Conference Abstract Book

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* Asterisk indicates presenting author(s).
# Table of Contents

## Monday

- Weed Laws and Policies .................................................. 4
- Biology and Impacts of Invasive Species .......................... 5
- Interrupting Pathways .................................................... 6
- Biology of Invasive Submersed Plants .............................. 7
- Management of Invasive Aquatic Plants 1 ......................... 8
- Terrestrial Invasive Plant Management: Early Detection & Rapid Response .......................... 9
- Best Management Practices ............................................ 10
- Outreach & Prevention 1 ................................................ 10
- Interrupting the Boating Pathway .................................. 11
- Biology of Invasive Emergent Plants ............................. 12
- Aquatic Invasive Species Public Awareness ..................... 13
- Terrestrial Invasive Plant Management: Prairie .............. 14

## Tuesday

- Herbicides .................................................................... 16
- Forest Early Detection and Rapid Response .................. 17
- Ballast Water ................................................................ 18
- Management of Invasive Submersed Plants: Herbicide Use ........................................... 19
- Aquatic Invasive Species Control: Technology and Efforts ........................................... 21
- Terrestrial Invasive Plant Management: Prairie and Wetlands ........................................... 22
- Biocontrol of Terrestrial Invasives .................................. 23
- Forest Insect Pests .......................................................... 24
- Aquatic Invasive Species in Lake Superior ..................... 25
- Management of Curlyleaf Pondweed ............................. 26
- Aquatic Invasive Invertebrates ...................................... 27
- Terrestrial Invasive Plant Management: Forest ............. 28
- Early Detection and Rapid Response 1 ......................... 29
- Invasive Pathogens ....................................................... 30
- Aquatic Invasive Species Programs and Partnerships .... 32
- Management of Invasive Aquatic Plants 2 ..................... 33
- Cooperative Weed Management Areas 1 ...................... 34
- Emerald Ash Borer Workshop 1 ..................................... 35
- Early Detection and Rapid Response 2 ......................... 36
- Biomass & Biofuels ........................................................ 37
- Aquatic Invasive Species Regulations & Enforcement .... 38
- Management of Invasive Submerged Plants: Funding and Economics ........................ 39
- Cooperative Weed Management Areas 2 ...................... 40
- Emerald Ash Borer Workshop 2 ..................................... 41
Wednesday

Restoration 42
Management of Woody Invasives 43
Citizen and Business Involvement 45
Management and Ecology of Eurasian Watermilfoil 46
Common Carp Management 47
Emerald Ash Borer Workshop 3 49
Outreach & Prevention 2 50
Distribution and Detection 51
Aquatic Early Detection and Rapid Response 52
Restoration of Emergent and Submersed Plants 53
Carp and Invasive Fish Management 54
Emerald Ash Borer Workshop 4 55

Poster Presentations

Invasive Species Biology, Ecology, Impacts, and Distribution 57
Invasive Species Prevention, Containment, and Preparedness 61
Invasive Species Early Detection and Rapid Response 66
Invasive Species Control and Management 67
Post Invasion Restoration 71

Index of Authors 72
The Revised Minnesota Noxious Weed Law
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During the 2009 legislative session significant changes were made to the Minnesota Noxious Weed Law. Most of the changes consist of additions to existing statutes with a few revisions and one repeal (18.81 Subd. 1). The majority of changes occur in statutes 18.79 (Duties of the Commissioner), 18.80 (Inspectors), and 18.81 (Duties of Inspectors). Three new sections have also been added: 18.89 (Noxious Weed and Invasive Plant Species Assistance Account), 18.90 (Grant Program), and 18.91 (Advisory Committee; Membership). These new sections will dramatically change the way that noxious weeds are classified, listed, and enforced. The purpose of revising the law was to make the law more consistent with modern weed issues, to provide greater transparency in how decisions for listing species are made, to involve more stakeholders in the decision making process, and to be more consistent with procedures that have shown great success in western rangeland states.

Wisconsin’s New Comprehensive Invasive Species Rule
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After five years and the active involvement of hundreds of people, Wisconsin now has a comprehensive invasive species classification rule. Plants, animals and pathogens – aquatic and terrestrial – are all covered in one rule, although there are parts of the rule that relate to only one group of organisms. This new rule uses science-based assessments to classify and regulate exotic invasive plants, animals, and disease-causing microorganisms, as well as the various pathways by which invasives can be transported across the landscape. In 2001 the state legislature authorized the development of an advisory Council and required DNR to create an invasive species classification rule. The Wisconsin Council on Invasive Species created several subcommittees to provide a wide range of input into the rule-making process. The Research Committee developed a science-based set of criteria upon which to assess each species for classification. The following criteria are used: 1) current status and distribution, 2) establishment potential and life history traits, 3) damage potential, 4) socio-economic effects, and 5) control and prevention potential. Species Assessment Groups, comprised of experts and stakeholders, were formed for each group of species to review the literature and recommend a legal classification for each species. Extensive public review of the rule allowed diverse stakeholders to provide valuable input and lent credibility to the process, leading to wide-ranging acceptance and support of the final rule. Due to the large number of species listed, the need for staff training and public outreach is extensive.

Minnesota’s State Management Plan for Invasive Species
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Under the leadership of Minnesota Invasive Species Advisory Council (MISAC)—a diverse group with a common interest in battling invasive species in Minnesota—an ad hoc team developed a plan framework to address terrestrial and aquatic invasive species issues in the state. Minnesota Statutes require the Departments of Agriculture and to establish statewide coordinating programs for invasive species. The statutes also require them to prepare this statewide invasive species management plan to coordinate the aspects of invasive species activities in Minnesota. This plan is intended to cover the full range of species: aquatic animals, aquatic plants, terrestrial animals, terrestrial plants, and pathogens. This plan is intended to address invasive species issues in the entire state of Minnesota. The primary purpose of this plan and its addendums is to provide a framework to coordinate and guide efforts to prevent the introduction, to reduce the spread, and to promote appropriate management of invasive species populations within the State of Minnesota by state, federal, tribal, and local governments, as well as the private sector. The benefit of implementing a state plan will be: “Minimizing the negative impacts caused by invasive species to native plants and animals, natural ecosystems, recreation, tourism, agriculture, businesses, and human health in Minnesota”. Many other invasive species plans exist or are being developed at the national, regional, state, and local levels. This plan is intended to work along with those plans and not replace them.
Principles of Invasion Biology and Their Role in Invasive Species Management  
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Invasion biology is the study of species that occur outside their native range and has the goal of providing more information about the fundamental ecological processes that all invasions have in common. Understanding these processes is critical for effective, long-term invasive species management. In general, invasion biology research has focused on processes that affect the entry, establishment, spread, and/or impacts from non-native species. Yet, the discipline of invasion biology is only 50 years old. Some early insights continue to be reaffirmed as new invasions occur, yet other firmly-held notions about invasion processes are coming into question. This talk will briefly review some of the common principles that have emerged from invasion biology and how this information can improve invasive species management strategies.

Invasive Earthworm Impacts on Ground-Nesting Songbirds in Northern Hardwood Forests  
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European earthworms (Family: Lumbricidae) have invaded previously earthworm-free hardwood forests of the northern Midwest, dramatically altering soil composition, the forest floor litter layer, vegetation cover, and ground-layer plant diversity. Whether these primarily human-assisted invasions impact the songbirds using forested habitats remains unknown. Earthworm-mediated changes to understory plant cover may increase susceptibility of ground nests to predation while reduction of invertebrate abundance may cause food shortages for ground-foragers. We conducted avian point count surveys and nest searching/monitoring at study sites representing both invaded stands and earthworm-free wilderness areas in the Chequamegon-Nicolet National Forest, Wisconsin. Sites were similar with regard to soil type, dominant tree species, age, and land use history. Results indicate that Ovenbirds (Seiurus aurocapillus) and Hermit Thrushes (Catharus guttatus), two common, but declining, ground-nesting species in the region, may indeed be negatively impacted by earthworm invasions. Densities of these species were significantly lower in invaded forests compared to earthworm-free stands during both 2008 and 2009. Nest survival models provide strong evidence that 2009 Ovenbird nest survival rates were inversely-related to the mass of one particularly damaging species, the Red Worm (Lumbricus rubellus). Ongoing research will clarify the mechanisms for this apparent impact of earthworms to nest survival and whether earthworm invasions pose a significant regional threat to the conservation of ground-nesting and ground-foraging forest songbirds.

Garlic Mustard (Alliaria petiolata) Invasion & Impacts: Implications for Management & Restoration  
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To determine whether the invasive herb garlic mustard (Alliaria petiolata) is driving or responding to declines in native species, I am investigating the effects of garlic mustard and its removal on native herbs, and the effects of native herbs on garlic mustard invasion in oak woodlands (Minnesota). To test garlic mustard’s impact on herbs, I planted native species into invaded and non-invaded plots in which existing vegetation was either removed or left intact. Plant growth was measured over two years and analyzed with repeated measures ANCOVA using light level as a covariate. Native plant size did not differ significantly across invasion or removal treatments, suggesting that garlic mustard may not have a strong impact on herb growth. To determine if native plants affect garlic mustard’s invasibility, I planted garlic mustard seeds into field plots ranging in native richness and cover and measured establishment, survival, biomass and silique production, as well as environmental variables. Analyses with regression and structural equation models suggest that native plant cover and understory light levels have a significant negative effect on garlic mustard invasion. While species
richness had little direct effect on garlic mustard, it does significantly affect native cover and thus has an indirect negative effect on garlic mustard invasion. If garlic mustard is not causing native herb decline, control efforts may not be sufficient to restore native diversity. However, restoring native herb communities may help decrease the vulnerability of woodlands to garlic mustard invasion.

**Interrupting Pathways: 1:20 pm - 2:35 pm**

**Using Technology to Prevent Invasive Species Introduction at Boat Accesses**
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Over 1000 lakes in Minnesota have been invaded by some form of Aquatic Invasive Species (AIS). Negative ecological impacts are quickly followed by adverse effects on recreation and property values. The cost of AIS management in a contaminated lake is significant. In 2008 The Gull Chain Of Lakes Association installed automated boat inspection cameras at the three busiest launch sites on Gull Lake. The Internet Landing Installed Devices (I-LIDS) are activated by motion detectors to take short video clips of boats and trailers as they enter the water. Boat numbers and any hanging aquatic vegetation are recorded. The devices work during all daylight hours. The clips are transmitted wirelessly to the device’s manufacturer and placed on the company web site for subsequent review. This project complemented a program employing DNR trained interns to provide personal inspection efforts. Participation in this project was supported by the Lake Association, county enforcement and the DNR. Although the technology can be used for enforcement, educational advantages are thought to be much more important. Significant improvements in boater clean-off behavior have been documented. Local newspapers covered the AIS issues extensively. After two years of service, the feedback on the program from boaters has been 100% positive.

**Effects of Fishing Tournaments in Minnesota’s Laurentian Region**
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Fishing tournaments have the possibility to increase the spread of invasive earthworms in Minnesota’s Laurentian region. Minnesota has over 350 fishing tournaments within the region. With high concentration of anglers in one area, there is potential for increased impact in regions where tournaments are held. Addressing the issue of potential introduction of earthworms through tournaments will allow development of prevention projects to arise, and also increase public awareness on the invasive earthworm issues. An interview study was conducted to understand tournament angler behavior that included a set of 10 to 12 questions focused on tournament angler's behavior and disposal practices of unused bait. The time frame was based on the summer months and walleye fishing tournaments. Walleye fishing was targeted because it is the most heavily targeted fish in Minnesota, and also earthworms are the preferred bait in the warm summer months. Early results show there is little evidence that tournament anglers are more likely to spread earthworms more than the average angler. The tournaments do not provide bait to their participants, and anglers are likely to keep their unused bait because of cost. Because of the large concentration of anglers, intense focus on fishing and the gathering of anglers at registration and weighing stations, tournaments would provide an opportunity for presenting educational material.

**Invasive Aquatic Species on Our Door Step: The Need For Vigilant Neighbors**
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Invasive species can alter ecological relationships among native species and can affect ecosystem function and structure as well as the economic value of ecosystems. The state of Wisconsin has recently implemented a statewide program to identify, classify and control its non-native invaders. Chapter NR 40, Wisconsin’s Invasive Species Identification, Classification and Control Rule helps citizens learn to identify and minimize the spread of non-native plants, animals and diseases that can invade our lands and waters and cause significant damage. Educating citizens about the invasive species already established in the state is important for stopping the spread of these species, however, being able to identify what species are the next major invaders is crucial for rapid response and to ultimately prevent the establishment of new invaders. Four prohibited aquatic plant species have recently been located...
in Wisconsin's waters: Yellow floating heart (*Nymphoides peltata*), Brittle naiad (*Najas minor*), Hydrilla (*Hydrilla verticillata*), and Brazilian waterweed (*Egeria densa*). Species identification, as well as the response and results of each case will be discussed. These case studies set the stage for future response efforts as invasions begin to occur in currently unmonitored waters such as backyard ponds and water gardens which provide pathways for invasive species to enter our lakes and rivers.

### Biology of Invasive Submersed Plants: 1:20 pm - 2:35 pm

**Seasonal Water Quality Patterns in Curlyleaf Pondweed Plots**  
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Curlyleaf Pondweed (CLP) life cycle is unusual in that it reaches peak biomass and senescence in early summer. In eutrophic north-temperate lakes, dieback of CLP is often followed by nuisance algal blooms, suggesting a linkage between breakdown of CLP tissue phosphorus and uptake by algae. However, similar patterns can occur in lakes that have no CLP, suggesting that other factors may be important in summer algal dynamics. This research examined phosphorus dynamics and algal response in CLP plots during a period of senescence in order to provide more insight into possible roles that CLP beds play in water quality.

**Invasion Trajectories and Population Trends of Eurasian Watermilfoil (*Myriophyllum spicatum*) in Wisconsin**  
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Populations of Eurasian watermilfoil (EWM) have been reported in 539 Wisconsin lakes and rivers since the 1960s, and we have surveyed about a quarter of the known populations. In lakes surveyed, time since discovery of EWM explains only a small proportion of the observed variation in frequency of occurrence. This implies the existence of different invasion trajectories. Accordingly, we report lakes in which milfoil rapidly achieves dominance as well as lakes that have maintained low levels of the plant over a long period of time. Related population trends and observations will be discussed, and patterns in statewide distribution of EWM and native plant species will also be presented.

**Control of Dormancy in Curlyleaf Pondweed (*Potamogeton crispus L.*) Turions**  
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Vegetative buds (turions) of Curlyleaf Pondweed (*Potamogeton crispus*) are the major source of propagation for this aquatic invasive. We are investigating the sprouting of turions as a control measure. From lab experiments we conclude that turions undergo two stages of dormancy. Current season turions collected in the spring were found to be photosynthetically active and accumulated starch over a 6 week period. They are in a quiescent state and presumably go into deep dormancy later in summer. In contrast, turions that have overwintered are not photosynthetically active, have stable starch levels and are in deep dormancy. Approximately 60% of Current Season turions and Overwintered turions sprout under autumn light conditions (10:14- light hrs: dark hrs). We conclude that all turions reach deep dormancy by the end of the summer. Dormancy in flowering plants is under hormonal control; we assume that abscisic acid (ABA) maintains dormancy in vegetative buds. We find that dormant turions will sprout at an increased rate compared to controls when treated with gibberellic acid, an ABA antagonist, and fluridone, an ABA synthesis inhibitor. We propose treatment to break dormancy of turions in autumn will be effective in preventing turion carry over to the next season.
Determining Treatment Areas for Curlyleaf Pondweed and Eurasian Watermilfoil

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If a partial treatment for non-native aquatic plants is being considered for a lake, then what are the most efficient techniques to delineate areas to control in a given season? The areas heavy growth should be the highest priority areas to control. Several assessment techniques can be used including early season scouting, use of plant growth histories, and conducting lake sediment surveys. Pre-treatment surveys are essential, but can be supplemented with using plant growth histories and sediment surveys. After an initial grow-out phase (6-8 years) non-native aquatic plant communities become relatively stable. A record of areas of light, moderate, or heavy growth from previous surveys helps zero in with the pretreatment survey to delineate control areas. Eight lakes with annual surveys conducted for ten years illustrate the stability of plant communities with seasonal variations. A third technique is the use of lake sediment surveys to determine what parts of a lake are conducive to light or heavy growth of curlyleaf (Potamogeton crispus) or milfoil (Myriophyllum spicatum). For example, a high sediment pH and low iron concentrations are correlated with heavy growth of curlyleaf pondweed. Whereas a high nitrogen and low organic matter content are correlated with heavy growth of Eurasian watermilfoil. These correlations were found for over 50 lakes that were tested. When all three techniques are available, delineations have resulted in partial lake treatments that effectively controlled the heavy growth of curlyleaf and/or milfoil.

Past, Present, and Future Efforts to Manage Flowering Rush (Butomus umbellatus) in Minnesota

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Flowering Rush is a perennial aquatic plant native to Europe and Asia that was sold for many years as an ornamental garden plant in North America. Its introduction to lakes and rivers was likely through humans planting them in the lake bed. Flowering rush is found in a number of locations across Minnesota but is causing problems for some lakes and rivers more than others. These plants can grow into dense stands and interfere with swimming, boating, and other activities on the water. Recently, efforts have been initiated to try and better understand this invasive aquatic plant to try and develop a strategy and method to better manage it.

Purple Loosestrife (Lythrum salicaria) Management in Minnesota

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Purple Loosestrife (Lythrum salicaria) is an invasive wetland plant growing in over 2000 sites in Minnesota that displaces native plants and causes ecological damage. A Purple Loosestrife Management Program was established in the Minnesota Department of Natural Resources in 1987. Management of Purple Loosestrife was initially accomplished through extensive application of herbicide. Expense and concern over large-scale herbicide use drove research toward and implementation of a biocontrol program utilizing insects. Research determined a weevil and two beetles were effective at controlling Purple Loosestrife in its native range but did not harm native plants or cause unexpected ecological problems in Minnesota. Since the inception of the biocontrol program in 1992 millions of beetles have been released throughout Minnesota. Biocontrol is now the primary method used to manage Purple Loosestrife in Minnesota although small-scale herbicide application is still used on new, small populations.
Identification and Management of Weedy Umbels
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White umbelliferous plant species have been invading various habitats in Wisconsin ranging from dry prairies and roadsides to riparian corridors for several years and still they are hard to distinguish from one another. During this talk we will compare similarities and differences between these species and why they are a threat to the native biodiversity of the state. Species included will be: Giant hogweed (*Heracleum mantegazzianum*), Japanese and spreading hedge-parsley (*Torilis japonica; T. arvensis*), Queen Anne’s lace (*Daucus carota*), poison hemlock (*Conium maculatum*), wild chervil (*Anthriscus sylvestris*), and burnett-saxifrage (*Pimpinella saxifraga*).

Narrowleaf Bittercress (*Cardamine impatiens*) – A Newly Recognized Invasive Plant in Minnesota
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Narrowleaf Bittercress is a recent discovery in Minnesota. It is an incredibly aggressive shade loving plant first observed in 2008 in a confined patch near the Mississippi River in the City of St. Paul Park. Because of its unusual and sudden appearance it was identified and determined as an invasive plant but one not yet documented in Minnesota. A USDA map in 2008 showed its range from the eastern seaboard; west to Michigan; south to North Carolina and north to Ontario. Since the initial discovery in 2008, it has spread in patches to over two acres of the park. Shortly after identification, action was taken to combat the spread of the plant. Massive hand-pulling efforts and herbicide treatments have been applied to control the infestation. A 1.5 percent mixture of Triclopyr (Garion 3) was used in late fall and early spring. The herbicide mixture worked on some of the plants, but only burned the leaves on others not killing the roots. This fall other herbicides and herbicide mixtures will be tested to find an appropriate solution. Though this plant has been well documented in the eastern U.S., a thorough defense against its spread has not been prepared, studied, or enacted. Being that its discovery in Minnesota was within a managed woodland, great care and concern is being used to discourage its spread within the natural area. Organizations such as the Minnesota Department of Natural Resources, Minnesota Department of Agriculture and the National Park Service have been notified of this new invasive plant.

Japanese Stiltgrass Ecology and Management: A Report from the Stiltgrass Summit
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Japanese stiltgrass (*Microstegium vimineum*), a new invasive species in the Midwest, is rapidly invading forests in Indiana, Illinois, Missouri, and Ohio. Its rate of spread and formation of monocultures in forest understories are of great concern to natural resource professionals. In August 2010, the River to River Cooperative Weed Management Area convened a Stiltgrass Summit to share the latest information on the ecology, spread, and management of Japanese stiltgrass. The Summit brought in 91 participants from 12 states. This talk will summarize the information provided at the Summit, including its current distribution and means of spread, habitat characteristics of areas most likely to be invaded by Japanese stiltgrass, community and ecosystem impacts of stiltgrass invasion, and methods for stiltgrass prevention and control.
Best Management Practices for Terrestrial Invasive Species

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Advisory committees of stakeholders and partners, with assistance from the US Forest Service, developed four tracks of Best Management Practices to limit the introduction and spread of terrestrial invasive plants: Forestry, Recreational Users, Urban Forestry, and Utility and Transportation Corridors. The overarching goal was to develop simple voluntary guidelines to limit the introduction and spread of invasive plants, insects, and disease. I will describe how the process started, the funding sources, how we got concurrence from partners, how you can integrate the DMPs according to your needs and the education efforts taking place.

Rights-of-ways and Invasive Species Best Management Practices

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Mike Grisar*, WeEnergies, Highway County Representative, WisDOT, MNDOT
Tim Ramburg*, St. Croix County, Wisconsin
Crystal Koles*, American Transmission Company
Tina Markeson*, Minnesota Department of Transportation

An advisory committee made up of utility and highway stakeholders developed Invasive Species Best Management Practices to limit the introduction and spread of terrestrial invasive plants in Utility and Transportation Corridors. The overarching goal was to develop simple voluntary guidelines to limit the introduction and spread of invasive plants, insects and disease. A panel consisting of highway and utility representatives will briefly describe the development process; implementation challenges; training efforts; and pilot projects. Plenty of time for interaction will be allowed.

Outreach and Prevention 1: 3:05 pm - 4:20 pm

Prevention Through Policy and Partnership
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Prevention of invasive species’ movement and introduction continues to fail. What have government agencies missed? This author contends that agencies lack authorities and appropriations to make prevention complete. What can we do? A basic piece of the puzzle is “awareness”. Only if the public understands this issue will agencies get public the regulation/policy and funding needed to make prevention happen. We have pieced together partnerships across the nation to accomplish success and cooperation. More is needed to overcome current obstacles. The author will suggest answers through examples based on thirty years of experience with the issue of invasive species in the public and private sectors.

Outreach Efforts Around Recreational Pathways for Terrestrial Invasive Species
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As part of a US Forest Service grant two studies were implemented to describe current behaviors, attitudes and knowledge of terrestrial invasive species among Minnesota recreationists. The first was a series of nine focus groups targeting three specific
user groups in three different geographical regions. These were motorized trail users, non-motorized trail users and campers. Participation was excellent (nearly 100% attendance) and the responses were enlightening. Then a phone survey was carried out with two purposes, 1) to verify and quantify the responses we got in our focus group study and 2) provide baseline understanding with which we can measure and monitor future outreach campaigns. The results of both studies will be presented and discussed here. The results mirror much of the data collected in the context of the Stop Aquatic Hitchhikers program. As a result, the core team of cooperators working on the project have decided to use that program as a model in future branding and outreach efforts.

Gravel Pit Certification, ATV and Snowmobile Trail Invasive Plant Management
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Hear what Becker Soil & Water Conservation District is doing to battle invasive plants in their county! The Gravel Pit Certification Program was developed in 2008 through the Pulling Together Initiative (PTI) Grant to prevent the five invasive plants chosen by the PTI Committee from being spread throughout Becker County. The Gravel Pit Certification program was implemented in 2009. December of 2009, the PTI Committee chose to add the ATV and Snowmobile Trail Management Program that is being developed in 2010. The invasive plants on Becker County’s management list are: Leafy Spurge (*Euphorbia esula*), Crown Vetch (*Coronilla varia*), Spotted Knapweed (*Centaurea stoebe* spp. *micranthos*), Common Tansy (*Tanacetum vulgare*), Wild Parsnip (*Pasinaca sativa*).

Interrupting the Boating Pathway: 3:05 pm - 4:20 pm

Invasive Species Prevention through Watercraft Inspection
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This presentation will cover the Minnesota Department of Natural Resources watercraft inspection program as an important tool in the effort to prevent the spread of aquatic invasive species. We will discuss the goals and approach of the program, history and evolution of the program, in response to the changes in invasive species populations and public perception, as well summarize inspection results. We will also discuss collaborative efforts with lake associations and local units of government through grants, contracts and training volunteers will be shared.

Launching Clean Boats and New Career Opportunities
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In the summer of 2009, a portion of the American Recovery and Reinvestment Act (ARRA) funding initiative was appropriated to give young adults ages 18-24 years job experience and to develop skills that would increase their value in the job market. Wisconsin Governor Doyle provided $88,000 of discretionary ARRA Workforce Investment Act funding to the Wisconsin Department of Natural Resources (WDNR) to hire youths as watercraft inspectors in the Clean Boats Clean Waters program. In the process of educating boaters on the St. Croix and Mississippi Rivers regarding responsible boating practices to avoid the spread of aquatic invasive species, these young adults learned basic job skills, public outreach skills, accumulated and reported important scientific data, and gained experience working with multiple agency partners. To encourage local involvement and ensure the safety of the youths when the supervisor was not available, the WDNR water guards, the National Park Service Law Enforcement Division, and local police departments and business owners in the communities of Pepin, Prescott and Hudson, WI were solicited and agreed to be available in the event of any emergency. This 2009 initiative was so successful that the program was re-funded in the summer of 2010 by the Wisconsin Department of Workforce Development even though the Stimulus funds were not renewed.
Cleaning of Recreational Boats to Slow the Spread of Aquatic Invasive Species
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Joanna McNulty and David M. Lodge, Center for Aquatic Conservation and University of Notre Dame

Trailer boats have been implicated in the spread of aquatic invasive species. There has been, however, little empirical research on the type and quantity of aquatic invasive species being transported, nor on the efficacy of management interventions (e.g., inspection crews, boat washing). In a study of small-craft boats and trailers, we collected numerous aquatic and terrestrial organisms, including some species that are morphologically similar to known aquatic invasive species. Additionally, a mail survey of registered boaters (n=944, 11% response rate) and an in-person survey of boaters in the field (n=459, 90% response rate) both indicated that more than two-thirds of boaters do not always take steps to clean their boats. Furthermore, we used a controlled experiment to learn that visual inspection and hand removal can reduce the amount of macrophytes on boats by 88%±5% (mean±SE), with high-pressure washing equally as effective (83%±4%) and low-pressure washing less so (62%±3% removal rate). For removing small-bodied organisms, high-pressure washing was most effective with a 91%±2% removal rate; low-pressure washing and hand removal were less effective (74%±6% and 65%±4% removal rates, respectively). This research supports the widespread belief that trailer boats are an important vector in the spread of aquatic invasive species, and suggests that many boaters have not yet adopted consistent and effective boat cleaning habits. Therefore, additional management efforts may be appropriate. In this regard, the Ottawa National Forest, with funding from the Great Lakes Restoration Initiative, conducted a demonstration project this summer to enhance boat inspection and cleaning activities.

Possible Negative Impacts of Hybrid Cattail on Wetlands in South Central Minnesota
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The author has monitored the same wetlands in Minnesota for the past 37 years. Significant changes have occurred in the diversity and function of these wetlands as broad-leaved cattail (Typha latifolia) has been replaced by narrow-leaved (t. angustifolia)/hybrid (T. glauca) cattails. (Narrow-leaved and hybrid cattails are both included under the name of hybrid cattail in this presentation.) While there may be numerous causes for this transition, nutrient enrichment is suspected to be one of the most significant factors. Hybrid cattail permanently occupies the zone of normal water level fluctuation, which greatly reduces the abundance of annual moist soil plants, eliminates an important food source for wildlife and retards the rapid natural decomposition cycle that supports an abundance of invertebrates in the spring. Muskrat populations have declined, and their ability to influence wetlands by removing emergent vegetation has been diminished. It appears muskrats don’t consume hybrid cattail. Utilization by amphibians has decreased in wetlands infested with hybrid cattail. Plant diversity has been reduced. Even other invasive species like purple loosestrife may not be able to compete against this invasive. This presentation is intended to serve as an alarm call. The impact of hybrid cattail has not been studied adequately, and the impacts it is having on wetlands are not fully appreciated. More research is needed to assess the impacts of hybrid cattail, and wetland management practices need to be modified in infested wetlands to maintain diversity and function.

Ecological and Genetic Variation of Purple Loosestrife Following Introduction of Biocontrol Agents
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Purple loosestrife (Lythrum salicaria) is an invasive wetland plant introduced to the U.S. in the early 1800’s. Today it is classified as a prohibited noxious weed in Minnesota. In 1992 a classical biocontrol program was launched introducing leaf feeding beetles from Germany to manage invasive populations and as a result of this program, two species have established in Minnesota. Variable
success has been achieved in wetlands throughout the state with some populations routinely subject to 90-100% defoliation of purple loosestrife and others with little to no observed effect of the biocontrol agents. In this study vegetation dynamics in invaded Minnesota wetlands were tracked for two years. Three sites were examined that consistently experienced historically high levels of herbivory as well as three sites experiencing historically low levels of herbivory by the biological control agents. Purple loosestrife was taller, accumulated greater biomass and compromised a greater proportion of the total vegetation in sites with historically low levels of herbivory. Herbivore damage increased throughout the growing season and a corresponding decline in plant health was observed. Seeds from these wetlands were then grown in experimental gardens to determine if the populations were genetically differentiated in vigor, competitive performance and herbivore defense traits. Contrary to the patterns observed in the field, purple loosestrife from sites with historically high levels of herbivory accumulated greater biomass and produced more inflorescence biomass. Future work will quantify the heritability of this variation to model the future evolutionary trajectory of these traits with continued biological control.

Exploring Molecular Determinants of Invasion in Purple Loosestrife (Lythrum salicaria) using Metabolomics
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Some benign environment hypotheses credit purple loosestrife’s colonization of US wetlands to favorable environmental conditions, but common garden experiments in which American and European genotypes were grown in identical conditions indicate an evolutionary divergence between US and European populations. Competing theories ascribe invasive characteristics in US populations to (1) resource reallocation from secondary metabolism to anabolic processes, increasing the plants’ growth and reproductive capabilities; (2) production of novel secondary metabolites that inhibit biological competition; (3) introgressive hybridization with native, related taxa; or some combination of the three. We describe the combination of spectrometric and statistical tools in a novel application: the search for biochemical determinants of invasiveness. We used liquid chromatography/mass spectrometry (LC-MS) techniques to obtain metabolic profiles of plants originating from the US and Europe, which were grown in a common garden. Multivariate data analysis (MDA) was used to identify metabolic contributors to variation between US and European populations. Our analysis indicates a greater metabolite diversity in European plants compared to their US conspecifics, which we argue is the result of selective pressures from increased herbivory. In addition, US plants subject to high herbivory had metabolic profiles that were more similar to European plants than to the US plants that experienced low herbivory. This study represents one of the first applications of metabolomics methodologies toward understanding the ecology and evolution of invasive plants.

Aquatic Invasive Species Public Awareness:  3:05 pm - 4:20 pm

Stop Aquatic Hitchhikers!™ From Theory to Application
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Preventing the spread of aquatic invasive species (AIS) starts with changing behavior. Over the past decade, community-based social marketing (CBSM) has emerged as an effective framework for promoting programs that foster sustained behavior. Most widely used in health care, it is also being applied in waste reduction, water and energy efficiency, and pollution prevention. Based on CBSM, Stop Aquatic Hitchhikers!™ is a national campaign to prevent the spread of AIS by boaters, anglers, and other recreationists. It uses strategic communication and outreach tools to promote sustainable behavior change. Campaign approaches used rely on guidelines designed to remove barriers for inaction, replacing them with simple, convenient, and effective actions. Communications, materials, and messages target each recreational audience. Reinforcing desired behavior through personal and social norms is critical to fostering desired behavior change. This presentation will reveal the theoretical underpinnings of the campaign’s applications providing insights into its success. Evidence from boater surveys indicates that Stop Aquatic Hitchhikers!™ is effective as a behavior intervention campaign. It is currently in use by more than 870 partners nationwide and continues to spread—a testimonial to its success as a model intervention strategy to prevent the spread of AIS.
Aquatic Invasive Species Prevention through Public Awareness: Examples from Minnesota DNR and its Partners

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Public awareness is a key strategy to address prevention and containment of aquatic invasive species. Minnesota DNR, partners such as Minnesota Sea Grant and Wildlife Forever, and prevention grantees have used many tools to attempt to raise public awareness about aquatic invasive species and prevention actions the people can take. Some of the tools, such as billboards, are targeting travelers into and throughout the state. Other tools, such as ads in local newspapers and are intended to reach local users of our lakes and rivers. Examples of these tools, including fish rulers, door mats, billboards, radio spots, and banners, will be presented to acknowledge our partners efforts and provide ideas for additional partners.

Great Lakes Invasive Species Outreach Partnerships

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Invasive species are making headline news. From flying carp to zebra mussels, their prevalence in the media is growing - a good news / bad news scenario. People are becoming more aware, but invasive species are spreading. Diverse and innovative partnerships are helping to combat these invaders by linking the talents and resources of multiple partners. This collective, comprehensive approach is saving money and raising awareness. Across the Midwest and into the Great Lakes there is a renewed investment into resource protection and restoration. One of the most critical elements of this work is outreach and education. Wildlife Forever started such a partnership five years ago called the Threat Campaign. Today, there are multiple partners; lake associations, sportsman’s clubs, universities, state and federal agencies, as well as non-government organizations, and large private business. Creatively capturing the resources of many, this partnership has invested $1.86 million into outreach across the Midwest and Great Lake states. Through traditional and nontraditional outreach such as television, print ads, news paper articles, radio interviews, billboards, events at professional angler tournaments, retail store promotions, youth fishing clinics, and a unique art contest called the State Fish Art Contest; over 500 million invasive species prevention impressions have been made. We have found there is not one method for reaching the masses, but by using the partnership mass we can reach millions. Join us.

Terrestrial Invasive Plant Management Workshop - Prairie: 3:05 pm - 4:20 pm

Canada Thistle (Cirsium arvense) Management in Minnesota Native Prairies

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J.B. Bright, US Fish and Wildlife Service

Numerous cooperative studies were conducted on management of Canada thistle (Cirsium arvense) in native prairies. Best Management Practices were studied within non-disturbance goals for optimum waterfowl production. Most native forbs survived clopyralid (Transline, Stinger) applications, although flowering and seed production were reduced or eliminated during the treatment season. Native sunflowers reestablished after herbicide applications ended. Canada thistle was controlled but situationally are reinvading. In herbicide trials, thistle control was most consistent with aminopyralid (Milestone), while native forb tolerance appears similar to that of clopyralid. During establishment, prairies are vulnerable to invasion. Studies are on going to compare time of seeding and native plant functional groups and the resultant ability to resist invasion by Canada thistle. Fall planting appeared most conducive to establishment of Canada thistle seedlings, spring planting the least. Cool season plantings dominated by native grasses
were more resistant to invasion than warm season plantings, and cool/warm season mixtures. Warm season plantings initially had a high percentage of bare ground open to invasion. Clopyralid treated plots initially had more native grass cover and fewer Canada thistle plants, but differences diminished with time. The movement of Canada thistle seed was studied. The contribution of wind dispersal to the spread of Canada thistle was largely local. Most seed fell near parent plants, relatively few traveled 6 m. Over 90% of trapped pappi were barren, and the percentage of barren pappi increased with distance from the source. The relative amount of seed distributed long distances by wind is minor, but may be important on a landscape scale in areas lacking an historical presence of Canada thistle.

Another Tool for the IPM Toolbox? Assessing Wetblade Technology to Manage Canada Thistle
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Canada thistle (Cirsium arvense) is a non-native, invasive plant commonly found in dense populations on roadside right-of-ways. We are comparing herbicide application with the Diamond wetblade to traditional broadcast spray application at various rates of aminopyralid (3, 5, and 7 oz/acre) for the management of Canada thistle along roadsides in the Twin Cities. The Diamond wetblade is a combination mower that applies herbicide directly to plant stems as it cuts. Preliminary data of this ongoing project suggest wetblade technology kills Canada thistle as well as broadcast application with less herbicide drift produced. The investigators will continue to monitor Canada thistle regrowth at the treated sites for three growing seasons.

Controlling Spotted Knapweed (Centaurea Stoebe) in NW Minnesota State Parks and Trails
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Spotted knapweed is an aggressive, introduced, short lived perennial weed species that rapidly invades road and trail edges, natural areas with light soils or areas disturbed by fire or mechanical means. The weed is a prolific seed producer with 1000 or more seeds per plant, seed can remain viable in the soil five years or more, and infestations may occur a number of years after vegetative plants have been eliminated. The plant releases a toxin that reduces growth of native species. The DNR Northwest Region Division of Parks and Trails (PAT) has waged a sustained and effective war on spotted knapweed over the last 10 years. NW Region PAT includes 70,000 acres of state park land spread over 16 management units across 4 ecological provinces as well as hundreds of miles of trail corridors and hundreds of public water accesses. Forests, prairies, and managed landscapes are all battle zones with spotted knapweed. Prevention, detection, mapping, control, monitoring and using native species establishment to prevent reinfestation are used. Control tactics include an integration of chemical, mechanical, cultural, and biological methods. Both successful and not so successful techniques have been tried over the years.
Invasive and Noxious Weed Management With Aminopyralid
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With the introduction of aminopyralid, an innovative, non-restricted use active ingredient from Dow AgroSciences, successful strategies for managing many noxious and invasive species in some of the most ecologically sensitive sites can be developed. Aminopyralid is a pyridine carboxylic acid herbicide developed for selective broadleaf weed control in sites such as natural areas, rangeland, pastures, rights-of-way, and non-cropland and was registered under the Environmental Protection Agency’s Reduced Risk Pesticide Initiative. Aminopyralid (Milestone™ Specialty herbicide) has broad range activity on a number of key invasive species, such as Canada thistle (Cirsium arvense), musk thistle (Carduus nutans), spotted knapweed (Centaurea maculosa), common and giant ragweed (Ambrosia spp.), teasel (Dipsacus spp.) and many others, and that spectrum is broadened even further when combined with certain other active ingredients. A new product with aminopyralid and metsulfuron (Opensight™ herbicide) has been developed for use on non-cropland sites including industrial sites, rights of ways, non-irrigation ditch banks, natural areas and grazed areas around those sites. This new combination will control additional noxious and invasive weeds such as wild parsnip, wild carrot, poison hemlock, sericea lespedeza, and multiflora rose. The data show that aminopyralid containing herbicides can be used in a long term integrated approach to managing noxious and invasive weeds in various habitats.™ Trademark of Dow AgroSciences LLC.Milestone is not for sale, distribution or use in New York state. Opensight is not registered for sale or use in all states. Contact your state pesticide regulatory agency to determine if a product is registered for sale or use in your state. Always read and follow the label.

Native Forb Tolerance to Aminopyralid (Milestone™ VM) Applications for Invasive Weed Control
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Aminopyralid (Milestone™ VM) is a broadleaf herbicide that has reduced risk to the environment compared with other herbicides, making it a desirable alternative for invasive weed control on wildland sites. Effect of aminopyralid on desirable forbs and shrubs is a consideration for land managers when making management decisions. Experiments were established at 10 locations in 4 states from 2004-2007 to determine long-term response of native forbs and shrubs to aminopyralid and to develop a tolerance/susceptibility ranking for native plants. Research locations were diverse plant communities with 29 plant families represented, with the greatest number of species (35%) in the Asteraceae family. Individual tolerance rankings to aminopyralid were established for 98 native forb species and 19 shrubs. Four ranking categories were developed: susceptible (S - 75% or more reduction), moderately susceptible (MS - 75 to 50% reduction), moderately tolerant (MT- 49 to 16% reduction) and tolerant (T – 15% or less). Of the 98 forb species categorized, 28, 17, 25, and 28 were ranked S, MS, MT, and T, respectively one year after application. Results from second year evaluations on 68 species showed most forbs had recovered with 77% of the species either MT or T. Shrubs were mostly tolerant to aminopyralid with 15 of the 19 shrubs ranked either MT or T after one year. Since most native forb and shrub species were moderately tolerant to tolerant, or quickly returned following treatment, land managers can use aminopyralid to restore the plant community by controlling invasive plants while minimizing non-target plant injury.
Most people working to control invasive plants turn to herbicides as one of the tools in their arsenal. Unfortunately, too many depend on only a few well-known herbicides when others might be more effective, safer and better suited for their specific plant problems. There are many herbicides that can be used for most invasives and new herbicides are being developed. Herbicide efficacy trials and operational scale treatments have been conducted that demonstrate utility and suitability of various herbicide products to control invasive plants that threaten natural areas. Extension agronomists, herbicide company representatives and an experienced contractor will be on hand to share information about herbicide and application technologies and to answer questions you might have about these technologies and the best herbicides for your problem species.

Forest Early Detection and Rapid Response: 8:30 am - 10:10 am

Forest Pest First Detector a Voluntary Early Detection Program in Minnesota
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Val Cervenka and Ken Holman, Minnesota Department of Natural Resources
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The Forest Pest First Detectors program is part of the federal National Plant Diagnostic Network (NPDN). This First Detector program is designed to identify the first incidence of emerald ash borer (Agrilus planipennis, EAB), gypsy moth (Lymantria dispar), Sirex wasp (Sirex noctilio), and Asian longhorned beetle (Anoplophora glabripennis) in Minnesota and each county. Forest Pest First Detector volunteers are one of the first lines of defense against the establishment of these forest pests by helping identify their first occurrence quickly. First Detectors also help disseminate information to the public about forest invasives and preventing their introduction. This first-in-the-United-States program is a joint project between the Minnesota Department of Agriculture (MDA), University of Minnesota Extension, and the Minnesota Department of Natural Resources. The program began in 2008, to date 483 participants have been trained and 321 have committed to the program. First Detectors utilize a step-by-step process to identify the signs and symptoms of forest pests. If a pest is suspected the MDA is notified. Confidentiality must be maintained for all suspected incidences. First Detectors may visit properties, correctly collect and safely mail samples, collect ash seed, and help educate and inform the public about these emerging forest pests. EAB was discovered in St. Paul, MN on May 13, 2009 via the First Detector Network. The program worked as was intended for the first EAB find in Minnesota. In 2009, First Detectors also volunteered 1281 hours and traveled 7650 miles for a total public value of almost $27,000.

Predicting the Distributions of Invasive Plants across Northern Wisconsin
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Non-native, invasive plants and animals have become major agents of environmental change. In Wisconsin alone, 29% of the approximately 2189 vascular plant species listed in the state’s official checklist are not native to the state. These nonindigenous plants vary greatly in their distribution, habitat requirements, ability to invade and impact natural ecosystems, and feasibility of control. Starting in the mid-1990s, the Great Lakes Indian Fish & Wildlife Commission (GLIFWC) has conducted surveys for invasive
plants and aquatic invertebrates across northern Wisconsin and western Upper Michigan. Using these data and those of regional partners, GLIFWC is employing species distribution modelling techniques to predict the current and potential distributions of invasive plants across northern Wisconsin. Model outputs are GIS grids with cell values representing probability of occurrence. These models can be combined with other relevant GIS layers to help identify which species pose the greatest threats to native ecosystems and tribal resources, and target invasive plant management efforts in a way that maximizes their cost-effectiveness.

**Determining the Potential Range of Forest Invaders Using Freely-Available Software and Climate Information**

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The potential distributions of introduced species have been predicted by climate envelope models (CEMs). This approach uses the simplifying assumption that range is completely dependent on climatic factors but may also include other macroscale components, such as topography. Despite the simplicity, CEMs can provide valuable information to help focus mitigation efforts. Using freely-available software and data, CEMs can be constructed for any introduced species for which the spatial extent of the native range is known. In order to illustrate this technique, we constructed CEMs for emerald ash borer (*Agrilus planipennis* Fairmaire) and Sirex woodwasp (*Sirex noctilio* F.) and determined zones of climatic equivalency in Minnesota and Wisconsin. In addition, we fused climate information with tree data from the USDA Forest Service’s Forest Inventory and Analysis program in order to provide more detail about forest resources in the predicted range.

**Invasive Plant Survey and Modeling to Support Forest Management Planning**

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MNDNR Forestry designed and implemented a road based survey of certain invasive plants along all maintained roads within state forest boundaries and DNR administered gravel pits. Survey methods were developed and training protocols designed to manage 2 to 5 survey crews over each of the last three years. Cold and hot checks of the survey data were also performed as a method of quality control to ensure the accuracy of the data. A simplified risk model was developed with the resulting data to assist field foresters in identifying and then prioritizing areas in need of additional inventory work to support planned management activities. The survey methods and the structure of the risk model will be presented and potential uses of each discussed.

**Ballast Water: 8:30 am - 10:10 am**

**Great Lakes Ballast Water Collaborative Update Panel Session**

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In 2009, the U.S. Saint Lawrence Seaway Development Corporation initiated the formation of the Great Lakes Ballast Water Collaborative, in conjunction with the International Joint Commission, to bring together industry and state and federal regulators on the issue of ballast water and invasive species in the region. One of the primary goals of the Collaborative is to share relevant, useful, and accurate information and foster better communication and collaboration among the key stakeholders engaged in the effort to reduce the risk of introduction and spread of aquatic nuisance species. A particular emphasis of the Collaborative has been to bring state representatives together with marine industry representatives and respected scientists to find workable and effective solutions...
to the aquatic invasive species challenge as they relate to the Great Lakes St. Lawrence Seaway System. The aim of the Collaborative is not to take away from any preexisting efforts in this regard, but rather to complement those efforts. The Collaborative provides a forum for discussing regulatory policy issues with a focus on workable and effective solutions. The Collaborative also recently assisted in data collection for WI DNR’s ballast water treatment feasibility assessment. For more information, visit: http://www.greatlakes-seaway.com/en/environment/ballast_collaborative.html.

**The Great Ships Initiative: Performance Assessment of a Candidate Ship-Board Treatment System**

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Ballast water discharge from ships is a significant source for the introduction and spread of aquatic invasive species. Using a land-based facility in Duluth/Superior Harbor, the Great Ships Initiative (GSI) is evaluating candidate shipboard treatment systems for their ability to prevent the introduction of freshwater nuisance species. Testing at the facility meets International Maritime Organization (IMO) guidelines and is the only system dedicated to testing ballast water treatment applications in fresh water. Testing scenarios involve accurate simulations of ship-board activities (e.g., pumping rates, water volumes, ballast holding times). Numbers of surviving ambient organisms in treated discharge are evaluated using an array of methods, and standard operating procedures are available on the project website, www.greatshipsinitiative.org. Specific GSI methods for sampling and assessing live microorganisms in size classes relevant to the IMO standards will be detailed. Results from the evaluation of a candidate treatment system will be presented relative to its ability to neutralize heterotrophic bacteria, protists (10-50 µm group) and zooplankton (>50 µm group). GSI test findings will support the development of ship-board treatment systems that meet and surpass IMO standards for preventing ballast-mediated aquatic species introductions.

**Management of Invasive Submersed Plants - Herbicide Use: 8:30 am - 10:10 am**

**Management of Invasive Aquatic Plants in Minnesota: Defining Success**

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Aquatic plant management in Minnesota includes activities intended to reduce, enhance or otherwise alter populations of aquatic plants by means of herbicides, biological agents, mechanical devices, physical alteration or transplanting. Beginning in the late 1980s, concern among waterfowl hunters and conservationists about purple loosestrife, *Lythrum salicaria*, prompted efforts to improve management of this non-native, invasive emergent plant. Partnerships among the Minnesota Department of Natural Resources (MnDNR) and other agencies led to development of an effective biological control program for purple loosestrife. Eurasian watermilfoil, *Myriophyllum spicatum*, was discovered in Minnesota in the late 1980s. Almost immediately, matted Eurasian watermilfoil interfered with use of Minnetonka and other lakes, which led to concern among owners of lakeshore property and boaters. Soon after discovery, the MnDNR began to work with lake associations and local units of government to manage the problems caused by Eurasian watermilfoil. In the late 1990s, research by the Corps of Engineers Aquatic Plant Control Research Program showed that curly-leaf pondweed, *Potamogeton crispus*, could be controlled by treatment with herbicide when water temperatures are low. In recent years, the MnDNR has invested ever-increasing amount of resources into pilot projects designed to evaluate the potential to selectively control curly-leaf pondweed on a lake-wide basis in Minnesota. Definitions of ‘success’ of management will be considered form a variety of perspectives.
Sampling of Herbicide Residuals Confirms Extended Exposure to Low Concentrations of 2,4-D and Triclopyr can Control Eurasian Watermilfoil
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Eurasian watermilfoil (Myriophyllum spicatum L.) and curlyleaf pondweed (Potamogeton crispus L.) are invasive submersed plants found throughout the Great Lakes Region. Herbicide programs targeting selective control of these species in Minnesota and Wisconsin have recently relied on the systemic auxin mimics triclopyr and 2,4-D, and the contact herbicide endothall. In conjunction with numerous operational treatments, a rigorous herbicide residue sampling program has been implemented to improve our understanding of how treatment scale and timing can impact herbicide concentration and exposure time relationships. Recent data generated in mesocosm systems indicate that Eurasian and hybrid watermilfoil can be controlled following extended exposures to low concentrations of triclopyr and 2,4-D (50 to 250 µg L⁻¹). Field sampling of herbicide residues has shown that larger scale applications can result in whole lake use patterns that result in extended exposures to the lower concentrations described above. While the efficacy of this use pattern has been documented at a lake-wide scale, the factors that influence selectivity remain under investigation. In contrast to large-scale applications, smaller spot applications in larger lake systems have resulted in significant variation in herbicide residuals and a resultant wide range of treatment outcomes. Despite many anecdotal claims of variable efficacy results being linked to factors such as milfoil hybridity, our sampling efforts suggest that large differences in water exchange rates within treatment plot have the greatest impact on treatment efficacy. Examples from operational treatments in Minnesota and Wisconsin will be discussed in conjunction with recent mesocosm data generated to simulate the concentration and exposure time profiles observed in the field.

Aquatic Herbicide Use Patterns: Differences in Restoration, Nuisance Control, and Eradication Strategies
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Aquatic herbicides have a long history of use in the upper Midwest with a recent emphasis being placed on selective control of submersed invasive plants such as Eurasian watermilfoil (Myriophyllum spicatum L.) and curlyleaf pondweed (Potamogeton crispus L.). Following successful establishment and spread of these plants within public waters, there is often considerable public pressure to initiate management or “eradication” efforts. This sentiment to initiate large-scale management is often counter-balanced by concerns that treatments will have undesired impacts on native vegetation or biota. Moreover, many agency resource managers as well as private angling and waterfowl interests often promote invasive plants as habitat that provides an ecological service. In the midst of this debate, aquatic plant managers within the Minnesota and Wisconsin DNR must often decide when to initiate or approve large-scale management efforts that target invasive plants with a goal towards habitat restoration, short term nuisance relief (invasives and natives), or implementing an eradication program to completely eliminate a new infestation. Aquatic herbicides have proven to be versatile, and several registered herbicides can be used as a major component of restoration, nuisance relief, or eradication plans. While versatile, aquatic herbicide use rarely proves to be a one-time effort, and restoration, nuisance relief, and eradication all generally require treatments over multiple years to achieve management objectives. Building a consensus on the outcomes of large-scale restoration efforts has proven particularly challenging. Specific examples with 2,4-D (registered in 1959) diquat (1962), endothall (1960), fluridone (1986), and triclopyr (2003) will be discussed.

Effects of Whole Lake Early Season 2,4-D on Eurasian Watermilfoil (Myriophyllum spicatum)
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Eurasian watermilfoil (Myriophyllum spicatum) is a non-native aquatic plant that is currently known from 539 lakes and rivers in Wisconsin, and oftentimes outcompetes and displaces native species, alters water quality, and interferes with recreational activities. Recent research efforts have attempted to move away from short-term management techniques (i.e. nuisance relief) towards more
strategic management techniques involving long-term goals of potential lake restoration and possible eradication. We will discuss the results of a controlled experimental study using a low dose (0.5 mg/L ae), whole lake, early spring liquid 2,4-D treatment on Eurasian watermilfoil. Application at this rate resulted in no Eurasian watermilfoil being detected during the past 3 survey years, though this has also resulted in significant declines in several non-target native species. In addition, chemical residuals were observed in the system for much longer than expected, and discussion on potential mechanisms for this persistence and future research will be presented.

Aquatic Invasive Species Control - Technology and Efforts: 8:30 am - 10:10 am

Reducing Spread of Invasive Species Through In-Line Screening
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The Minnesota DNR required a shutdown of the Snail Lake Flow Augmentation System in 2008 to prevent the spread of invasive zebra mussels (Dreissena polymorpha) from Sucker Lake source water, which has supplemented Snail Lake’s water supply since the early 1990s via a 1,800-gallon-per-minute pumping intake. The City of Shoreview, Minnesota DNR, and SEH, Inc. considered five alternatives for improved pumping processes that would prevent the transfer of zebra mussels into Snail Lake, ranging from chemical disinfection to filtration systems. The in-line screening facility option with a single 250 micron screen followed by two-25 micron self-cleaning screens selected was implemented in late 2009. The spring 2010 pumping period has provided a restoration of Snail Lake water levels with zebra mussel free water supply. This technology could provide similar solutions to reduce the spread of zebra mussels and other aquatic invasive species at other waters in the Midwest and beyond.

Response to Appearance of the Red Swamp Crayfish (Procambarus clarkii) in Southeast Wisconsin
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The Wisconsin DNR confirmed reports of populations of red swamp crayfish (Procambarus clarkii) in two Southeast Wisconsin manmade ponds in August and October of 2009. Red swamp crayfish is one of the most successful invaders in the world and DNR realized that it must act quickly to control the species. DNR, UW-Madison and UW-Parkside staff and students were brought together to conduct a multi-tiered integrated pest management plan. A request was made to Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) and the EPA for permission to use chemicals to control crayfish in an aquatic environment. Crayfish were trapped for population control and monitoring in both ponds prior to chemical treatment revealing important information about the age structure and reproductive status of the populations. Catch rates dropped sharply in one of the ponds but reproduction continued while catch rates were lower but consistent in the other pond. Following chemical treatment of both ponds with sodium hypochlorite, trapping revealed that catch rates were reduced by 89% and 82% compared to pre-treatment, but crayfish persisted in the ponds. Lessons learned from trapping and chemical treatments of this species will be discussed.

Development of Methods to Orally Deliver Biocides to Control or Limit Invasive Aquatic Animals
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Aquatic invasive organisms are a serious problem throughout the United States, causing billions of dollars in losses to economies that depend on aquatic resources. Natural resource managers consistently list the lack of chemical tools to control aquatic
invasive species as one of their top concerns. Currently, only four chemicals, the general piscicides antimycin and rotenone and the lampricides 3-trifluoromethyl-4-nitrophenol and niclosamide are registered with the U.S. Environmental Protection Agency for control of aquatic pests. Though Asian and common carp, as well as most other invasive fish species, are sensitive to antimycin or rotenone, the current formulations do not offer selective control of these species. Applications of antimycin or rotenone are thus limited only to those aquatic systems where a complete fish kill may be tolerated. Present application methods, which rely on dissolution of a piscicide in the water column, limit management applications to small aquatic habitats of limited volume. This limitation effectively permits invasive aquatic animals to move unchecked through large aquatic systems such as the Great Lakes or Mississippi River. The development of targeted delivery systems to deliver bioactive agents to specific invasive aquatic animals could facilitate the development of integrated pest management programs. Developing alternative delivery systems presents a unique opportunity to enhance the selectivity of general piscicides and substantially reduce effects on non-target species.

Key Points from the 2010 International Symposium on Genetic Biocontrol of Aquatic Invasive Species
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This international symposium explored the use of genetic biocontrol to manage established invasive finfish species. Genetic biocontrol refers to release of genetically manipulated organisms designed to disrupt the survival or reproduction of a targeted invasive species. Genetic biocontrol strategies have the capability to be more effective and targeted than current control methods but turning genetic biocontrol methods into practical tools requires identifying and successfully addressing obstacles and concerns. The symposium assembled scientists from fish genetics and biotechnology to risk assessment science and ecology, and professionals working in various facets of managing aquatic invasive species to address three key issues: 1) the status of genetic biocontrol technologies, including chromosome-based, gene-based and other targeted methods, and methods for combining genetic biocontrol with other control tools; 2) scientific risk assessment of these technologies; and 3) the regulatory and economic contexts surrounding development of these technologies. This presentation will recap key points emerging from the presentations of the symposium.

Terrestrial Invasive Plant Management - Prairie & Wetlands: 8:30 am - 10:10 am

Reed Canary Grass – Why is it So Successful and How Can it be Controlled?
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Reed canary grass (Phalaris arundinacea) has been challenging wetland managers for decades. More recently it has been expanding into forests and grasslands; not only in wet soils, but also in uplands. This talk will cover an overview of recent research on the biology, spread and control of this persistent grass. Reed canary grass has several characteristics that allow it to be so successful. Knowing how and why it spreads is key to preventing or controlling it, and to prioritize sites for control. There are many control methods that may be useful depending on the site conditions. We will discuss the range of techniques to help participants identify the best combination of methods for any specific site. Participants will receive a publication with comprehensive control information.

Large Scale Control of Phragmites and Lyme Grass in Wisconsin on Lake Michigan
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Phragmites, also known as common reed grass, is a major invader of Lake Michigan coastal wetlands in Northeast Wisconsin. The Wisconsin Department of Natural Resources has been successful in controlling phragmites by working with partners using four control methods (bundle, cut and treat; ground spraying; and aerial spraying) on small and large populations in a variety of wetland types. The Department has also been successful in controlling Lyme Grass with ground spraying and is beginning a three year EPA funded grant of a large scale phragmites and Lyme grass control program in six counties.
Cheatgrass (*Bromus tectorum*) Management for High Diversity Dry Prairies in Minnesota

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Control of non-native invasive cheatgrass is progressing at a high-diversity sand-gravel prairie complex in east-central Minnesota using a combination of methods. Data collected from monitoring plots are being used to document effectiveness of individual techniques and their combinations, including “very late cutting”, burning, and herbicide applications. Based on the data collected, a preliminary prescription for cheatgrass control in high quality prairies in the upper Midwest will be presented. Cheatgrass, the dominant invasive plant over millions of arid and semi-arid acres in the western U.S., has been recently documented in at least two high-quality Minnesota dry prairies, underscoring the importance for expeditiously developing regional control techniques.

Management of Invasive Species of the Prairie

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Basic management techniques for three prairie invasive species (exotic cool season grasses, bird’s foot trefoil, and common tansy) will be discussed.

Biocontrol of Terrestrial Invasives: 10:40 am - 11:55 am

The Minnesota Department of Agriculture’s New and Established Biological Control Programs

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Biological control can be a cost-effective and sustainable pest management tool. In partnership with other agencies, the Minnesota Department of Agriculture (MDA) initiated biological control of emerald ash borer (*Agrilus planipennis*) with three wasp species (*Spathius agrili*, *Tetrastichus planipennisi*, and *Oobius agrili*) and gypsy moth (*Lymantria dispar*) with a fungal pathogen (*Entomophaga maimaiga*). The efficacy of emerald ash borer biocontrol has yet to be determined. Successful programs are established for leafy spurge (*Euphorbia esula*) with beetles (*Aphthona lacertosa* and *A. nigriscutis*) and spotted knapweed (*Centaurea biebersteinii*) with a combination of seedhead weevils (*Larinus minutus* and *L. obtusus*) and root weevils (*Cyphocleonus achates*). MDA also coordinates the development of biological control for common tansy (*Tanacetum vulgare*). These programs are cooperative and involve multiple agencies, universities, and landowners.
Biological Control of Garlic Mustard (*Alliaria petiolata*) and Buckthorn: an Update
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Use of biocontrol agents to control garlic mustard would provide long-term control and management of this invasive biennial weed. Extensive host specificity testing on a potential biocontrol agent, the stem and crown-boring weevil, *Ceutorhynchus scrobicollis*, has been completed at CABI Bioscience in Switzerland and at the University of Minnesota. Results of these tests indicate that *C. scrobicollis* is a highly specific herbivore. At the University of Minnesota, the Level 2 High Security Containment Facility is currently the only location in the country where work on *C. scrobicollis* is being conducted. At this facility, we have been rearing and conducting host specificity testing with *C. scrobicollis* for the past five years. After completion of a series of vigorous host range tests, we have applied to the Technical Advisory Group (TAG) for Biocontrol of Weeds for approval for field release of *C. scrobicollis* and are now testing some additional native mustards at reviewers’ request. We will discuss the current status of our garlic mustard biocontrol project with *C. scrobicollis* as well as our work with *Ceutorhynchus alliariae*, another potential biocontrol insect. This talk will also give a brief update on the status of the biological control research on common and glossy buckthorn (*Rhamnus cathartica* and *Frangula alnus*).

Status of Biological Control Development for Several Invasive Wetland and Terrestrial Plants
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In addition to plant species with established biological control programs, there are several other species with ongoing research that this presentation will highlight. Most biocontrol work for invasive plants is done by CABI – Europe, a private organization headquartered in the UK and Switzerland. Researchers there are working on dozens of species that are invasive in North America. Additional research is underway at Cornell University in cooperation with other institutions. Some of the species with ongoing research of interest to the Upper Midwest include: Japanese knotweed (*Polygonum cuspidatum*), phragmites/giant reed grass (*Phragmites australis*), tansy (*Tanacetum vulgare*), houndstongue (*Cynoglossum officinale*), swallow-worts (*Vincetoxicum* spp.), buckthorns (*Rhamnus cathartica*, *Frangula alnus*) and several other species more common in western states.

Forest Insect Pests: 10:40 am - 11:55 am

An Overview of Asian Longhorned Beetle (*Anoplophora glabripennis*) in the United States
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Asian Longhorned Beetle, an invasive insect pest from China, has become established in parts of New York, New Jersey and Massachusetts. Introduced to the US through wood packing material, this insect has a large host range which can have a devastating effect on hardwood forests in the US. With its introduction in the Northeastern US, this insect could have very large ramifications for the Midwest and its hardwood forests if it were to become established throughout the nation. USDA-APHIS-PPQ in cooperation with state and local governments is underway in eradicating this pest through a cooperative eradication programs in NY, NY and MA. This cooperative program has developed a strategic plan in an attempt to successfully eradicate this pest including detection, regulation, control, outreach/education, research and restoration. This strategic plan’s successes and failures will determine what plan will have to be taken in order to prepare for a potential Asian Longhorned Beetle outbreak.
Some of the most significant threats to trees in the Lake States are from invasive insects that feed in the wood and phloem. This presentation will give a brief introduction to the main groups of wood and phloem feeding insects and the damage that they cause.

Gypsy Moth (Lymantria dispar) Trapping & Treatments in Minnesota - MDA Program Update
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The gypsy moth is one of North America’s most destructive tree pests. The Minnesota Department of Agriculture tracks its movement into the state and treats localized infestations to protect the state’s forests, local property values, and vital tourism industry. The update will provide current trapping and treatment information about this invasive species and an overview of the changes occurring in Northeastern Minnesota’s Slow the Spread (STS) Action Area as moths are being detected in higher numbers.

Aquatic Invasive Species in Lake Superior: 10:40 am - 11:55 am

Comparing Planktonic Bacterial Communities in Ship Ballast Water and the Duluth-Superior Harbor
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Ship ballast water has been shown to be a potential vector for spreading exotic or invasive microorganisms and the Duluth-Superior Harbor receives more ballast water discharge than any other harbor within the Great Lakes. Currently, little is known about the diversity of natural microbial communities within this harbor, yet this information is crucial for identifying future introductions of potentially harmful microorganism via ballast water discharge. To characterize planktonic bacterial communities within the harbor, water samples were collected at six sites along a transect from Lake Superior, through the Duluth-Superior Harbor, and into the lower St. Louis River. Additional water samples were collected from ship ballast water and the Western Lake Superior Sanitary District because discharges from these sources may alter the composition of bacterial communities within the Duluth-Superior Harbor. DNA was extracted from microbes collected on membrane filters and used for T-RFLP DNA fingerprint analysis to compare the molecular similarity of bacterial communities in the harbor with potential sources of bacteria to this harbor from the lake, river, ballast water, and wastewater effluent. DNA fingerprint analysis indicates the bacterial communities discharged into the harbor by ship ballast water can be different than those bacterial communities found within the harbor. In addition, bacterial communities in freshwater ballast water were different than bacterial communities in saltwater ballast water. To further characterize bacterial community composition, 16S rRNA gene clone libraries were created for one of the harbor sites and three ship ballast water samples including both freshwater and saltwater sources.

Status of Aquatic Non-Indigenous Species in the Duluth-Superior Harbor
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As part of a study to develop recommendations for aquatic non-indigenous species (NIS) monitoring in Great Lakes areas at risk of invasion, we conducted comprehensive, multi-gear sampling in the Duluth, MN-Superior, WI harbor and lower St. Louis River in 2005-2007. This effort represents the most spatially and taxonomically comprehensive NIS survey of this complex, invasion-vulnerable area.
Great Lakes subsystem to date. The objectives of this presentation are to report which NIS were detected, describe their abundance and distribution, and evaluate which sampling gears were most effective in detecting them. Our findings confirm that this major shipping port remains a NIS invasion “hotspot”. Ten of the 41 fish species and 19 of the ~240 benthic invertebrate taxa recorded were non-indigenous. Eight of the benthic invertebrates, including the New Zealand mud snail (*Potamopyrgus antipodarum*), a Eurasian-origin amphipod (*Echinogammarus ischnus*), and the quagga mussel (*Dreissena bugensis*), were first-detection records. Notably, zebra mussel (*Dreissena polymorpha*), round goby (*Neogobius melanostomus*), and Eurasian ruffe (*Gymnocephalus cernuus*) were found to be abundant and widespread in the system (“invasive”), while most NIS were uncommon and localized (“non-invasive”). A few NIS were extremely rare and required considerable sampling effort to detect. Because the sampling gear differed substantially in the habitats covered and the species composition recovered, monitoring multiple habitats with multiple gear types provided the most complete and nuanced picture of aquatic NIS status.

**Lake Superior Aquatic Invasive Species Complete Prevention Plan**

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Canada and the United States share responsibility for protecting Lake Superior from the introduction of new aquatic invasive species (AIS). To address the risk of AIS, the Lake Superior Binational Program developed the Lake Superior AIS Complete Prevention Plan (Plan), which outlines actions that need to be implemented to close existing vectors and pathways of introduction. Current vectors of AIS introduction include: maritime commerce, agency activities, illegal activities, organisms in trade, fishing and aquaculture, canals and diversions, tourism and development, and water recreation. At present, domestic shipping is considered to pose the greatest threat of spreading AIS to Lake Superior from the lower Great Lakes. The Plan proposes a comprehensive binational program of education, monitoring, and regulation (including inspection and enforcement) that recognizes the importance of shipping, port operations, and trade and commerce to both the Lake Superior region and the American and Canadian economies. Members of federal, state, provincial and tribal agencies were involved in the development of the Plan, which integrates the existing Great Lakes AIS prevention efforts of various agencies into a common plan for Lake Superior. The actions and recommendations outlined in the Plan serve as a basis for agencies and others with a role in AIS prevention to develop work plans in support of the Plan. These work plans will reflect the institutional and legislative differences between Canada and the United States but will focus on the needs of the Lake and will create the domestic decision frameworks necessary to lead to actions on the ground.

**Management of Curlyleaf Pondweed: 10:40 am - 11:55 am**

**Attempts to Improve Water Quality by Management of Curlyleaf Pondweed in Minnesota**

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A brief summary of monitoring of lake-wide treatments to control curlyleaf pondweed in an attempt to improve water quality will be presented. Lake-wide treatments with herbicides reduced the frequency, biomass, and surface matting of curlyleaf pondweed. More study is needed to determine the longevity of control of curlyleaf pondweed after lake-wide treatments are stopped. Though the average density of turions in the lake sediments tended to decrease after years of treatment, significant numbers of turions remained in the lakes after as many as five years of treatment. Overall, most native aquatic plants were not harmed by lake-wide treatments of curlyleaf pondweed with endothall herbicide. In lakes treated to control curlyleaf pondweed, there did not appear to be a strong and consistent pattern of increases in the amount of area occupied by native submersed plants during late summer. In some treated lakes, abundance, as reflected by biomass, of native plants appeared to increase over time. The principal species that increased included coontail, elodea, and chara. Overall, there did not appear to be a consistent trend of increasing water clarity in lakes following lake-wide treatments to control curlyleaf pondweed. In the future we expect to have a more complete assessment of the potential benefits of lake-wide treatment of invasive submersed plants based on additional analysis of the data that are summarized here as well as analyses of more data from additional lakes.
Control and Management of Curlyleaf Pondweed (*Potamogeton crispus*) in a Shallow Lake

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A research study was initiated in 2007 to treat Gleason Lake in Hennepin County Minnesota with Aquathol K® herbicide to control and manage the curlyleaf (*Potamogeton crispus*) pondweed, a non-native invasive aquatic plant in Minnesota. The main objective of the research study was to determine if herbicide treatments are a viable long-term solution to control and manage the curlyleaf pondweed, reduce the internal nutrients loads, improve the water quality, and enhance the growth of native vegetation in Gleason Lake. Three years of whole lake treatment followed by two years of spot treatment were proposed for the study. Pre and Post treatment aquatic plant surveys were conducted to determine the effectiveness of the treatments. Fall season aquatic plant surveys were conducted to document the presence and growth of native aquatic plants. Post treatment aquatic plant survey data showed that herbicide treatment was effective in all three years of whole lake treatment as well as one year of spot treatment by eradicating curly-leaf pondweed after the treatment. Curlyleaf pondweed stem densities continue to decline and water quality monitoring data shows that water transparency has improved in the Gleason Lake. First four years of the study data will be presented.

Evaluation of Lake-wide, Early-season Herbicide Treatments for Controlling Invasive Curlyleaf Pondweed (*Potamogeton crispus*) in Minnesota Lakes

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Non-native curlyleaf pondweed (*Potamogeton crispus* L.) is widespread throughout temperate regions of North America. Its early-season growth, propensity to form dense surface mats, and ability to out-compete native aquatic plants allow it to degrade the ecological and recreational quality of lakes. Consequently, there is great interest in adopting lake-wide management strategies that can reduce the negative impacts of curlyleaf and provide some degree of long-term control. We collaborated with the Minnesota Department of Natural Resources in 2006 - 2009 to evaluate lake-wide, early-season herbicide treatments for curlyleaf management. Six curlyleaf-infested lakes were treated with endothall at 0.75 to 1.00 mg/L active ingredient (ai), or fluridone at 2 to 4 µg ai/L for at least three consecutive years. Three additional lakes with established infestations were selected to serve as untreated reference lakes. We annually assessed the frequency and biomass of curlyleaf in May and June, documented the production of new curlyleaf turions (reproductive buds) on standing plants, and tracked changes in the abundance and viability of turions in lake sediments. Frequency, biomass, turion production, and sediment turion abundance were all significantly lower in treated than in untreated reference lakes. However, viable turions remained in lake sediments after three consecutive years of treatment. These results suggest that serial lake-wide, early-season herbicide treatments can effectively decrease the negative impacts of curlyleaf and reduce the abundance of turions in lake sediments, but ongoing management will likely be required to maintain long-term control of curlyleaf.

Aquatic Invasive Invertebrates: 10:40 am - 11:55 am

Faucet Snails (*Bithynia tentaculata*): What They Are and Why We Should Care
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The faucet snail is an aquatic snail native to Europe that was introduced to the Great Lakes in the 1870’s. It has since spread beyond the Great Lakes and is now finding its way into more and more waters across the midwest. These snails are hosts to three species of parasitic trematodes or flukes that have a complex life history that includes both the snails and waterfowl. When waterfowl consume these infected snails the adult trematodes attack internal organs that cause lesions and hemorrhages that many times lead to the death of the bird. The faucet snail, and the trematodes that kill many 1,000s of waterfowl each season continue to be a relatively unknown invasive species to many and pose a big risk to migrating and local waterfowl populations across North America.
Preventing Between-lake Hitchhiking of the Spiny Water Flea (*Bythotrephes longimanus*)

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The spiny water flea (*Bythotrephes longimanus*) presents a serious threat to the health of native zooplankton assemblages in Minnesota and Wisconsin. Although only a handful of lakes have been invaded thus far by spiny water flea, there are thousands of lakes across the bi-state region with suitable habitat. Our goal was to identify an effective method to prevent human-assisted transfer of spiny water flea between lakes. Using a lab-based bioassay approach, we discovered that the resting eggs of spiny water flea do not survive 12 or more hours of drying at room temperature (17-18ºC) and typical summer humidity (40-70%). This was true whether we tested an individual free egg (e.g., those already released from the mother’s brood chamber) or a batch of eggs being carried in the brood chamber of a mother. Freezing resting eggs prolonged their tolerance to drying. Our experiments with chlorine solutions, saline solutions, and a range of acidic and basic pH solutions had comparatively minor and sometimes no effect on hatching success of the resting egg. Our results point to overnight drying (>12 hours) at room temperature as the most effective method to kill resting eggs of spiny water flea. Although the method is both procedurally easy and inexpensive, it demands both time for drying and effort to ensure that contaminated surfaces are actually thoroughly dry for >12 hours.

Using Suitability Assessments to Determine the Degree of Zebra Mussel Colonization Potential

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A question from lake users regarding zebra mussels often is: What will the zebra mussels do if they come into our lake? Monitoring results from lakes with zebra mussels show different growth responses based on lake conditions. Three areas to assess to determine the suitability of zebra mussel colonization and growth are lake chemistry, substrate availability, and food quality. The key lake chemistry parameter that could limit zebra mussel growth is the calcium concentration but pH and alkalinity are often monitored as well. The best substrate for optimal zebra mussel growth is the presence of hard surfaces such as rocks or course woody habitat. Zebra mussels will grow on silt, sand, and even plants but not at optimal densities. Food availability as measured by chlorophyll, is also a factor supporting either optimal growth or limiting growth. Parameters from these three areas were calibrated with lakes with zebra mussels that had light or heavy growth. Then assessments were conducted in lakes without zebra mussels. We found several lakes in Wisconsin (Pike Lake Chain, Price Co) would be calcium limited whereas two lakes in Minnesota (White Bear Lake, Washington Co and Lake Sylvia, Wright Co) would be food limited. In Lake Minnetonka, where zebra mussels were found in July of 2010, all 26 bays were assessed and findings showed a mix of optimal to suboptimal growth conditions based on water column characteristics. However, the dominant substrate type was sand and silt in all the bays. This type of substrate generally supports only moderate zebra mussel growth. Lake suitability assessments are relatively inexpensive and much of the data that are needed are already available.

Terrestrial Invasive Plant Management Workshop - Forest: 10:40 am - 11:55 am

Japanese Knotweed (*Polygonum cuspidatum/Fallopia japonica*) – Biology, Impacts and Control Methods

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Japanese knotweed is one of the most problematic species along waterways in the UK and New England and it is becoming a serious threat to the wetlands and shores of streams and lakes in the Midwest. This aggressive clonal plant is generally thought to spread only vegetatively, but recent evidence shows some plants are producing viable seed, as well. Recent reports from around Wisconsin show that it is more widespread near and on shorelines than previously thought. Control needs to be well planned, targeting the entire clone and generally repeated for several years. The various control methods that are used will be covered. Participants will be encouraged to share their results of success or failure. A comprehensive WI DNR publication on this species will be available.
A Tale of Two Bittersweets: Ecology, Morphology, Invasion, Hybridization, Control and Conservation
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The invasive oriental bittersweet is expanding its range westward across central North America and in the process it is impacting the native American bittersweet as well as indigenous vegetation especially in forested habitats. In the Great Lakes, open sand dunes are refugia for American bittersweet, but at the ecotones with adjacent forests, the two preferred habitats for these species overlap. We will discuss these distributional patterns in relation to physiology and ecology of these two species. We will discuss the challenges of attempting to distinguish the two species based on morphology and the issue of their hybridization. We will discuss fire effects and control measures for eradicating oriental bittersweet.

Garlic Mustard, a Comparison of Management Options
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Garlic mustard (Alliaria petiolata) continues to spread throughout Wisconsin and Minnesota. While initial infestations were isolated to woodland habitats, new populations have recently been observed invading a wide range of habitats including prairies, wetlands and roadides. While control methods for garlic mustard have traditionally focused on individual plant treatment methods, new techniques have now been tested to control garlic mustard dominated forests as well as these new habitats. This presentation will review management options for suppressing garlic mustard. Management methods compared will include herbicide applications, mowing, prescribed fire, hand-pulling, and manipulation of the environment as these all have shown to provide some level of suppression of garlic mustard. As part of the presentation, a discussion of the appropriate timing to conduct management activities, potential for non target injury, and ability to integrate with other techniques will be highlighted. The goal of this presentation is to highlight the positive and negative aspects of each management activity so a land manager can improve management of this common invasive plant.

Early Detection and Rapid Response 1: 1:30 pm - 2:45 pm

Terrestrial Invasive Plant Early Detection
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Roger Becker, University of Minnesota
Laura Van Riper, Minnesota Department of Natural Resources

It is possible to eradicate target plant species with high invasive potential and very limited distribution. Preventing the establishment and spread of these species is cost-effective and minimizes environmental damage. Land management resources are too limited to survey for all invasive plant species. Providing land managers with information on which high priority species are likely to move into their areas and how to identify, find and control these species will enable strategic resource allocation and rapid response to emerging threats. An initial list of target species is at www.mda.state.mn.us/plants/pestmanagement/weedcontrol/terrestrial.aspx.
Increasing the Impact of an Early Detection Rapid Response Program
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Early Detection and Rapid Response (EDRR) staff and partnership teams that focus on active detection of newly establishing invasive species rely on highly trained taxonomists for identification and risk-based sampling followed by control conducted by professional staff. Models from the Hawaii Invasive Species Committees for developing EDRR capacity have included contracting private firms, agency partnerships and in-house specialist staff development. Review has determined that detection rates, target list development and follow up are most successful for full time “in-house” staff that are tied to an ongoing project. Maintaining these taxonomic and control specialists requires a significant commitment of time and resources but the additional benefits of developing this capacity are under reported. An argument is made based on the Hawaii partnerships that developing full time specialist positions has increased the presence and success of local invasive species prevention and control efforts through: nursery surveys, engagement with nursery industry groups and local municipalities, providing trainers for public “eyes and ears” programs. Based on this experience a recommendation is made to develop capacity for local projects to conduct EDRR utilizing full time trained specialists.

Common Lake Shore Weeds – A Guide for Identification and Control
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Mary Blickenderfer, University of Minnesota Extension

Native shoreland buffers have been a very useful tool in reducing erosion, protecting water quality and improving wildlife habitat on area lakes and streams. Additionally, raingardens planted to native species have also proven to be effective at reducing stormwater runoff and the subsequent water quality degradation associated with it. A major challenge associated with the establishment of native plants is knowing what to control and what to save; followed closely with how to control the unwanted plants. To assist landowners through the establishment period, the Sherburne SWCD in cooperation with U of M Extension compiled and published the spiral bound booklet: Common Lake Shore Weeds – A Guide for Identification and Control in Shoreland Buffers, Wetlands and Raingardens. The booklet has proven to be a resource that has enabled shoreland owners to successfully establish and maintain native shoreland buffers and rain gardens. The guide provides color photographs of 62 of the most commonly encountered species that tend to impede establishment of native species in restoration efforts. The photographs show each plant at seedling, flowering, and seed head stage. Information for each species includes: perennial, biennial or annual, plant family, flower color, leaf description, seed/fruit description, height, bloom time, other unique/interesting features, relative level of invasiveness, recommended control methods, method of spread and expected control time.

Invasive Pathogens: 1:30 pm - 2:45 pm

Three Year Efficacy of Oak Wilt Treatments in Minnesota
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Robert C. Venette, USDA Forest Service

Oak wilt, caused by the invasive fungus Ceratocystis fagacearum, is a serious disease of oaks, particularly among red oaks (Quercus spp.; section Lobatae), which experience frequent mortality as a result of infection. White and bur oaks (Quercus spp.; section Quercus) are also affected, but infections are rarely fatal. Several treatments, which address the belowground or aboveground mechanisms of spread, are available to prevent or delay tree damage and death. However, relatively little is known about their efficacy in an operational setting. This analysis was undertaken to elucidate the relative efficacy of oak wilt treatment combinations in preventing the spread of the disease from infected to healthy oaks in Minnesota in order to inform future management decisions.
We found that when fungicide injection was added to a treatment regime including potential spore-producing tree (PSPT) removal and vibratory plowing (VP), probability of successful treatment significantly decreased when compared to treatment regimes including PSPT removal alone or in combination with VP. We also found that successful oak wilt treatments were more likely to be located near other successful treatments. Thus, successful oak wilt management is spatially clustered and is associated with treatments including PSPT removal and VP, used alone or in combination. Increased understanding of the relative efficacy of oak wilt treatment options can allow tree care professionals to make more informed oak wilt treatment decisions.

**Thousand Cankers Disease of Walnut: What, Where, and Why should we care?**
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Thousand cankers disease occurs on walnut trees (*Juglans* species) and is caused by the combination of the walnut twig beetle (*Pityophthorus juglandis*) and an associated fungus, (*Geosmithia morbida*). While tunneling in the inner bark, the beetle introduces the fungus which causes cankers by killing the bark and phloem. Following mass attacks by fungus-bearing beetles, the resulting cankers coalesce and subsequently girdle and kill the affected branch or trunk. Black walnut (*J. nigra*) trees can die within 6 to 8 years of initial beetle invasion. The disease occurs mainly in western and southwestern United States on both native and non-native walnut trees; however, it has been recently confirmed in Tennessee. The disease is a threat to black walnut in its native range which covers all or parts of 30 states, including southeastern Minnesota and southern Wisconsin. Black walnut is a highly valued hardwood species for wood products as well as nut production. Major pathways for spread are movement of timber, firewood, wood packaging material, nursery stock and scion wood. To reduce the risk of spread and protect our black walnut resource, Federal and State agencies are collaborating on early detection survey and outreach efforts. In addition, Minnesota has joined several states in establishing regulations for the movement of walnut wood into the state.

**Invasive Forest Pathogens in Wisconsin: Current and Future Concerns**
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Though they may not receive as much attention as their insect counterparts, invasive pathogens have killed hundreds of thousands of trees in Wisconsin. First described in the 1940’s, oak wilt continues to be a serious disease of oak in Wisconsin. *Annosum* root rot has been confirmed in 21 counties in Wisconsin since first detected in 1993. Beech bark disease was first found in Wisconsin last year; yet recent beech scale surveys have detected widespread low to very low populations of the insect in 7 eastern counties. Collaborative multi-agency/organization approaches have been effective for early detection, prevention, and management of invasive pathogens. For example, site-specific oak harvesting guidelines were recently developed and implemented in Wisconsin as a collaborative effort among USDA Forest Service, County, industry, and WI DNR foresters, and WI DNR Forest Health Protection, based on recent vector biology and climate data. Prevention for *annosum* root have been more widely accepted in forestry communities in Wisconsin due to tireless efforts by forestry professionals of various disciplines, such as researchers, forest health specialists, foresters, loggers, logging equipment manufacturers, pesticide manufacturers, and landowners. The WI DNR has also been working closely with the WI DATCP, the University of Wisconsin, and USDA Forest Service for the detection of several major forest disease threats to Wisconsin, such as thousand cankers disease and sudden oak death. This presentation will be a summary of the efforts that have been taken to fight against invasive pathogens in Wisconsin.
Aquatic Invasive Species Programs and Partnerships: 1:30 pm - 2:45 pm

An Overview of Wisconsin’s Aquatic Invasive Species Program
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Wisconsin’s Aquatic Invasive Species Program is implemented through partnerships designed to utilize the best each partner has to offer. Funding sources include state ($4.5 million annually) and federal (variable). Funds are dispersed to local units of governments, lake organizations, non-profit conservation organizations, universities, tribes, and other state and federal agencies through grants, and contracts to achieve the objectives identified in the states Aquatic Nuisance Species Plan. Heavily diversified the state’s AIS Program is flexible, responsive and supportive of local efforts to fight AIS. The program supports research, educational opportunities (Clean Boats Clean Waters), management (control and restoration), monitoring, and law enforcement. Areas of growth include; developing new partnerships with other organizations invested in the AIS arena, investigating other potential vectors for releasing aquatic invasive species, enhanced monitoring and data management, development of smart containment strategies at local levels and research for developing control strategies.

Clean Boats, Clean Waters: Citizens and Staff Work Together to Protect Wisconsin’s Lakes
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Educating boaters and anglers at boat landings through watercraft inspection is a vital part of Wisconsin’s aquatic invasive species (AIS) prevention efforts. With so many waterbodies and so few state resources, the success and continuation of our watercraft inspection program has been very reliant upon our enthusiastic, highly motivated citizens. Since the creation of the Clean Boats, Clean Waters program in 2004, thousands of citizens have been trained at inspection workshops on how to initiate boater education efforts at their local boat landings. These volunteers, as well as paid staff, collect data about the actions of boaters and anglers and share information about how to help prevent the spread of aquatic invasive species. The data that has been gathered over the past six plus years has revealed some fascinating, and exciting, trends in the AIS preventative behaviors and AIS awareness of people using our boat landings. By engaging citizens and local governments, providing education to boaters and anglers, and accumulating valuable data, watercraft inspections are a beneficial tool in preventing and containing the spread of aquatic invasives.

Aquatic Invasive Species Prevention Program Development in Burnett County, Wisconsin: Integrating Education, Outreach, Remote Sensing, and Enforcement
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Eric Lindberg, Environmental Sentry Protection, LLC

Over 1000 lakes in Wisconsin have been invaded by some form of Aquatic Invasive Species. Impacts to ecology, recreation, and property values typically follow. Cost of AIS management to lake residents is significant. In 2006 Burnett County Lakes and Rivers embarked on a 2 year project to educate boaters to protect key lakes in the county. This project complemented Clean Boats Clean Waters in person inspection efforts with continuous video inspection of boat launches at 7 sites when volunteers were not present. Participation in this project happened from Wisconsin DNR, lake associations, county agencies, and commercial entities. Significant improvements in boater clean-off behavior were documented and rewarded. 5 citations and 10 gift certificates were issued based on a new county ordinance with adoption by other counties and strengthened AIS transport laws at a state level. Educational flyers were designed and distributed to all bait shops and marinas. Local newspapers covered the AIS issues extensively. We will discuss the project elements, lessons learned, and results over time.
Regional Collaboration on Invasive Species Management in the Cisco Chain of Lakes
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Invasive species management of Eurasian Watermilfoil (Myriophyllum spicatum) and Curlyleaf Pondweed (Potamogeton crispus) in the Cisco Chain of Lakes located near the Ottawa National Forest on the border of Wisconsin and Michigan is complicated by the numerous organizations that have overlapping jurisdictions in the area. Treatments have been spread out over the course of the last ten years and the Sigurd Olson Environmental Institute of Northland College performed an invasive species assessment on the Cisco Chain in July 2010 to determine effectiveness and further actions. It was determined that for any sort of long term management strategy to be enacted for the Cisco Chain of Lakes, a cooperative understanding is needed to be reached among the many stakeholders.

Ecology and Management of Flowering Rush in the Detroit Lakes Chain
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Flowering rush (Butomus umbellatus L.) is a lesser-known invasive aquatic plant, with infestations appearing in Flathead Lake, MT downstream into Idaho and Washington, and in the Detroit Lakes chain in Minnesota. While several genetic and taxonomic studies have been completed, little has been done on the ecology and management. We have initiated a two-year field study in May 2010 for the Detroit Lake chain, examining the phenology, depth distribution, and biomass allocation with depth in the five lakes of the Detroit Lakes chain. For the phenology study, we are sampling four sites every three weeks from May to October and every other month from November to April. Twenty samples of flowering rush per site will be taken using a 15-cm diameter biomass core sampler. In addition, twenty point samples will be recorded for phenological characteristics of hardstem bulrush (Schoenoplectus acutus (Muhl. ex Bigelow) A.& D. Löve). Ecological distribution will be evaluated using a point intercept survey in all five lakes in the chain, visiting points in a 100m grid interval throughout the system. At each point, plant species presence will be recorded and depth measured. At every other point, a sediment sample will be taken using a 5-cm diameter core for particle size analysis. Previous experience in managing flowering rush has shown that Imazapyr was effective at controlling emergent flowering rush, but did not control submersed plants. We initiated a field trial of endothall on flowering rush in May 2010. Twelve 0.5 ha plots were selected for treatment, with four untreated reference plots. Our trials included treatments of endothall once (May), twice (May and June), or three times (May, June, and July) with an initial target concentration of 3.0 mg ai/L in the water, or 0.44 kg ai/ha-m. Each treatment was replicated in four plots. Preliminary results of these three studies will be presented.

Assessment Techniques for Effect of Weevil Stocking on Eurasian Watermilfoil Populations in Two Coastal Lakes
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Laura Brutscher and Emily Lichte, Concordia College

Myriophyllum spicatum, Eurasian watermilfoil, is among the most problematic invasive aquatic plant species throughout North America. Several treatment alternatives are available for milfoil control, including chemical, mechanical and biological control alternatives. The native milfoil weevil Euhrychiopsis lecontei is a specialist on watermilfoils that has been used as a biological control organism. However, the efficacy of stocking milfoil weevil eggs and small larvae is unclear. We monitored weevil and watermilfoil populations in two lakes stocked with weevil eggs and larvae by EnviroScience, Inc. (Stow, Ohio). The East Mitigation Pond, a 1.4 ha pond located in Olympia, WA completely covered with a continuous Eurasian watermilfoil bed, was stocked with approximately
12,000 weevils in August 2009. Indian Lake, a 79 ha lake in Sharon, CT plagued by many patches (often greater than 5 ha) of both Eurasian and/or variable-leaf watermilfoils, was stocked from 2007 to 2009 with 31,500 weevils. The milfoil weevil was not found in the East Mitigation Pond prior to stocking and had a density of 0.321 +/- 0.064 weevils per stem one year after stocking. Weevil populations in Indian Lake ranged from 0.11 to 1.84 weevils per stem. Weevil populations were higher on Eurasian than on variable-leaf watermilfoil (F=34.32, p<0.0001). Stocked weevil beds did not have significantly more weevils than non-stocked beds. Weevil stocking increased weevil populations in the East Mitigation Pond. However, the impact of weevil stocking in Indian Lake is confounded by many factors. The impacts of weevil stocking on weevil and watermilfoil populations will be discussed.

**Cooperative Weed Management Areas 1: 1:30 pm - 2:45 pm**

**Leveraging Time, Materials and Funding, Partnership Examples from Minnesota Cooperative Weed Management Areas (CWMAs)**

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Since 2008 State funding has facilitated the creation of 21 new Cooperative Weed Management Areas in Minnesota. Funding has been coordinated through a Minnesota Board of Water and Soil Resources (BWSR) State Cost-Share grant program with Soil and Water Conservation Districts acting as fiscal agents. The new CWMAs have exercised flexibility in how they set up partnerships, and conduct education/outreach, early detection, mapping, and invasive species management. New CWMA have collaborated with a large number of partners, leveraging significant amounts of time, materials and funding. These new CWMAs have demonstrated great innovation and created new models for the establishment of strong partnerships and the management of invasive species.

**Cooperative Weed Management Areas**

Luan Johnsrud, Pope Soil and Water Conservation District
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Local, state and federal agencies pooled their resources to form a Cooperative Weed Management Area to reduce the environmental, economic and health threats posed by invasive plants to the grasslands in Pope and Swift counties through education, documentation (mapping), treatment (including cost share), and monitoring. A Cooperative Weed Management Area allows improved effectiveness and efficiency of management activities, manage invasive species across jurisdictional boundaries, pool available resources, apply for grants and prioritize issues.

**Northwoods Cooperative Weed Management Area**

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The Northwoods Cooperative Weed Management Area (NCWMA) is a collective group of state and federal agencies, municipalities, tribes, nonprofits, community organizations, and individuals who have come together to combat invasive species in Wisconsin’s northern four counties along Lake Superior. The NCWMA is an active forum where members share resources, collaborate on projects, coordinate regional efforts, and exchange information. The NCWMA was the first CWMA to form in Wisconsin, and has served as a model for similar groups throughout the state. The focus of the NCWMA has been on aquatic and terrestrial invasive plants. The presentation will provide an overview of NCWMA projects, strategies, funding, challenges, and successes over the past five years.
Emerald Ash Borer Workshop 1: 1:30 pm - 2:45 pm

Regulatory Tactics to Prevent Spread of Emerald Ash Borer (*Agrilus planipennis*)
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Mark Abrahamson and Paul Ahlen, Minnesota Department of Agriculture

Regulatory tactics are an important component in preventing the movement of emerald ash borer (EAB) to new areas. Minnesota has had three counties quarantined for EAB (Ramsey, Hennepin and Houston) since early 2009. The Minnesota Department of Agriculture works in concert with the USDA to maintain the quarantine for intrastate and interstate movement of regulated materials respectively. One of the primary tactics in regulating the quarantine in Minnesota has been educating businesses and private individuals as to how EAB can be moved in a variety of materials. MDA has employed a variety of techniques to undertake this effort from mass media advertising to visits to individual businesses to discuss how the movement of EAB can be prevented. Businesses that with a need to move regulated articles out of a quarantine area work with MDA and/or USDA through compliance agreements. Compliance agreements spell out the terms of movement and any treatment of materials that must occur. Compliance agreements are enforced through routine inspections, which are also performed on entities that are operating without compliance agreements. In 2010, some minor breaches have been documented by MDA and resolved, no serious breaches have been discovered. In addition to preventing the movement of materials out of quarantine, MDA has also worked to educate entities about avoiding the unnecessary movement of EAB within the quarantine in hopes that this will slow movement out of the quarantine as well.

Reducing the Risk of Invasive Species Introduction on Firewood: Regulation and Certification
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For wood infesting invasive pests and diseases, firewood is recognized as the most difficult vector to regulate. The industry is not as organized as are the nursery or timber industries and much is produced and moved by private individuals. This presentation will discuss how Wisconsin state agencies regulating trade (DATCP) and managing public forests (DNR) are working together to reduce the long distance movement of firewood and encourage the development of a safer firewood industry.

- Regulation of firewood entering state parks and forests to that harvested within 25 miles of the property or from certified dealers gives some protection from introduction of wood borne pests but also provides an opportunity for public education and a market for wood certified as treated to kill infesting organisms. The allowable distance for wood was reduced from 50 to 25 miles this spring in response to new models of the risk of introduction of new invasives with increasing distance moved by wood.
- State certification for firewood dealers allows several methods of wood treatment which kill a wide variety of pests and diseases. This could serve as a model for national a national certification program for firewood.
- State regulation of invasive species movement, NR 40, allows regulation of infested material within a quarantine area and the use of wardens in enforcement in addition to DATCP staff.

Minnesota Department of Natural Resources Firewood Program, History, Status and Future Directions
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EAB and its association with the movement of firewood highlighted the need to step up outreach efforts to change public behavior. In response, the MNDNR developed new regulations regarding the use of firewood on MNDNR administered lands. It was felt that even though the MNDNR owned only 15% of the recreational land in MN, the visibility of the state park system would go a long way toward gaining public attention and move not only the public, but other recreational land managers in a direction more conducive to sustainable management. The results have been mixed. In this talk, the MNDNR firewood program will be presented and discussed; what has worked, what has been a challenge and the lessoned learned. The difference between “MNDNR approved” and “MDA certified” vendors will also be explained and discussed.
A National Scale Citizen Science Program for Invasive Species
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The National Institute of Invasive Species Science has developed a national scale invasive species program for citizen scientists linked to a publicly available cyberinfrastructure (www.citsci.org). The products of the program include: (1) A citizen science website that consolidates data on invasive species across regions; (2) Customizable online data entry forms and Personal Digital Assistant (PDA) programs that allow its users to rapidly collect and quickly disseminate invasive species data; (3) An invasive plant monitoring protocol with an accompanying quality assurance/quality control procedure; and (4) Online tutorials that teach citizen scientists how to use these online resources. Evaluation by its initial end users has proved initial success of the program and the tools that have been developed. As the program continues to grow, evaluation will continue to ensure the capability of the system to train citizen scientists to collect and publicly disseminate high quality invasive species data.

Early Detection System for the Great Lakes Early Region
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Mark Renz, University of Wisconsin – Madison
Carmen Chapin, National Park Service, National Institute of Invasive Species Science, Midwest Invasive Plant Network

The National Park Service (NPS), National Institute of Invasive Species Science (NIISS), Midwest Invasive Species Network (MIPN), and University of Wisconsin-Madison are collaborating in the development, implementation, and maintenance of an online database and early detection warning system for invasive species. This database will provide new users with the ability to store and access data online and allow users with existing databases to contribute their data to a larger database by automatically sharing data across the region. We will also create an alert system from this database to inform users when new invasive species are reported. Alerts will be sent to users via email and can be tailored by the user using criteria such as species, area within the region, and/or habitat type. This session will outline the basic form and functions of the planned database and culminate in small group sessions during which participants will contribute their input on what features and functionality such a system should have. Feedback will be collected and used to develop the early detection warning system which will be operational in 2012.

Feedback on an Early Detection System for the Great Lakes Early Region
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Mark Renz, University of Wisconsin – Madison
Carmen Chapin, National Park Service, National Institute of Invasive Species Science, Midwest Invasive Plant Network

The National Park Service (NPS), National Institute of Invasive Species Science (NIISS), Midwest Invasive Species Network (MIPN), and University of Wisconsin-Madison are collaborating in the development, implementation, and maintenance of an online database and early detection warning system for invasive species. This database will provide new users with the ability to store and access data online and allow users with existing databases to contribute their data to a larger database by automatically sharing data across the region. We will also create an alert system from this database to inform users when new invasive species are reported. Alerts will be sent to users via email and can be tailored by the user using criteria such as species, area within the region, and/or habitat type. This session will outline the basic form and functions of the planned database and culminate in small group sessions during which participants will contribute their input on what features and functionality such a system should have. Feedback will be collected and used to develop the early detection warning system which will be operational in 2012.
**Does Woody Biomass Harvest Open Forests to Increased Exotic Plant Invasion?**

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Woody biomass harvest is growing as one potential response to global climate change and energy security, with at least one power plant utilizing this resource already, and more planned. Harvest involves increased mechanical effort, however, and may allow for increased invasion of exotic plants and noxious weeds through its increased disturbance of the soil and litter. Presented here is a multi-year study tracking the impacts of this increased harvest using a Before, After, Control, Impact (BACI) design. Two northern Minnesota forests were divided into three treatments: control (no harvest) clearcut with slash retention, and clearcut with mechanical slash removal (biomass harvest). The plant community was surveyed the year before harvest and one and two years post harvest. Compared to the control treatment and pre-harvest conditions litter depth and litter coverage decreased in both harvested forests, while bare ground increased. This was more significant in the treatments with slash removal. Both harvested forests showed a decrease in native forbs and an increase in exotic and noxious weed plants, with a stronger effect in the slash removal treatments. Plants found to increase in population as a result of woody biomass harvest include white campion (*Silene latifolia*), clover (*Trifolium* spp.), field bindweed (*Convolvulus arvensis*), hemp nettle (*Galeopsis tetrahit*), hawksbeard (*Crepis* spp.), and thistle (*Cirsium* spp.).

**Exposure of the Upper Midwest to Invasive Terrestrial Plants from Mandated Cellulosic Biofuel Crop Production**

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Conventional crops domesticated for foods and fibers are highly dependent on agronomic inputs (e.g., fertilizer, water) and therefore generally have a low risk of invasion. Demand for new bioenergy feedstock species for the production of biofuels, biopower, and bioproducts is being fueled primarily by renewable energy mandates. The desirable traits of bioenergy feedstock species overlap with those of invasive terrestrial plant species. This has prompted qualitative risk assessments of the most likely bioenergy feedstock species and lead to development of a watch list of species by the Global Invasive Species Program. However, investigations into their economic potential have been largely speculative. Quantitative risk assessments that account for competitiveness of invasive terrestrial plants in and beyond the emerging bioenergy sector can significantly aid current understanding of the risk of exposure. These assessments can determine the magnitude and location of the exposure risk based on the relative profitability of bioenergy feedstock species. This paper 1) assesses establishment risk of bioenergy crops in the environment by examining climate suitability and invasion history 2) develops a crop choice model to aid in estimating the risk of exposure of the Upper Midwest to invasive terrestrial plants from the production of bioenergy 3) outlines the state and federal invasive species and plant pest/weed regulations which may mitigate risk through enforcement.

**Buckthorn to Bioenergy: How Minnesota is Linking Habitat Restoration to Bioenergy and Local Economies**

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Linking Habitat Restoration to Bioenergy and Local Economies is an innovative project providing grants to help landowners restore high quality native plant communities by removing ecologically inappropriate woody vegetation (exotic and/or native species) while stimulating local economies through utilization of the biomass material for bioenergy or other products. Thirteen state funded projects have been completed resulting in nearly 10,400 tons of woody biomass material removed from 157 acres of oak savanna, 61 acres of oak woodland and 55 acres of prairie now under restoration. Non-native, invasive species such as buckthorn (*Rhamnus cathartica*), honeysuckle (*Lonicera sp.*), Amur maple (*Acer ginnala*), Siberian elm (*Ulmus pumila*), black locust (*Robinia pseudoacacia*), and others, as well as native invasive species such as Eastern red cedar (*Juniperus virginiana*) comprised a good portion of the material utilized by District Energy St. Paul in its cogeneration facility. The long-term vision is to support emerging woody biomass
markets state-wide through an ecologically sound approach to achieving long-term ecological restoration goals while utilizing woody invasive species.

Aquatic Invasive Species Regulations and Enforcement: 3:15 pm - 4:30 pm

New “No Transport” Law in Wisconsin
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Transient boaters represent the greatest advantage aquatic invasive species have in moving between waterways. After years of educating boaters of the need to keep boats clean to protect against aquatic invasive species, Wisconsin now has a new law which makes it illegal to transport aquatic invasive species. Plants, animals and water are addressed in the law. Any law enforcement personnel in the state may stop an individual that is seen violating the law and issue a citation which can exceed $2,000. Aquatic invasive species are classified, as either prohibited, or restricted. Control objectives are established based upon the classification.

Law Enforcement Techniques for Aquatic Invasive Species
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Phil Meier*, Minnesota Department of Natural Resources, phil.meier@state.mn.us

Law enforcement is a tool that is used to slow the spread, prevent new introductions, and educate the public on aquatic invasive species. Minnesota DNR has formed a unit devoted to creating new enforcement techniques and to increase enforcement efforts in relation to aquatic invasive species issues. This talk will be presented by Water Resource Enforcement Officers.

Invasive Species Prevention through Minnesota’s Prohibited Invasive Species and Infested Waters Permits
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Minnesota has several regulations intended to help prevent the spread of aquatic invasive species and some invasive wild animals. These regulations require permits to import, possess, transport, buy, sell, and propagate prohibited invasive species. There are also permits required to transport or divert water from designated infested waters. This paper will cover the following questions. What are the regulations related to prohibited invasive species and infested waters? What types of situations are permitted? What is the process to obtain permits? And what are the exemptions for permits? Examples of permit situations and actual permitted activities will also be presented.
Management of Invasive Submersed Plants: Funding and Economics: 3:15 pm - 4:30 pm

Tried-and-True Versus Experimental Methods for Eurasian Watermilfoil Control: An Economic Analysis
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Eurasian watermilfoil (Myriophyllum spicatum), an invasive aquatic plant, is known to be present in over 200 water bodies in Minnesota and over 400 in Wisconsin. Mechanical and localized chemical treatments are effective in making lakes suitable for recreational boating and swimming, but only temporarily because root systems remain intact. These methods are costly as one-time treatments, and the need for repetition makes them even more costly in present value terms. Experimental treatments such as biocontrol using milfoil weevils (Euhrychiopsis lecontei) have the potential to permanently suppress Eurasian watermilfoil populations yet, because of the experimental nature of these treatments, effectiveness is not guaranteed. The cost and success potential of experimental techniques affect the wisdom of trying to achieve control via these methods. We examine the economic trade-offs between proven temporary methods of Eurasian watermilfoil control and experimental methods. Key factors that affect management decisions include the benefits of milfoil removal, the time horizon, the rate of time preference, and the probability that an experimental method will succeed.

Aquatic Invasive Species Control Funding in Wisconsin
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The State of Wisconsin is fortunate to have substantial and diverse financial resources for the prevention and control of aquatic invasive species (AIS). This presentation will describe these resources, how they came about, and how they are used to fund a still evolving comprehensive AIS management effort that includes: Education, Planning and Prevention, Early Detection and Control, Established Population Control, Containment and Maintenance, Research and Demonstration and Technical Assistance.

Minnesota DNR Grants for Control and Prevention of Aquatic Invasive Species
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Since the early 1990’s the Minnesota Department of Natural Resources has worked cooperatively with lake associations, park districts, counties, cities and other groups to help prevent the spread of aquatic invasive species and to control infestations of invasives where they occur. In 2010 approximately $100,000 was made available for three types of grants aimed at preventing the spread of aquatic invasive species. These grants were for posting of DNR signs at water accesses, for watercraft inspections, and for public awareness projects. The MN DNR also made approximately $550,000 available for the control of invasive aquatic plants through three grant programs. These grants were for lake-wide control of curly-leaf pondweed (Potamogeton crispus) or Eurasian watermilfoil (Myriophyllum spicatum) for ecological benefits, for control of Eurasian watermilfoil or flowering rush (Butomus umbellatus) on a partial-lake basis to reduce interference with recreation, and for Early Detection and Rapid Response for Eurasian watermilfoil or Flowering rush. This presentation will describe these grant programs and will discuss funding opportunities for 2011.
Cooperative Weed Management Areas 2: 3:15 pm - 4:30 pm

Development and Activities of the Hawkeye Cooperative Weed Management Area in East Central Iowa
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Managing the increasing problem of invasive species can be a formidable task. Federal, State, County, City, and local partners in East Central Iowa are now working together as the Hawkeye CWMA to manage some of these problems, focusing on funding, on the ground control efforts, and public education.

The Indiana Coastal Cooperative Weed Management Area
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The Indiana Coastal Cooperative Weed Management Area (ICCWMA) is comprised of the Lake Michigan Coastal Zone of highly industrialized northwest Indiana. The southern shore of Lake Michigan boasts natural areas which contain the highest biodiversity in the entire state of Indiana. The ICCWMA was formally organized in 2009 because the local natural areas managers realized there was a need to engage adjacent land owners in invasive plant control. Involving these non-traditional partners -- such as right-of-way managers, and land managers of industrial sites -- would be crucial to the successful restoration and management of natural areas in the region. This presentation will convey the unique challenges and opportunities for a CWMA working in a complex landscape, with a diversity of land uses, and land owners. It will also discuss the ICCWMA's formation process, and rationale behind the CWMA's prioritization of high biodiversity natural areas. The presentation will also explain why the ICCWMA chose a small geographic area (the northern half of three counties), while many other CWMAs in Indiana seem to be much larger. Finally, the presentation will talk about the ways in which the ICCWMA intends to use the Great Lakes Restoration Initiative funding that it will soon be receiving.

Aquatic Invasive Species: State, County and Town Coordination in Wisconsin's Northwoods
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Vilas County's economic foundation is rooted in its abundant tourism businesses surrounding its 1,320 lakes. The perceived threat of aquatic invasive species (AIS) ruining lakes, reducing tourism and causing declines in waterfront property valuation prompted the Vilas County Board of Supervisors to take proactive action in 2004. The board authorized the Land and Water Conservation Department to work with the Wisconsin Department of Natural Resources to obtain grant funding which enabled the hiring of an AIS Coordinator to assist with county-wide AIS strategic planning and to provide a link between State AIS programs and local lake residents. Learn how the project has unfolded and how Town Lakes Committees have become the backbone of the county's AIS public awareness, prevention, early detection and management programs and how additional WDNR grant funding has benefitted the Vilas County AIS initiative and has created more AIS County Coordinator positions in other Wisconsin counties.
Emerald Ash Borer Workshop 2: 3:15 pm - 4:30 pm

Wisconsin’s EAB Response Plan – Past, Present and Future
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The State of Wisconsin Cooperative Emerald Ash Borer Program developed and approved an official EAB Response Plan in July 2008. The plan was put to the test with the subsequent detection of EAB in the state that same year. Since that time agency staff have worked to refine and improve the plan to best utilize currently available resources as well as taking into consideration future needs of the Cooperative Program.

County-level Forecast of Emerald Ash Borer Presence/Absence in Minnesota and Wisconsin
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Susan J. Crocker and Greg C. Liknes, USDA Forest Service

With the recent introduction of the emerald ash borer (*Agrilus planipennis* Fairmaire, EAB) to Minnesota and Wisconsin, there are many decisions to be made regarding preparedness and resource allocation. It is difficult to know how and where EAB will spread, so information that can be used to predict its presence is useful for mitigation efforts. In this study, we utilize a county-level forecast model to predict the presence or absence of EAB in Minnesota and Wisconsin. The model uses the RandomForests classification algorithm, 19 different county-level metrics describing landscape pattern, forest inventory data, and EAB quarantine information through 2009 for a four-state area: Illinois, Indiana, Ohio, and Kentucky. The model was developed for a highly varied landscape, ranging from sparsely to heavily forested and low to high population densities, similar to that found in Minnesota and Wisconsin. We present a map depicting the county-level predicted presence/absence of EAB as well as information about which metrics were the most critical to model accuracy.

Emerald Ash Borer Community Preparedness in Minnesota
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Rebecca Koetter, University of Minnesota

Emerald ash borer (EAB) (*Agrilus planipennis*) is a devastating wood-boring tree pest that has already killed millions of trees in the United States. In May 2009, EAB was found in Minnesota. In an effort to help Minnesota communities prepare for the impacts EAB will cause to their green infrastructure, the Minnesota Department of Agriculture, Minnesota Department of Natural Resources and the University of Minnesota-Department of Forest Resources worked jointly to provide training and assistance to communities regarding EAB. The training included workshops throughout Minnesota providing the framework communities need in order to write an EAB Community Preparedness Plan. An EAB Community Preparedness Manual was compiled; the manual contains a template preparedness plan and numerous resources from throughout the country on topics related to EAB preparedness. This presentation will provide an overview of why and how a community can prepare for the EAB. Potential funding opportunities available to communities for preparedness and response will also be addressed.
Formation of the Southeastern Wisconsin Invasive Species Consortium
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Jill Hapner, Washington County, Wisconsin: Planning & Parks Department

Southeastern Wisconsin is the primary gateway for invasive species into our state due to the high population density, rate of urbanization, roadway travel from Illinois, and maritime traffic into the Port of Milwaukee. The landscape in our region ganges from densely populated urban to rural agricultural with fragmented forests, wetlands, and prairie remnants. An estimated 5 new invasive plant and animal species may be entering the region each year. Small-scale efforts to control invasives in southeastern Wisconsin have been employed for decades, and in June 2007 a Cooperative Weed Management Area (CWMA) was formed to integrate resources for management of invasives across jurisdictional boundaries to benefit the entire region. Functioning as a CWMA< the Southeastern Wisconsin Invasive Specie Consortium, Inc. (SEWISC) is a broad-based coalition that promotes efficient and effective management of invasive species throughout an 8-county region (Sheboygan, Washington, Ozaukee, Waukesha, Milwaukee, Walworth, Racine, and Kenosha). SEWISC provides the opportunity for partners to share and leverage limited resources, raise awareness about invasive species problems, and provide a mechanism for collaborative problem-solving on both public and private lands. To-date more that 200 individuals representing private, government, and corporate interests have partnered through SEWISC, striving to accomplish our mission to educate the public and protect the biodiversity and ecological function of southeastern Wisconsin. SEWISC was incorporated in June 2010, as a non-profit organization under section 501(c)(3) or the Internal Revenue Code.

Effects of Planting Method and Seed Mix Diversity on Tallgrass Prairie Restoration Success
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Nick Palaia, Litchfield Wetland Management District
Doug Wells, Fergus Falls Wetland Management District
Jennifer Larson, University of Minnesota

The goal of this study is to determine if planting method (dormant broadcast, summer broadcast, or summer drill) and seed mix diversity (10, 20, or 34 species) can be optimized to both encourage establishment of native tallgrass prairie species and discourage invasion by nonnative species. Seeding occurred in 2005 and here we summarize results as of the 2007 field season. The dormant broadcast method has consistently produced the greatest perennial forb cover of the three planting methods, but forb cover has not varied with diversity of the seed mix. By 2007, warm-season grasses planted with the summer drill method seemed to have a slight edge over the dormant broadcast, but, as with forbs, diversity of the seed mix had no influence on cover. The summer broadcast had the lowest cover of warm-season grasses. In contrast, cover of cool-season grasses was greatest in plots planted with the high diversity seed mix, but was unaffected by planting method. To discourage invasion, we would like to favor the guild that has the largest negative effect on non-planted cover. We used a structural equation model to partition effects of each guild (warm-season grasses, cool-season grasses and perennial forbs) and seeding method on non-planted cover. In 2007, cool-season grasses had the greatest negative effects on non-planted cover across all three planting methods; warm-season grasses had a smaller and less consistent effect. These results suggest that in the early years of a new restoration, good cover of cool-season grasses may help prevent invasion by undesirable plants.
Restoring Invasive Plant Species Dominated Areas By Means of Assisted Succession
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A thesis project at Camp Ripley Army National Guard Training Site will address the effectiveness of using assisted succession as a means of restoring areas dominated by perennial invasive species: Common tansy (*Tanacetum vulgare*) and spotted knapweed, (*Centaurea maculosa*). Restoring these areas into a native plant community is necessary for this federally maintained study site to be in compliance with Executive Order 13112. This restoration will take place in spring 2010 through fall 2012 and will incorporate site manipulation of four seedbed preparations, two cover crop types, and two seed dispersal methods for each of these invasive species. I hypothesize that by introducing a competitive cover crop immediately upon intentional disturbance of these invaded areas, followed by the seeding of native grasses, an increase in the establishment of native grasses will occur. I hypothesize that drill seeding will be the most effective means of establishing these native grasses in the seedbed. I also hypothesize that the most successful establishment of native grasses will occur on sites that are mowed/burned and then sprayed with an herbicide. If successful, these methods may be applied on a larger scale in other restoration endeavors.

Bird City Wisconsin Addresses Invasives
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Carl Schwartz, Bird City Wisconsin

*Bird City Wisconsin*, a new coalition of citizens, public officials, and organizations, led by the Milwaukee Audubon Society, the Wisconsin Bird Conservation Initiative, and the Wisconsin Society for Ornithology, wants to ensure that folks living in Wisconsin’s communities maintain healthy populations of birds and appreciate them. We have developed a new community recognition program modeled on the successful nationwide program, Tree City USA. Wisconsin communities, whether they are towns, villages, cities, or counties, which come together to help protect birds using a variety of conservation activities, will be designated as a *Bird City Wisconsin* recipient. The program offers public recognition to communities that create/protect bird habitat, foster conservation education, and take steps to protect birds from a range of perils. While this program may seem to be outside the realm of invasive species, in fact, there is a strong component that addresses the problems posed by invasive species. A community must show they meet at least 7 of 22 criteria in order to receive recognition. Included in these criteria are: not restricting “wild” or natural lawns and landscaping, offering the public information on control and removal of invasive plant species, providing easy-to-obtain information to property owners on methods to create and enhance backyard habitat using native species, and participating in programs promoting effective community forest management. See website: http://www.birdcitywisconsin.org for details.

Management of Woody Invasives: 8:30 am -10:10 am

Forestry Mowing: An Economical Solution for Woody Invasive Species Management in Hardwood Forests
Clay Frazer, EC3 Environmental Consulting Group, Inc.
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Invasive species such as Buckthorns, Honeysuckles, and Black Locust reduce the ecologic and economic value of native timber stands in numerous ways. Invasive understory growth prevents native tree seedling regeneration and shades out native herbaceous vegetation, leading to a decline in forest health and forest species diversity. Forestry mowing has proven to be an efficient and economic method on some forest sites to mechanically remove invasive species of multiple age classes. Successful woodland restoration depends heavily on the implementation of well-timed and well-executed herbicide regimes following forestry mowing. Without high herbicide efficacy, mechanical removal of woody invasives will rapidly lead to a net increase of invasive species density and biomass. One great benefit to forestry mowing is that slash is light and highly manageable. Even partially cured slash adds fuel structure for subsequent prescribed burns. With the invasive understory removed from a larger area, hardwood leaf litter is allowed to accumulate for one to two seasons. Prescribed fire is re-introduced in the woodlot to ensure depletion of woody invasive seed
bank and to encourage native herbaceous seedling regeneration. EC3 has developed a method of foliar herbicide application via boomless sprayers mounted in modified UTV’s. Though multiple herbicide applications may be necessary for complete eradication, foliar based applications are more economical on larger scale (more than five acres) than “cut-stump” treatments due to lower percentage solutions and lower labor inputs, also leading to less negative soil impacts such as soil compaction and herbicide persistence.

New Control Method for Buckthorn and Other Invasive Tree Species
John K. Lampe, Private Landowner
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This presentation describes a new method for controlling buckthorn (Rhamnus) called the “tall stump treatment method.” The method is especially suitable for private landowners and can easily be undertaken by one person. Buckthorn is an invasive species that has invaded woodlands throughout much of North America including Minnesota and Wisconsin. It grows fast and birds readily spread its seeds after eating the berries. It thrives in forest understories crowding out desirable native plants. The tall stump method as described here involves these steps: First, use a hand saw or lopper to cut the trunk of the tree to waist or shoulder height, making sure to cut off virtually all branches with leaves or buds. Second, haul the cut tops and branches to a pile for burning or chipping. The tall stumps can then be left alone for as long as eight months. Third, use the cut-and-frill method to treat the stump at its base. Winter is an ideal time for treatment. An herbicide such as glyphosate (20% to 30% concentration) can be used. The tall stump method has a number of advantages. First, the control process can be broken into two distinct phases: cutting and treating. This means fewer tools to carry and keep track of during each phase, making it easier for one person to manage. Second, many months can separate the cutting from treating. With the traditional cut-stump method, stump faces need to be treated within minutes of the cutting. This results in inefficiencies because one must constantly switch tools. Especially in deep snow, this can be very difficult. Third, it is easy to spot the tall stumps for treatment. Short stumps, on the other hand, can easily be lost in leaves or snow. Fourth, the tall stump method can expose more inner bark for treatment than the traditional cut stump treatment method. This increases the chances of a successful treatment. Fifth, if treatment is not effective with the tall stump method, the branches will re-grow just below the cut but well above ground level. A person can generally make another set of frills just below this re-growth and still easily kill the tree. On the other hand, if one fails to kill a tree whose stump is cut at ground level, the stump will have many sprouts forming a bush, and each branch will have to be cut and treated.

DIE Buckthorn Scum!!
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Jon Alness*, Zumbro Valley Forestry, jonalnesszf@msn.com

Buckthorn sucks. We will discuss some of our efforts to control it. We don’t have the solution but the presentation will include a discussion of successes and failures, costs, and interaction with the audience to see what their experiences have been.

Post-Buckthorn Removal: What Have We Learned?
Jyneen Thatcher, Washington Conservation District
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The Washington Conservation District (WCD) provides technical assistance to landowners regarding weed management as part of our suite of services offered to local residents. While we don’t serve as the weed inspector, we address weed management through information and implementation of targeted grant funds. The WCD has developed innovative ways of coaching management efforts through education programs and coordinating control efforts. *Rhamnus cathartica* (common buckthorn) and *Frangula alnus* (aka *Rhamnus frangula*, glossy buckthorn) are significant problems in our county, and through our outreach efforts and a “buckthorn survey”; we have accumulated information on real-life results of control efforts. In addition to a summary of our outreach efforts on “weeds,” this presentation will describe the feedback we have received from landowners on their buckthorn battle: what has gone right with their management efforts; what benefits have they seen; what would they do differently; what advice would they give others.
Citizen and Business Involvement: 8:30 am - 10:10 am

Minnesota Waters’ Aquatic Invasive Species Position and Recommendations – Quelling the Aquademic
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Minnesota Waters developed and adopted a position statement (April 2009) that called the epidemic of aquatic invasive species (AIS) and Aquademic. Minnesota Waters’ position is that a) AIS have ecological, economic, recreational, commerce and human health impacts, b) AIS are increasing exponentially, c) there are significant barriers to addressing AIS-related impacts, but d) it is not too late. Minnesota Waters recommends: 1) Minnesota adopts a management system focusing on prevention, 2) 80% of AIS resources be devoted to prevention, 3) the system recognizes regional differences, 4) prevention funding should double, 5) grant funding should increase significantly, 6) invasive plant control should require lake vegetation management plants and 7) a dialog must be started to consider level 3 (including new fees, increased penalties, increased enforcement and perhaps quarantines). A status update will be provided.

Prevent the Spread: Aquatic Invasive Species Training for Lake Service Providers
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Courtney Kowalczak, Minnesota Waters

Lake Service professionals, such as watercraft rental companies, dock and boat lift installers, fishing outfitters or guides, and lakeshore professionals, routinely travel between AIS infested and un-infested waters as a part of their daily operations. Yet they are an under represented group in AIS prevention efforts. In response to the ever-increasing presence of aquatic invasive species in Crow Wing County, the Brainerd Lakes Aquatic Invasive Species Task Force worked with the Minnesota Department of Natural Resources (MN DNR), Minnesota Waters, and lake associations to host Lake Service Provider AIS seminars. Seminar participants were given an overview of the AIS problem in the region, an up-to-date report of infested lakes, current state regulations that apply to their profession, steps to prevent the spread, how to identify AIS, and steps to report AIS sightings. In light of the push for legislation that would require lake service providers to attend AIS trainings, this presentation will highlight the problems and successes of these trainings that were held from 2008 – 2010, along with suggestions to improve future Lake Service Provider trainings and outreach. We will also discuss the collaboration of Minnesota Waters and MN DNR to streamline the Lake Service Provider trainings for statewide distribution.

Citizen Engagement in Aquatic Invasive Species Prevention
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Jay Rendall, Minnesota Department of Natural Resources

The Minnesota Department of Natural Resources (DNR) and Minnesota Waters partnered to hold a series of five stakeholder meetings and public open houses across the state to inform citizens of current DNR prevention efforts, to gain citizen input and share new ideas on improving prevention, and to develop new partnerships focused on local and state action. Over 200 citizen leaders, local government officials or staff, and community business representatives participated in the meetings and open houses. The citizens of Minnesota take the threat of aquatic invasive species seriously and feel that not enough is being done to effectively prevent the spread of aquatic invasive species. In particular, those who attended the meetings are most concerned with the spread of zebra mussels, Eurasian watermilfoil, and Asian carp, among others. Stakeholders stated that State agencies need to take bold action or aquatic invasive species will continue to spread in the state. Many also stated that not enough resources are available to meet the invasive species prevention needs. Much discussion during the stakeholder meetings was around potential actions that could be implemented to help prevent the spread of aquatic invasive species. Additional stakeholder meetings are planned to work through the potential actions in detail and determine what support and resources are needed to put them in to practice.
Empowering Citizens to Address the Sale and Use of Invasive Species
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Invasive plants and animals, both aquatic and terrestrial, continue to be sold throughout the Midwest. Both traditional and non-traditional sales outlets have been found selling species that are legally prohibited and restricted in Wisconsin as recently as the summer of 2010. Continued education will be the key to preventing the spread of more invasive species. This education must be more than simply handing the business operator a list of invasive species and making a request. It can be significantly more complicated than that. This presentation will address some of the difficulties the business owners have in complying with regulations regarding invasive species. It will also address how to approach the issue of sales of invasive plants and animals in a manner that encourages voluntary compliance with any state's regulations.

Management and Ecology of Eurasian Watermilfoil: 8:30 am - 10:10 am

Shoreline Habitat Requirements of the Native Milfoil Weevil, Euhrychiopsis lecontei, in Portage County, Wisconsin
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Michael A. Bozek, U.S.G.S. Wisconsin Cooperative Fisheries Unit, University of Wisconsin-Stevens Point
Nancy B. Turyk, Center for Watershed Science and Education, University of Wisconsin--Stevens Point

Eurasian watermilfoil (Myriophyllum spicatum, L.) (EWM) is a non-native, aggressively invasive aquatic plant that can easily be spread across lakes by anthropogenic activities. Management of EWM has traditionally relied heavily on chemicals, which offer quick, but often temporary relief. Research shows that the native milfoil weevil, Euhrychiopsis lecontei (Dietz), can be an effective biological control agent for EWM, but more research concerning factors that limit milfoil weevil populations is needed to develop protocols and understand the potential for success in a specific lake. To better define habitat requirements for overwintering success of the milfoil weevil, univariate and multivariate statistical methods were used to assess weevil hibernation habitat on the shorelines of two lakes in Portage County, Wisconsin. Thomas Lake is a 13-ha glacial seepage lake, and Springville Pond is a 7-ha impoundment of the Little Plover River and McDeill Pong is a 109-ha impoundment of the Plover River. Depth of duff material was found to be positively correlated with weevil presence and quantity on Springville Pond, and percent cover of leaves was found to be positively correlated with weevil presence and quantity on Thomas Lake; both of which suggest that management activities that remove duff material, such as mowing and raking, would degrade weevil habitat. Analyses from both Thomas and Springville found distance from shore to be negatively correlated with weevil presence and weevil quantity, suggesting that weevils occur more often in near shore habitats. Discriminant (canonical) function on Thomas Lake also identified height above water as a significant variable with positive correlation with weevil presence, suggesting that weevils occur more often at higher (and thereby drier) sites. The combined results suggest that higher sites nearer to shore, with more duff material, correlate positively with weevil presence.

Contrasting Effects of Early-Season Harvesting and Chemical Treatment in Lake Monona
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Jennifer Hauxwell, Michelle Nault, and Scott van Egeren, Wisconsin Department of Natural Resources

Eurasian watermilfoil (Myriophyllum spicatum, EWM) is a conspicuous member of the Lake Monona (Madison, WI) macrophyte community that often forms nuisance-level monocultures which interfere with recreation and may affect biodiversity. For the past four years, we have studied the effects of early-season mechanical harvesting as well as early-season herbicide treatment with granular 2,4-D on both EWM and non-target native macrophyte species. We will present results that contrast these management options relative to untreated controls. The results of this study present an opportunity to compare the relative costs and benefits of several EWM management alternatives.
Water Level Fluctuation as a Tool for Eurasian Watermilfoil (*Myriophyllum spicatum*) Control and Lake Restoration
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Fluctuation of water levels on lakes and rivers is a natural event to which thousands of aquatic organisms have evolved around. Low periods of water levels can transform aquatic plant communities and restore beneficial plants. Aquatic organisms depend on these fluctuations to repopulate, reclaim, and essentially restore lake ecosystems. Thus, fluctuating water levels is a viable tool to lake restoration on impoundments where the aquatic plant community has been altered by artificially high water levels. Water level fluctuations and also has shown to be an effective tool to manage Eurasian Watermilfoil. Using drawdown techniques in combination with low dosage herbicide treatments, (0.5-1.0 mg/l 2,4-D), has shown considerable promise to control Eurasian Watermilfoil and restore high value native plants on McDill Pond, Marion Millpond, Montello Lake and Lake Alpine in Central Wisconsin. These lakes all showed significant decline in Eurasian Watermilfoil frequency (100%, 92%, 93%, 87% respectively) and an increase in Floristic Quality Index when calculated the first year following the drawdown and herbicide treatment. However, long-term controls are not well defined and are currently being evaluated to determine efficacy over time.

Eurasian Watermilfoil Impacts to Native Plants in Christmas Lake
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Eurasian watermilfoil (*Myriophyllum spicatum*) was confirmed in Christmas Lake (Hennepin County, MN) in 1992, but had not become prevalent until about 2000. Aquatic plant inventories were conducted in 2001, 2003, 2006 and 2007 using the line-intercept method (2001) and the point-intercept method in other years. Eurasian watermilfoil increased from 23% frequency to 60% frequency over that time span and native plant richness decreased correspondingly \((r = 0.94)\). No comprehensive plant controls had been implemented prior to or during this time interval. The conclusion – that Eurasian watermilfoil, left unchecked, is highly correlated with serious ecological and habitat impacts.

Common Carp Management: 8:30 am - 10:10 am

Population Estimates of Common Carp Demonstrate that Nursery Habitat May Be Limiting
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Recent research has indicated that recruitment of common carp (*Cyprinus carpio*) in Midwestern lakes is driven by recruitment events in shallow basins prone to winterkill (Bajer & Sorensen 2010). However, the abundance of year-0 carp has yet to be determined in any North American lake. We used trap-nets and minnow traps to conduct a mark-recapture study in three lakes in the Phalen Chain of Lakes in St. Paul, MN to determine these values. Preliminary data suggest that the number of age-0 carp varies greatly and that large lakes, which do not winterkill typically have none. We estimated 12,000 in a 6 ha pond (Markham) that winterkills and 2114 in another (Casey); no young carp were caught in the main lake (Keller), which does not winterkill. Age-0 carp in Casey and Markham had equivalent condition factors, suggesting that food availability does not explain variation in their abundance. Notably, Lake Keller catches were dominated by bluegill sunfish (*Lepomis macrochirus*), which eat carp eggs, while no bluegill were found in the two nursery lakes. Instead, these nurseries had large numbers of other fishes, with carp dominating (69% of fish caught) in Markham Pond. Ongoing research is refining these measures and examining other techniques eDNA to determine if they might provide easier measures of fish abundance as trap nets are laborious. Once perfected these techniques should permit control of carp using IPM schemes. (Funded by the Minnesota Environment and Natural Resources Trust Fund).
Hormone Implants Induce Potent Pheromonal Attractant Release from Common Carp (Cyprinus carpio)
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The common carp (Cyprinus carpio) is one of the most damaging invasive fish species in North American lakes, wetlands and shallow rivers. To date, carp control has focused on rotenone poisoning but it is expensive and kills all fish. Pheromones that mediate behavioral interactions between conspecifics, show promise for use in targeted removal of the carp. Recent lab studies have shown that ovulated female carp release a mixture of F prostaglandins and unknown bodily metabolites which attract males at picomolar concentrations. Because we do not know the identity of the bodily metabolites we have devised a way of continuously inducing high levels of sex pheromone release by implanting carp with F prostaglandin. Laboratory tests show they release extremely high levels of the entire pheromone for up to two weeks. Field tests show that they can attract males from a distance of 50m. Future studies are planned in Australia. We hope that this technique can serve as tool in integrated control strategies to remove small numbers of adults from lakes after netting or treatment with rotenone. (Funded by the Invasive Animals Cooperative Research Centre, Australia).

Egg Predation by Native Sunfish Control Recruitment of Invasive Common Carp
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The common carp (Cyprinus carpio) was introduced to North America a century ago and now dominates many shallow lakes where it wrecks great ecological damage. Control methods currently rely on poisoning and draw-downs, and are damaging and difficult to sustain. Recent studies (Bajer & Sorensen 2010) suggest that carp recruitment (survival of young) is sporadic and may be triggered by winter hypoxia that kills native fishes which otherwise might eat young carp. This study examined the fate of carp eggs in lakes that experienced hypoxia and normoxic lakes that did not. Carp spawning activity was monitored daily in the spring of 2009, and spawning areas were sampled using electro-fishing to ascertain if carp eggs were being consumed. While carp eggs disappeared within three days in the normoxic lake (which had many native fishes), they survived five days in a hypoxic lake. Sampling demonstrated that bluegill sunfish (Lepomis macrochirus) were the primary consumers of carp eggs in the normoxic lake (94% of 49 fish found feeding on eggs were sunfish). Autumnal sampling found young carp in the hypoxic lake but none in the normoxic lake. This pattern of recruitment was observed again in the summer of 2010, and laboratory studies have since shown that bluegill sunfish actively consume both carp eggs and larvae. We conclude that if populations of bluegill sunfish can be maintained in lakes, they might control carp. (Ramsey Washington Metro Watershed District and Minnesota Environment and Natural Resources Trust Fund).

Integrated Pest Management of the Common Carp
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The common carp (Cyprinus carpio) is one of the most abundant and destructive invasive fish in both North America and Australia where it has severely damaged shallow water ecosystems. Control presently focuses on nonspecific poisons and water-drawdowns and has not had sustainable success. Recently, we discovered that carp population abundance in the Midwest has little density dependence because recruitment is driven by seasonal environmental fluctuations that control native fish predation on young carp (Bajer & Sorensen 2010). This insight has permitted us to initiate an experimental integrated pest management (IPM) scheme which focuses on targeted adult removal using radiotagged Judas fish and pheromones while suppressing recruitment by limiting access to unstable nurseries and balancing native fish populations. A statistical model describes and guides this process. Using this targeted approach we have been able to suppress carp populations to about 10% of their initial levels in three local lakes for several years. During this time improvements in water quality have been noted. We believe that the lessons we have learned with common carp will be applicable to other invasive fishes (Funded by The Minnesota Environment and Natural Resources Trust Fund, Riley Purgatory Bluff Creek Watershed District, Ramsey-Washington Metro Watershed District).
Emerald Ash Borer Workshop 3: 8:30 am - 10:10 am

Cold Hardiness of Emerald Ash Borer and Its Implications for the Upper Midwest
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Emerald ash borer (EAB) was first detected in Wisconsin in 2008 and in Minnesota in 2009. The potential movement of this insect across both states is a serious concern. Portions of Minnesota and Wisconsin frequently have low winter temperatures that are colder than areas where EAB has been a serious problem. The purpose of this study was to measure the cold hardiness of emerald ash borer larvae, the overwintering stage of the insect. Supercooling point, the temperatures at which an insect freezes, is a widely used indicator of cold hardiness. Winter-ready larvae from infested trees in St. Paul, MN had an average supercooling point of -25°C (-13°F). Laboratory assessments of cold hardiness were confirmed during field tests. Naturally infested logs were held outdoors in St. Paul, MN (low winter air temp=-28°C) and near Grand Rapids, MN (-34°C) for ca. 5.5 weeks. Approximately 40% of larvae from logs in St. Paul were inactive or brown, both evidence of death; approximately 90% of larvae from logs near Grand Rapids were inactive or brown, compared with the approximately 10% that showed evidence of death prior to exposure or after being held under cool, non-lethal conditions. Overwintering mortality may help to minimize the damage caused by emerald ash borer in areas with extremely cold winter climates.

The Influence of Satellite Populations on Emerald Ash Borer (Agrilus planipennis Fairmaire) Damage in U.S. Communities, 2010-2020
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As of January 2010, satellite infestations of the emerald ash borer have been detected in thirteen states and two Canadian provinces. We simulate the effect of satellite populations that formed by human transport from 2005-2010 on projected emerald ash borer (EAB) damage over the next decade (2010 to 2020). Damage is measured by the projected discounted cost of treatment, removal, and replacement of native ash trees (Fraxinus sp.) growing within U.S. communities. The reduced damages from scenarios of fewer satellites range from one to seven billion US$. The most damaging satellites are far from the core infestation and close to large cities highlighting the need for policies to reduce long-distance human transport of EAB and improve the detection of EAB near cities. Scenarios also include the effectiveness of tactics to slow the spread of ash mortality (SLAM) applied to satellites detected during 2009. SLAM tactics that are one hundred percent effective reduce damages by roughly one billion US$, and SLAM tactics must be at least fifty percent effective to reduce damages more than 250 million US$.

Identification and Removal of Emerald Ash Borer (Agrilus planipennis) Infested Trees
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One of the main components of emerald ash borer (EAB) suppression is identifying, removing and processing infested trees before adults emerge and infest new trees. However, few details are available on how to identify which trees are about to produce adult beetles so that they can be prioritized for removal. We worked in two EAB infested areas (St Paul and Minneapolis) to visually assess trees and rate them using woodpecker feeding as a primary indicator of their likelihood to produce adult beetles. As trees were removed we sampled them to estimate EAB abundance and condition in those trees. In addition to evaluating our ability to identify trees likely to produce beetles, we also estimated the impact the removals had on EAB population growth in each area. We found that within an EAB-infested area, it may be possible to identify which trees will produce the most adult EAB in a given summer by inspecting them for woodpecker feeding during the preceding winter / spring. However, characteristics of the area such as tree size...
and density may influence the degree to which this procedure is successful. Trees with smaller EAB larvae will not be identified by this process until the larvae become large enough for woodpeckers to prey on them. The impact of tree removal on EAB population size is dependent on accurate identification of trees with beetles near emergence – i.e., a higher degree of accuracy in identifying and removing trees will result in a larger impact on EAB population size.

SLAM – A Strategy to SLow A.sh M.ortality in Emerald Ash Borer Outlier Sites
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SLAM is an integrated strategy designed to suppress EAB population growth and delay the onset and progression of widespread ash mortality in isolated EAB outlier sites. Basically, SLAM projects are intended to be implemented in newer EAB sites where the goal is to buy time for land managers to take proactive steps in dealing with the impending loss of the ash resource. SLAM projects attempt to integrate EAB survey efforts, ash surveys for tree distribution and amount of ash phloem, population suppression tools and tactics, regulatory activities, data management and evaluation, and outreach and communications. EAB population suppression tools can include the use of insecticide treatments, girdled ash trees (sinks), sanitation of infested trees, and ash utilization (phloem reduction). SLAM Pilot projects are being implemented and evaluated at sites in the Upper Peninsula (U.P.) of Michigan. This presentation will provide a description and update of the U.P. SLAM pilot projects.

Right Plant, Right Place, Right Time, Right Now
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Nursery and landscape organizations refer to their members as the “green industry.” But how “green” are they on the invasive plants issue? Are the days over when the prevailing attitude was that of the obstinate nurseryman who didn’t believe there was any such thing as a bad plant? Has a new generation of nursery and landscape professionals seen the light and is the new generation ready to play it safe on new plant introductions? We will discuss the transition era we are now in within nursery and landscape circles; and how even the most stubborn plant sellers are recognizing the need for more environmental responsibility. On the other hand, nursery and landscape associations and plant breeders are hoping the ecological community is ready to recognize the potential positives offered by new cultivars of old problem plants.

Development of Non-invasive Plant Alternatives for Use in the Landscape
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Alan G. Smith, University of Minnesota

The distribution of plants has been very beneficial and has provided nutritional and aesthetic improvements throughout the world. However, a minority of these displaced plants possess traits that allow them to escape their intended area of cultivation and spread to other regions. These plants have become invasive weeds. Examples from the upper Midwest include Norway maple (Acer platanoides), Amur maple (A. ginnala), Japanese barberry (Berberis thunbergii), common tansy (Tanacetum vulgare) and many other species. These plants are sold for use in the landscape, but have the potential to escape from their controlled cultivation and thrive as invasive species. Many of these invasive species have been or may be regulated. Regulation results in loss of sales to the green industry, restricts consumer choice and imposes on government agencies to enforce new laws. The goal of our research is to test strategies to produce sterile cultivars of valuable, but invasive landscape plants through biotechnology and mutagenesis breeding. Sterile varieties would allow continued sales and provide consumers with non-invasive alternatives for use in the landscape.
Weed Feed: Edible Invasive Species & Community Activism
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Garlic mustard escaped into the United States from Europe, introduced originally as a culinary herb. Many invasive species are edible and can be utilized as nutritious ingredients in food preparation. Local communities increasingly rely on neighborhood organizations and their volunteers to eradicate invasive species on public land. Educating, motivating and recruiting volunteers can be a serious challenge to these efforts. A unique local approach to restoration & volunteerism success puts the party into work party with a culinary event which showcases edible invasive species, live music and theatrical entertainment focused on ecological education.

Distribution and Detection: 10:40 am - 11:55 am

Buckthorn Detection Using Small Format Aerial Photography
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The invasive plant, common buckthorn (*Rhamnus carthartica*), has been in Minnesota for over one-hundred and fifty years. During that time it has spread into many of the state’s forests, pushing out native species, reducing forest regeneration by competing for space and nutrients, contributing to soil erosion and helping spread certain pests and pathogens. Aerial detection of buckthorn is possible because it generally loses its leaves after the over-story trees have lost theirs and because buckthorn leaves remain a dark green until a few days before they drop. In cooperation with area foresters and Sue Burks – MN DNR Invasive Species Program Coordinator, the Resource Assessment Program of MN DNR Forestry has taken small format stereo aerial photos of several forested areas just after canopy leaf fall; testing both color and color infrared images and both large and small scales for their interpretability and efficiency in detecting and mapping buckthorn. Field checks of the interpreted photos indicate that buckthorn can be detected and used in an integrated program of detection and eradication. Lessons learned and suggested improvements will be presented.

Using Forest Inventory and Analysis Data to Detect the Invasion Stage of Non-Native Invasive Plants and Quantify the Invasibility of Forested Lands in the Upper Midwest
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W. Keith Moser, USDA Forest Service Northern Research Station

Non-native invasive plant (NNIP) species are spreading rapidly from managed ecosystems into natural ecosystems (e.g., forests, grasslands) in the Midwest. Using the strategic inventory data from the 2005-2006 U.S. Department of Agriculture, Forest Service’s Forest Inventory and Analysis (FIA) program, we mapped the spatial distribution patterns of major NNIPs by using kernel density smoothing. Based on the smoothed presence probability and cover percentage, the Midwest counties were classified into different invasion stages for each NNIP by using the classification and regression tree method. Meanwhile, based on the weighted mean of all NNIPs presence probability and cover percentage, the invasibility of forested lands in the Midwest counties was quantified and classified into high, medium, low and hint risk levels. This information is helpful for NNIP surveillance, control and mitigation. Keywords: invasive stage, non-native invasive plant, kernel density, classification and regression tree.
Extent and Spread of Selected Non-Native Invasive Plants in Upper Midwest Forests
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Non-native invasive plants (NNIP) represent a serious threat to the composition and structure of native forest ecosystems. Possessing life history strategies that convey competitive advantage, NNIP can capture growing space and impact normal regeneration and growth of co-occurring native plant species. Once established, NNIPs can be extremely difficult to eradicate. Identifying presence and potential for spread is critical to developing a strategy for minimizing or mitigating the influence of NNIPs in the forests of the northern United States. The USDA Forest Service’s Northern Research Station Forest Inventory and Analysis Program (NRSFIA) has been sampling for selected NNIP species on plots in the Upper Midwest and Northeastern states since 2005. The different species evidenced varying levels of intensity and direction of spread. Multiflora rose (Rosa multiflora) had a strongly demarcated northern limit, likely reflecting its sensitivity to severe winter cold. Common buckthorn (Rhamnus cathartica) appears to have no northern limit in the contiguous United States, whereas Japanese honeysuckle (Lonicera japonica) was more concentrated in the southern tier of the region. Non-native bush honeysuckles (Lonicera spp.) were more generalists, exhibiting no apparent latitudinal limits. Garlic mustard (Alliaria petiolata) presence probability was strongly concentrated in the center of the region, likely reflecting disturbance and forest fragmentation, rather than climatic influences. NRSFIA is coordinating an effort to produce estimates of extent and composition of northern states forests 60 years into the future under varying climate scenarios. Such estimates will provide a framework to take these modeled relationships of NNIP extent and see how future climate affects potential invasions.

Keywords: non-native invasive plant, forest inventory and analysis, climatic influences.

Citizen Scientists Monitor Wisconsin’s Rivers for Invasive Species
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Over 150 Project RED (riverine early detectors) monitors have been trained in Wisconsin to monitor rivers and streams for 15 invasive species of concern including early detection species hydrilla (Hydrilla verticillata) and Brazilian waterweed (Egeria densa). In 2009 they monitored over 170 miles of riverbank finding over 100 new records of invasive species including Japanese knotweed (Polygonum cuspidatum) and Japanese hops (Humulus japonicas).

Aquatic Invasive Species Monitoring Through the Citizen Lake Monitoring Network
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Wisconsin Department of Natural Resources’ staff have recruited lake volunteers to watch for Aquatic Invasive Species (AIS) since 1991. This effort was non-standardized, but successful. In 2006, UW Extension - Lakes staff drafted standardized volunteer AIS monitoring protocols that mesh with the Department’s protocols. The Citizen Lake Monitoring Network (CLMN) hosts Train the Trainer workshops for County and local AIS staff. Then CLMN staff and Trainers host AIS monitoring workshops to teach the volunteers how to identify, collect and document suspect invasives. Based upon participant comments, it was determined that some of the protocols were too technical for all volunteers. The Network thus added a “casual observer” monitoring level while maintaining the more technical standardized monitoring level. The Wisconsin Department of Natural Resources set up a website so lake residents and volunteers can initiate the verification process if a suspect AIS is found. The suspect invasives are delivered to local Department staff. The staff then completes the verification and vouchering process. Trained volunteers can enter on-line incident reports which include questions on where the invasive was collected. Staff can go to the location to verify the location and densities of the AIS in the lake. Once the AIS is verified and vouchedered, the data is entered into the statewide Surface Water Integrated Monitoring System (SWIMS) database. Having volunteers monitor for invasives is both a time and cost savings to the Department plus the volunteers become advocates when the State is considering AIS monitoring and control funding.
Early Detection Monitoring for Vulnerable Great Lakes Coastal Ecosystems
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Great Lakes harbors/embayments are vulnerable to introduction of aquatic invasive species. Monitoring is needed to inform on new introductions, as well as to track success of prevention programs intended to limit spread. We have completed a pilot field case study in the Duluth-Superior Harbor, an at-risk shipping port on Lake Superior. Our “oversampling” strategy used spatially-comprehensive, high-density sampling strategies. We found >35 fish species and >162 benthic invertebrate taxa, including all known non-native and invasive species and another 8 new non-native benthic invertebrates we have now reported for the first time. “Oversampling” provided an empirical basis to perform analyses/modeling and illustrate the prime dilemma with detection of potentially-invasive species while they are still rare in their abundance and distribution: we can improve detection probability through increased sampling effort, but this comes at increased cost. A related technical issue is to how to develop cost-efficiency yet maintain a high statistical confidence in ability to detect species in very low abundance, when rapid responses could be most effective. We have used the extensive information base from our case study to evaluate effectiveness of sample allocation strategies, in an effort to develop a model approach. Other Great Lakes case studies are being planned for 2010-2011; together these will help define an early detection monitoring design for a broad network to be established across the Great Lakes by 2014.

Restoration of Emergent and Submersed Plants: 10:40 am - 11:55 am

Initial Attempts to Restore Native Plants After Carp Removal in Lake Susan
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Josh Knopik and James A. Johnson, University of Minnesota

Removal and control of common carp (Cyprinus carpio) to enhance water quality should promote aquatic macrophyte growth. We are studying a Twin Cities Metro lake to determine if we can promote establishment of native plants and prevent dominance by invasive curlyleaf pondweed (Potamogeton crispus) and Eurasian watermilfoil (Myriophyllum spicatum) following carp removal. After winter carp removal, spring water clarity improved compared to previous years and macrophytes expanded their distribution. By June 2009, 56% of the littoral area (depth ≤ 4.6 m) was vegetated. Coontail (Ceratophyllum demersum) was the most frequent taxon (43%) followed by Eurasian watermilfoil (35%), curlyleaf pondweed (17%) and narrow leaf pondweeds (15%). By August, curlyleaf decreased and coontail became dominant. Eurasian watermilfoil decreased, likely from herbivory by the milfoil weevil, Euhrychiopsis lecontei. In 2010, curlyleaf increased in spring to 30% of the littoral area but narrow leaf pondweeds were found at 40% of sites and persisted through the summer. Eurasian watermilfoil remained controlled. Five native plant species were transplanted from a nearby lake into Lake Susan in 0.5m water depth: muskgrass (Chara sp.), water celery (Vallisneria americana), northern watermilfoil (M. sibiricum), water stargrass (Zosterella dubia) and bushy pondweed (Najas sp.). All plants initially established, but after 6 weeks bushy pondweed and water stargrass performed best. However, in the following spring and summer water celery and water stargrass grew and expanded whereas muskgrass and northern watermilfoil were not found.

Water Quality Issues Associated with Native Macrophyte Re-establishment
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Direct biomass control programs (i.e., herbicide, biocontrol, mechanical) that target non-native macrophyte species may not always produce the desired goal of restoring native macrophyte community dominance in shallow aquatic systems. Native re-establishment is often complicated by eutrophic conditions, enhanced nutrient recycling, and frequent nuisance algal blooms that result in poor light penetration and limited colonizable macrophyte habitat. Thus, plans for re-establishing native submerged macrophyte growth also need to consider lake management strategies that reduce nutrient inputs (primarily phosphorus) and limit algal productivity in
order to improve underwater light habitat. This research examines the role of algae in attenuating light in eutrophic shallow lakes and projected changes in light penetration as a result of managing the lake to control algal growth.

Avoiding Reinvasion: Theory, Practice, and Policy
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The ecological mechanisms responsible for reinvasion are well-documented and include unfavorable propagule pressure, altered disturbance regimes and environmental conditions, and differential establishment and growth of native vs introduced species. Reinvasion risk varies among ecosystems and situations; depending primarily on the importance of landscape-scale factors. Based on observations from wet meadows and riparian forests, reinvasion risk is often over-estimated. Reinvasion is increasingly seen as a universal, intractable problem for restoration projects that must overcome initial dominance by invasive species. Yet, practice-related factors that are controllable explain reinvasions on many restorations; these can be categorized into decisions that lead to high post-treatment populations and those that delay the re-establishment of replacement vegetation. High-post-treatment population abundance is very common due to poor timing of control, incomplete spatial coverage of control or lack of attention to seedbanks. Lags in restablishment of replacement vegetation stem from inadequate seed quantities, ill-suited species composition of seed mixes, and a lack of seed priming. Minimizing problems associated with these practice-related factors requires increased accountability of weed-control contractors, integration of weed control and revegetation, and longer project durations to reduce post-control weed populations and to acquire needed seed supplies. Widespread adoption of best-practices is limited less by a lack of available information than by designs of policies and programs that reinforce ineffective practices and increase the incidence of reinvasion. Many of the needed changes to policy design would increase cost-effectiveness because of reduced incidence of restoration failure.

Carp and Invasive Fish Management: 10:40 am - 11:55 am

Asian Carp and the Great Lakes - What Can We Expect?
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For nearly eight years we’ve watched Asian carp advance towards the Great Lakes. Our focus on preventing their expansion into Lake Michigan has been an electric barrier located in Romeoville, IL about 35 miles from Chicago. New genetic detection methods suggest the electric barrier may not be effective and that the fish are very near or already in Lake Michigan. This presentation will discuss the movement of Asian carp towards the Great Lakes from the Mississippi River, the new detection techniques, potential failures of the electric barrier, habitat requirements of these non-native species and efforts to stop these potentially harmful fish from establishing a population in the Great Lakes basin. Finally the presentation will discuss possible long-term approaches to Asian carp management in the Great Lakes and Mississippi River drainage basins.

Control of Invasive Carp Movements Using Non-Physical Behavioural Barrier Techniques
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Fish deterrents utilizes years of research followed by a number of successful and proven installations of “guiding” or “deterring” fish via the proper combination of stimuli. The use of sound, air and light has been successfully employed to deter populations of fish from a particular area. The use of a Sound Projection Array (SPA), which utilizes an alternating frequency of sound, repels or deters fish to steer away from designated areas. Other methods include a BioAcoustic Fish Fence (BAFF), which utilizes a SPA combined with an air bubble curtain that captures the sound, and thus increases the to read dispersion intensity of the generate sound signal and its dispersion to the surface. In addition, high intensity specially designed light bars can provide a visual queue or warning to deter or guide fish. Certain species require the use of all three. Levels as high 73-95% deflection have been attained in many installations. Common carp (Cyprinus carpio) are a highly mobile species that spread invasively through interconnecting watercourses, often with disastrous results for the aquatic ecosystems. Among the possible techniques for controlling carp invasions,
use of non-physical behavioural barriers is one that appears promising. Carp have a highly sensitive auditory system which makes them especially amenable to behavioural guidance using BAFF (sound & air bubble curtain) stimuli. They also have the ability to learn quickly and associate combinations of aversive stimuli, suggesting those multi-stimulus barriers, using e.g. combinations of acoustic, air bubble, high intensity light bars, electric, offer considerable potential for controlling invasions. This paper will discuss the biological basis of developing carp barriers, review data on responses of cyprinids to barriers and discuss the scope and limitations of using barriers in different types of watercourse.

**Round gobies in the Duluth Superior Harbor**

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The round goby, *Apollina melanostomus*, is an aggressive invasive fish which has become a major component of the Laurentian Great Lakes ecosystem since its introduction in 1990. We currently are assessing its movement, site fidelity, growth and bioacoustics in the Duluth-Superior Harbor. Our initial studies indicated a maximal movement of less than 1 km per year. A current tag and recapture study confirms high site fidelity with minimal seasonal or yearly movement. Fish were captured biweekly using 16” minnow traps located every 25 meters along a 550 meter stretch of the Duluth-Superior Harbor shoreline. A total of 1,328 tagged gobies, representing 419 individuals were recaptured during the ice-free months from July 2009 to August 2010. Net movement between captures exhibited a leptokurtic distribution centered at the site of original capture with 88% of the recaptured gobies showing no net movement and a maximum recorded movement of 475 meters. Instantaneous growth rates varied significantly between seasons, gender, and initial length with the greatest growth exhibited by small males in midsummer. We are also monitoring round goby nesting sites with hydrophones to develop a bioacoustic library of round goby calls. Preliminary results indicate that males will produce trains of short grunts. Concurrent phonotaxis experiments are examining whether female round gobies can be acoustically attracted to traps. The goal is to integrate the natural history and sensory biology of the fish to produce a bioacoustical trap for management or early detection of the fish.

**Emerald Ash Borer Workshop 4: 10:40 am - 11:55 am**

**The Risks and Benefits of Biological Control: A Case Study of the Emerald Ash Borer**

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The emerald ash borer (EAB) (*Agrilus planipennis*) was first discovered in the U.S. in 2002 and has since spread to 15 states and is causing considerable mortality to ash trees in urban and forest environments. Mechanical, chemical, and cultural control methods, including quarantine implementation, have proved unable to stop the spread of this insidious pest. Classical biological control of EAB was initiated as an alternative control strategy and the steps followed are presented. The benefits of classical biological control include economic benefits (reduction in loss of timber, reduction in cost of control measures) and environmental benefits (reduction in damage to natural systems, reduction in pesticide contamination). The successful biological control projects against the cottony cushion scale and the cassava mealybug are presented in terms of the benefits of biocontrol. The unintended consequences of biocontrol, most specifically impacts on non-target organisms, are discussed and the evidence for the host specificity of EAB parasitoids is presented. After an in depth review process, the benefits of EAB biocontrol were considered to outweigh the risks, and permits were issued for the release of three parasitoids from China. All three parasitoids have successfully reproduced and overwintered in MI and OH.
Effects of Emerald Ash Borer on Ash Populations and Forest Plant Communities
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Emerald ash borer (EAB) (Agrilus planipennis), an introduced insect pest, has killed millions of ash trees in the Midwest and is spreading rapidly. The effects of EAB on forest ecosystems are being studied through a collaborative research program between the US Forest Service and the Ohio State University. We are monitoring EAB populations, decline and mortality of >4500 ash trees and saplings, changes in understory light availability, responses of both native and invasive plant species, changes in species composition and forest structure, and effects on other organisms and ecosystem processes in over 250 monitoring plots in forests in Ohio and Michigan, representing a gradient of EAB infestation duration. Although there is some variation due to habitat type, ash species, light exposure, and initial health, survival analysis shows healthy ash stands experience nearly complete mortality within approximately 6 years. EAB will kill ash saplings as small as 2.5 cm DBH. In many sites that have reached nearly complete mortality of larger ash, there are many established ash seedlings and small saplings, and few newly germinated seedlings. It is too early to tell whether this final cohort of ash will be killed by EAB when it reaches susceptible size. EAB populations begin small, rapidly increase and peak, and then crash but persist at low densities after eliminating their food source. Forest canopy gaps, formed by dying ash trees, allow increased light to the understory in ecosystems without a well-developed midstory. The increased light affects both native and invasive plants in these ecosystems. We have identified 14 species of invasive plants in the monitoring plots, with at least one invasive plant species present in most plots. Initial cover of invasive species was low in most plots, which may indicate an opportunity to control invasive plants in these ecosystems before they respond to gaps. We have begun research on the restoration of EAB-impacted ecosystems through control of invasive plants and planting of Dutch elm disease-tolerant elm seedlings.

Potential Impact of EAB in Riparian Forests in Wisconsin and Minnesota
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Since its North American discovery in 2002, the emerald ash borer (Agrilus planipennis Fairmaire, Coleoptera: Buprestidae, EAB) has shown a considerable ability to adapt to native ash trees and cause extensive tree mortality regardless of species, size or vigor. While these factors have not shown to have tremendous weight in driving spread, there is some evidence that the position of ash trees on the landscape may play a role in guiding EAB dispersal patterns. Patterns of dispersal will, in turn, shape changes in forest structure and composition. In this study, the potential impact of EAB on riparian forests is examined. Forest inventory and geospatial data from Michigan were used to compare ash mortality and the abundance of standing dead trees across different physiographic classes (e.g. upland vs. riparian), as well as the relative change in species composition over time. We then discuss the potential impact of EAB on the composition of riparian forest ecosystems in Wisconsin and Minnesota, USA.
**Naturalized Yellow-flowered Alfalfa (Medicago sativa ssp. falcata): Is It Invasive?**
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The occurrence of naturalized yellow-flowered alfalfa (YFA) on private and adjacent public rangeland in northwestern South Dakota presents a dilemma. The capacity for natural reseeding demonstrates value for rehabilitating severely depleted rangelands by increasing soil organic C and N and augmenting forage production. Ironically, the same plant characteristics that make it suitable for rangeland improvement also increase its invasive potential. In fact, there has been great concern expressed by the USFS regarding the impact of YFA on the native plant communities where YFA has invaded. A study was initiated on the Grand River National Grassland in 2003 to describe spatial distribution patterns of YFA, to determine associations between YFA occurrence and species richness and biomass production of native plant communities, and to examine density and viability of the seed bank of YFA along environmental gradients. Although YFA plants were occasionally found on upper and mid-slopes, highest densities occurred on the lower slopes in fine-textured soil. Areas dominated by YFA had low richness and biomass production from native species, but high total biomass. Density of the YFA soil seed bank was positively correlated with YFA cover and biomass and was > 39,000 seed m⁻² in the lower slopes. Ninety-nine percent of YFA seeds were viable but < 4% germinated under standard laboratory conditions. The distribution of YFA was clumped, and periodic seed production and high frequency of hard seeds presumably provided population maintenance on the lower slopes. However, its potential for dominance on less favorable landscape positions appeared to be low.

**An Invasive Species May Limit Diet Expansion in a Native Lady Beetle**
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Invasive predators may exclude native predators from available resources either by preying on them or by causing them to avoid certain habitats. We used a series of manipulated and observational studies to assess the impact of the invasive multicolored Asian lady beetle (Harmonia axyridis) on resource use of the native twelve-spotted lady beetle (Coleomegilla maculata). Our hypothesis is that the risk of predation by the invasive, intra-guild predator, H. axyridis limits the expansion of diet breadth by C. maculata to include soybean aphid. In 2008 and 2009 visual counts of coccinellids on maize and soybean plants revealed that although all stages of H. axyridis were common in both habitats, in soybean, C. maculata sightings were almost exclusively adults. Egg mass identification confirmed that C. maculata eggs were very rarely found in soybean. Studies on caged maize and soybean plants and outplants of sentinel eggs in 2009 and 2010 will determine the effect of H. axyridis on fitness of the native predator in maize and soybean habitats.

**Evaluating the Invasive Potential of Norway Maple (Acer platanoides L.) and Amur Maple (Acer tataricum L. ssp. ginnala (Maxim.) in Central Minnesota - Initial Results**
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Amur maple and Norway maple have long been popular landscape plants in the United States, valued for their ornamental attributes and tolerance of harsh environments. However, both are often cited as being invasive and are currently on the invasive species lists
of many states. While documented research concerning invasiveness exists only for Norway maple, none of the work was conducted in the upper Midwest. A multi-year investigation of characteristics potentially contributing to invasiveness of these species in Minnesota was initiated at the University of Minnesota Landscape Arboretum in 2007. Four native species, boxelder, (Acer negundo L.), red maple (Acer rubrum L.), silver maple (Acer saccharinum), and sugar maple (Acer saccharum Marshall) were also evaluated to provide a reference for comparison. Cultivars of Amur and Norway maple differed in seed quantity per gram dry weight of stem tissue indicating it may be possible to breed and select for less invasive genotypes of these species. Seed persistence ranged from 1-3 weeks for Norway, Red, Silver, and Sugar maples to six months or more for Box Elder and Amur maple. Sown seed of all species established more readily in wood chips or tilled soil than in grass or forest understory plots. Seed predation appeared to be a factor limiting establishment in the grass and forest plots. Initial hybridization trials suggest that neither Amur nor Norway maple readily outcrosses with any of the four native maple species. Ongoing trials will quantify growth rates and length of juvenile periods of these species.

**Phenology of Flowering Rush and Hardstem Bulrush in the Detroit Lakes Chain**

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Flowering rush, *Butomus umbellatus*, is an invasive plant species that has been present in the Detroit Lakes system (Becker County, Minnesota) since the 1960’s. It is an emergent plant present in the littoral zone that reproduces primarily by asexual budding of the rhizome. Past control efforts, which began in the 1980’s, mainly consisted of digging up flowering rush beds and in the 1990’s, application of herbicides. We measured above- and below- ground biomass of flowering rush relative to growth of the native emergent hardstem bulrush, *Schoenoplectus acutus* in order to understand the phenological differences between the two species. This experiment consisted of four plots, corresponding to Big and Little Detroit Lake, Lake Sallie, and Curfman Lake (Becker County). The site selection was made in conjunction with the Minnesota DNR Fisheries and Invasive Species programs to prevent damage to sensitive habitats, such as fish spawning sites. Every three weeks throughout the summer, samples were taken from each site using a 6” diameter corer. Samples were washed, and separated into: emergent leaves, submersed leaves, flowers and rhizomes. Both wet and dry biomass was recorded as well as the plant height and number of ramets, bulbils, and rhizome buds present in each sample. Understanding the timing of flowering rush plant emergence and carbohydrate allocation relative to water temperature and the growth of hardstem bulrush will be important to identifying effective treatment methods.

**Inter Simple Sequence Repeat (ISSR) Variation in Reed Canarygrass (Phalaris arundinacea L.)**

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Reed Canarygrass (*Phalaris arundinacea L.*), a perennial grass native to temperate Europe, Asia, and North America, has become invasive in many wetland and disturbed habitats in the US. This project aims to use Inter Simple Sequence Repeat (ISSR) molecular markers to analyze the genetic diversity and relatedness between individuals and populations from European and North America. DNA from 500 Reed Canarygrass genotypes comprising wild populations in four US states and six commercial forage cultivars has been isolated. Additional DNA samples of genotypes from eight European countries have been provided by Dr. Michael Casler’s lab at the University of Wisconsin. To date, data from three ISSR primers with a total of 24 polymorphic loci have been analyzed. While a preliminary cluster analysis of pair wise genetic similarity did not indicate a high level of geographic differentiation, several intriguing patterns emerged. Of the ornamental and forage cultivars, only one variety formed a distinct group while the other cultivars were widely distributed throughout the dendrogram. Additionally, there were many indistinguishable or highly similar pairs consisting of either one European and one wild North American or one cultivar and one wild North American genotype. These results are consistent with the small number of selection cycles of most of the commercial cultivars, and suggest a relatively high level of genetic similarity between cultivars and wild populations from both continents surveyed. Ongoing work will augment the dataset with markers from additional primers. Further analyses will focus on population-level differences at regional, state, and continental geographic scales.
The relationship between invasive species presence, site characteristics (e.g. disturbance, live tree volume, city distance, edge distance, physiography, and type of water [e.g. streams] present on plot), and climate (annual average number of days the temperature is ≥ 90°F and annual average number of days the temperature is ≤ 32°F) was modeled for five non-native invasive plants [multiflora rose \( \textit{Rosa multiflora} \), common buckthorn \( \textit{Rhamnus cathartica} \), non-native bush honeysuckles \( \textit{Lonicera spp.} \), garlic mustard \( \textit{Alliaria petiolata} \), and reed canary grass \( \textit{Phalaris arundinacea} \)] sampled by the USDA Forest Service’s Forest Inventory and Analysis program in seven Midwestern states for 2005-2006. Species’ response to site and temperature predictors varied due to trait differences such as shade tolerance and moisture affinity. Most species presence was positively related to biotic disturbance (disease(s)/animal(s)) and mesic physiography and negatively related to distance from a city or nonforest edge. The best predictor for the presence of non-native invasive plants was annual average number of days the temperature is ≤ 32°F, with all five species correlated. Understanding the effect of site and climate on NNIP distribution provides insights into important drivers of species presence at a regional scale and allows concerned citizens to predict invasion risk and future ecosystem response.

Invasive garlic mustard \( \textit{Alliaria petiolata} \) has become abundant in many forested regions of the United States. This study examined the fluctuations of garlic mustard populations over time and their relationship with native species, levels of leaf litter, photosynthetic radiation, and insect herbivores. At half of the 12 monitoring sites, garlic mustard populations showed strong two-point cycling with alternating dominance of the first- and second-year life stages. Increased garlic mustard cover was negatively correlated with native species richness and cover. All sites had litter layers that had been significantly impacted by earthworms. Light was a key factor in understanding garlic mustard populations. Adult plant cover is higher where light is more abundant, but high cover of adult plants produces shade and can cause low cover of seedling plants. We found that less than 2% of garlic mustard leaf area is currently being damaged by herbivores in Minnesota. These results have implications for both the release of potential biological control agents and restoration of garlic mustard invaded sites. When working to restore a site that has been heavily invaded by garlic mustard, the level of earthworm impact, the number and abundance of native species that remain, and any changes to the light available from the canopy should all be considered as factors that could influence the recovery of the site, in addition to the potential decrease in garlic mustard.

The Light Brown Apple Moth, \textit{Epiphyas postvittana}, is an invasive pest and was recently confirmed to be established in California. The Midwest region has several host plants (e.g., apples, alfalfa) but may be too cold for the insect to survive. The aim of this study was to measure the capability of this species to survive low temperatures and to estimate the potential of this pest to overwinter in northern states. Two indices of cold hardiness, supercooling point (SCP) and lower lethal temperature (LLT), are reported here for instars and pupae reared at 15 or 22°C. SCP is the lowest temperature recorded before detection of the exotherm. We measured SCP
Establishment and persistence of invasive species depend on the genetics of the invasive and native populations. Populations may differ in their ability to invade or tolerate invasion depending upon their genetic structure. This research examines the genetics of a competitive interaction between the widespread invasive perennial, common tansy (Tanacetum vulgare), and the native polyploid perennial, late goldenrod (Solidago altissima). Clones of five diploid and tetraploid genotypes of goldenrod were grown in competitive arrays with three tansy clones. Thirty tansy genotypes were cloned such that each experienced competition from diploid and tetraploid goldenrod. From the native species perspective, tetraploids were generally larger than diploids, but there was no difference among ploidy levels in the extent to which competition reduced traits. However, diploids benefited more from the presence of tansy in having fewer aphids than tetraploids. Significant differences were also found among goldenrod genotypes within ploidy levels in their competitive ability suggesting that the presence of tansy may alter goldenrod genetic structure. From the invasive species perspective, significant variation in plant size among tansy genotypes were found depending on their competitive pairing with diploid or tetraploid goldenrod suggesting that the ploidy composition of the invaded population may exert selection on tansy. Overall, this research does not demonstrate a competitive advantage of polyploidy. However, the greater genetic variability among tetraploids suggests they may evolve competitive traits more readily than diploids. This work also indicates tansy invasion in native goldenrod populations may be influenced by the ploidy distribution.

The threat of nonnative invasive plant species in the nation’s forests is an ever-growing concern. Their aggressive nature allows many of them to out-compete native species, causing ecological and economic harm. The Forest Inventory and Analysis (FIA) program of the USDA Forest Service is taking an active role in the inventory and monitoring of these species in order to provide statistically valid estimates of their distribution and abundance. While a national protocol has been established to describe the process of collecting invasive vascular plant data, each FIA region is responsible for identifying the most important invasive plants to monitor on its forestlands. The list developed by the Northern Research Station currently includes 43 species. From 2007 to 2009, the presence and abundance of these species were documented on more than 2,400 forested locations across the northern region, stretching from the Great Plains to Maine. Each of the forested sites will be re-visited on a 5-year cycle in order to monitor change. We present maps depicting the distribution of 5 of these invasive plants based on FIA data. A field guide that can be used to identify all 43 invasive plant species is now available at http://nrs.fs.fed.us/pubs/34183.
cover in new restoration sites, but in older sites with abundant vegetation it had negative effects on the macroinvertebrates. Reed canarygrass was a definite impediment to riparian prairie restoration in some restoration sites. The degree of invasion was highest along stream banks and wet meanders. Trout stream restoration provides a unique opportunity to restore high-quality native riparian vegetation, and methods to prevent invasive species colonization are needed.

*Celastrus orbiculatus* (Oriental bittersweet) at the University of Wisconsin Arboretum, Madison, WI

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*Celastrus orbiculatus* (Oriental bittersweet) is widely recognized as a noxious plant species in much of the eastern U.S., but it is only beginning to show its invasive potential in the Upper Midwest. However, rapidly growing populations such as the one observed in this study in Madison, Wisconsin suggest that there is substantial reason for concern. Recently, the vine has become invasive in the Grady Tract of the UW Arboretum. The goals of this study were two-fold: to determine the extent of *C. orbiculatus* in the Grady Tract and to determine how topography, distance to edge, and tree community composition affect its presence and abundance. We sampled 100-m² circular plots spaced every 100 m throughout the Grady Tract. In each plot, we tallied *C. orbiculatus* climbing stems, measuring the diameter of those larger than 1 cm. We measured slope, aspect, and terrain shape at each plot. We determined tree community composition by identifying all canopy trees in a plot and measuring the basal area using a 2M basal area prism. The data showed no significant correlation between local topography or distance to edge and *C. orbiculatus* abundance. However, there was a weak positive correlation between tree basal area and *C. orbiculatus* abundance. Areas dominated by red pine (*Pinus resinosa*) and white pine (*Pinus strobus*) also had higher abundance of *C. orbiculatus* than areas dominated by other tree species such as oaks (*Quercus* spp). Understanding the factors that determine the distribution of *C. orbiculatus* in the Upper Midwest is important for designing effective management strategies to minimize its spread.

**Invasive Species Prevention, Containment, and Preparedness**

*Wisconsin DNR Monitor Effort for Aquatic Invasive Species: A Partnership Approach*

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Wisconsin Department of Natural Resources’ staff have recruited lake volunteers to watch for Aquatic Invasive Species (AIS) since 1991 and provided training in collecting and entering data independently. Once the AIS is verified and vouchered, the data is entered into the statewide Surface Water Integrated Monitoring System (SWIMS) database. The benefits to the Department include greater coverage than staff alone would achieve which can lead to earlier detection of priority species. Following detection, local communities can apply for funding to conduct a response or depending on the species identified, DNR staff may initiate a rapid response. The distribution data is also used to quantify spread of priority aquatic invasive species in the state and determine efficacy of longer term outreach efforts designed to slow the spread of these species. Trained volunteers are a valuable point of contact in their communities and help distribute messages about aquatic invasive species. In addition to tracking the distribution of aquatic invasive species some of the volunteers may monitor for water quality as well. These volunteers are the first line in observing the conditions in the lake and taking steps to protect a healthy and diverse aquatic community.
Current Regulatory Policy for Invasive Earthworms in Minnesota
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To prevent the spread of environmentally damaging invasive species a regulatory policy needs to be in place and enforced. Under current legislation in Minnesota, earthworms, a non-native terrestrial species from Europe and Asia, are not regulated and are being spread throughout the state, damaging the northern hardwood forest ecosystem. Here we review the present regulatory policy in Minnesota for invasive earthworms. We have identified seven Federal and seven State agencies that may have authority to regulate invasive earthworms in northern Minnesota. Relevant personnel at each agency were interviewed by telephone to determine authority, plans and actions for regulating invasive earthworms. We found that nearly all agencies asserted some regulatory authority over invasive earthworms; however this authority was typically narrowly constrained or indirect. In addition, we found that few agencies had plans for regulating invasive earthworms and fewer still were taking action to do so. After an analysis of the current action of agencies we expect to find that there are no state-wide comprehensive authoritative measures being taken to prevent the spread of earthworms in the northern Minnesota hardwood forests. These findings suggest a need to coordinate and strengthen statewide authority for invasive species, and perhaps even introduce new legislation that would cover the earthworm issue specifically.

Demand for Earthworm Bait
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Earthworms otherwise known as Angle Worms (Aporrectodea caliginosa) or Night Crawlers (Lumbricus terrestris) are present in the northern hardwood forests of Minnesota, likely due to human activity. Researchers suspect that the use of earthworms for fishing bait, and the activity of anglers have transported the earthworms to these northern forests. Earthworms are considered an invasive species in these forests because they are not naturally occurring and they consume leaf litter that native woodland wildflowers and other native species rely on for survival. Educating anglers about the invasiveness of earthworms in northern hardwood forests is thought to have great potential for reducing future introductions. The purpose of this study was to identify when anglers are most likely to use earthworms as bait. By knowing when earthworms are likely to be used, educational efforts can be targeted so they have the greatest effect. The objective of this study was accomplished by interviewing fishing guides to determine what factors influence when earthworms are typically used as bait. The results of these interviews indicated that lake temperature is a key factor because earthworms are most effective in lakes that have a temperature of 65 degrees Fahrenheit or greater. To corroborated these findings, weekly live bait sales for bait shops in the Cass Lake region will be related to weekly average temperatures to determine if the use of earthworms increases relative to other live baits as air temperatures (which are correlated with lake temperatures) rise.

Genetic Conservation of Minnesota’s Ash Resource
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The Emerald ash borer (EAB, Agrilus planipennis) is an exotic, invasive insect that threatens all ash (Fraxinus) species in North America. It was first detected in Detroit, Michigan and Windsor, Ontario in 2002 and has since killed tens of millions of ash trees in 14 states and two provinces. It was identified in Minnesota in 2009. Our native ash species have no known resistance to EAB and thus mortality rates could reach 100% in an undetected outbreak in four to six years. These localized extinctions result in the loss of genetic diversity and adaptation to local climate conditions. The goals of our project are to conserve the genetic variation found in Minnesota’s ash species through seed collection and long-term storage and to evaluate three seed collection strategies to determine which is the most efficient at capturing genetic variation. We have collected seed from 299 green ash (F. pennsylvanica) and 205 black ash (F. nigra) using three different collection strategies: population collections (groups of 20-30 trees from small geographic areas), ecoregion collections (11-15 trees across Omernik Level III ecoregions), and volunteer collections (individual trees scattered across the state). Microsatellite markers from European ash (F. excelsior) will be used to characterize the genetic variation in a subset of the seeds and to determine the efficacy of the three collection strategies.
Semi-Automated Identification of Municipal Ash Trees Using High Resolution Aerial Imagery
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While ash is a significant component of forests, it has also been widely planted in municipal areas as a replacement for elm lost to Dutch elm disease during the latter half of the 20th century in the Midwestern United States. Now, however, ash is in peril as the emerald ash borer (*Agrilus planipennis*) continues to spread after killing millions of ash trees in Michigan and the surrounding areas. In 2008 and 2009, EAB was discovered in Wisconsin and Minnesota, respectively, and a number of cities in each state have taken action to respond to this threat. For example, the city of Milwaukee has undertaken a huge endeavor to map all of its tree cover and classify the ash crowns. Their undertaking includes acquiring and incorporating hyperspectral imagery and associated LiDAR data to produce an accurate tree canopy dataset over a large area (95 sq. miles) (Souci et al. 2009). While Milwaukee’s approach will provide a data-rich inventory, not all municipal areas can carry out a project of this magnitude. We present a viable alternative for identifying and mapping ash tree canopies using eCognition Developer 8 image segmentation software and freely-available four-band high-resolution imagery from the USDA’s National Agriculture Imagery Program. A fine-scale map of ash trees is presented for a study area in the Twin Cities metropolitan area. Souci, J.S., I. Hanou, and D. Puchalski, 2009. High-resolution remote sensing image analysis for early detection and response planning for emerald ash borer. Photogrammetric Engineering & Remote Sensing, 75(8):905-909.

Clean Boats, Clean Waters: Citizens and Staff Work Together to Protect Wisconsin’s Lakes
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Educating boaters and anglers at boat landings through watercraft inspection is a vital part of Wisconsin’s aquatic invasive species (AIS) prevention efforts. With so many waterbodies and so few state resources, the success and continuation of our watercraft inspection program has been very reliant upon our enthusiastic, highly motivated citizens. Since the creation of the Clean Boats, Clean Waters program in 2004, thousands of citizens have been trained at inspection workshops on how to initiate boater education efforts at their local boat landings. These volunteers, as well as paid staff, collect data about the actions of boaters and anglers and share information about how to help prevent the spread of aquatic invasive species. The data that has been gathered over the past six plus years has revealed some fascinating, and exciting, trends in the AIS preventative behaviors and AIS awareness of people using our boat landings. Even though an all-time-high of 50,034 boats were inspected in 2008, inspectors exceeded that number by more than 13,000 in 2009. More people were contacted during watercraft inspections in 2009 than ever before, as well. These exciting data finds wouldn’t exist if it weren’t for all of the volunteers and staff who collect and report inspection data. Thanks to all of you who have worked so hard to prevent the spread of AIS! It is clear were making a difference for Wisconsin’s waterbodies.

Youth Protecting Wisconsin Waters: The Department of Workforce Development Boat Inspection Program
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In the summer of 2009, an increase in watercraft inspectors was made possible by a new project and partnership with the Wisconsin Department of Workforce Development. Forty-nine young adults who were unfamiliar with aquatic invasive species (AIS) or outreach efforts were given the opportunity to become educators and help protect Wisconsin’s lakes by working as inspectors. With the support of numerous partner organizations and outstanding supervisors, these young adults, known as the Water Force, conducted boat inspections in 23 counties. Many of them gained valuable work experience and insight into their career interests, while lakes with an AIS presence gained some much needed boat inspections. Our partnerships were key in the evolution of the Water Force project, and the lessons learned will benefit future inspection efforts.
Preventing Saltcedar (Tamarix spp.) Invasion in the Northern Great Plains
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Although the seasonally wet conditions associated with the prairie pothole region (PPR) in the Northern Great Plains (NGP) appear uniquely suited for saltcedar (Tamarix spp.) invasion, this area has few infestations of this pervasive non-native. Saltcedar typically colonizes freshly exposed moist soils following disturbances including overgrazing, fire, or flooding. Controlled burns are being tested to manage other invasive species in NGP rangelands, which may inadvertently promote saltcedar invasion by opening the vegetative canopy. Saltcedar establishment was investigated in fire, clipped (simulated grazing), and control (nonburned/nonclipped) treatments in NGP PPR soils. Three soil cores per treatment were collected in spring immediately after fire treatment from three sites (one containing paired footslope and summit positions) in eastern South Dakota. Cores were seeded with saltcedar seeds in the greenhouse and subirrigated to maintain high soil water conditions typical near potholes during late spring/early summer. Seedlings were counted during the first three weeks and, in order to calculate growth rates, heights of five seedlings per core were measured weekly from weeks 3 to 7. More saltcedar seedlings established and had higher growth rates in fire treatments compared with controls from footslope positions. Fire did not influence these parameters at the summit. Clipping increased seedling establishment and growth rates in the absence of fire. These results suggest that opening the canopy with fire or grazing increases the potential for saltcedar invasion in lower-elevation areas of the NGP. Areas adjacent to viable saltcedar seed sources should be managed to maintain canopy cover to limit further establishment.

Firewood Use and Movement: Before and After Regulation and an Education Campaign
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Surveys were conducted in 2008 and 2006 following regulation of firewood allowed onto state lands and an associated education campaign. In both surveys, we measured camper attitudes, behaviors related to camping and firewood transport, and features of firewood supplies at/near state forests and parks. We also asked why campers brought firewood from home. For the 2008 survey, we included questions to help determine if various education efforts, regulations, and notices have influenced camper transport of firewood, and which of these efforts campers thought were most informative and/or persuasive. We also asked how firewood quality could be improved inside the parks and whether campers transported firewood when they visited private or county campgrounds. Over this period, awareness of emerald ash borer (EAB) increased, awareness of the role of firewood in spread of EAB increased, support for stopping long distance movement of firewood increased, and movement of firewood by respondents decreased. The most common source of information was parks staff and it was also the most trusted.

What Does “Local” Firewood Buy You? Managing the Risk of Invasive Species Introduction
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Firewood can serve as a vector in the transport of non-native species, including wood-boring insects that feed within the wood and thus can be transported accidentally. Governments have enacted limitations on the movement of firewood in an effort to limit the anthropogenic movement of non-native species through, for example, recreational camping. Although the movement of invasive species through firewood is a documented invasion pathway, it is not trivial for governments to determine a “safe” allowable distance for moving firewood. We were motivated by this challenge and developed a theoretical simulation to determine the campgrounds that could be potentially exposed to infested firewood based upon the hypothetical distribution of an invasive species and the allowable distance for moving firewood. We extend this concept to the known distributions of emerald ash borer (Agrilus planipennis Fairmaire) and Asian longhorned beetle (Anoplophora glabripennis Motschulsky). We illustrate, based upon theoretical and empirical
observations, that as the distribution of an invasive species increases, more rigid constraints on the movement of firewood would be required relative to those species that are distributed over a smaller scale. Also, on the level of management within a state, smaller states have far less margin for error than larger ones, as even extremely rigid restrictions on the movement of firewood could have little management effect unless the infested area is spatially limited. These results collectively suggest the potential for a dynamic management strategy that adjusts allowable distances for firewood movement based upon the distribution of the non-native species.

**NR 40 - Wisconsin's New Comprehensive Invasive Species Rule**

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After five years and the active involvement of hundreds of people, Wisconsin now has a comprehensive invasive species classification rule. Plants, animals and pathogens – aquatic and terrestrial – are all covered in one rule, although there are parts of the rule that relate to only one group of organisms. This new rule uses science-based assessments to classify and regulate exotic invasive plants, animals, and disease-causing microorganisms, as well as the various pathways by which invasives can be transported across the landscape. In 2001 the state legislature authorized the development of an advisory Council and required DNR to create an invasive species classification rule. The Wisconsin Council on Invasive Species created several subcommittees to provide a wide range of input into the rule-making process. The Research Committee developed a science-based set of criteria upon which to assess each species for classification. The following criteria are used: 1) current status and distribution, 2) establishment potential and life history traits, 3) damage potential, 4) socio-economic effects, and 5) control and prevention potential. Species Assessment Groups, comprised of experts and stakeholders, were formed for each group of species to review the literature and recommend a legal classification for each species. Extensive public review of the rule allowed diverse stakeholders to provide valuable input and lent credibility to the process, leading to wide-ranging acceptance and support of the final rule. Due to the large number of species listed, the need for staff training and public outreach is extensive.

**Forest Resource Information to Support Decision-makers and Land Managers**

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Since the discovery of emerald ash borer in Minnesota and Wisconsin, numerous news reports have cited statistics on the number and volume of ash trees in these states. Have you ever wondered how those numbers were derived? Would you like to generate similar statistics for your area of interest? The Forest Inventory and Analysis (FIA) program of the USDA Forest Service has been collecting information on forest resources since the 1930's. FIA gathers data across all 50 states on both public and private lands. Statistically precise estimates for a suite of forest attributes can be generated from data collected on a network of thousands of plots across Minnesota and Wisconsin. Highlighting ash as an example, we present a variety of resources, including maps, geospatial data-sets, on-line tools, and published reports, that decision-makers and land managers can use to help assess what’s at risk.

**Freshwater Ballast Treatment - Moving Toward Prevention in the Great Lakes**

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While ballast water treatment regulation and technology for saltwater vessels advances steadily, progress on freshwater applications has been slow. This is due largely to the relatively small number of freshwater vessels and differences in their operation and construction. Isle Royal National Park has partnered with industry, government, academia and non-profits to advance permanent, interim, and emergency freshwater ballast treatment for vessels in the Great Lakes. This poster presentation provides an update of our current efforts at developing ballast water treatment technology and emergency response procedures.
Invasive Species Early Detection and Rapid Response

Early Detection System for the Great Lakes Early Region
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The National Park Service (NPS), National Institute of Invasive Species Science (NIISS), Midwest Invasive Species Network, and University of Wisconsin-Madison are collaborating in the development, implementation, and maintenance of an online database and early detection warning system for invasive species. This database will provide new users with the ability to store and access data online and allow users with existing databases to contribute their data to a larger database by automatically sharing data across the region. We will also create an alert system from this database to inform users when new invasive species are reported. Alerts will be sent to users via email and can be tailored by the user using criteria such as species, area within the region, and/or habitat. This poster will feature a short description of the proposed system and feature a large blank space for participants in the conference to contribute their input on what features and functionality such a system should have in written form.

New Invaders to Wisconsin
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Yellow-floating heart (Nymphoides peltata), Brazilian Elodea (Egeria densa) and Red swamp crayfish (Procambarus clarkii) were recently discovered in Wisconsin. The ability to order these organisms over the internet and through mail order gives them the ability to travel to all parts of the world. Yellow-floating heart, a popular water garden plant, is very difficult to control due to its ability to form a new plant from rhizomes, stolons, separated leaves, plant fragments, or seeds. Attempts to mechanically harvest only serve as means of creating and introducing more plant fragments aiding in dispersal to new locations. Yellow-floating heart has the potential to colonize large areas within one growing season by means of vegetative propagation and a single plant can produce over 100 new plants in only 12 weeks. Periods of drawdown facilitate germination of the seeds, which stay viable for 3-5 years, and chemicals normally used in aquatic plant control seem ineffective. Brazilian waterweed, a top selling aquarium and pond plant, is native to South America. It grows in still and flowing waters such as lakes, ponds, pools, ditches, quiet streams and seems to grow best in mildly acidic, nutrient-rich lakes. During winter, it survives along the bottom and resumes growing when waters reach 50 degrees Fahrenheit. It forms mats dense enough to restrict water movement, trap sediment and cause fluctuations in water quality. Reproducing via fragmentation allows it to spread from a single plant and tends to choke out slower-growing native plants. It can out compete Eurasian water-milfoil. This species is the most widely introduced crayfish in the world. Red swamp crayfish are farmed extensively in the Southeastern United States and make up the vast majority of crayfish consumed worldwide. Biological supply companies commonly sell this species as pets or for educational purposes and they prefer marshes, swamps, ponds and slow moving rivers and streams, but have also become established in lakes.

Early Detection of Invasive Cereal Cyst Nematodes Using PCR-Restriction Fragment Length Polymorphism
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During the field season of 2009, Minnesota Department of Agriculture (MDA) field staff collected soil samples from small grain and corn fields across the state as part of a three year survey for invasive cereal cyst nematodes (CCN). The invasive cereal cyst nematodes surveyed for are Heterodera filipjevi, H. latipons and Punctodera chalcoensis. Also included in the survey are H. avenae and H. zea. Each year a third of the grain producing counties in the state are sampled. The soil samples are extracted using either a centrifugation and sugar flotation method or a Fenwick can extraction. Initial morphological screening separated any cysts in the genus Punctodera. The CCN cysts are in the same genus as the soybean cyst nematodes (SCN) found in Minnesota and are morphologically
similar. Molecular diagnostics are needed to differentiate the species. Cysts from the extracted samples are stored in a nematode extraction buffer followed by a DNA extraction. Initial polymerase chain reaction (PCR) screening for soybean cyst nematode (*Heterodera glycines*) is done and any positive finds eliminates those samples as suspect CCN. The remaining DNA samples are differentiated using a PCR-restriction fragment length polymorphism (RFLP) amplifying regions of the internal transcribed spacer, ITS1 and ITS2 and the 5.8S gene. Amplification was followed by RFLP digestions using up to three restriction endonucleases, HinfI, TaqI and PstI. The first year of sample screening done in 2009 resulted in no positive finds for CCN.

### Invasive Species Control and Management

**Yellow Floating Heart Eradication Experiences in Wisconsin**
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Wisconsin has had two cases of ponds infested with yellow floating heart (*Nymphoides peltata*). Manual removal either did not work, or was not an option, chemical control was ineffective, so both ponds were removed with care taken to remove and contain all seeds in water and mud. The ponds were rebuilt, and control efforts appear to have been effective. This poster provides photos, highlights problems/resolutions from both examples, and presents take home messages, along with contact info for both ponds.

**Biological Control of Garlic Mustard (*Alliaria petiolata*): an Update**
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Use of biocontrol agents to control garlic mustard would provide long-term control and management of this invasive biennial weed. Extensive host specificity testing on a potential biocontrol agent, the stem and crown-boring weevil, *Ceutorhynchus scrobicollis*, has been completed at CABI Bioscience in Switzerland and at the University of Minnesota. Results of these tests indicate that *C. scrobicollis* is a highly specific herbivore. At the University of Minnesota, the Level 2 High Security Containment Facility is currently the only location in the country where work on *C. scrobicollis* is being conducted. At this facility, we have been rearing and conducting host specificity testing with *C. scrobicollis* for the past five years. After completion of a series of vigorous host range tests, we have applied to the Technical Advisory Group (TAG) for Biocontrol of Weeds for approval for field release of *C. scrobicollis* and are now testing some additional native mustards at reviewers’ request. We will discuss the current status of our garlic mustard biocontrol project with *C. scrobicollis* as well as our work with *Ceutorhynchus alliariae*, another potential biocontrol insect.

**Impact of Mowing Timing on Japanese Hedge Parsley (*Torilis japonica*) Seed Production**
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Although a relatively new invader in Wisconsin, many believe that Japanese hedge parsley (*Torilis japonica*) will present a formidable challenge, and it is widely heralded as the next garlic mustard. As a prohibited/restricted species under new Wisconsin state legislation, management is required by law, and spreading Japanese hedge parsley seed, even accidentally during mowing, is illegal. This study investigated the impact of mowing timing on the quantity of Japanese hedge parsley seeds produced. Randomly sampled plants at three sites in south central Wisconsin (Black Earth, Madison, and Spring Green) were cut at different phenological stages throughout the summer. Data on phenology, height, aboveground biomass, and vegetation cover of Japanese hedge parsley were collected at each mowing interval. At every interval, cut plants were removed from the site and allowed to dry at room temperature.
The seeds initially produced from cut plants were counted. Individual plants were revisited in the fall, and the seeds produced from resprouting tissue were also collected and counted. Results will provide important basic information on the phenology and ecology of this new invader, as well as specific information on how to manage Japanese hedge parsley with mowing to prevent seed production.

**Cool Season Grass Management in Riparian Zones and Resulting Impact on Stream Characteristics**

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Riparian zones present challenges for the management of invasive species. Cool season grasses, particularly reed canary grass (*Phalaris arundinacea*), are known to invade these systems and form dense monocultures. To determine the best method for establishing higher biodiversity in these riparian zones and assessing ecosystem impact of methods, experiments were initiated at three sites in southwestern Wisconsin. A split plot design was implemented at each site with revegetation treatments as the main plot and control method as sub-plots. Control methods included late fall + spring glyphosate application at 0.84 kg ae/ha, spring glyphosate application at 0.84 kg ae/ha, mowing, and no treatment. Revegetation treatments included planting grasses and forbs with a no-till drill in spring, planting grasses with a no-till drill in spring and frost seeding forbs the following winter, and an unplanted control. An additional glyphosate application was made after several frosts, but prior to seeding forbs to provide additional weed suppression. Experiments were repeated at each site in an upstream location. Preliminary results indicate late fall + spring applications of glyphosate show the best control of cool season grasses, while increasing cover of biennial weeds. Treatment comparisons in terms of biodiversity and invasive control will be presented, as well as the establishment success of the different revegetation techniques. The impacts of both the treatments and the revegetation techniques on the stream ecosystem will also be presented. These findings provide valuable information on invasive cool season grasses and the best revegetation methods in disturbance sensitive riparian zones.

**Developing Biological Control for Common and Glossy Buckthorn**

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*Rhamnus cathartica* (common buckthorn) and *Frangula alnus* (glossy buckthorn) (Rhamnaceae) are both shrubs and small trees of Eurasian origin which have become invasive in North America. In 2001, a new research program to develop biological control for buckthorns was initiated. Candidate biological control agents would be monospecific to *R. cathartica* or *F. alnus* or their host ranges restricted to a few non-native species in the *Rhamnus* or *Frangula* genera. Initial surveys and research found that there were no species or genus-specific potential biocontrol agents for *F. alnus*. By 2008, several potential biocontrol agents had been identified for *R. cathartica*. Host-specificity testing focused on the leaf-feeding moth *Philereme vetulata*, the leaf-margin gall psyllid *Trichocheermes walkerii*, and the seed-feeding midge *Wachtiella krumbholzi*. *P. vetulata* was determined not to show enough host-specificity and will be eliminated from future testing. Future work will include continuing to assess the feasibility of using *T. walkerii*, *Cacopsylla rhamnicolla* (psyllid), and *W. krumbholzi* as biological control agents for *R. cathartica*. However, the phytoplasma ‘*Candidatus Phytoplasma rhamni*’ (buckthorn witches’ broom) has been detected in two populations of *T. walkerii* in Switzerland. *T. walkerii* is the first insect host record for this phytoplasma. Additional study of the phytoplasma is necessary to determine if *T. walkerii* could be used as a biological control agent. Research will also be conducted to determine the causes of the high levels of seed and seedling mortality of *R. cathartica* observed in Europe as a step toward identifying additional potential biological control agents including pathogens.
Biological Control of Invasive Plants in Minnesota
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Biological control, the use of natural enemies to control non-native pests, can be an effective tool in managing invasive plants. Non-native plants can become invasive because they lack the insects and diseases that control them in their native environments. Biological control reunites natural enemies, such as herbivores and pathogens, with their host (invasive plant) to reduce impacts caused by the pest. Frequently, this involves the use of specialized insects that were tested extensively for host specificity (safety) and efficacy. The goal of biological control is not to eradicate the invasive plant, but to reduce its impact to an acceptable level. The Minnesota Departments of Agriculture and Natural Resources have implemented successful biological control programs for leafy spurge (Euphorbia esula), spotted knapweed (Centaurea biebersteinii), and purple loosestrife (Lythrum salicaria, L. virgatum, hybrids, and cultivars) statewide. Development of new biological control efforts for garlic mustard (Alliaria petiolata), buckthorn (Rhamnus cathartica and Frangula alnus), and common tansy (Tanacetum vulgare) are underway.

Southeast Ohio Non-Native Invasive Species Interest Group: Building Collaboration for Landscape-Level Impacts
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In 2007 a group of interested stakeholders, including private landowners, land managers, researchers and non-profit organizations began meeting to explore opportunities to share knowledge and experience and coordinate efforts across the landscape. This group identified three watersheds in Southeastern Ohio where the presence of public lands and private non-profit lands intermixed with private holdings could create the right conditions for successful Cooperative Weed Management Areas (CWMAs). Groups and individuals within these three areas began working together to: remove the most vigorous of invasive species; prevent new infestations through early detection and rapid response; and educate and engage landowners, citizens and youth about non-native invasive species (NNIS) in order to have positive landscape-level impacts. Future direction for the group includes participation in the Central Hardwoods Invasive Plant Network (CHIP-N), which inventoried and mapped aquatic and terrestrial NNIS along portions of the Ohio River, its tributaries and nearby inland lakes in 2010.

Preliminary Characterization of Digestive Enzymes in Native Mussels and Zebra Mussels: a Step Toward Developing a Species-Specific Control for Aquatic Invasive Species
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Resource managers consistently list the lack of chemical tools to control aquatic invasive species, like zebra mussels (Dreissena polymorpha), as a top resource concern. Zebra mussels have been reported to clog water intakes for hydroelectric companies; displace native mussel species; and are believed to be a source of avian botulism. A molluscicide that can be delivered to zebra mussels while limiting impacts on non-target native species is highly desirable. One possible delivery method is to exploit enzymatic differences used for digestion. Unfortunately, little is known about the digestive physiology of zebra mussels and native mussels. Therefore, we characterized the enzymatic profile of the digestive glands of zebra mussels and two native mussels: threeridge (Ambeloma plicata) and pocketbook (Lampsilis cardium). A commercial enzyme kit, api®ZYM (bioMérieux, Inc. Durham, NC), was used to qualitatively assess enzymatic profiles among the three species. Preliminary results suggest further study of N-acetylglucosaminidase (NAGase), an enzyme responsible for the degradation of mucopolysaccharides and glycoproteins. This enzyme appears to be present at a higher concentration in zebra mussels than either of the two native mussel species. Differences in either the presence or activity levels of enzymes may be incorporated into a zebra mussel specific molluscicide delivery system.
Efforts to Develop Potential Selective Agents for the Control of Common Carp (*Cyprinus carpio*) Through Large-Scale Synthesis of GD-174 and Analog Design

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Controlling the population of non-native carp in upper Midwestern waterways has been a problem for several decades. In the 1970’s GD-174 was discovered by Marking et al. as a fish toxicant that exhibited selectivity towards common carp. This selectivity, coupled with its fairly short half-life in aqueous solutions, made it a compound of great interest. Unfortunately, pond trials conducted in 1983 by Gilderhus and Burress demonstrated that GD-174 did not induce a complete carp kill in 19 of 23 ponds. Further studies to understand this drop in activity have not been pursued, and it is possible that with new technology and understanding, GD-174 may be a potential solution to the carp problem. A scalable synthesis of GD-174 has been developed in two steps from geraniol. Through implementation of the synthesis, 18 grams of GD-174 have been made that will be used to more fully study its activity in whole fish assays. Additionally, the synthesis provides a route for analogs that have been chosen to alter its ability to bind to aquatic plant life, which may increase bioavailability of the compound in fish habitats.

The Effects of Burning and Herbicide Treatments on Spotted Knapweed (*Centaurea maculosa*)

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Previous research has shown biological controls for invasive species are effective, but it takes several years to see results. Herbicides and mechanical controls have been studied and shown to work, but they can be costly and labor intensive. The best approach for controlling invasives has been an integrated approach. The purpose of this study is to test a combination of herbicide and burning treatments to help reduce the spread and control spotted knapweed (*Centaurea maculosa*). The burning treatments will use a catalyst of invasive free hay. The herbicide treatments will use Milestone, a chemical produced by DowAgro®. I expect that the combination of the burning and herbicide treatment will have the greatest reduction in post treatment percent cover when compared to the control. The burning only treatments will have higher post treatment percent cover when compared to the control. Once this study is complete, it will demonstrate a new integrated management strategy for spotted knapweed.

Identification and Management of Weedy Umbels

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White umbelliferous plant species have been invading various habitats in Wisconsin ranging from dry prairies and roadsides to riparian corridors for several years and still they are hard to distinguish from one another. This poster will compare similarities and differences between these species and provide some control information. Species included will be: Giant hogweed (*Heracleum mantegazzianum*), Japanese and spreading hedge-parsley (*Torilis japonica; T. arvensis*), Queen Anne’s lace (*Daucus carota*), poison hemlock (*Conium maculatum*), wild chervil (*Anthriscus sylvestris*), and burnett-saxifrage (*Pimpinella saxifraga*).
Prairie Restoration: Increasing Warm-Season Native Grasses with Fire, Herbicide, and Nitrogen Application
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Only 3% of the original 260 million acres of native tallgrass prairie exists in the United States today. Reduction of native prairie acreage has been influenced by farming, loss of historic interactions with buffalo and fire, and the introduction of exotic plants. Introduced plant species often outcompete native species for resources including nutrients, light, and water causing reductions in overall diversity of the remaining prairie. This study examines the use of prescribed burns, glyphosate, and nitrogen application at specific stages of plant growth to reinvigorate native species and suppress invasive species at two South Dakota locations that contain a mix of native and exotic, non-native species. Native species include big bluestem (*Andropogon gerardii*), sideoats and blue grama (*Bouteloua curtipendula* and *B. gracilis*) and accounted for 35-60% of the starting vegetation. Invasive species of interest consists of smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*). First year field results of the herbicide treatment applied after native grass senescence the previous fall indicates a visual decrease in non-native grass species cover and an observed increase in forb production, such as sweet clover (*Melilotus officinalis*). Plots that received a prescribed burn in spring and evaluated six weeks later had stunted non-native grass growth and an increase in native grass species in both biomass and visual presentation. Continued field work includes further evaluation of first year treatments (fall sampling) and a second year of repeated treatments and evaluations. Organisms: big bluestem (*Andropogon gerardii*), sideoats (*Bouteloua curtipendula*) and blue grama (*Bouteloua gracilis*) Herbicides: glyphosate (32 oz./acre fall treatment, 8 oz./acre spring rate)
<table>
<thead>
<tr>
<th>Author Name</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abrahamson, Mark</td>
<td>17, 35, 49</td>
</tr>
<tr>
<td>Ahlen, Paul</td>
<td>35</td>
</tr>
<tr>
<td>Allinger, Lisa E.</td>
<td>19</td>
</tr>
<tr>
<td>Alness, Jon</td>
<td>44</td>
</tr>
<tr>
<td>Amberg, Jon</td>
<td>69</td>
</tr>
<tr>
<td>Anderson, Neil</td>
<td>58, 59</td>
</tr>
<tr>
<td>Andow, David A.</td>
<td>57, 62</td>
</tr>
<tr>
<td>Bajer, Przemek</td>
<td>48</td>
</tr>
<tr>
<td>Balcer, Mary D.</td>
<td>19</td>
</tr>
<tr>
<td>Balfour, Martha</td>
<td>6</td>
</tr>
<tr>
<td>Beck, K. George</td>
<td>16</td>
</tr>
<tr>
<td>Becker, Roger</td>
<td>14, 16, 24, 29, 59, 67</td>
</tr>
<tr>
<td>Bergeron, Dale</td>
<td>18</td>
</tr>
<tr>
<td>Biske, Rich</td>
<td>23</td>
</tr>
<tr>
<td>Blackburn, Laura M.</td>
<td>64</td>
</tr>
<tr>
<td>Blair, Robert B.</td>
<td>5</td>
</tr>
<tr>
<td>Blickenderfer, Mary</td>
<td>30</td>
</tr>
<tr>
<td>Blossey, Bernd</td>
<td>24, 67</td>
</tr>
<tr>
<td>Bode, Jeff</td>
<td>62</td>
</tr>
<tr>
<td>Boe, Arvid A.</td>
<td>57</td>
</tr>
<tr>
<td>Boos, Thomas</td>
<td>10, 65</td>
</tr>
<tr>
<td>Bozek, Michael A.</td>
<td>46</td>
</tr>
<tr>
<td>Braustrup, Donn K.</td>
<td>28</td>
</tr>
<tr>
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