Goals and Options

There are three general options to manage wild populations of Asian carp:

1) no action;
2) attempt to prevent further geographical spread; and
3) attempt population control after colonization.

Based on results in areas where Asian carp have already become established, it is clear that, if no actions are taken, Asian carp will eventually jeopardize aquatic resources and use of those resources in much of the UMRB. Currently there are no effective measures that would selectively control these species. The Minnesota DNR's goal is to prevent or slow the introduction of Asian carp into state waters and continue to support research efforts to develop new control techniques. To accomplish this goal, states, federal agencies, and Congress will need to act promptly to limit the northern spread of Asian carp in the UMRB.

Progress in Management of Asian Carp - 2006

- DNR Invasive Species Program staff contacted Fish Guidance, Ltd. regarding the potential to use a Bio Acoustic Fish Fence (BAFF) at the mouth of the St. Croix River to deter Asian carp from entering the St. Croix River from the Mississippi River. This effort was identified as a 2006 action in the *St. Croix National Scenic Riverway Comprehensive Interstate Management Plan for the Prevention and Control of Nonindigenous Aquatic Nuisance Species*. Preliminary estimates of the cost to install a BAFF near the railroad bridge (Figure 21) were about $4 million. Discussions were held with other St. Croix partners—Wisconsin DNR, USFWS, and St. Croix National Scenic Riverway—and due to the cost, concerns about native fish migration and issues related to threatened and endangered mussels, there was no further action taken in 2006 to pursue a BAFF at the mouth of the St. Croix River.

Figure 21. Mouth of St Croix River viewed from the east side of the river in Prescott, Wisconsin.

- The DNR continued to work with the Minnesota Congressional Delegation to pursue $7 million of federal funding to implement recommendations from an earlier feasibility study (FishPro, 2004) to slow Asian carp movement up the Mississippi River. The DNR desires to have fish barriers installed in conjunction with two Mississippi River locks and dams (L&D) such as L&D 11 and L&D 14 or 15, ideally by spring 2006 (Figure 22). The costs to build two fish barriers will depend on the sites and types of technologies:
    - Sound and bubble diversions (Bio Acoustic Fish Fence) placed at the lock chambers are estimated to cost approximately $1.2-$1.6 million each.
    - Costs of $.5-$3 million are estimated for creating a harvesting area for carp that congregate below each lock.
    - The need and feasibility of adding additional barrier technology along the spillway of the dam that will not compromise other river management concerns is still being examined and, if pursued, could cost an additional $8- to $10-million per dam.

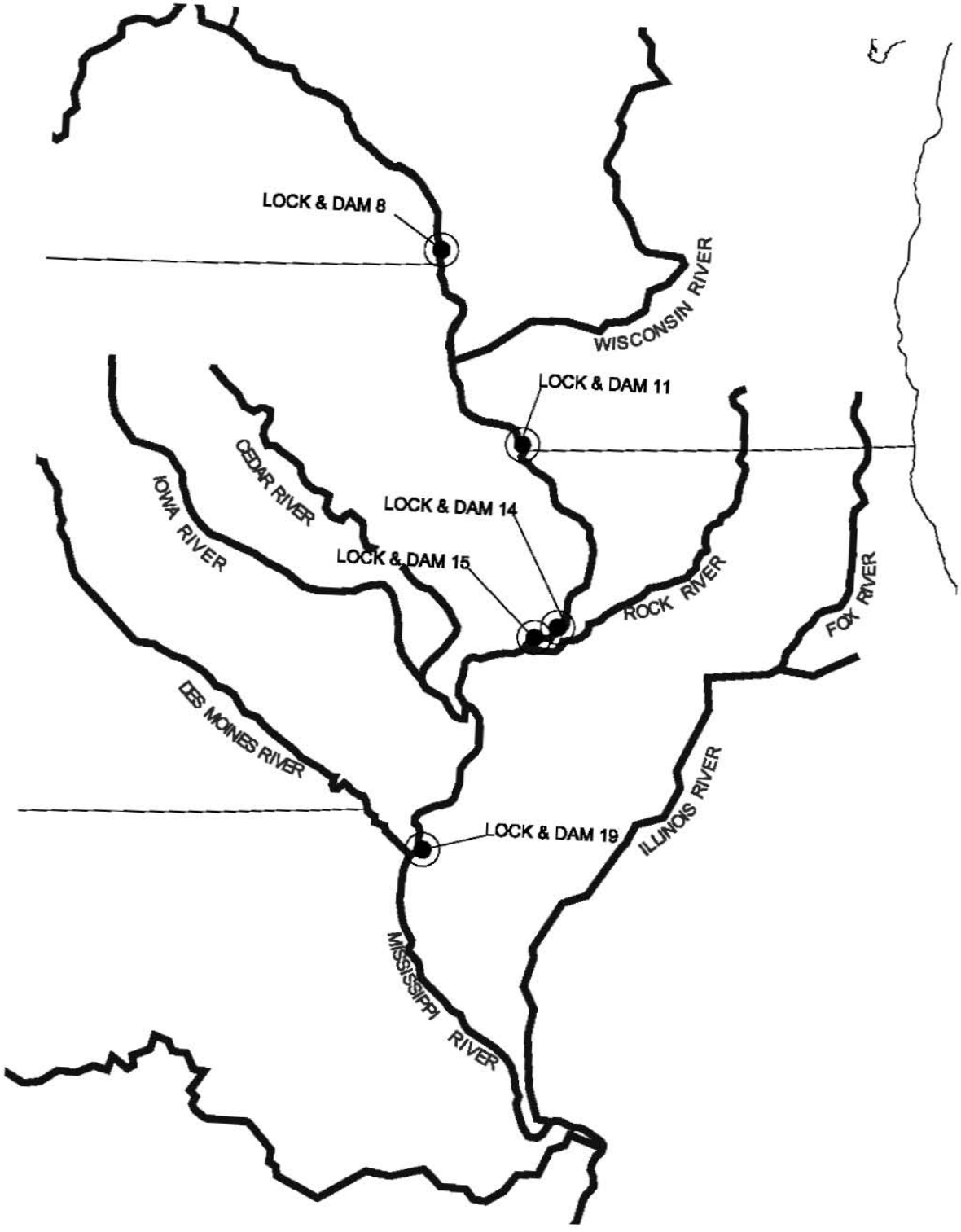

Figure 22. Locations of selected locks and dams on the Mississippi River.

Participation of Others

Federal Regulations

The USFWS began a process in 2002 to determine if it will list black carp as an injurious wildlife species. A similar process was initiated in 2003 to determine if bighead and silver carp should be listed as injurious wildlife species. In 2005, a bill was introduced in Congress to designate several Asian carp as injurious wildlife (see Regulations and Proposed Changes). On September 5, 2006, the *Federal Register* included a notice of a proposed rule by the USFWS that would list silver carp and large-scale silver carp as injurious wildlife. If listed, it would be illegal to import these species into the country or to ship them between states. As of December 2006, the USFWS has not designated any of the three species as injurious wildlife.

National Asian Carp Management and Control Plan

The USFWS formed an Asian Carp Work Group (ACWG) to develop a national Asian Carp Management and Control Plan. Jay Rendall, Minnesota's Invasive Species Program Coordinator, was a member of that group which developed a draft of the plan. On October 24, the *Federal Register* announced that the draft plan was available for public comment until December 24, 2006.

The draft plan has the following goals:

1. Prevent unauthorized introductions of bighead, black, grass, and silver carps in the United States.
2. Contain and control the expansion of feral populations of bighead, black, grass, and silver carps in the United States.
3. Reduce feral populations of bighead, black, grass, and silver carps in the United States.
4. Minimize potential negative effects of feral bighead, black, grass, and silver carps in the United States.
5. Inform the public, private industries, and government agencies about bighead, black, grass, and silver carps, their potential effects, and how to prevent unauthorized introductions, control the spread of feral populations, and minimize potential negative effects resulting from introductions in the United States.
6. Conduct research to provide accurate and scientifically valid information necessary for the effective management and control of bighead, black, grass, and silver carps in the United States.
7. Effectively plan, implement, and evaluate management and control efforts for bighead, black, grass, and silver carps in the United States.

Following the public comment period, the ANS Task force will prepare the final draft and seek partners to implement the plan.

Illinois Barriers I and II

Construction on Illinois Barriers I and II started in October 2004. Construction of the first half of the permanent barrier and both electrode sets is complete. Although problems continue to occur in the construction and operation of the new electrical barriers. The new Barrier IIA is not operational due to the sparking that put barges at risk. As a result, safety testing was ongoing in 2006.

Once again, lack of funds to complete Barrier IIB is an issue. June appropriations allowed for Corps reprogramming to operate the barrier through Spring 2007, pending unpredicted repairs. The Corps in now seeking another $8.5 million from Congress to complete the second part of the new double barrier. The State of Illinois would like O&M to be federally funded.

Future needs for management of Asian carp

- Support efforts to maintain two effective barriers to prevent Asian carp passage through the Illinois waterways into the Great Lakes.
- Seek funding for one or more dispersal barriers in the Mississippi River to prevent Asian carp from moving into Minnesota waters.
- Evaluate potential to re-establish St. Anthony Falls as a natural barrier.
- Evaluate potential to prevent spread of Asian carp in Minnesota's major tributaries to the Mississippi River including the St. Croix, Minnesota, Zumbro, Cannon, and Root rivers.
- Evaluate non-target impacts for proposed dispersal barriers in the Mississippi River.

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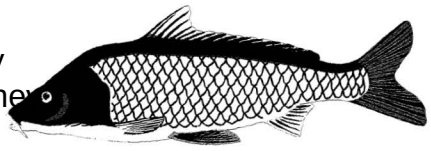
Management of Common Carp

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 caused many wetlands and wetland areas around lakes to dry up and set the stage for an explosion of aquatic vegetation and invertebrates. The early wetland drainage efforts also provided connections into many wetlands and shallow lakes previously inaccessible to fish. 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 in part 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. In addition, their consumption of invertebrates translocates nutrients from invertebrates into the water column. Carp have high metabolic and growth rates and their excretion contributes to internal nutrient loading in a lake. The additional phosphorus increases the growth of phytoplankton. As water clarity is reduced, the 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 game fish 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 would prey on young carp.

Common carp are a carrier of a new disease in the state, spring viremia of carp. All *Cyprinids* (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 23).

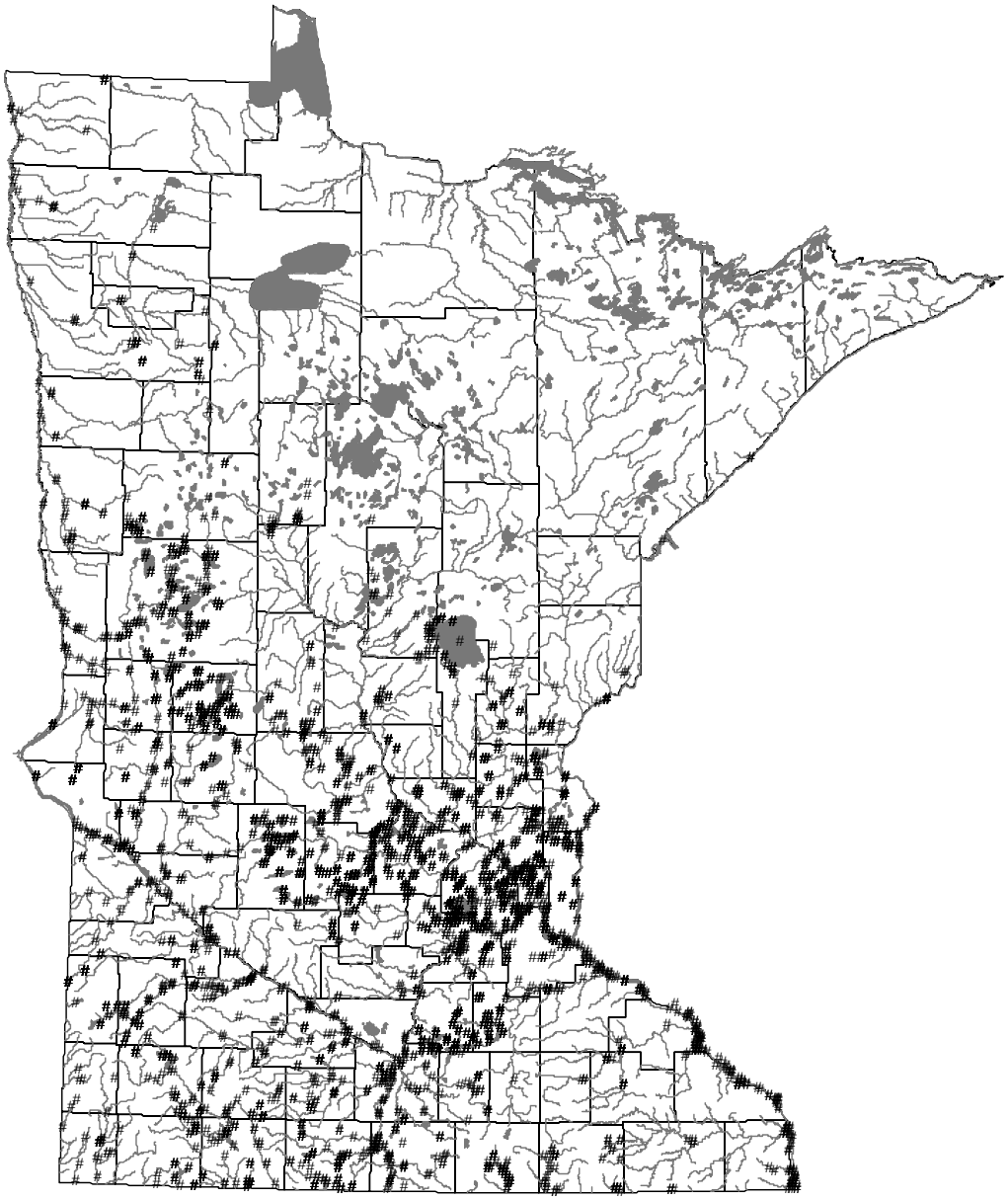


Figure 23. Distribution of common carp in Minnesota as of December 2006.

Progress in Management of Common Carp - 2006

Several activities occur to inventory common carp infested waters, limit their spread, and remove carp from waters where they exist. Those activities are primarily conducted by staff of the Division of Fish and Wildlife.

Evaluation of habitat conditions on shallow lakes
Habitat evaluation surveys were conducted on about 290 shallow lakes by DNR Wildlife and Ecological Services staff in 2006. These surveys evaluate water clarity, chemistry, and depth along with percent occurrence of rooted aquatic plants.

Evaluation of fish populations
Fish population surveys were proposed at 600 managed fishing lakes by DNR Fisheries. The results of those surveys are available in June the following year.

Establish and maintain fish barriers
Fish barriers are used to limit the movement of common carp between connected waters. Six electric fish barriers are currently operated under contracts with Smith-Root. A seventh electrical fish barrier was installed at Lake Maria in 2006. Other types of fish barriers including velocity tubes continued to be constructed, repaired, and maintained by DNR Wildlife in 2006.

Remove carp from priority lakes
A large project was conducted by DNR Wildlife at Howard and Mud lakes, shallow lakes near Carlos Avery Wildlife Management Area, to remove common carp, bullheads, and other zooplankton-eating fish in October 2004. The project yielded excellent results on bullheads and carp. In 2005, the result was extremely clear water as intended. DNR Wildlife also repaired the electric fish weir in November 2005.

A similar treatment was conducted in Lake Christina in 2003. The lake has continued to improve through 2006 and water chemistry analysis is being conducted. An electric rotating drum barrier was also installed on an inlet to this lake to prevent carp movement.

A major effort was initiated at Swan Lake in Nicollet County during 2005 to eliminate carp. The presence of carp in this premier waterfowl lake was confirmed in late November 2005. In early December, the DNR began to drawdown the water in the lake to eliminate the carp or at least the majority of them, but many carp remained. The drawdown continued in 2006 and a lakewide Rotenone treatment was done in fall 2006.

Research
Research to identify pheromones to attract or repel carp is being conducted at the University of Minnesota, with Dr. Peter Sorensen as the project leader, in cooperation with DNR Division of Fish and Wildlife. A project entitled “Developing Pheromones for Use in Carp Control” was recommended for funding by the Legislative Commission on Minnesota Resources (LCMR) and subsequently approved by the Legislature for FY 04/05. In 2006, control of carp was conducted by DNR Wildlife at other shallow lakes via drawdown and, in some cases, combined with Rotenone treatment. They include Lake Maria (Murray County), Heron Lake (Jackson County), Geneva (Freeborn County), North and South Spellman (Yellow Medicine County), Goose Lake (Waseca County), Rice Lake (Blue Earth County), and Rice Lake (Faribault County). There are also some carry-over projects from 2005 where the drawdowns occurred over the winter and let refill in spring 2006. They occurred at Towner Lake in Grant County and East Twin Lake in Lincoln County.

In 2005, the LCMR recommended and the Legislature provided additional funding of $550,000 for a project titled "Integrated and Pheromonal Control of Common Carp." This funding will allow Dr. Sorensen to continue research on common carp management during FY 06-09. The DNR is a partner on the proposed project and will contribute staff and equipment from DNR Fisheries and $60,000 over a three-year period from the Invasive Species Program. This project initiated work this year on three objectives: 1) to develop sensory attractants for female common carp so that efforts might focus on their removal via trapping; 2) to elucidate spawning habitat preferences of wild common carp in Minnesota so that their spawning habitats, and young, might also be targeted for removal; and 3) to develop a population dynamics model to explore how best to control local populations of common carp. It is hoped that the findings will allow development of an integrated approach to carp management.

On October 6, 2006 a workshop was held on the topic of "Biology and Management of Common Carp." The workshop was organized by Dr. Sorensen and supported by the USFWS. One outcome of the workshop was the creation of a Web site related to common carp at http://fwcb.cfan.umn.edu/sorensen/research/invasivecarp.html.

Effectiveness of carp management

Common carp management has been only moderately effective in all types of waters within Minnesota, which is why more research to improve management of common carp is ongoing. Nevertheless, 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. Participation on common carp management projects often includes Ducks Unlimited, Minnesota Waterfowl Association, USFWS, DNR Fisheries, and local lake associations.

Future needs for management of common carp

- Continue support for funding of research related to: the use of pheromones, winterkill to remove carp, new fish barrier designs, common carp life history and refinements of chemical applications to remove common carp.
- Continue to seek and provide funding for management to accelerate the removal of common carp from high-priority affected waters and/or the construction of barriers to limit natural dispersal.
- Monitor the new disease, spring viremia of carp, to determine how widespread it is in Minnesota and consider new limitations on live carp shipments.

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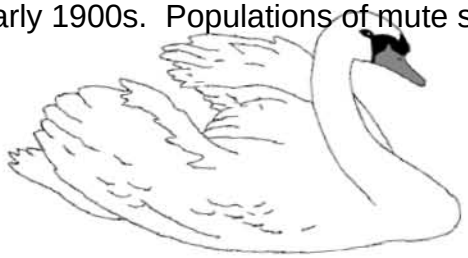
Management of Mute Swans

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. Populations of mute swans have established in numerous states. These populations have originated from release or escape of individuals from captive flocks. The current population growth in the Great Lakes states is estimated at 10-20% or higher per year (Scott Petrie, Bird Studies Canada, Port Rowan Ontario, presentation to Mississippi River Basin Panel, 8 September 2005). The birds can consume 8 pounds of submersed vegetation and uproot 20 pounds per day causing significant harmful impacts on lake ecosystems.



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 invasive species* in Minnesota Rules 6216.0260. It is illegal to release mute swans into the wild in Minnesota under the game farm and regulated invasive species statutes.

During the past three years, the DNR has received comments from riparian landowners who are concerned about the presence and increase of mute swans on the lakes where they reside. They are concerned about mute swans interfering with loon nesting that has previously occurred on those lakes. Individuals have also reported seeing the mute swans harassing trumpeter swans. Individuals and lake associations have requested that the DNR remove mute swans from lakes and wetlands where there were birds in the wild.

Goal

The DNR's goal for mute swan management is to avoid the establishment of naturalized populations of mute swans in Minnesota.

Distribution

Several unconfined mute swans were reported in Minnesota in 2006 and in previous years. Monitoring mute swans in the wild is a strategy necessary to help DNR respond to birds that may establish naturalized populations. During 2006, the DNR recorded reports of wild or escaped mute swans at six locations in the state. A total of 14 birds were reported in the wild in six counties (Table 18). Sources of the reports include: conservation officers, birders, the public, and other DNR staff who observed unconfined birds.

Progress in Management of Mute Swans - 2006

During 2006, DNR staff captured and removed four mute swans from the wild at Big Carnelian Lake in Washington County and two from a marsh near Cokato in Wright County. The bird reported at Swim Lake was not found after the initial report.

Table 18. Unconfined mute swans reported in Minnesota counties during 2006.

County	Number of Mute Swans Reported	Months Reported
Anoka	5 - Lake Amelia	April (2), September (5)
Douglas	1 – Swim Lake	June
Hennepin	1 – Normandale area	April
Winona	1 – pond near Winona	April
Wright	2 - near Crow River and Co Rd 4	April
Washington	4 - Big Carnelian Lake	April (4), May (2), November (2)
Total for all counties	**14**	

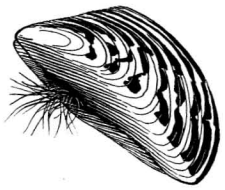
Future needs for management of mute swans

- Encourage reporting and verify occurrences of mute swans in the state.
- 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.

Management of Zebra Mussels

Introduction

Issue



The zebra mussel (*Dreissena polymorpha*) is a small striped invasive 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. The ability of these mussels to attach 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 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 over land. 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.

Goal

- Prevent the spread of zebra mussels to uninfested waters within Minnesota.

Distribution

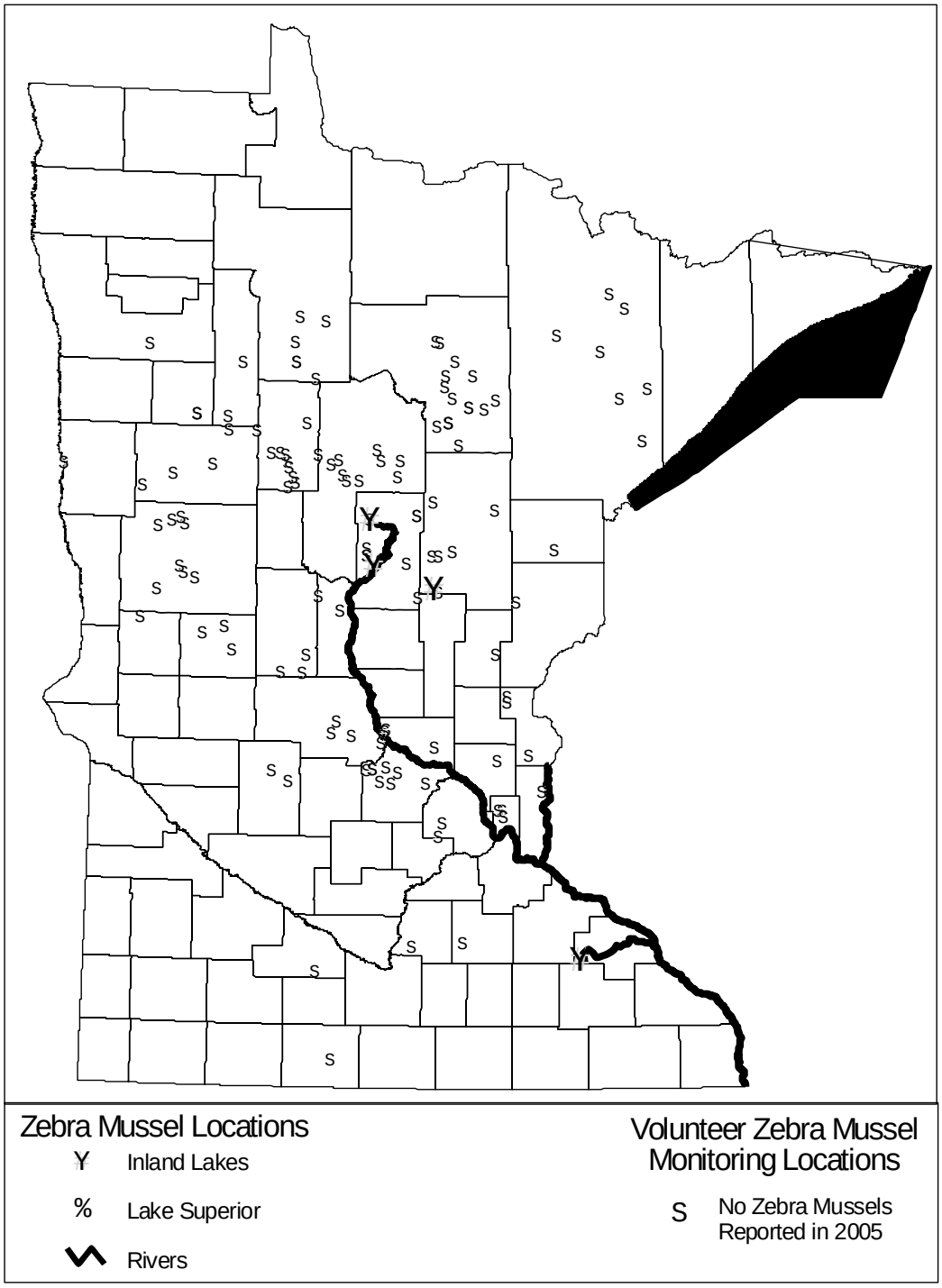


Figure 24. Zebra mussel and volunteer zebra mussel monitoring locations in Minnesota as of November 2006.

Management of Zebra Mussels - 2006

Monitoring

Diving surveys in Lake Ossawinnamakee (Figure 24) found many zebra mussels of different size classes attached to rocks and wood on the lake bottom. The population still appears to be expanding in the lake. Diving and sampling in Kimball Lake, upstream of and connected to Lake Ossawinnamakee by a small creek, found no evidence of zebra mussels. Invertebrate sampling in Pelican Brook recorded isolated small zebra mussels attached to woody debris below the outlet area. Sampling further downstream failed to find any attached mussels, and sampling at the boat access on the Pine River (approximately 16 miles downstream from the lake) failed to document any zebra mussels.

Diving during routine fisheries survey work in Lake Mille Lacs found eight more zebra mussels attached to rocks in several sites along the northern shore. Water samples taken during the summer did not find any veligers. However, the size of Lake Mille Lacs may prevent finding clusters of reproducing zebra mussels and, in early stages of infestation, veligers may be so dispersed and diluted that samples may easily miss this life stage.

Zebra mussels were first reported from Rice Lake, on the northern edge of Brainerd in late fall of the previous year. This lake is a backwater on the Mississippi River and contiguous with the main river channel over a large area. Diving in Rice Lake found extensive settlement of young zebra mussels, on aquatic vegetation and woody debris in multiple sites in the lake. Settlement on some docks, which last year numbers in ten to 20 small mussels, were in the hundreds or thousands of young mussels. Reproduction and settlement appears to have been extensive in Rice Lake, and the population increase is much more rapid than seen in Lake Ossawinnamakee. Shoreline surveys downstream of the dam below Rice Lake discovered attached mussels on rocks along shore, downstream as far as the Highway 210 Bridge. This downstream settlement can be expected to increase in future seasons, eventually establishing new reproductive “pools” further downstream in slower current areas.

Water samples were collected from above the Coon Rapids Dam in the metropolitan area. These were all negative, suggesting that zebra mussels have not established this far downstream, or that the numbers of veligers were too low to detect.

Diving on a long-term site in Lake Zumbro revealed a change in the numbers of zebra mussels. In previous years, structures on the bottom were completely covered with this invasive. This season, dead shells covered much of the bottom area, and many objects were no longer completely covered by encrusting mussels. While only a single site was examined, it remains to be seen if this abrupt decline in zebra mussel numbers changes the overall population in the lake, or was a result of extremely low waters coupled with warm summer temperatures.

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 last year. Reports to date from 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 and veliger samples 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 office by DNR biologists. No zebra mussels were found on the slides examined for 2006, suggesting that this invasive has not been moved upstream within these waters. However, reports from riparian owners in the lower river (downstream of Stillwater) documented substantially higher zebra mussel settlement than in previous seasons. This may indicate a growing population in the lower river, or may be a result of reduced water levels in the summer, leading to more retention time for veligers and permitting settlement.

Prevention of spread

Increased public awareness and education efforts continued in the Brainerd lakes area in response to the increasing zebra mussel population in Lake Ossawinnamakee as well as at Mille Lacs Lake. The number of hours of watercraft inspections increased, as well as inspection time spent in these areas (see Watercraft Inspections and Awareness Events). Public awareness efforts increased (see Watercraft Inspections and Awareness Events) as well as enforcement efforts. A pilot program was initiated with cooperators to guide people to private car wash facilities to wash their boats after use in zebra mussel infested waters in central Minnesota. Brochures and maps were provided at the access as well as other cooperating locations.

Fisheries staff investigated a report from a private resort on North Twin Lake of a private boatlift that had been transported from Lake Ossawinnamakee. They found extensive attached zebra mussels on the boatlift, which was still on land. Enforcement staff followed up on the discovery and issued a citation to the owner who had trailered the lift from Ossawinnamakee to North Twin.

Effectiveness of Management

Minnesota has only four inland lakes that contain this invasive. However, the presence of zebra mussels in Lake Mille Lacs places this species in a lake supporting an extremely high level of boating recreation. The number of visits to this lake by anglers and other boaters presents a much higher risk of accelerating movement of zebra mussels to other inland lakes within the state. Equally of concern is the rapidly increasing population of zebra mussels in Rice Lake. As was documented this season, zebra mussels are being transported to other habitats downstream in the river. When zebra mussels establish reproducing populations throughout the river from the Brainerd area to St. Paul, many more boaters and connecting waters can be exposed to this invasive.

Participation of Others

Monitoring efforts for zebra mussels continued by lakeshore residents throughout Minnesota. Approximately 200 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 invasive than could be conducted by the Invasive Species Program alone. Inland lake infestations in Minnesota (Zumbro, Ossawinnamakee, Rice) were reported by members of the public indicating the importance and value of this volunteer effort.

Discussions were conducted in early spring with staff from the St. Paul Regional Water Services. Water is pumped from the Mississippi River to a series of four lakes which function as a storage facility for increased water needs during the summer in St. Paul and surrounding communities. However, the listing of the river as infested created the need for actions to prevent movement of zebra mussels into these four lakes. An interim short-term treatment involving the addition of copper sulfate to the pumped water to kill veligers was instituted this season. Additional meetings will be held to examine long-term treatments to avoid long-term chemical addition to the water.

Researchers at the U.S. Army Corps of Engineers Research and Development Center published a paper in the Journal of Great Lakes Research on the results of their work on copper toxicity to zebra mussel veligers. This work was funded by the DNR Invasive Species Program under the efforts on Lake Ossawinnamakee to prevent movement of veligers through natural water pathways.

Future needs for management of zebra mussels

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

Other Invasive Animal Species in Minnesota

Introduction

Numerous invasive wild animals exist in the state. The previous chapters described species for which there were ongoing efforts. The species described in this chapter exist in the state, but there are no ongoing efforts by the DNR to manage them in the wild. They are included because they are or have been of interest within the state. In addition to the information presented on Eurasian collard-dove, New Zealand mudsnail, rusty crayfish, and spiny waterflea in this chapter, Table 19 presents a summary of other invasive animal species in Minnesota.

Examples of Releases of Non-native Species in 2006

Local examples of aquarium or water garden types of releases continue to appear in the state. During 2006, as in previous years, pacu, a species of South American freshwater fish that are closely related to the piranha were caught in state waters. One was caught in the St. Croix River in July and another in the Mississippi River near South St. Paul in October.

Black-tailed Prairie Dog

In 2005, we reported that black-tailed prairie dogs (*Cynomys ludovicianus)* were observed in the state at two locations. At a Mankato site in 2005, the animals were poisoned by the landowner to protect his horses that were at risk of breaking their legs in burrows. The colony previously reported in Pipestone County during 2005 is actually a colony of native Richardson's ground squirrel. Richardson's ground squirrels are a species of greatest conservation need in southwest Minnesota (pers. comm. Kelly Lynch, Minnesota County Biological Survey April 5, 2006).

Eurasian Collared-dove

Species and origin - The Eurasian collared-dove (*Streptopelia decaocto*), a bird native to the Indian subcontinent and Turkey, was first described as a new, non-native bird species in the state in the annual report for 1999. It arrived from expanding wild populations that are spread across the country (Figure 25).

Distribution - The bird has been observed in 25 Minnesota counties from 1999 to 2005: Big Stone, Blue Earth, Brown, Carver, Chippewa, Dakota, Freeborn, Houston, Jackson, Kandiyohi, Lac qui Parle, Lyon, Martin, Nicollet, Otter Tail, Pennington, Pipestone, Renville, Rock, Roseau, Stearns, Swift, Wabasha, Winona, and Yellow Medicine.

In 2006, Eurasian collared-doves were reported for the first time in the town of Hanska in Brown County, Moorhead in Clay County, west of Bombay and Wanamingo in Goodhue County, Minneapolis in Hennepin County, 16 miles east of Baudette in Koochiching County, between Morgan and Redwood Falls in Redwood County, Winthrop in Sibley County, and in Wheaton and near Lake Traverse in Traverse County. They were reported again in Blue Earth, Carver, Dakota, Houston, Kandiyohi, Stearns, Wabasha, and Wright counties. The birds are likely to be in other Minnesota counties and to continue spreading throughout the state.

Figure 25. Four Eurasian collared-doves feeding in Wabasha County. (Photo: Donnie Lien)

Management - 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.

Chinese Mystery Snail

Species and origin - The Chinese mystery snail (*Bellamya [=Cipangopaludina] chinensis*) is a viviparid gastropod native to Eastern and Southeastern Asia (Pace 1973, Chung and Jung 1999). This large olive-colored snail has small depressions above the shell opening and rows of fine, short stiff hairs parallel to the whorl of the shell that may wear off with age and abrasion. The snail gives birth to live young in the spring. This reproductive strategy is how it came to be known as a "mystery" snail because suddenly young, fully developed snails would appear mysteriously in a water body after females gave birth.

The Chinese mystery snail was originally brought to California in 1892 as a food source (Wood 1892), and was later found in Massachusetts in 1915 after a suspected aquarium release (Johnson 1915). It has since been found in several states (Jokinen 1982), presumably dispersed by people.

The Chinese mystery snail makes seasonal migrations in most lakes, with females moving to deeper water first in the early fall, and moving to shallower water after males in the spring to give birth. These snails can live up to four years, and after reproducing for the last time, will die. This yearly die-off can cause rafts of dead rotting shells to wash up on shore during the summer. They feed both by filtration and grazing.

Impacts - Under the correct conditions, they can form dense aggregations. This may interfere with other benthic grazers and filter feeders, but the extent to which the Chinese mystery snail competes with other aquatic species is not known. In Asia, this snail can transmit human intestinal flukes (Ingles 1930, Chung and Jung 1999), however, no reported cases have been documented in the United States. It also is a

carrier of unionid parasites that have been reported in mussels in the St. Croix River drainage (Williams, 1978).

Distribution - There are 82 reported occurrences for the Chinese mystery snail in Minnesota waters. Most records are from lakes and areas of rivers near the Twin Cities area and in the North Central lakes region. Other areas of concentration are in the Moose Horn River (St. Croix River drainage), Sturgeon River (Little Fork River drainage), and parts of the Lake Superior drainage system. The range of this snail appears to be increasing in Minnesota. Some of the lake residents that DNR staff has spoken with had only noticed the snails in the last few years. DNR Fisheries staff and others continue to report new infestations to the Division of Ecological Services (Figure 26).

Management - Chinese mystery snails and other snails in the genus *Cipangopaludina* are designated as *regulated invasive species* in Minnesota Rule 6216. State statute prohibits the introduction of regulated invasive species into the wild.

A literature review for aquatic snail control methods was conducted by a staff member in the Division of Ecological Services during 2006. It revealed several control options that could be further investigated: chemically baited traps, hand collection, molluscicide application, introduction of a competitor snail, alteration of aquatic nutrient cycles, and introduction of obligate snail pathogens. Many of these options may be unacceptable in Minnesota waters or unfeasible for widespread control.

Future needs - Future needs for this and other mystery snails include: 1) increasing public awareness of the state regulations regarding introduction and spread; 2) assessment of control methods that may be permitted in Minnesota; and 3) review of regulated and prohibited species classifications and designations to ensure they address current threats and species.

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Pace, G.L. 1973. The freshwater snails of Taiwan (Formosa). Malacological Review Supplement 1:1-118.

Williams, D. D. 1978. *Aspidogaster conchicola* in St. Croix River, Wisconsin clams. Proceedings of the Helminthological Society of Washington 45:257-258.

Wood, W.M. 1892. *Paludina japonica* Mart. for sale in the San Francisco Chinese markets. Nautilus 5:114-115.

Japanese Mystery Snail

Species and origin - The Japanese mystery snail (*Bellamy [=Cipangopaludina] japonica*) is native to Japan and Southeast Asia (Clench and Fuller 1965). It is very similar in appearance to the Chinese mystery snail, except it has a more pointed, pronounced spire (set of whorls). This snail was introduced as a food source to the United States in California in 1911 (Hannibal 1911).

Distribution - It was found for the first time in 2004 at five sites in the Namekagon River (St. Croix River drainage), Wisconsin. This species could occur in other areas of the St. Croix River drainage, and given its close proximity, possibly in Minnesota waterways. However, it has not yet been recorded in Minnesota. It follows the same seasonal migrations in lakes like the Chinese mystery snail and the banded mystery snail. The Japanese mystery snail has been recorded to reach high densities; in Lake Erie fishermen have retrieved over two tons in just one seine haul (Wolfert and Hiltunen 1968). These densities have not been recorded in Wisconsin waterways (Figure 26).

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Hannibal, H. 1911. Further notes on Asiatic *Viviparus* in California. Nautilus 25:31-32.

Wolfert, D.R., and J.K. Hiltunen. 1968. Distribution and abundance of the Japanese snail, *Viviparus japonicus*, and associated macrobenthos in Sandusky Bay, Ohio. Ohio Journal of Science 68:32-40.

Banded Mystery Snail

Species and origin - The banded mystery snail (*Viviparus georgianus*) is a viviparid gastropod, which has red bands that are parallel to the whorl of the shell. Females give birth to live, fully developed young in the spring. The snail's historic range is in the southeastern United States, primarily in the Mississippi River system up to Illinois (Clench 1962, Burch and Jung 1988), but it now has invaded lakes and slow moving waterways in Minnesota.

Impacts - This snail can form dense aggregations under the correct conditions, but information on competitive interactions with other grazing aquatic species is unknown. The banded mystery snail has been shown to cause significant mortality of largemouth bass (*Micropterus salmoides*) embryos when they invade nests (Eckblad and Shealy 1972). The banded mystery snail makes the same seasonal lake migrations as the Chinese mystery snail. It has been suggested that some North American populations could be the European snail species, *Viviparus viviparus*, since the two species are nearly indistinguishable.

Distribution - There are 45 reported occurrences for the banded mystery snail in Minnesota waterways. The banded mystery snail is most prevalent in the Twin Cities and in the North Central lakes region, mainly in lakes and in slow moving rivers. Other areas of concentration are in the St. Croix River drainage (Figure 26).

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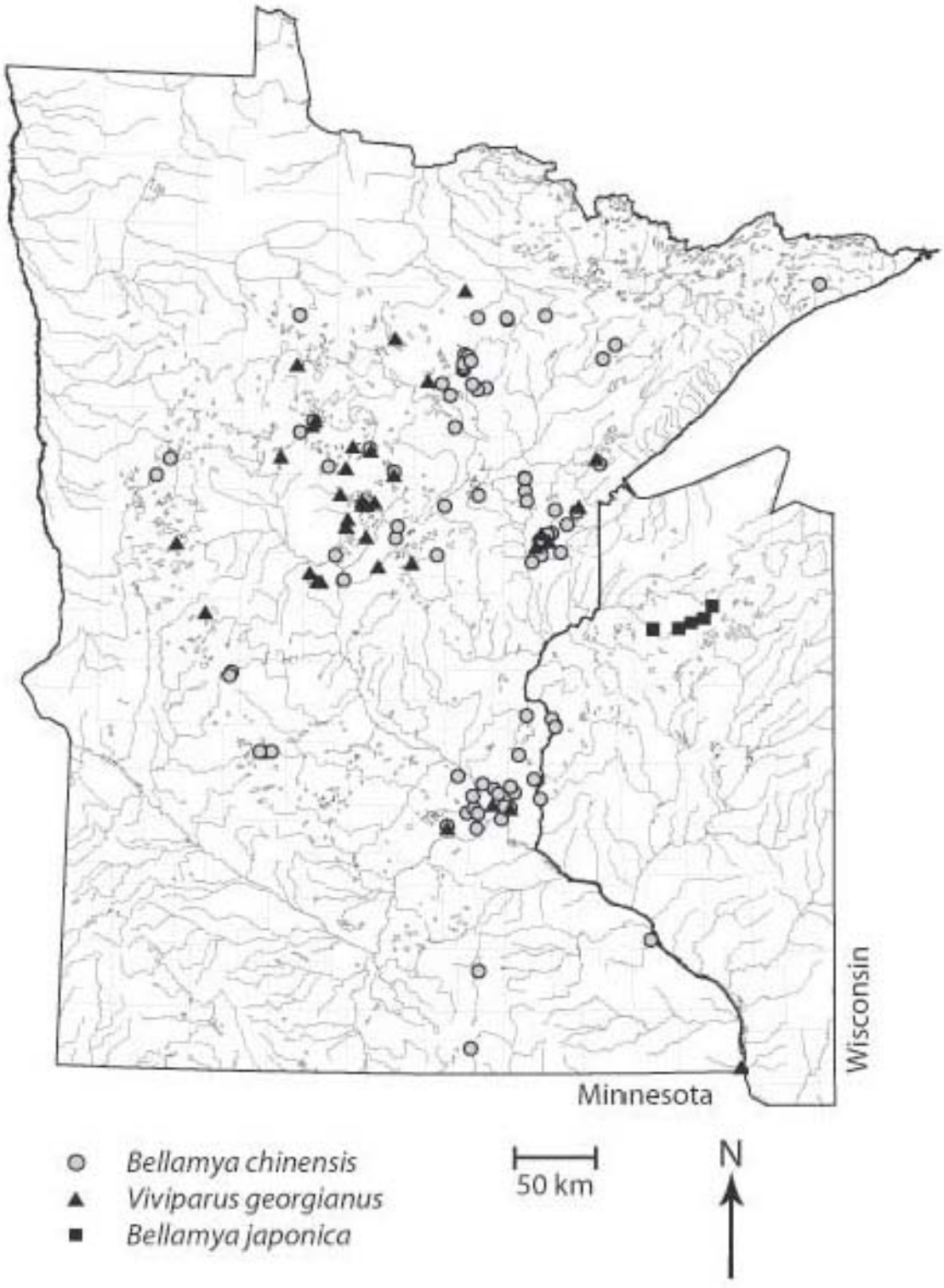

Figure 26. Distribution of mystery snails in Minnesota and bordering waters as of December 2006.

New Zealand Mudsnail

Species and origin - The New Zealand mudsnail (*Potamopyrgus antipodarum*), a tiny snail native to New Zealand, was collected for the first time in Minnesota waters during fall of 2005. Hundreds of the snails were found by a contract research scientist who was surveying for new invaders in the Duluth Harbor for the U.S. Environmental Protection Agency's (EPA) Mid-Continent Ecology Division. Following confirmation of the discovery, the EPA disclosed preliminary results in spring 2006.

New Zealand densities can reach 100,000 to 700,000 per square meter in preferred habitats. They may outcompete species that are important forage for trout and other fishes and provide little nutrition to fish that eat them. Another concern is that they can spread easily in water, as well as on aquatic plants, waders, and other gear used in infested waters. They are able to close their shells, allowing them to survive out of water for days.

Distribution - The mudsnails were first discovered in the U.S. in the late 1980s in the Snake, Idaho, and Madison rivers, they quickly spread to other western rivers. They were discovered in Lake Ontario, and later in Thunder Bay, Lake Superior in 2001.

Management - In 2006, DNR and Minnesota Sea Grant responded to the new infestation by issuing a press release, developing and distributing a New Zealand Mudsnail WATCH card, and adding information about the new species on the DNR Web site. The DNR is in the process of designating the New Zealand mudsnail as a prohibited invasive species and is also in the process of designating Lake Superior and the St. Louis River below the Fond du Lac Dam as waters infested with the mudsnails. The designation as prohibited means the mudsnails will be illegal to transport, possess, and place into other waters in the state, as with other invasive species such as zebra mussels.

Rusty Crayfish

Species and origin - The rusty crayfish (*Orconectes rusticus*) is an invasive species that is native to the eastern and mid-eastern United States. It has been spread across the Midwest through human activities, likely through release of bait by anglers. This invasive can outcompete 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.

Distribution - These crayfish have been reported from more than 40 lakes and eight rivers in the state, scattered from northeast to south-central Minnesota. DNR Fisheries staff encounter rusty crayfish in their lake sampling gear and report findings to the

Division of Ecological Services. Judging from the widespread reported distribution, it is highly likely that rusty crayfish are present, but unrecorded in more waters in the state. Management - There are currently no selective and effective control methods once the rusty crayfish become established in lakes or rivers. A report on crayfish control (*Investigation of Crayfish Control Technology*, M. W. Hyatt, Arizona Game and Fish Department) looked at varying methods of control and came to the conclusion that non-specific biocides might work in very limited circumstances, but no other control method (manual removal, trapping, predator management) would eliminate crayfish. An ongoing Wisconsin study found that intensive continual trapping coupled with strict fisheries regulations reduced the population of rusty crayfish in a small lake to approximately 10% of the original level. However, research has not been completed on what the population will do once the trapping and regulations are ended. This may be ineffective in larger lakes, due to the practical constraints on the effort needed to trap the crayfish. With the lack of any selective or even effective control methods, the Invasive Species Program does not conduct any active management of rusty crayfish.

Research - The Bemidji Regional Fisheries office began a cooperative study with researchers from Bemidji State University to examine possible negative impacts from rusty crayfish on walleye populations in Leech Lake. Local sports groups have suggested that crayfish predation on walleye eggs might impact game fish numbers in the lake. Preliminary work on relative crayfish abundance~~s~~ was conducted this season, with cage exclosure studies and laboratory work planned for the upcoming year.

Spiny Waterflea

Species and origin - The spiny waterflea (*Bythotrephes longimanus*) is an invasive cladoceran zooplankter native to Europe. It was brought to the North American Great Lakes in ballast water in the late 1980s. This zooplankter is a predaceous cladoceran, feeding on other smaller zooplankton. The long, barbed tail spine on this invasive can prevent predation by small larval fish as well as other aquatic animals. Some species of larger fish have been shown to feed heavily on the spiny waterflea. This invasive may interfere with lake food webs by preying heavily on and reducing the number of other zooplankton. Some research suggests that the most significant impacts will occur in larger, oligotrophic (lacking plant nutrients) lakes with simpler fish communities. The spiny waterflea produces resting eggs similar to those of native Cladocera, which can resist desiccation and freezing, providing a long-range dispersal method for overland spread. Adults may become entangled in fishing gear and moved to other water bodies.

Distribution - The spiny waterflea was discovered in Lake Superior in the late 1980s, and shortly after that was found in two nearby lakes (Fish and Island lakes, near Duluth). Monitoring by area DNR Fisheries staff reported that it disappeared from Fish Lake, while remaining in Island Lake. Recent discoveries in several lakes in northern Minnesota suggest that this invasive will spread to other waters through natural water connections. The resting eggs or viable adults can be carried through such connections into other water bodies. The latest infestations were reported from Rainy Lake and Namakan Lake on the northern border of Minnesota in 2006.

DNR Fisheries staff in the Duluth area are currently working on completing a research study examining *B. longimanus* populations in Island Lake. The DNR Aquatic Invertebrate Biology staff is assisting in laboratory work for this study.

Table 19. Other invasive and non-native species that have been found in the wild in Minnesota.

Species	Status	Legal Status	Last annual report to include info on this species
Daphnia lumholtzi	*D. lumholtzi* were first found in reproductive densities in Lake Pepin in 2003. Samples from 2005 found a single specimen from the main channel in mid-September.	Unlisted	2005
Earthworms (various genera)	Continued public education has focused on preventing the release of earthworms.	Unlisted	2003
Eurasian swine (*Sus scrofa)*	No new reports of escaped Eurasian swine in 2006.	Prohibited	2002
Fallow deer *(Dama dama)*	Several escapes in past years. Reports to DNR of nine escaped in 2006. Eight were recaptured and returned to a fence farm. The ninth was disposed of after escape.	Unlisted	2001
Red deer *(Cervus elaphus)*	Reports to DNR of six escaped in 2005. They were dispatched by DNR.	Unlisted	1999
Round goby (*Neogobius melanostomus)*	No new water bodies in 2006.	Prohibited	2005
Ruffe (*Gymnocephalus cernua)*	No new water bodies since 1988.	Prohibited	2002
Sika deer (*Cervus nippon)*	Several escapes in past years. Reports to DNR of four escaped in 2005. They were returned to a fenced farm. Another was reported shot by a deer hunter in 2005.	Unlisted	2001
Three spine and four spine stickleback (*Gasterosteus aculeatus* and *Apeltes quadracus)*	In Lake Superior.	Unlisted	2000
Tubenose goby (*Proterorhinus marmoratus)*	The tubenose goby was first discovered in the St. Louis River estuary in 2001. It has also been documented in several other lakes and rivers within the Great Lakes Basin.	Proposed prohibited	2005

Appendix A - Invasive Species Program Staff

Title / Area of Responsibility	Name	Phone	E-mail
Invasive Species Program Coordinator - rulemaking, legislation, state representative on regional aquatic invasive species committees or panels and federal invasive species issues, education and public awareness	Jay Rendall	651-259-5131	jay.rendall@dnr.state.mn.us
Purple Loosestrife Coordinator - technical assistance for management of purple loosestrife, and biological control of other invasive species	0Luke Skinner	651-259-5140	luke.skinner@dnr.state.mn.us
Eurasian Watermilfoil Coordinator - technical and financial assistance for management of milfoil, and technical assistance for other invasive aquatic plants	Chip Welling	651-259-5149	chip.welling@dnr.state.mn.us
Invasive Species Biologist - technical assistance for management of milfoil, curly-leaf pondweed, and other invasive aquatic plants	Wendy Crowell	651-259-5085	wendy.crowell@dnr.state.mn.us
Invasive Species Biologist - technical assistance for management of milfoil, flowering rush, and other invasive aquatic plants	Nick Proulx	651-259-5129	nick.proulx@dnr.state.mn.us
Invasive Species Biologist - invasive species issues in northern portions of the state	Dan Swanson	218-833-8645	dan.swanson@dnr.state.mn.us
Invasive Species Ecologist - invasive species issues in northern portions of the state; purple loosestrife database management	Rich Rezanka	218-833-8646	richard.rezanka@dnr.state.mn.us
Watercraft Inspection Program Coordinator - supervises watercraft inspection interns; awareness events at water accesses	Heidi Wolf	651-259-5152	heidi.wolf@dnr.state.mn.us
Watercraft Inspection Program Assistant - awareness events at water accesses	Vacant	651-259-5146	
Aquatic Invertebrate Biologist - zebra mussels, rusty crayfish, and other invasive aquatic invertebrates	Gary Montz	651-259-5121	gary.montz@dnr.state.mn.us
Conservation Officer - statewide enforcement of invasive species regulations for aquatic plants and wild animals	Ken Soring	218-999-7809	ken.soring@dnr.state.mn.us
General Information		651-259-5100	

Appendix B - Other State Contacts for Invasive 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 MDA, is charged with surveying and controlling forest pests, including invasive 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
Southern Forest Health Specialist	Ed Hayes	507-285-7431
Northeast Forest Health Specialist	Mike Albers	218-327-4115
Northwest Forest Health Specialist	Jana Albers	218-327-4234
Forest Development Health and Use Supervisor	Al Jones	651-259-5271

U of Minnesota Sea Grant - Aquatic Invasive Species Information Center
The Aquatic Invasive Species Information Center at the University of Minnesota Sea Grant Program provides research, outreach, and education in collaboration with the DNR's Invasive 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 MDA is responsible for the state's noxious weeds, plant pests, and invasive species of terrestrial plants and insects. MDA's Invasive Species Program addresses species such as gypsy moth, Asian long-horned beetle, Grecian foxglove, and emerald ash borer. MDA prepares an annual report for these programs.

Plant Protection Division Contacts

Invasive Species Unit	Teresa McDill	651-201-6448
Terrestrial Invasive Species Program	Val Cervenka	651-201-6590

Agricultural Resources Management Division Contacts

Weed IPM Program Coordinator	Anthony Cortilet	651-201-6608
Weed Biological Control Project	Monika Chandler	651-201-6468

Interagency Invasive Species Groups
There are several invasive species committees or work groups that facilitate coordination between the involved agencies.

Weed Integrated Pest Management Committee - Jean Ciborowski, MDA - Integrated Pest Management Coordinator, Ag Development Division, 651-201-6217.

Gypsy Moth Program Advisory Committee - Kimberly Thielen Cremers, MDA - Invasive Species Unit, Plant Protection Division, 651-201-6692.

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: Val Cervenka, MDA - Invasive Species Unit, Plant Protection Division, 651-201-6590 and Jay Rendall, DNR Invasive Species Program, Ecological Services Division, 651-259-5131.