2001 Project Abstract

FINAL REPORT

For the Period Ending June 30, 2004

TITLE: Biological Control of Eurasian Watermilfoil and Purple Loosestrife-Continuation

PROJECT MANAGER: Luke Skinner
ORGANIZATION: Minnesota Department of Natural Resources
ADDRESS: 500 Lafayette Road, Box 25, St. Paul, MN 55155-4025
FUND: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2001, 1st Special Session, Chap. 2, Sec. 14, Subd. 04(d)

APPROPRIATION AMOUNT: $90,000

Overall Project Outcome and Results

The purpose of this research was to evaluate biological controls for Eurasian watermilfoil, *Myriophyllum spicatum*, and purple loosestrife, *Lythrum salicaria*, two exotic aquatic plants that are degrading Minnesota's aquatic resources statewide. Researchers found that the milfoil weevil, *Euhrychiopsis lecontei*, can cause sustained declines of the invasive, non-native Eurasian watermilfoil if sufficient densities of the insect are maintained throughout the summer each year. Unfortunately, in many lakes, weevils do not reach adequate densities, or their densities do not persist through the summer over several years, to sustain control. In many lakes, sunfish appear to limit densities of the milfoil weevil, and so prevent sustained declines in Eurasian watermilfoil. Also, sustained control of this non-native plant is likely to require an increase in rooted native plants following reductions in the amount of the invasive species. For a complete description of the Eurasian watermilfoil research, see Newman (2004).

Evaluation of purple loosestrife biological control found that the leaf-beetles, *Galerucella* spp., can provide long-term control of purple loosestrife. As purple loosestrife populations were reduced, the diversity of other plant species increased (Skinner et al.2004). *Galerucella* ssp. populations fluctuate over time in response to purple loosestrife abundance. At some sites, the leaf beetle populations declined and have not rebounded, suggesting control may vary depending on a number of factors *Galerucella* spp. did not impact two native Lythrum species. Although *Galerucella* larvae were present and some feeding observed on swamp and winged loosestrife, plant growth or reproductive parameters were not affected (Stamm Katovich et al. 2004). *Galerucella* spp. can readily disperse and colonize purple loosestrife infestations within wetlands and across landscapes. *Galerucella* spp. on average, dispersed 5 km to new purple loosestrife infestations within 3 years. The maximum dispersal distance recorded was 20 km. Beetles were found in 85% non-release sites visited (McCornack et al. 2004).

Project Results Use and Dissemination

Results of this project will be published in peer-reviewed scientific journals and also in special publications and newsletters. Results also will be presented at national, regional and state scientific meetings to peers in the field, as well as to resource managers and planners who will use the results of this project. Currently, the research results are used in decision making for management activities in the state. For example, recent results provide guidance for releasing purple loosestrife control agents and what to expect after release. A list of future publications can be found in the final report.

Date of Completion: August 18, 2004

LCMR Final Work Program Report

I. PROJECT TITLE: Biological Control of Eurasian Watermilfoil and Purple Loosestrife- Continuation

Project Manager: Luke Skinner
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Total Biennial Project Budget: $90,000

$ LCMR Appropriation $90,000 **$ Amount Spent**: $90,000 **= $ Balance:** $0

Legal Citation: ML 2001, 1st Special Session, Chap. 2, Sec. 14, Subd. 04(d)

Appropriation Language: $45,000 the first year and $45,000 the second are from the trust fund to the commissioner of natural resources for the fifth biennium of a five biennia project to develop and implement biological controls for Eurasian water milfoil and purple loosestrife. This appropriation is available until June 30, 2004, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

II. FINAL PROJECT SUMMARY

The purpose of this research was to evaluate biological controls for Eurasian watermilfoil, *Myriophyllum spicatum*, and purple loosestrife, *Lythrum salicaria*, two exotic aquatic plants that are degrading Minnesota's aquatic resources statewide. Researchers found that the milfoil weevil, *Euhrychiopsis lecontei*, can cause sustained declines of the invasive, non-native Eurasian watermilfoil if sufficient densities of the insect are maintained throughout the summer each year. Unfortunately, in many lakes, weevils do not reach adequate densities, or their densities do not persist through the summer over several years, to sustain control. In many lakes, sunfish appear to limit densities of the milfoil weevil, and so prevent sustained declines in Eurasian watermilfoil. Also, sustained control of this non-native plant is likely to require an increase in rooted native plants following reductions in the amount of the invasive species. For a complete description of the Eurasian watermilfoil research, see Newman (2004).

Evaluation of purple loosestrife biological control found that the leaf-beetles, *Galerucella* spp., can provide long-term control of purple loosestrife. As purple loosestrife populations were reduced, the diversity of other plant species increased. *Galerucella* ssp. populations fluctuate over time in response to purple loosestrife abundance (Skinner et al.2004). At some sites, the leaf

beetle populations declined and have not rebounded, suggesting control may vary depending on a number of factors *Galerucella* spp. did not impact two native Lythrum species. Although *Galerucella* larvae were present and some feeding observed on swamp and winged loosestrife, plant growth or reproductive parameters were not affected (Stamm Katovich et al. 2004). *Galerucella* spp. can readily disperse and colonize purple loosestrife infestations within wetlands and across landscapes. *Galerucella* spp. on average, dispersed 5 km to new purple loosestrife infestations within 3 years. The maximum dispersal distance recorded was 20 km. Beetles were found in 85% non-release sites visited (McCornack et al. 2004).

IV. OUTLINE OF PROJECT RESULTS

Detailed descriptions of the background for each objective listed below, as well as proposed methods to accomplish these objectives, are provided in two proposals written by the researchers who will do this work. The proposals are included as attachments B1 and B2 to the workprogram.

A. Eurasian watermilfoil

Result 1. Research on the potential for biological control of milfoil is subdivided into three activities, which are described below.

Activity 1. Attempt to detect additional lake-wide milfoil declines and assess populations of the milfoil weevil in a broader array of lakes. Continue to sample intensive sites and begin to sample six new lakes with a range in densities of sunfish. These tasks will allow us to determine if milfoil declines are occurring and if declines are related to control agent occurrence or densities. These results will be combined with information in task B to determine if sunfish or other factors may be limiting weevil densities.

LCMR Budget: **$5,000** Other: $7,500
Balance: $ 0 Other Balance: $ 0
Completion Date: June 30, 2004

Activity Status: Intensive monitoring of five lakes documented declines of Eurasian watermilfoil in four of these lakes. These declines appear to be related to herbivory by biological control agents. Two declines were lake-wide and persisted for 3 or more years. Observations by this team of researchers from the University of Minnesota and work from elsewhere indicates that milfoil weevils can control Eurasian watermilfoil when adequate densities of weevil are reached and sustained. Nevertheless, in many lakes, weevils do not reach adequate densities or their densities do not persist through the summer over several years to sustain control. For a complete description of the research done under this activity, please see Newman (2004).

Activity 2. Identify and manipulate factors that limit populations of milfoil biocontrol agents such as the milfoil weevil. Continue biweekly surveys of weevil densities in four

lakes. The results of this task and the lakewide data from task A will allow us to determine if weevil density and longevity are related to sunfish density and other lakewide factors. Conduct large-scale open augmentations of weevils in two lakes, one with high sunfish and the other with low sunfish. This task will allow us to further assess the importance of sunfish on the establishment and success of the milfoil weevil.

LCMR Budget:: **$20,000** Other: $20,000
Balance: $ 0 Other Balance:$ 0
Completion Date: June 30, 2004
Activity Status: Regressions suggested that sunfish density explains 60 and 70% of the variation in total weevil and adult weevil density, respectively, among lakes. This result supports experimental observations by researchers from the University of Minnesota that sunfish predation is an important factor limiting weevil density, and thus milfoil control, in Minnesota lakes.

Though stocking of two study lakes resulted in establishment of detectible weevils populations that carried over to the next summer, there were no significant reductions of milfoil associated with weevil stocking in either lake.

For a complete description of the research done under this activity, please see Newman (2004).

Activity 3. Identify and manipulate factors that may limit the effectiveness of milfoil control agents (plant community response). Assess the response of the plant community to the effects of treatment with alum on water clarity in Minneapolis lakes. Experimentally manipulate plant communities to determine the importance of plant competition on abundance of milfoil in one of the Minneapolis lakes treated with alum and in two other lakes with low water clarity. Determine if exchangeable N is an important factor in determining plant community composition, abundance of milfoil, and response of the plants to biocontrol agents.

LCMR Budget:: **$20,000** Other: $22,500
Balance: $ 0 Other Balance:$ 0
Completion Date: June 30, 2004

Activity Status: Attempts to increase water clarity via treatments with alum did not enhance native plant communities. In three Minneapolis lakes with successful alum treatments, Eurasian watermilfoil maintained or increased its dominance after treatment. It is possible that the increases in clarity were not sufficiently large, or sustained for a long enough time, to benefit native plants. Alternatively, a reduction in the abundance of milfoil, such as might be caused by herbivory, may be needed to reduce milfoil's competitive advantage and allow native plants to increase.

To test the hypothesis that competition among different plant species may affect

reestablishment of Eurasian watermilfoil after a decline or reduction due to weevil damage, experimental removals of milfoil and other plants were conducted. Overall, the experimental removals did not reveal dramatic shifts or competitive interactions among plant species. Coontail tended to move into the plots from which milfoil was removed, but the milfoil recovered within a year. Somewhat surprisingly, milfoil did not increase rapidly in the plots from which all plants were removed. Milfoil appears to be slow to recover from removal due to its need to develop an extensive root system. The lack of increase in rooted native plant species enabled milfoil to again become dominant a year or more after removal.

This research found some support for McComas's (1999, 2003) hypothesis that native plants will do better than milfoil on low nitrogen sites, but milfoil will reach nuisance levels on high nitrogen sites. If milfoil is controlled by factors other than sediment, such as herbivory or water clarity, it will not reach nuisance levels, apparently even on high nitrogen sites. High levels of milfoil biomass appear less common on low nitrogen sediments.

For a complete description of the research done under this activity, please see Newman (2004).

Reports cited

McComas, S. 1999. The role of lake soils in managing lakes. Focus 10,000 11(1): 7-9.

McComas, S. 2003. Lake and pond management guidebook. Lewis Publishers, Boca Raton, FL.

Newman, R.M. 2004. Biological control of Eurasian watermilfoil: Completion report for 2001-2004. Unpublished report dated June and submitted by the Department of Fisheries, Wildlife and Conservation Biology, University of Minnesota, Saint Paul, MN 55108 to C.H. Welling, Eurasian Watermilfoil Program, Division of Ecological Services, Minnesota Department of Natural Resources, 500 Lafayette Rd., Saint Paul, MN 55155.

B. Purple loosestrife

Result 2. Evaluate the effects Galerucella spp. on beneficial wetland plant community, divided in to 2 activities below.

Activity 1. Documentation of the beneficial wetland plant community response to release of *Galerucella* spp. for purple loosestrife control. The effect of *G. calmariensis* and *G. pusilla* on plant communities will be studied at a minimum of two locations. The objective of this study is to determine the impact of *Galerucella* leaf defoliation on purple loosestrife plants and nontarget wetland species abundance and diversity.

LCMR Budget: **$15,000** Other: $20,000
Balance: $ 0 Other Balance: $ 0
Completion Date: December 31, 2003

Activity Status:

Long-term monitoring projects that examine the effect of biological control agents on target weeds and native plants are important components of biological control projects. We examined ata collected by the Ecological Services Division of the Department of Natural Resources from 1997 through 2003 is currently being analyzed. Permanent transects were established in a variety of wetlands throughout Minnesota. The transects have been monitored on a yearly basis for the impact of *Galerucella* spp. on purple loosestrife and other native wetland plants. These data are currently being analyzed and results of this study will be submitted for publication in a peer-reviewed journal. Preliminary results suggest that significant declines are occurring in purple loosestirife populations in response to feeding by *Galerucella* spp. Native plants are also rebounding in several of the sites. Results will be submitted for publication in a peer-reviewed journal and for final LCMR report.

For a complete description of the research done under this activity, please see Skinner et al. (2004).

Activity 2. Assess impact of *Galerucella* spp. on *Lythrum alatum* and *Decodon verticillatus*. *Galerucella* spp. adult feeding and presence of egg masses have been reported on the non-target plants, winged and swamp loosestrife. However, the effect of *Galerucella* feeding on non-target plant growth and development has not been investigated. Phenology of *Galerucella* spp. emergence in the spring in relation to the emergence of winged and swamp loosestrife will also be evaluated.

LCMR Budget: **$10,000** Other: $10,000
Balance: $0 Other Balance: $0
Completion Date: December 31, 2003

Activity Status:

Previous studies have characterized the feeding, oviposition and larval development of the biological control insects, *Galerucella* spp., on non-target Lythraceae species, including two species native to Minnesota, winged loosestrife (*Lythrum alatum*) and swamp loosestrife (*Decodon verticillatus*). However, the impact of *Galerucella* spp. feeding on growth and seed production of the non-targets, winged loosestrife and swamp loosestrife, has not been reported. The objective of this study was to compare the phenology, growth and seed capsule production of winged loosestrife and swamp loosestrife, in relation to purple loosestrife (*Lythrum salicaria*), with and without the impact of *Galerucella* spp. Our study has documented minimal larval feeding on winged loosestrife and swamp loosestrife from the first generation of beetles in mid-June. Although *Galerucella* larvae were present on swamp and winged loosestrife, with one

exception, none of the measured plant growth or reproductive parameters were reduced as a result of larval or adult *Galerucella* feeding. In the first year of the study, the number of winged loosestrife seed capsules were reduced with *Galerucella* feeding compared to control plants. However, there were no *Galerucella* spp. present on winged loosestrife in the second year of the study. In Minnesota, flowering and seed development in swamp loosestrife occurs a month later than in purple loosestrife or winged loosestrife. Since *Galerucella* larval shoot tip feeding reduces the number of seed capsules formed on purple loosestrife, missing the main period of larval feeding in mid-June provides a degree of "phenological protection" for swamp loosestrife from *Galerucella* spp. feeding.

For a complete description of the research done under this activity, please see Stamm-Katovich et al. (2004).

Result 3. Two studies will document movement of *Galerucella* spp. within wetlands and on a landscape scale (miles) where wetlands with purple loosestrife are spatially isolated. *Galerucella* will move through purple loosestrife infested wetlands where there is a A green bridge of purple loosestrife plants connecting two distinct areas of infestation. Circumstantial evidence indicates that mass movement occurs when small barriers, e.g., 50m of woods without loosestrife, separate two large areas of purple loosestrife (observations from Winona, MN August 2000). These studies will provide information that will help guide release strategies for loosestrife management in Minnesota.

LCMR Budget: **$20,000**	Other: $20,000
Balance: $0	Other Balance: $ 0
Completion Date: December 31, 2003	

Result Status:

In 1992, leaf beetles *Galerucella calmariensis* and *G. pusilla*, were introduced from Europe as biological control agents against purple loosestrife, *Lythrum salicaria* L. The ability of *Galerucella* spp. to control or reduce purple loosestrife infestations has been well documented. However, there is a limited knowledge regarding the ability of this insect to disperse, and a technique often used to study insect spatial distributions is geostatistics. The objectives of this study were to 1) characterize the spatial distribution of *Galerucella* spp. within a wetland and 2) evaluate the ability of *Galerucella* spp. to disperse to noncontiguous loosestrife infested wetlands on a landscape-scale. Our results suggest that *Galerucella* spp. can disperse and colonize purple loosestrife infestations within wetland habitats shortly (less than three years) after the initial release. In our experiment, apparent reductions in purple loosestrife infestations were often related to high egg mass densities of *Galerucella* spp. egg masses and beetle damage observed in the spring. This trend was present in all four wetlands studied. On a landscape level, *Galerucella* spp. appear to be well adapted to changing environments and are capable of dispersing and colonizing distant purple loosestrife infestations. On average, beetles dispersed 5 km from established release sites to non-release sites within 3 years. The average maximum dispersal distance from all four locations was approximately 19 km. Beetles were found in 85% of the 167 non-release sites visited. To maximize redistribution efforts of the biological control

agents, we advise resource managers to select wetlands that are greater than 5 km from known release sites. *Galerucella* spp. is capable of colonizing new purple loosestrife infestations, thus reducing redistribution efforts from resource managers.

For a complete description of the research done under this activity, please see McCornack (2004).

Reports Cited

Stamm Katovich, E. J., R.L. Becker, D.W. Ragsdale and L.C. Skinner. 2004. Growth and phenology of three Lythraceae species in relation to *Galerucella* spp. Unpublished report submitted by the University of Minnesota, Saint Paul, MN 55108, to Luke Skinner, Purple Loosestrife Program, Division of Ecological Services, Minnesota Department of Natural Resources, 500 Lafayette Rd., Saint Paul, MN 55155. Final Report for Result 2, Activity 2.

McCornack, B. P., L.C. Skinner and D.W. Ragsdale. 2004. Landscape-Scale and Within Wetland Movement of *Galerucella* spp. Introduced for Management of Purple Loosestrife (*Lythrum salicaria* L.). Unpublished report submitted by the University of Minnesota, Saint Paul, MN 55108 to Luke Skinner, Purple Loosestrife Program, Division of Ecological Services, Minnesota Department of Natural Resources, 500 Lafayette Rd., Saint Paul, MN 55155. Final Report for Result 3 to Minnesota Department of Natural Resources.

Skinner, L.C., E.J. Stamm Katovich, D.W. Ragsdale, W.J. Crowell, N. Proulx and R.L. Becker. 2004. Population Dynamics and Long-term Effects of *Galerucella* spp. on Purple loosestrife, *Lythrum salicaria,* and non-target native plant communities in Minnesota. Unpublished report to the Legislative Commission on Minnesota Resources. Final Report for Result 2, Activity 1.

V. TOTAL PROJECT BUDGET:
All Results:
Other: $ 90,000 (Contracts with the University of Minnesota)

Total Budget: $90,000

VI. PAST, PRESENT AND FUTURE SPENDING:
A. Past and Current Spending:

	July 91-June 93	July 93-June 95	July 95-June 97	July 97-June 99	July 99-June 02	July 01-June 04
LCMR	$160,000	$400,000	$300,000	$150,000	$150,000	$90,000
Other state	--	--	--	$150,000	$150,000	$100,000
In-kind	--	$200,000	--	--	--	--
Total	$160,000	$400,000	$300,000	$300,000	$300,000	$190,000

C. Cooperation and Project Partners:

The DNR's Exotic Species Program applied $100,000 from the Water Recreation Account, designated as 'other' in this work program, towards this project over a two year period. This support in conjunction with funding that we hope the legislature will appropriate at the recommendation of the LCMR will provide $190,000 for this research. This project will be directed by Luke Skinner with assistance from Chip Welling and Wendy Crowell, both of the DNR.

A. Eurasian watermilfoil
Cooperators at the University of Minnesota include: Drs. Raymond Newman, David Ragsdale, and David Biesboer. Technical expertise on milfoil will be provided by the Army Corps of Engineers.

Cooperator	Dollars received	Percent time spent on project
R. Newman*	$95,000	20%

B. Purple loosestrife
Cooperators at the University of Minnesota include: Drs. Roger Becker, David Ragsdale, and Elizabeth Stamm Katovich. Technical expertise on loosestrife will be provided by Dr. Bernd Blossey of Cornell University, and Dr. Dharma Sreenivasam, Minnesota Department of Agriculture

Cooperators	Dollars received	Percent time spent on project
R. Becker and D. Ragsdale*	$95,000	15% each

*Includes DNR Funding contribution

D. Time: This project is expected to be completed within the time allotted under this work program.

VII. DISSEMINATION: It is expected that the results of this project will be published in peer-reviewed scientific journals and also in special publications and newsletters. Results also will be presented at national, regional and state scientific meetings to peers in the field, as well as to resource managers and planners who will use the results of this project.

<u>In preparation for future submission to peer-reviewed scientific Journals:</u>

McCornack, B. P., L.C. Skinner and D.W. Ragsdale. *In prep*. Landscape-Scale and Within Wetland Movement of *Galerucella* spp. Introduced for Management of Purple Loosestrife (*Lythrum salicaria* L.). For Submission to Environmental Entomology.

Skinner, L.C., E.J. Stamm Katovich, D.W. Ragsdale, W.J. Crowell, N. Proulx and R.L. Becker. *In prep*. Population Dynamics and Long-term Effects of *Galerucella* spp. on Purple loosestrife, *Lythrum salicaria,* and non-target native plant communities in Minnesota. For submission to Biological Control.

Solarz, S.L., R.M. Newman, D.L. Byers, and R.G. Shaw. *In prep*. Heritability, environmental effects and genetic correlations of oviposition preference and fitness components for the milfoil weevil reared on two hosts. For submission to Evolution.

Stamm Katovich, E. J., R.L. Becker, D.W. Ragsdale and L.C. Skinner. *In prep*. Growth and phenology of three Lythraceae species in relation to *Galerucella* spp. For submission to Weed Science.

Ward, D.M. and R.M. Newman. *In prep*. Fish predation on Eurasian watermilfoil herbivores and indirect effects on macrophytes. For submission to Canadian Journal of Fisheries and Aquatic Sciences.

VIII. LOCATION: Milfoil research will take place on 7 county Metro area lakes. Loosestrife research site will take place in the 7 county metro area and along the Mississippi river corridor between Red Wing and Winona MN. Site selection for both projects is not complete.

IX. REPORTING REQUIREMENTS: Periodic workprogram progress reports will be submitted not later than January 2002, July 2002, January 2003 July 2003. A final workprogram report and associated products will be submitted by June 30, 2004, or by the completion date as set in the appropriation.

X. RESEARCH PROJECTS: Refer to the attached research proposals for project details (attachment B1 and B2.

ATTACHMENT A

Date: August 18, 2004

Project Title: Biological Control of Eurasian Watermilfoil and Purple Loosestrife-Continuation

Project Number: 4(D)

LCMR Recommended Funding: $90,000

Attachment A Deliverable Products and Related Budget															
2001 LCMR Project Biennial Budget				Objective/ Result											
	Result 1 Budget:	Result 1 Current invoice:	Result 1 Balance:	Result 2 Activity 1 Budget:	Result 2 Current Invoice:	Result 2 Activity 1 Balance:	Result 2 Activity 2 Budget:	Result 2 Current Invoice:	Result 2 Activity 2 Balance:	Result 3:	Result 3 Current Invoice:	Result 3 Balance:	PROJECT TOTAL:		
Budget Item (Title of Result)	Milfoil study			Loosestrife Study			Loosestrife study			loosetrife Study			BUDGET TOTAL:	CURRENT INVOICE TOTAL:	BALANCE TOTAL:
Wages, salaries & benefits – Be specific on who is paid $															
Contracts	45,000		0	15,000		0	10,000		0	20,000		0	90,000		0
Professional/technical (with whom?)	University of MN			University of MN			University of MN			University of MN					
Other contracts (with whom?)															
Space rental: NOT ALLOWED	X			X			X			X			X		
Maintenance															
Utilities															
Other direct operating costs (for what? – be specific)															
Printing															
Advertising															
Communications, telephone, mail, etc.															
Office Supplies (list specific categories)															
Other Supplies (list specific categories)															
Local automobile mileage paid															
Other travel expenses in Minnesota															
Travel outside Minnesota (where?)															
Tools and equipment (list categories)															
Office equipment & computers (be specific)															
Other Capital equipment (list specific items)															
Land acquisition															
Land rights acquisition (less than fee)															
Buildings (for what?)															
Other land improvement (for what?)															
Legal fees (for what?)															
COLUMN TOTAL	45,000	$	0	15,000	$	0	10,000	$	0	20,000	$	0	90,000		0