Invasive Non-native Plant Management During 2001

by

Miles Falck
Wildlife Biologist

and

Steve Garske
Invasive Plant Aid

Administrative Report 02-08
September 30, 2002

Great Lakes Indian Fish
& Wildlife Commission
Biological Services Division
P.O. Box 9
Odanah, WI 54861
(715) 682-6619

TABLE OF CONTENTS

List of Tables

List of Figures

EXECUTIVE SUMMARY

The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) is an organization exercising delegated authority from 11 federally recognized tribes in Minnesota, Wisconsin, and Michigan (Figure 1). These tribes retain hunting, fishing, and gathering rights in the territories ceded to the United States through various treaties (Figure 1). The exercise of these rights may be threatened by the degradation of native ecosystems by invasive non-native plants.

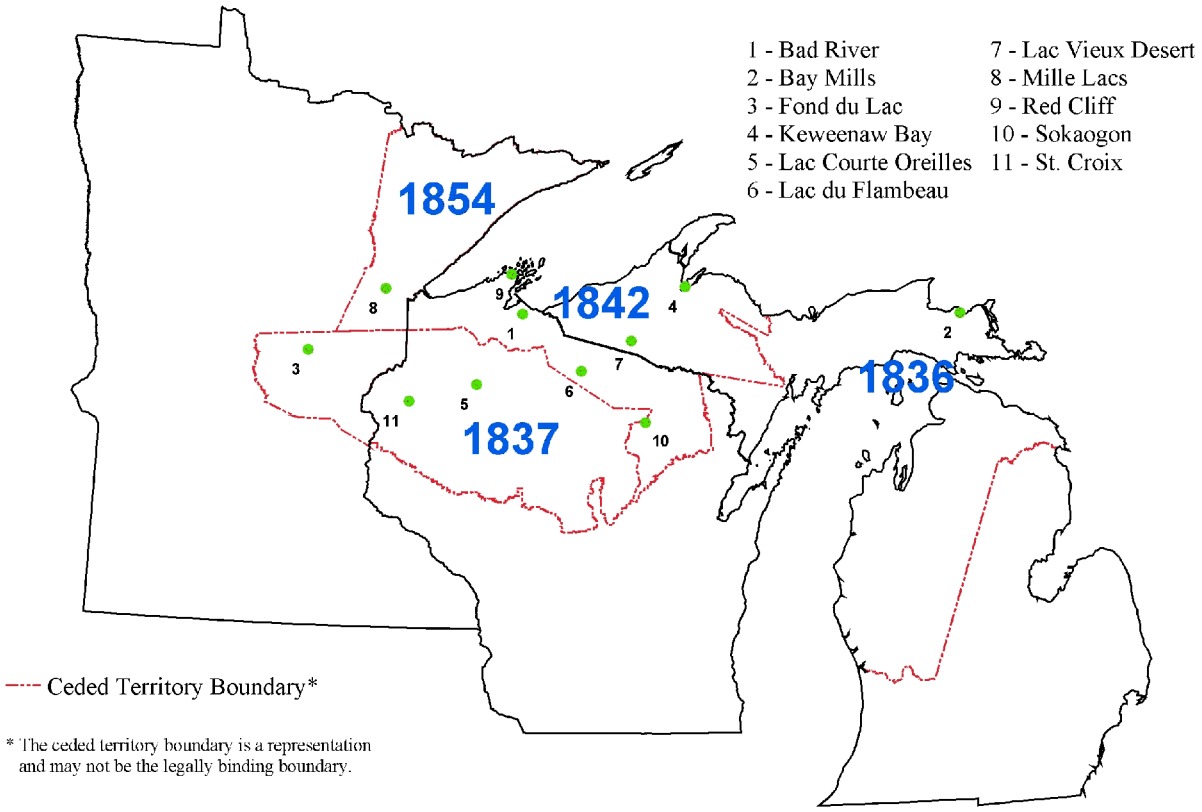


Figure 1. Locations of GLIFWC member tribes and ceded territories.

This report summarizes the activities undertaken by GLIFWC staff during 2001 to address the spread of invasive non-native plant species in the ceded territories. Since 1988, GLIFWC staff have conducted annual inventory and control work on purple loosestrife (*Lythrum salicaria*) (Gilbert and Parisien 1989, Edblom *et al.* 1995, Gilbert *et al.* 1995, Gilbert *et al.* 1998, Falck *et al.* 1999, Falck *et al.* 2000, Falck 2001). In 2001, GLIFWC staff identified the need to 1) continue and expand purple loosestrife control activities, 2) inventory and assess the threat of other non-native plants that are becoming established in the region, 3) continue educational

outreach activities aimed at preventing the introduction and spread of additional non-native plants, and 4) continue to coordinate activities with cooperating resource agencies, universities, non-governmental organizations, and the general public. Vascular plant nomenclature cited in this report follows Gleason and Cronquist (1991).

ACKNOWLEDGMENTS

The activities summarized in this report were partially funded by the Bureau of Indian Affairs' Noxious Weed Program (BIA), the Environmental Protection Agency's Great Lakes National Program Office (EPA-GLNPO), the Natural Resources Conservation Service's Environmental Quality Incentive Program (NRCS-EQIP), NRCS-EQIP Multi Agency Land & Water Education Grant Program, and The Nature Conservancy (TNC).

PURPLE LOOSESTRIFE CONTROL ACTIVITIES IN THE BAD RIVER-CHEQUAMEGON BAY WATERSHED

INTRODUCTION

Purple loosestrife (*Lythrum salicaria*) is a perennial, herbaceous wetland plant native to Europe. It arrived in eastern North America in the early 1800's via plants brought by settlers and seeds carried within livestock and the ballast holds of ships (Thompson *et al*. 1987). In North America, purple loosestrife quickly spread westward displacing native wetland plant communities. Its current distribution covers much of the U.S. and Canada. GLIFWC has been treating purple loosestrife within the Bad River - Chequamegon Bay watershed since 1988. The Nature Conservancy (TNC) has been contributing to this effort in cooperation with GLIFWC since 1998 with an emphasis on private lands in the upper reaches of the watershed.

METHODS

Purple loosestrife populations within the Bad River - Chequamegon Bay watershed were inventoried in 1994, 1995, 1999, and 2000 (Gilbert *et al.* 1995, Edblom *et al.* 1995, Falck and Sutton 2000, Falck 2001). Data from these surveys were used to prioritize effort and select control methods based on the area of the site, number of plants, and the site's location within the watershed. Small sites with few plants (< 1 acre or < 1,000 plants) that threatened to infest downstream reaches were given the highest priority for chemical control (Figure 2). Large sites (> 1 acre or >1,000 plants) were given low priority for chemical control but high priority for biological control (Figure 2).

Chemical Control:

Prior to conducting field applications of herbicide, all loosestrife control workers attended a 1-day training workshop conducted by GLIFWC staff. Participants learned or reviewed safe handling, storage, and application procedures, applicable state and federal regulations, and received training on equipment operation and maintenance.

Herbicides were applied to loosestrife stands using backpack sprayers. Glyphosate, a non-selective herbicide, was used in very dense stands or over water. The dicot-specific herbicide triclopyr was used on dry sites such as roadsides and fields. Efforts were focused primarily on the Fish Creek Slough, and the Highway 13 right-of-way between Highbridge and Washburn. Private uplands in the Highbridge area were treated primarily by staff from TNC with assistance from the GLIFWC crew, after consent forms were signed by the landowner.

Biological Control:

The release of *Galerucella* beetles (native to Europe) in the United States for biological control of purple loosestrife was approved by USDA - APHIS in 1992. *Galerucella* beetles were

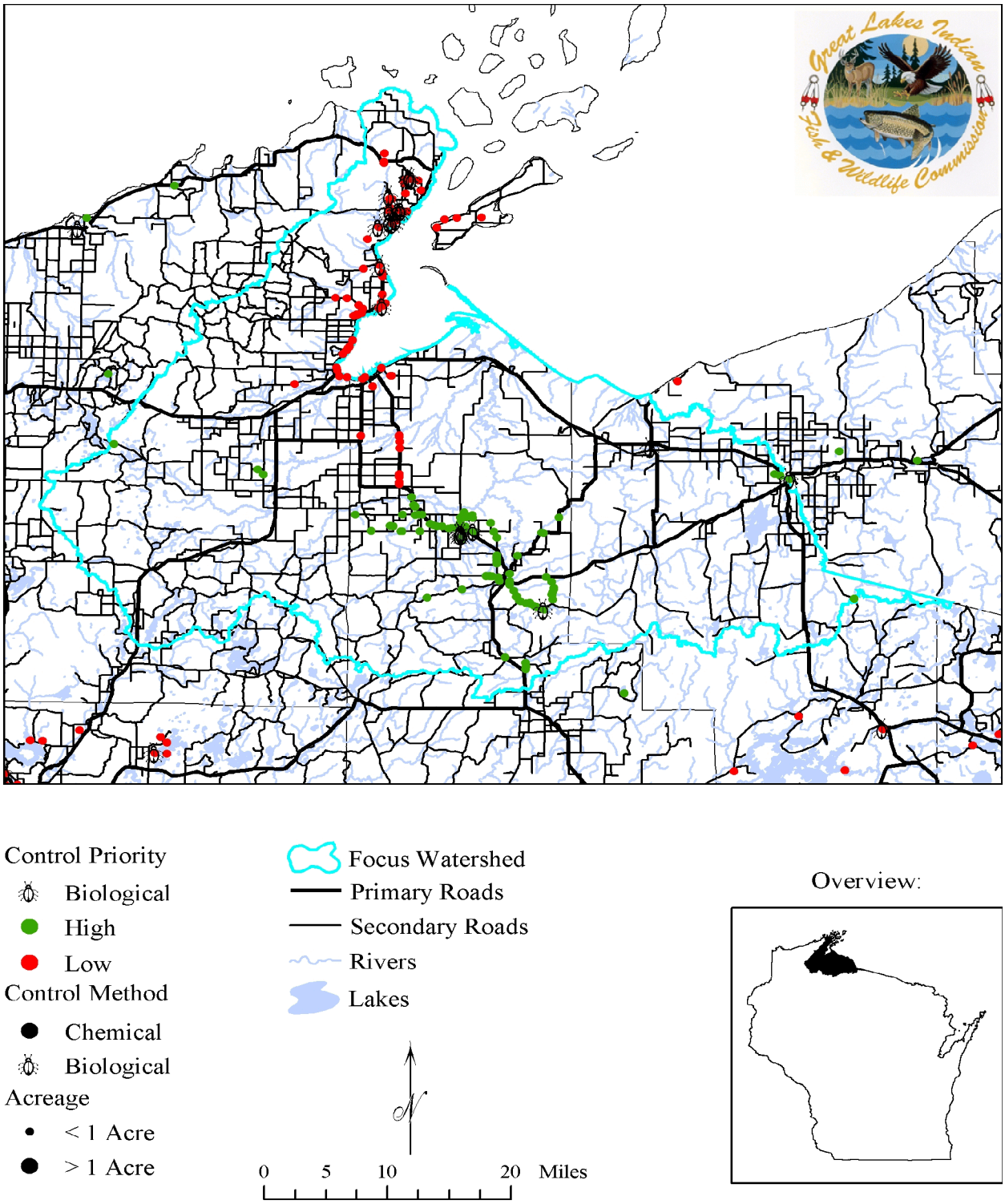


Figure 2. Control priority and method for off-reservation purple loosestrife sites, 2001.

reared following methods outlined by Loos and Ragsdale (1998). Mature purple loosestrife root stock was transplanted into pots from a population on Wisconsin DNR property, at the mouth of the Sioux River. The UW-Extension's Ashland Agricultural Research Station provided space for rearing *Galerucella* beetles. One hundred sixty potted plants were placed in small wading pools containing 4-6 inches of water. In late May and early June, adult *Galerucella* beetles were collected from previous release sites and placed on the potted plants. Approximately 10-12 beetles were placed on each plant, which were enclosed in individual mesh net bags to protect the beetles and their larvae from bird and insect predation. An estimated 750 adult beetles (Brock Woods, WI DNR, pers. comm.) were reared in each pot.

Evaluation

Spatial data collected during annual surveys were used to quantify the progress of control efforts. Treated loosestrife patches were identified on maps and coded for control in 2001. Each *Galerucella* release site was photographed during the peak of purple loosestrife's blooming period to document the pre-treatment condition of each site. Summary statistics for treated patches were calculated using ArcView GIS.

RESULTS

A total of 109 sites were treated in 2001. GLIFWC crews released approximately 122,000 *Galerucella* beetles among 7 sites and treated another 62 sites with herbicide, while TNC crews applied herbicide at 40 additional sites (Figure 3). The success of biological controls was evaluated at the 16 sites where beetles were introduced in 2000. *Galerucella* beetles successfully overwintered at all 16 sites, and a reduction in loosestrife flowering was visually apparent at 2 of these sites (Figures 4 and 5).

DISCUSSION AND FUTURE WORK

The use of biological controls has expanded the acreage treated annually by GLIFWC's purple loosestrife control program and allowed control crews to place more emphasis on treating small roadside populations with herbicide before they become significant source populations. Increased production of *Galerucella* beetles in 2002 will enable GLIFWC to expand biocontrol efforts beyond the Bad River - Chequamegon Bay watershed.

Regional coordination of control efforts will benefit from GLIFWC's participation in the Wisconsin Wetland Association's new statewide survey to update purple loosestrife distribution data and digitize existing biocontrol sites. GLIFWC will host this data on its Internet map server (www.glifwc-maps.org). Data from Minnesota and Michigan will be added in 2002 as well.

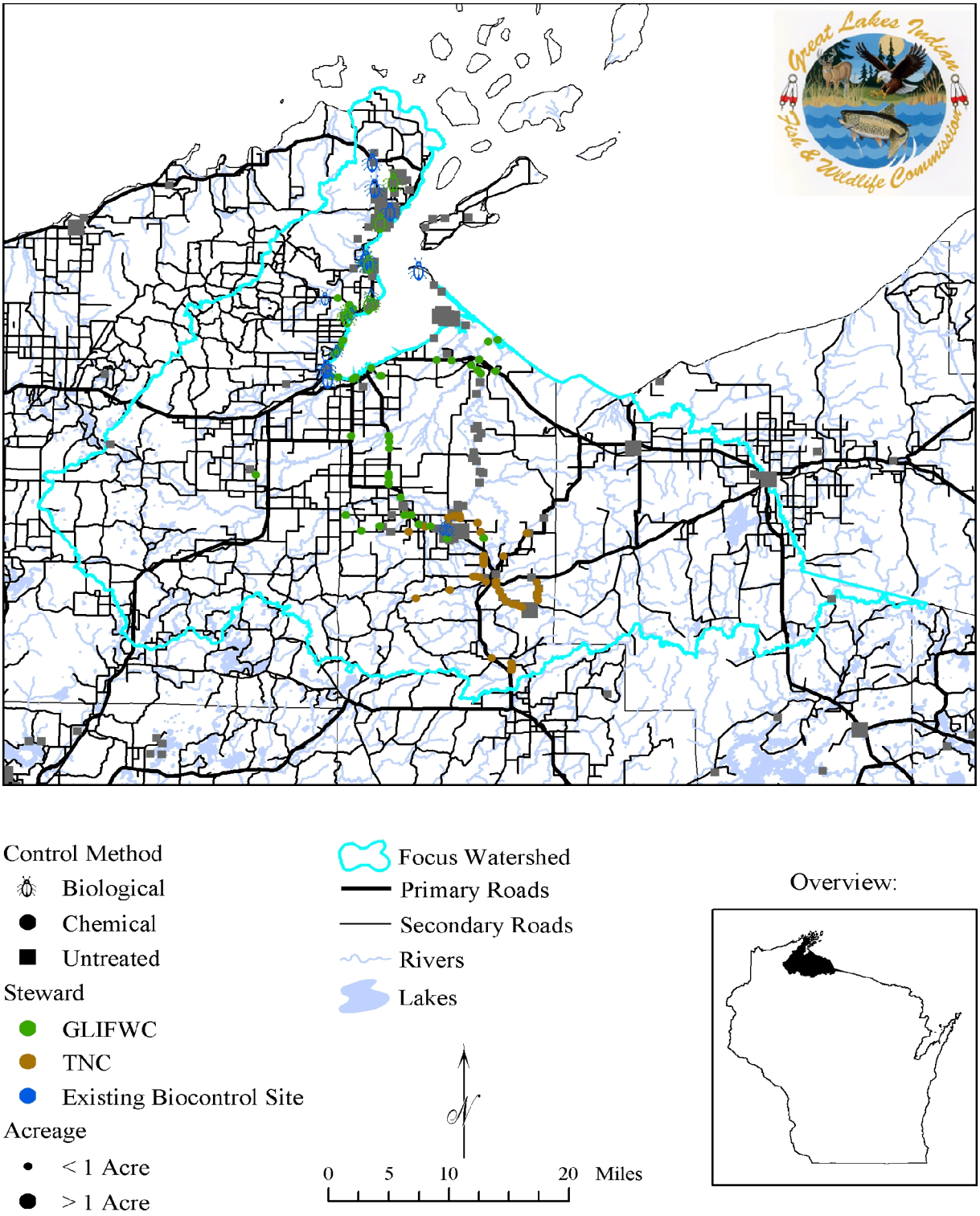


Figure 3. Purple loosestrife control activities in the Bad River-Chequamgeon Bay watershed, 2001.

Figure 4. Comparison of purple loosestrife flowering in 2000 vs. 2001 at Washburn site following release of *Galerucella* beetles in July, 2000.

Figure 5. Comparison of purple loosestrife flowering in 2000 vs. 2001 at Bayfield site following release of *Galerucella* beetles in July, 2000.

INVASIVE PLANT SURVEY

INTRODUCTION

In addition to purple loosestrife, GLIFWC recognizes that a multitude of other non-native plant species are present within the ceded territories. Some of these pose serious risks to the integrity of local ecosystems. Besides physical displacement of native flora and fauna, non-native plants can alter fire frequency, hydrologic properties, soil chemistry, and the structure and function of entire ecosystems (Westbrooks 1998).

Non-native plants vary substantially in their impacts and feasibility of control. Management of these plants will require an accurate inventory, objective prioritization criteria, and an array of effective integrated control methods. To help address these needs, GLIFWC conducted a survey of Ashland and Bayfield counties in the summer of 2001, to determine the composition, relative abundance, and distribution of non-native invasive plants. The information will be compiled with data from published literature and other sources, to develop a database that can be used to prioritize species for future management.

METHODS

The survey targeted the most likely areas for non-native plant introductions. Road corridors were surveyed from a vehicle while sites with high visitation rates (e.g. boat landings, trail-heads, parks) and sites with potential to serve as source populations (e.g. old homesteads, gravel pits) were surveyed on foot. Surveys were conducted throughout the growing season and most routes were re-surveyed to account for the different phenology of various species. While road corridor surveys have obvious shortcomings, such surveys can still be informative (Mack 2000, Brown *et al.* 2001). The biggest advantage is being able to cover a large territory in a relatively short amount of time. Roadsides are a logical place to survey for non-native plants because they often act as corridors, facilitating invasion of disturbance-dependent species (Heckman 1999, Parendes and Jones 2000, Brown *et al.* 2001).

The locations of non-native plant populations were determined using a hand held GPS receiver. Data files were then differentially corrected and exported as shapefiles for use in ArcView GIS. Where satellite signals were unavailable, locations were plotted on a map and later digitized manually using ArcView GIS. Attributes for each site were recorded using the receiver's "data dictionary" (Table 1).

Voucher specimens intended for herbarium accession were collected from selected populations, depending on how "unique" the population was relative to its known distribution. These were submitted to the Wisconsin State Herbarium, University of Wisconsin - Madison

Table 1. Site attributes collected during the 2001 invasive plant survey.

Attribute	Categories
Area	living room (0.004 Acres) baseball diamond (0.200 Acres) football field (1.00 Acres) > football field (> 1.00 Acres)
Number of Plants	<50 50-1000 >1000
Habitat	open shoreline wooded woodland edge
Hydrology	dry mesic seasonally wet wet
Land Use	agricultural natural area right-of-way urban
Disturbance	construction cultivation foot traffic logging motorized traffic mowing unknown
Land Ownership	county federal local municipality private state tribal

(WIS), the University of Wisconsin - Oshkosh Herbarium (OSH), and/or GLIFWC's herbarium in Odanah. Numerous photographs were also taken of both native and non-native plant species during the course of the survey for use in developing educational materials. The location, date, and subject of each photo was recorded for future reference.

RESULTS AND DISCUSSION

Overview

Unfortunately, Ashland and Bayfield counties have not escaped the worldwide influx of invasive, non-native plants. A number of significant or serious invasives [*e.g.*, spotted knapweed (*Centauria maculosa*), common tansy (*Tanacetum vulgare*)] have already become so common and widespread (at least along roadsides) throughout most or nearly all of the survey area, that it was not practical to record their presence (Table 2) [Purple loosestrife was not recorded because comprehensive distribution data has already been obtained for this plant in the project area (Gilbert *et al.* 1995, Edblom *et al.* 1995, Falck and Sutton 2000, Falck 2001)]. However, most of the invasive plants documented during this survey have not yet reached anywhere near their potential in terms of frequency or abundance. Some of the most ecologically invasive species noted during this survey are discussed briefly below.

Approximately 1,780 km of roadsides, 39 recreational sites (campgrounds, parks, and trail-heads), and 99 boat landings were surveyed for the presence of non-native plants (Figure 6). A total of 882 non-native plant populations were recorded (Figure 7) representing 59 taxa (Table 3). Genera most frequently encountered included *Salix* (18%), *Lonicera* (13%), *Rhamnus* (10%), *Coronilla* (10%), *Lathyrus* (8%), *Euphorbia* (6%), and *Valeriana* (4%). Similarly, comparison of acre class midpoints revealed that *Salix* occupied the most area, followed by *Rhamnus*, *Lonicera*, *Lathyrus*, *Euphorbia*, and *Valeriana*. Non-natives plants were most often found along woodland edges (52%), followed by open areas (36%), wooded areas (7%), and shorelines (5%). Figure 8 depicts those species encountered most frequently by habitat.

Well-established, major invasives

Two Eurasian buckthorn species almost certainly rank among the most serious invasives found in the survey area. Although common buckthorn (*Rhamnus cathartica*) typically invades upland sites and glossy buckthorn (*R. frangula*) typically invades wetland sites, there can be substantial habitat overlap. Both are aggressive, shade-tolerant shrubs that can rapidly invade natural ecosystems, displace natural vegetation, and even prevent the establishment of tree seedlings (Catling and Porebski 1994, Archibold *et al.* 1997, Czarapata 1999). While the berries of these two species are attractive to birds, their diarrhetic qualities can result in a net energy loss (Czarapata 1999). Both species have become major problems throughout much of the eastern US and adjacent Canada, and are increasing in abundance in the upper Great Lakes region.

The survey found that common buckthorn is well-established in woodlots around several towns and cities, including Ashland, Washburn, Bayfield, Highbridge, and Mason. (A substantial patch was also found just south of US Hwy 2, near the Bad River.) Glossy buckthorn is common in Prentice Park just west of Ashland and in Memorial Park just north of Washburn. Substantial populations of both species (often growing together) were found just west of the Great Divide District of the Chequamegon-Nicolet National Forest (CNNF), in Bayfield county. It is also

Table 2. Introduced taxa that were too widespread to map effectively during the 2001 survey.

Species	Common Name	Typical Habitat
Agrostis gigantea	Redtop	roadsides, barrens
Arctium minus	Burdock	fields, roadsides, disturbed woods
Bromus inermis	Smooth Brome	fields, roadsides, disturbed woods, wetland edges, barrens
Centaurea maculosa	Spotted Knapweed	roadsides, barrens
Chrysanthemum leucanthemum	Ox-eye Daisy	fields, roadsides, disturbed woods, wetland edges
Cirsium arvense	Canada Thistle	fields, roadsides, disturbed woods, wetland edges
Dactylis glomerata	Orchard Grass	fields, roadsides, disturbed woods
Daucus carota	Queen Anne's Lace	fields, roadsides
Elytrigia repens	Quackgrass	fields, roadsides, disturbed woods, barrens
Festuca arundinacea	Tall Fescue	fields, roadsides, disturbed woods, wetlands
Glechoma hederacea	Creeping Charlie	fields, disturbed woods, wetland edges
Hieracium aurantiacum	Orange Hawkweed	fields, roadsides, disturbed woods, barrens
Hieracium piloselloides	Yellow Hawkweed	fields, roadsides, barrens
Hypericum perforatum	Common St. John's Wort	fields, roadsides, disturbed woods, wetland edges
Linaria vulgaris	Butter and Eggs	fields, roadsides, barrens
Lotus corniculatus	Birds-foot Trefoil	fields, roadsides, barrens
Lupinus polyphyllus	Bigleaf lupine	fields, roadsides, disturbed woods
Melilotus alba	White Sweet Clover	fields, roadsides
Melilotus officinalis	Yellow Sweet Clover	fields, roadsides
Phalaris arundinacea	Reed Canary Grass	fields, roadsides, wetlands
Phleum pratense	Timothy Grass	fields, roadsides, wetland edges
Poa compressa	Canada Bluegrass	roadsides, barrens
Poa pratense	Kentucky Bluegrass	fields, roadsides, disturbed woods, wetland edges
Ranunculus acris	Tall Buttercup	fields, roadsides, disturbed woods, wetland edges
Rumex acetocella	Red Sorrel	roadsides, barrens
Tanacetum vulgare	Common Tansy	fields, roadsides, disturbed woods, wetland edges, barrens
Taraxacum officinale	Dandelion	fields, roadsides, woods, wetland edges
Trifolium pratense	Red Clover	fields, roadsides, disturbed woods
Trifolium repens	White Clover	fields, roadsides, disturbed woods
Verbascum thapsus	Mullein	fields, roadsides, barrens

well-established along portions of the White River and in surrounding areas of southwestern Bayfield county, on both public and private lands. It is abundant in wetlands on both sides of County Highway H, from Delta northeastward towards Iron River, and has begun to colonize wetland edges within the Great Divide district.

Eurasian bush honeysuckles (including *Lonicera tatarica*, *L. morrowii*, and their hybrid, *L. x bella*) have also become established throughout eastern temperate North America (Schmidt

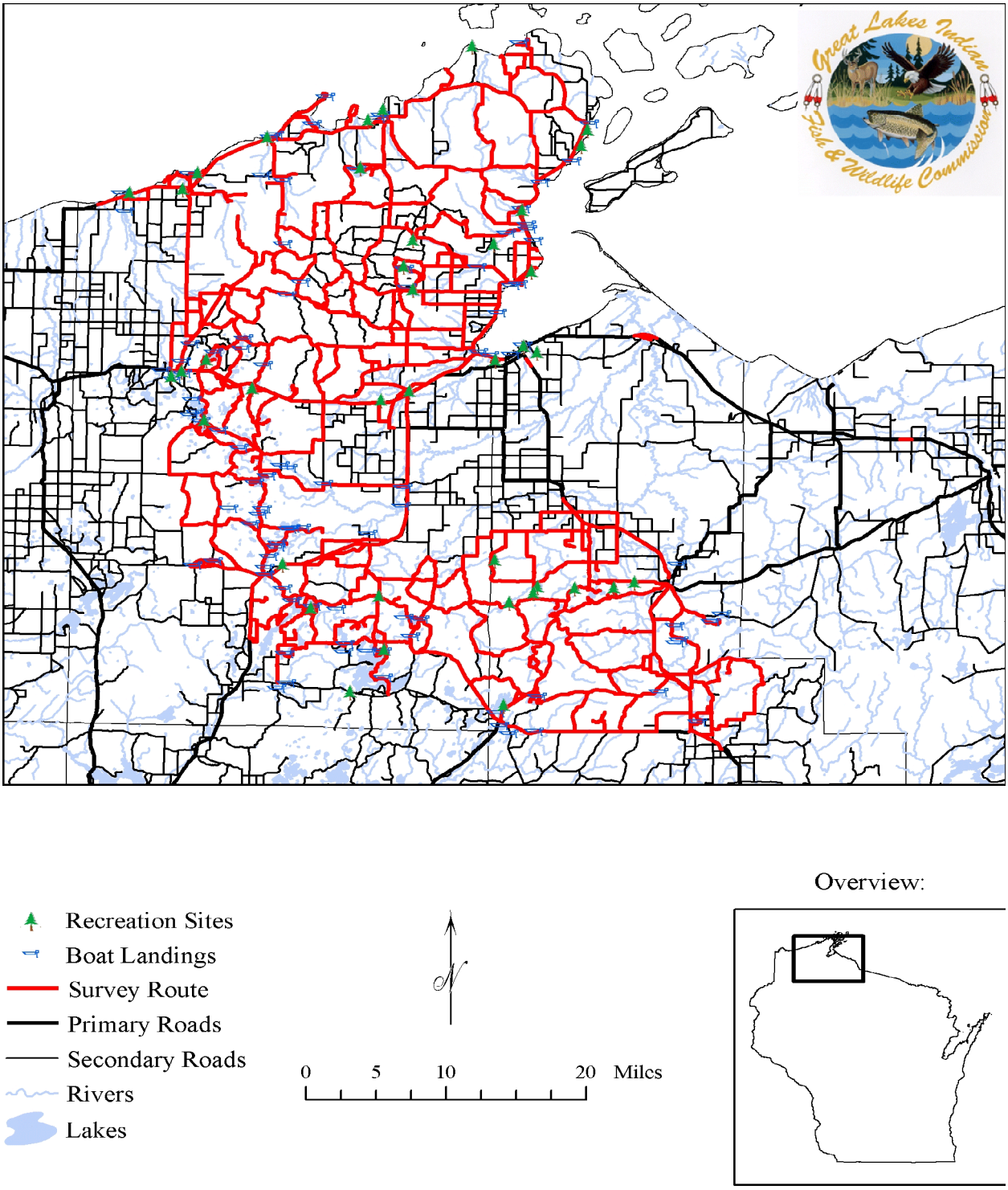
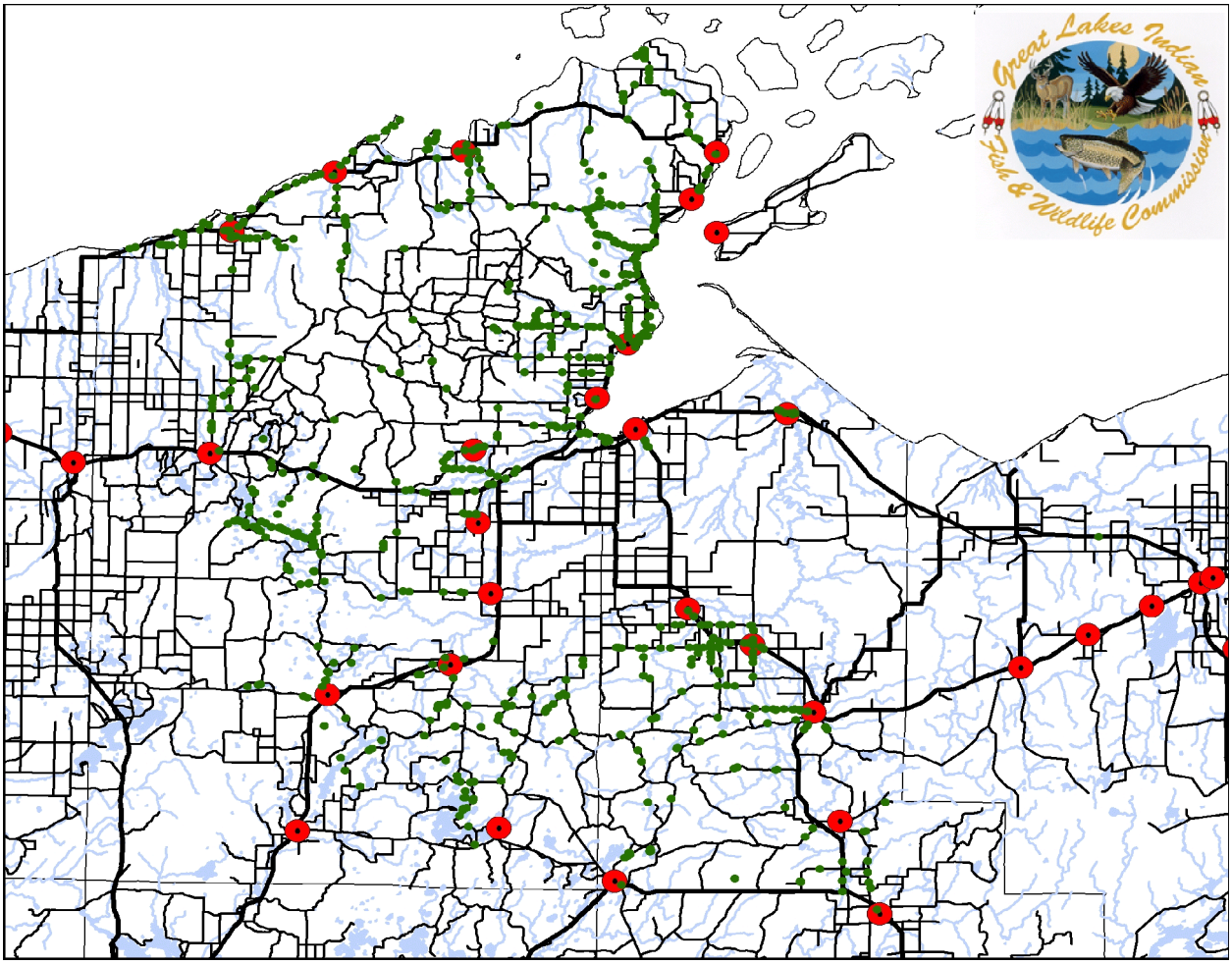


Figure 6. Invasive plant survey route, 2001.



Non-Native Plant Populations
Cities
Primary Roads
Secondary Roads
Rivers
Lakes

0 5 10 20 Miles

Overview:

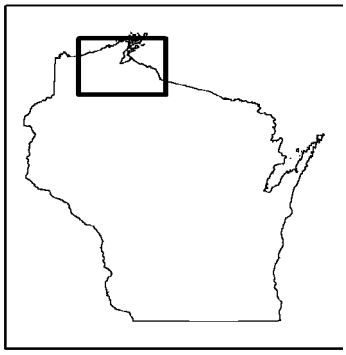


Figure 7. Non-native plant populations detected in 2001.

Table 3. Summary of non-native plant taxa detected during 2001 surveys.

Taxa	Common Name	No. of Sites	Percent of Sites
Salix fragilis	Crack Willow	163	18.5%
Lonicera spp.	Eurasian Bush Honeysuckles	121	13.7%
Coronilla varia	Crown Vetch	92	10.4%
Lathyrus sylvestris	Everlasting Pea	74	8.4%
Rhamnus frangula	Glossy Buckthorn	53	6.0%
Euphorbia esula	Leafy Spurge	50	5.7%
Valeriana officinalis	Garden Heliotrope	41	4.6%
Rhamnus cathartica	Common Buckthorn	39	4.4%
Robinia pseudoacacia	Black Locust	22	2.5%
Veronica officinalis	Common Speedwell	20	2.3%
Anthoxanthum odoratum	Sweet Vernal Grass	19	2.2%
Polygonum sachalinense	Japanese Knotweed	18	2.0%
Lapsana communis	Nipplewort	14	1.6%
Pastinaca sativa	Wild Parsnip	13	1.5%
Solanum dulcamara	Nightshade	11	1.2%
Aegopodium podagraria	Goutweed	9	1.0%
Berberis thunbergii	Japanese Barberry	8	0.9%
Knautia arvensis	Blue Buttons	8	0.9%
Linaria dalmatica	Dalmation Toadflax	8	0.9%
Saponaria officinalis	Soapwort	8	0.9%
Phlox paniculata	Summer Phlox	7	0.8%
Achillea ptarmica	Sneezeweed	6	0.7%
Campanula rapunculoides	Bellflower	6	0.7%
Miscanthus sacchariflorus	Amur Silver Grass	5	0.6%
Vinca minor	Periwinkle	5	0.6%
Convallaria majalis	E. Lilly of Valley	4	0.5%
Setaria faberi	Giant Foxtail Grass	4	0.5%
Sorbus aucuparia	European Mtn. Ash	4	0.5%
Ulmus pumila	Siberian Elm	4	0.5%
Ranunculus repens	Creeping Buttercup	3	0.3%
Rosa spp.	Eurasian Rose	3	0.3%
Acer platanoides	Norway Maple	2	0.2%
Elaeagnus angustifolia	Russian Olive	2	0.2%
Elaeagnus umbellata	Autumn Olive	2	0.2%
Euphorbia cyparissias	Cypress Spurge	2	0.2%
Galium verum	Yellow Bedstraw	2	0.2%
Lathyrus tuberosus	Everlasting Pea	2	0.2%
Malva moschata	Musk Mallow	2	0.2%
Rorippa nasturtium-aquaticum	Water-cress	2	0.2%
Salix alba	White Willow	2	0.2%

Taxa	Common Name	No. of Sites	Percent of Sites
Secale cereale	Perennial Rye	2	0.2%
Sorbaria sorbifolia	False Spiraea	2	0.2%
Viburnum lantana	Wayfaring Tree	2	0.2%
Betula pendula	European White Birch	1	0.1%
Calamagrostis epigejos	Feathergrass	1	0.1%
Caragana arborescens	Siberian Pea Shrub	1	0.1%
Filipendula ulmaria	Queen-of-the-meadow	1	0.1%
Hemerocallis lilioasphodelus	Lemon Daylily	1	0.1%
Iris pseudacorus	Water Flag	1	0.1%
Lathyrus latifolius	Everlasting Pea	1	0.1%
Leonurus cardiaca	Motherwort	1	0.1%
Lychnis viscaria	German Catchfly	1	0.1%
Mentha × gentilis	Scotch Mint	1	0.1%
Rosa eglanteria	Sweetbrier Rose	1	0.1%
Rumex acetosa	Green Sorrel	1	0.1%
Salix pentandra	Bay-leaved Willow	1	0.1%
Thymus pulegioides	Wild Thyme	1	0.1%
Veronica arvensis	Corn Speedwell	1	0.1%

and Whelan 1999). These species were found along road corridors, forest edges, and some interior forest sites throughout much of the survey area, in both wet and dry soils. They also appeared to be spreading from cities, towns, and agricultural areas into natural areas. While not as shade-tolerant as the two buckthorns, they have a wide ecological amplitude and are capable of invading, persisting, and reproducing in disturbed forests, forest edges, wetlands, and even the barrens. Schmidt and Whelan (1999) found that American robin (*Turdus migratorius*) nesting success was significantly lower in nests built in *Lonicera maackii* (another Eurasian bush honeysuckle) and common buckthorn than in native shrub species. Eurasian bush honeysuckles produce relatively energy-poor, low-quality fruits (Williams 1999).

Crack willow, white willow, and presumably their hybrid (*Salix fragilis*, *S. alba*, and *Salix × rubens* Schrank, respectively) proved to be common and apparently spreading in flood plains and wetland edges throughout much of the survey area, particularly in farm country. These willows are often planted as shelterbelts and shade trees along rivers and streams, where they readily spread. While information on the effects of colonization of natural communities by these species in eastern North America appears to be limited, one might reasonably suspect that the addition of a large, fast-growing riparian tree species would have significant effects on these communities.

Garden heliotrope (*Valeriana officinalis*) has established widely scattered colonies across much of the survey area, including an extensive roadside infestation just north of Washburn. This species was first introduced into the Duluth-Superior area in 1938 (MINN 2002). It has since

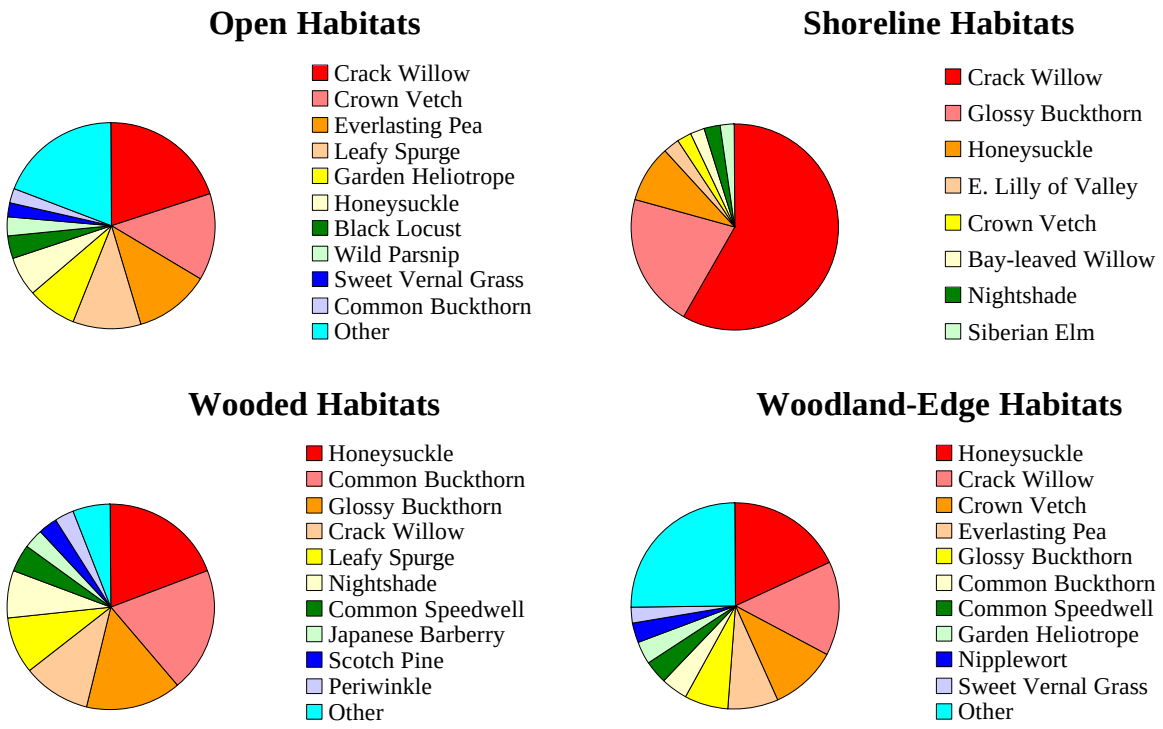


Figure 8. Most frequently observed non-native flora by habitat.

become abundant there and appears to be spreading eastward. Scattered infestations were found in Bayfield county, including a large one along Superior Avenue just north of Washburn. A long-time resident there informed us that this population had originated from 3 plants planted in a local garden roughly 60 years ago. This species is moderately shade-tolerant and capable of forming dense stands in open wet woods, moist meadows, and wetlands. It is wind-dispersed and capable of traveling long distances. While little has apparently been published on the invasive tendencies of this weed in North America, our personal observations and experience lead us to include it as an important and potentially major invasive here. Some infestations of this species may still be small and discrete enough to be controlled or eradicated.

A large colony of Dalmatian toadflax (*Linaria dalmatica*) was discovered along the Whiting Road corridor, west of Hwy 13, between Washburn and Bayfield in Bayfield county. This colony extends for roughly 3 miles along both sides of the road, invading adjacent openings and open woods. This species has become a serious weed of roadsides, rangelands, and disturbed open woods in the western US and Canada (Vujnovic and Wein 1997, Carpenter and Murray 1998). It rapidly invades on course-textured soils, particularly after disturbance. Once established, it is a strong competitor, and difficult to impossible to eradicate. Fortunately, several

(moderately effective) biocontrol organisms have been approved for its control (Julien 1992, Carpenter and Murray 1998).

Asian knotweeds (*Polygonum cuspidatum* and *P. sachalinense*) are commonly planted around the survey area (particularly in eastern and northern Bayfield county), and generally spread clonally, forming large patches which eliminate competing species. These species have become important pests across much of temperate North America (Toney *et al.* 1998, Reeder and Eick 2001) and major pests in Britain (Beerling *et al.* 1994). The two species are closely related and capable of hybridizing. Fortunately, their spread in North America (and most of their introduced range) is limited to vegetative dispersal, as only male-sterile (functionally female) forms of each have been introduced (at least so far).

Still-uncommon, major invasives

Japanese barberry (*Berberis thunbergii*) is established in a fairly mature, closed-canopy hardwood forest north of Drummond. This species is already a major understory invasive in eastern deciduous forests (Kourtev *et al.* 1998, Ehrenfeld 1999, Ehrenfeld *et al.* 2001), and has formed several large colonies in western Upper Michigan (Steve Garske, pers. obs.). This very spiny, shade-tolerant species can invade a wide variety of dry to wet forest habitats, sometimes forming dense, impenetrable thickets. Its bright red berries often remain on the plants well into the winter, a reflection of their low nutrient value and unattractiveness to birds (Ehrenfeld 1999). While other populations of this species may well exist undetected within the survey area, it is apparently still uncommon here overall, and may still be amenable to control measures.

Except for occasional yard trees, Norway maple (*Acer platanoides*) was rarely detected during the survey. This is very likely due at least in part to its rather close superficial resemblance to sugar maple (*A. saccharum*), a dominant in the region's hardwood forests. This very shade-tolerant species has also become a major invasive of relatively undisturbed, mature deciduous forests of the northeastern US and adjacent Canada, where it is replacing the two overstory dominants, sugar maple and American beech (*Fagus grandifolia*) (Kloeppel and Abrams 1995, Wyckoff and Webb 1996, Anderson 1999, Webb *et al.* 2000). With its milky sap, Norway maple is presumably useless for maple syrup/sugar production. Thus this species poses a direct long-term threat to a very important cultural and economic resource of the upper Great Lakes region.

Another species of serious concern in pine barrens habitats is autumn-olive (*Elaeagnus umbellata*). Our survey found two small populations of this species, one well within the Moquah barrens. This species was (and occasionally still is) promoted for wildlife plantings and erosion control. It has become a major pest on dry, infertile soils in parts of Ontario and the US (Sather and Eckardt 1987, Catling *et al.* 1997). Its seeds are widely distributed by birds. While not highly shade-tolerant, it is drought-tolerant and a nitrogen-fixer, and is able to displace native vegetation and alter natural communities. In addition to these two colonies, at least one other site for this species exists just west of the survey area, in northwest Bayfield county (WIS 2002).

While leafy spurge (*Euphorbia esula*) is still uncommon in the survey area, several colonies occur on private land just east of the Moquah barrens. A notorious invasive weed in the western US, it is a threat to open, mesic to dry habitats in the eastern US also (Bangsund *et al.* 1999, Czarapata 1999, Di'tomaso 2000). One population is quite large and dominates both sides of the road and an adjacent pasture. Except for goats and sheep, which favor the flower clusters, spurge is generally poisonous to domestic and wild grazers, reducing forage available to them (Olson and Wallander 1998, Czarapata 1999). Although its shade-tolerance is low, this species is extremely competitive and aggressive in mesic to dry open habitats, and presumably presents a significant threat to the open woods and other sandy habitats characteristic of the Moquah barrens.

Spotted knapweed is already widely established along roadsides and disturbed, dry areas throughout the survey area and the upper Great Lakes region (WIS 2002). Its shade-tolerance is low, precluding its spread into relatively undisturbed, closed-canopy forest. It has become a major weed of open pastures, grasslands, and rangeland over much of the western US, however (Harris and Cranston 1979, Roche and Roche 1991), and presumably presents a significant threat to the Moquah barrens. At least twelve insect species and one rust fungus have been released to combat spotted knapweed so far (Julien 1992, Weeden *et al.* 2002), several of which have been released (but have not necessarily become established) in the upper Midwest (Weeden *et al.* 2002). Spotted knapweed is a rare species in its indigenous range, apparently because of parasitism and predation by these organisms (Lang 2002).

Additional problem species

This survey revealed several relatively invasive species that, by their apparently aggressive behavior, have the potential to cause serious problems in the future. Some of these species are apparently still rare in the region and thus might be justified as targets for control or eradication from the region as a precautionary measure.

Woodland everlasting pea (*Lathyrus sylvestris*) proved to be abundant along highway corridors, logging roads, and woods edges along parts of the survey route, especially in eastern and northern Bayfield county. In these areas, this species was often the dominant along right-of ways (and in one case, a large "wildlife opening") for stretches of as much as several miles. By contrast, two cogeners, common everlasting pea (*L. latifolius*) and tuberous everlasting pea (*L. tuberosus*), often considered more invasive than *L. sylvestris*, were found in only a few sites. It is not clear at this point how invasive and persistent *L. sylvestris* will prove to be in natural ecosystems, and what effects it will have on them, but its abundance in these habitats is cause for concern.

Due to its bird-distributed seeds, bittersweet nightshade (*Solanum dulcamara*) is widely established in the Upper Great Lakes region. Its habitat is usually low open woods and open or

shaded wetlands, but it can survive and reproduce in dry upland sites as well (Pegtel 1985). Unripened berries are toxic to mice (and people) (Hornfeldt and Collins 1990). Due to its often low stature and ability to colonize forested or brushy areas, populations of this species are undoubtedly under-represented in the data.

Scotch pine (*Pinus sylvestris*) was not recorded at first, as it was assumed to be predominantly a plantation tree. After learning that it was a pest that freely re-seeded in parts of the Moquah barrens (Russ Newman, CNNF, pers. comm.), we began recording it. Most of the populations in the survey area appear to be discrete plantings, but seedlings and saplings are not infrequent, especially in older plantings (Steve Garske, pers. obs.). It is a species that should be monitored, and its planting should be discouraged.

Although not formally recorded during the survey, garden forget-me-not (*Myosotis sylvatica*) is widely established in more mesic road corridors, logging roads, and disturbed woods throughout the survey area. In western Upper Michigan it is locally abundant, invading relatively undisturbed, mature hardwood forests. Where it is found it often carpets the ground with its numerous deep blue flowers in the spring, and dying brown stems of spent plants by mid summer. In these areas it is often the most abundant plant on the forest floor by far in terms of numbers of individuals (or shoots), and perhaps in terms of biomass as well. Similar to *Alliaria petiolata* (garlic mustard), this species is a very shade-tolerant biennial or short-lived perennial. [Garlic mustard is an obligate biennial in North America (Anderson *et al.* 1996)]. Garden forget-me-not may one day turn out to be a major woodland pest.

One still-uncommon species (actually a species complex) includes brown knapweed (*Centaurea dubia*), black knapweed (*C. jacea*), and their fully-fertile hybrid, meadow knapweed (*C. jacea* × *C. nigra*, or *C.* × *pratensis*). These have collectively become established in several locations within the survey area along US Hwy 2. Additionally, a large population of *C.* × *pratensis* occurs along Hwy 2 just east of Wakefield, Michigan. Here, it is spreading into relatively undisturbed wet meadow (Steve Garske, pers. obs.). Roche and Roche (1991) consider these knapweeds (especially *C.* × *pratensis*) to be potentially serious invasives in the Pacific Northwest.

Another still-uncommon but potentially invasive species is blue buttons (*Knautia arvensis*). Blue buttons was found in relatively small but dense populations along roadsides in northern and central Bayfield county, as well as in open woods along the North Country National Scenic Trail in central Bayfield county.

Several Amur silvergrass (*Miscanthus sacchariflorus*) patches were found, most of which had obviously originated as plantings. One large population, on the southern edge of the Marengo city limits, appeared more or less “naturalized”, however. This species has been shown to be cold-hardy in USDA hardiness zone 4a (Meyer *et al.* 1994).

One wild and one cultivated colony of wayfaring tree (*Viburnum lantana*) was found. Unlike most native *Viburnum* spp., which tend towards moist to wet habitats, wayfaring tree is a dryland species (Moor 1981), listed as an obligate upland species in Michigan by Herman *et al.* 2001. Along with a number of other invasive species, the US National Arboretum still promotes this species for landscaping, recommending it for dry sites in full sun (USNA 1999).

Yellow bedstraw (*Galium verum*) was found dominating an old homestead site as well as forming a smaller patch in partial shade, along the North Country Trail. German catchfly (*Lychnis viscaria*), which is apparently known in Wisconsin from only one northeastern Bayfield county site (WIS 2002), appears to be spreading rapidly into pasture and open woods there.

A number of seemingly less aggressive invasives are also established in the region. These include nipplewort (*Lapsana communis*), common speedwell (*Veronica officinalis*), and sweet vernal grass (*Anthoxanthum odoratum*), which appear to be moving into the region from the south and east. Common speedwell is well-established in hardwood forests of western Upper Michigan, forming patches of up to a meter or so across, and often appearing as a native there (Steve Garske, pers. obs.). While its low stature and lack of large showy flowers surely resulted in its being under-recorded, it appeared to be fairly frequent in the eastern part of the survey area and uncommon to rare in the western part. Other species of concern in the surveyed area include bell flower (*Campanula rotundifolia)*, soapwort (*Saponaria officinalis)*, black locust (*Robinia pseudoacacia*), and goutweed (*Aegopodium podagraria*).

Although not found during our survey, one other invasive is poised to become a serious problem in the Upper Great Lakes Region. Eurasian marsh thistle (*Cirsium palustre*) is a large (to 2 m or more), very spiny monocarpic perennial that is well-established throughout most of Upper Michigan, and has spread into adjacent lower Michigan and northeastern Wisconsin (Voss 1996, WIS 2002). Voss (1996, p. 519) briefly describes marsh thistle's introduction and spread in Michigan. It continues to spread rapidly westward and southward. British Columbia has issued an invasive plant "Alert Notice" for this species (Martin 2001). It is somewhat shade tolerant, and can apparently invade and displace native vegetation in a wide variety of damp to wet habitats, from roadside ditches to open wet woods and wetlands (Voss 1996, Martin 2001).

Summary

In general, there appears to be a strong tendency for species used as landscape plantings to become established just outside of cities, towns, and other areas of settlement, decreasing in abundance with distance from these areas (Figure 7). These species appear to be following roads, trails, power and gas corridors, and other disturbed areas away from plantings and other points of introduction. By contrast, except for the occasional presence of one or more of the "ubiquitous" species mentioned above (Table 2), relatively undisturbed forests and other habitats in and around the CNNF appear to be mostly free of invasive species. Thus there is still an opportunity to implement carefully-planned control measures against some of these species.

GLIFWC is currently compiling a comprehensive invasive plant database that will facilitate prioritization of invasive plant species for management purposes based on the following general criteria: (1) current ecological impacts, (2) potential ecological impacts, and (3) feasibility of control. The field data and observations collected during this survey will be included in the database to help gauge current ecological impacts based on species composition, relative abundance, and affected habitats in the survey area.

INVASIVE PLANT EDUCATIONAL OUTREACH ACTIVITIES

INTRODUCTION

Because the vast majority of invasive plant introductions are attributable to human activities, effective prevention and control efforts depend on an informed public. Unfortunately, awareness of the ecological and economic impacts of invasive plants among the general public is generally low (Colton and Alpert 1998). To help address this situation, GLIFWC initiated an educational outreach program in 1998 to raise public awareness of this important issue.

PROGRAM OVERVIEW

A suite of educational materials, with an emphasis on purple loosestrife, have been compiled and/or developed to reach a broad range of audiences. These materials include brochures, slide and poster presentations, and videos. Additional outreach is provided via the *Exotic Plant Information Center* web site (www.glifwc.org/epicenter), newspaper articles, and presentations at local events. In 2001, emphasis was placed on upgrading the web site to include additional invasive species and provide a "clearinghouse" for information on invasive plants in the upper Great Lakes region.

ACCOMPLISHMENTS

In 2001, GLIFWC distributed 1,200 *Purple Loosestrife: What You Should Know, What You Can Do* brochures and 5,200 *Plants Out of Place* brochures to cooperating agencies, non-government organizations, and private citizens. Several articles were also written or contributed to GLIFWC's newsletter *Mazina'igan*, the *Ashland Daily Press*, and the *ANS Update* (Newsletter of the Great Lakes Panel on Aquatic Nuisance Species). GLIFWC's purple loosestrife program was also featured on the nationally televised program *The Cutting Edge of Technology Report: Plants out of Place (Exotic Weeds)*, produced by the Information Television Network. The program debuted in Washington D.C. during "National Invasive Weeds Awareness Week" in March, 2001.

A comprehensive web site devoted to purple loosestrife was initially published on GLIFWC's web site in 1999. In 2001, a series of java-scripted templates were developed to standardize the look of the site, and improve site navigation. The web site was also reorganized into 9 sections (Table 4). Although still under construction, the new templates and organization provide a foundation that makes it much easier to add and update information. Species accounts were added for buckthorn, honeysuckle, leafy spurge, and garlic mustard. Photographs, distribution data, and other information obtained during the invasive plant survey will be added to the site in 2002.

Table 4. Organization and status of GLIFWC exotic plant web site.

Section	Description	Status
Species Accounts	Information on ID, ecology, impacts, and control	6 spp. online
Internet Map Server	Interactive maps depicting distribution and control efforts	loosestrife data online
Literature Search	Searchable database of literature citations	under construction
GLIFWC Reports	GLIFWC's annual invasive plant reports in PDF format	online
Slide Library	Searchable database of images available for educational	online
Educational Materials	Links & contacts for obtaining educational materials	online
Internet Resources	Links to other invasive plant web sites	online
Funding	Information on grants funding invasive plant activities	under construction
Site Map	Aids navigation within the web site	online

REMAINING NEEDS

Information on non-native invasive plants is widely scattered. In 2002, GLIFWC will place an emphasis on using the web site as a means of coordinating and consolidating this information to provide a comprehensive portal for anyone seeking information on invasive plants in the upper Great Lakes region.

INTERAGENCY COORDINATION

INTRODUCTION

Because non-native invasive plants disperse widely across the landscape and administrative boundaries, it is advantageous to work cooperatively towards management and control objectives. In addition, the number of new exotics being introduced into local ecosystems continues to out-pace control activities, and is too much for any one agency to manage alone.

ACTIVITIES

To address this need, GLIFWC has undertaken several activities designed to enhance cooperation and coordination among government agencies, non-government organizations, and private citizens (Table 5).

Table 5. Cooperative activities conducted in 2001.

Cooperators	2001 GLIFWC Activities
Keweenaw Bay Indian Community (KBIC)	Provided ~8,000 *Galerucella* beetles for control of purple loosestrife.
Northwoods Weed Initiative (NWI)	Developed a poster highlighting NWI activities for the *Plants out of Place* Conference in March, 2001.
Invasive Plant Association of Wisconsin (IPAW)	Consulted with IPAW's Science Committee to design and implement a survey to solicit data on invasive plants from professionals in the field.
The Nature Conservancy (TNC)	Coordinated purple loosestrife control efforts in the Bad River - Chequamegon Bay watershed.
Wisconsin Dept. of Natural Resources (WIDNR)	Participated on WIDNR's Invasive Species Team to provide technical advice to the Governor's Task Force on Invasive Species.
U.S. Forest Service (USFS)	Compiled USFS invasive plant distribution data with GLIFWC data for future Internet map services.
Other cooperating agencies	Provided educational brochures to numerous cooperators.
Internet users	Upgraded *Exotic Plant Information Center* web site and Internet map server software and content.

FUTURE WORK

In 2002, GLIFWC will continue to provide *Galerucella* beetles and other technical assistance to GLIFWC member tribes requesting those services. Additional activities will include assisting the Wisconsin DNR develop a statewide Aquatic Nuisance Species Management Plan that accommodates Tribal concerns, consulting with IPAW's education committee and the UW Extension to identify cooperative projects that increase public awareness of invasive species issues.

LITERATURE CITED

Anderson, R. 1999. Disturbance as a factor in the distribution of sugar maple and the invasion of Norway maple into a modified woodland. Rhodora. 101:264-273.

Anderson, R. C., S. S. Dhillion, and T. M. Kelley. 1996. Aspects of the ecology of an invasive plant, garlic mustard (*Alliaria petiolata*), in central Illinois. Restoration Ecology. 4:181-191.

Archibold O.W., D. Brooks, and L. Delanoy. 1997. An investigation of the invasive shrub European buckthorn, *Rhamnus cathartica* L., near Saskatoon, Saskatchewan. Canadian Field Naturalist. 111:617-621.

Bangsund, D. A., F. L. Leistritz, and J. A. Leitch. 1999. Assessing economic impacts of biological control of weeds: the case of leafy spurge in the northern Great Plains of the United States. Journal of Environmental Management. 56:35-43.

Beerling, D. J., J. P. Bailey, and A. P. Conolly. 1994. Biological flora of the British Isles. *Fallopia japonica* (Houtt.) Ronse Decraene (*Reynoutria japonica* Houtt.; *Polygonum cuspidatum* Sieb and Zucc.). Journal of Ecology. 82:959-979.

Brown, W. T., M. E. Krasny, and N. Schoch. 2001. Volunteer monitoring of nonindigenous invasive plant species in the Adirondack Park, New York, USA. Natural Areas Journal. 21:189-196.

Carpenter, A. and T. Murray. 1998. Element stewardship abstract for *Linaria genistifolia* (L.) P. Miller ssp. *dalmatica* (L.) Maire & Petitmengin (synonym: *Linaria dalmatica* (L.) P. Miller) and *Linaria vulgaris* P. Miller (Dalmatian toadflax, broad-leaved toadflax and yellow toadflax, butter and eggs, wild snapdragon, common toadflax). (March 25, 1998). *TNC wildland invasive species team page*. http://tncweeds.ucdavis.edu/esadocs/documnts/linadal.html. (15 July 2002).

Catling P.M., M. J. Oldham, D. A. Sutherland, V. R. Brownell, and B. M. H. Larson. 1997. The recent spread of autumn-olive, *Elaeagnus umbellata*, into Southern Ontario and its current status. Canadian Field Naturalist. 111:376-380.

Catling, P. M. and Z. S. Porebski. 1994. The history of invasion and current status of glossy buckthorn, *Rhamnus frangula*, in Southern Ontario. Canadian Field Naturalist. 108:305-310.

Colton, T. F. and P. Alpert. 1998. Lack of public awareness of biological invasions by plants. Natural Areas Journal. 18:262-266.

Czarapata, E. J. 1999. Invading weeds: a growing threat to Wisconsin's biological diversity. Elizabeth J. Czarapata, Muskego, Wisconsin , USA.

Di'tomaso, J. M. 2000. Invasive weeds in rangelands: species, impacts, and management. Weed Science. 48:255-265.

Edblom, T., J. Gilbert, L. Dlutkowski, and S. Peterson. 1995. Purple loosestrife surveys in Wisconsin and Michigan during 1995. Admin. Rep. 95-11. Great Lakes Indian Fish and Wildlife Commission, Odanah, Wis.

Ehrenfeld, J. G. 1999. Structure and dynamics of populations of Japanese barberry (*Berberis thunbergii* DC.) in deciduous forests of New Jersey. Biological Invasions. 1:203-213.

Ehrenfeld, J. G., P. Kourtev, and W. Huang. 2001. Changes in soil functions following invasions of exotic understory plants in deciduous forests. Ecological Applications. 11:1287-1300.

Falck, M. 2001. Invasive non-native plant management during 2000. Admin. Rep. 01-07. Great Lakes Indian Fish and Wildlife Commission, Odanah, Wisconsin, USA.

Falck, M. and E. Sutton. 2000. 1999 Invasive exotic plant activity report. Admin. Rep. 00-01. Great Lakes Indian Fish and Wildlife Commission, Odanah, Wisconsin, USA.

Falck, M., J. Gilbert, and O. Gonzalez. 1999. 1998 Purple loosestrife survey and control activities. Admin. Rep. 99-07. Great Lakes Indian Fish and Wildlife Commission, Odanah, Wisconsin, USA.

Gilbert, J., B. Carlson, and R. LaRue. 1995. Purple loosestrife survey of the Bad River watershed, 1994. Admin. Rep. 95-01. Great Lakes Indian Fish and Wildlife Commission, Odanah, Wisconsin, USA.

Gilbert, J., K. Linder, and M. Falck. 1998. 1996 Purple loosestrife survey and control activites. Admin. Rep. 98-6. Great Lakes Indian Fish and Wildlife Commission, Odanah, Wisconsin, USA.

Gilbert, J. and R. Parisien. 1989. Purple loosestrife control efforts of the Great Lakes Indian Fish and Wildlife Commission 1988-1989. Admin. Rep. 89-13. Great Lakes Indian Fish and Wildlife Commission, Odanah, Wisconsin, USA.

Gleason, H. A. and A. Cronquist. 1991. Manual of the vascular plants of northeastern United States and adjacent Canada. Second edition. The New York Botanical Garden, New York, New York, USA.

Harris, P. and R. Cranston. 1979. An economic evaluation of control methods for diffuse and

spotted knapweed *Centaurea diffusa* and *Centaurea maculosa* in western Canada. Canadian Journal of Plant Science. 59:375-382.

Heckman, C. W. 1999. The encroachment of exotic herbaceous plants into the Olympic National Forest. Northwest-Science. 73:264-276.

Herman, K. D., L. A. Masters, M. R. Penskar, A. A. Reznicek, G. S. Wilhelm, W. W. Brodovich, and K. P. Gardiner. 2001. Floristic quality assessment with wetland categories and examples of computer applications for the State of Michigan - Revised. 2nd Ed. Michigan Department of Natural Resources, Lansing, Michigan, USA.

Hornfeldt, C. S. and J. E. Collins. 1990. Toxicity of nightshade berries (*Solanum dulcamara*) in mice. Journal of Toxicology Clinical Toxicology. 28:185-193.

Julien, M. H., editor. 1992. Biological control of weeds : a world catalogue of agents and their target weeds. Third edition. CAB International, in association with Australian Center for International Agricultural Research (ACIAR), Wallingford, Oxon, United Kingdom.

Kloeppel, B. D. and M. D. Abrams. 1995. Ecophysiological attributes of the native *Acer saccharum* and the exotic *Acer platanoides* in urban oak forests in Pennsylvania, USA. Tree Physiology. 15:739-746.

Kourtev, P. S., J. G. Ehrenfeld, and W. Z. Huang. 1998. Effects of exotic plant species on soil properties in hardwood forests of New Jersey. Water Air and Soil Pollution. 105:493-501.

Lang, R. F. *Urophora affinis* (*Diptera*: *Tephritidae*). *Biological control: a guide to natural enemies in North America*. Weeden, C. R., A. M. Shelton , Y. Li, and M. Hoffmann. Cornell University College of Agriculture and Life Sciences. Ithaca, New York, USA. http://www.nysaes.cornell.edu/ent/biocontrol/weedfeeders/urophora.html. (31 July 2002).

Loos, A. and D. Ragsdale. 1998. Biological control of purple loosestrife: a guide for rearing leaf-feeding beetles. Rep. No. FO-7080-GO. University of Minnesota, St. Paul, Minnesota, USA.

Mack, R. N. 2000. Assessing the extent, status, and dynamism of plant invasions: current and emerging approaches. Pages 141-168 *in* H. A. Mooney and R. J. Hobbs, editors. Invasive species in a changing world. Island Press, Washington, DC.

Martin, M. 2001. No. 4. marsh thistle (*Cirsium palustre*): a British Columbia alert notice. (February, 2001). *Invasive plants of Canada project*. http://infoweb.magi.com/~ehaber/bc_news.html. (15 July 2002).

Meyer, M. H., D. B. White, and H. Pellett. 1994. Ornamental grasses for Minnesota. Journal of

Environmental Horticulture. 12:159-163.

[MINN] University of Minnesota Herbarium. 2002. Vascular plant collection. *J.J. Bell museum of natural history university of Minnesota*. http://www.cbs.umn.edu/herbarium/. (15 July 2002).

Olson, B. E. and R. T. Wallander. 1998. Effect of sheep grazing on a leafy spurge-infested Idaho fescue community. Journal of Range Management. 51:247-252.

Parendes, L. A. and J. A. Jones. 2000. Role of light availability and dispersal in exotic plant invasion along roads and streams in the H. J. Andrews Experimental Forest, Oregon. Conservation Biology. 14:64-75.

Pegtel, D. M. 1985. Germination in populations of *Solanum dulcamara* from contrasting habitats. New Phytologist. 100:671-680.

Reeder, K. K. and B. Eick. 2001. Northeast parks' regional strategy to control knotweed. Park Science: Integrating Research and Resource Management. 21:33-35.

Roche, C. T. and B. F. J. Roche. 1991. Meadow knapweed invasion in the Pacific Northwest, USA, and British Columbia, Canada. Northwest Science. 65:53-61.

Sather, N. and N. Eckardt. 1987. Element stewardship abstract for *Elaeagnus umbellata* (Autumn Olive). (87-08-28). *TNC wildland invasive species team page*. http://tncweeds.ucdavis.edu/esadocs/documnts/elaeumb.html. (15 July 2002).

Schmidt, K. A. and C. J. Whelan. 1999. Effects of exotic *Lonicera* and *Rhamnus* on songbird nest predation. Conservation Biology. 13:1502-1506.

Thompson, D., R. Stuckey, and E. Thompson. 1987. Spread, impact, and control of purple loosestrife (*Lythrum salicaria*) in North American wetlands. USDI Fish and Wildlife Service, Washington, D.C., USA.

Toney, J. C., P. M. Rice, and F. Forcella. 1998. Exotic plant records in the northwest United States 1950-1996: an ecological assessment. Northwest Science. 72:198-213.

[USNA] U.S. national arboretum plant introduction - floral and nursery plants research unit. 1999. *Viburnum lantana* 'Mohican'. *US national arboretum*. http://www.usna.usda.gov/Newintro/mohican.pdf. (15 July 2002).

Voss, E. G. 1996. Michigan flora. part III. dicots (*Pyrolaceae-Compositae*). Cranbrook Institute of Science and University of Michigan Herbarium, Ann Arbor, Michigan, USA.

Vujnovic, K. and R. W. Wein. 1997. The biology of Canadian weeds: 106. *Linaria dalmatica* (L.) Mill. Canadian Journal of Plant Science. 77:483-491.

Webb, S. L., M. Dwyer, C. K. Kaunzinger, and P. H. Wyckoff. 2000. The myth of the resilient forest: case study of the invasive Norway maple (*Acer platanoides*). Rhodora. 102:332-354.

Weeden, C. R., A. M. Shelton, Y. Li, and M. Hoffmann. *Biological control: a guide to natural enemies in North America*. Cornell University College of Agriculture and Life Sciences. Ithaca, New York, USA. http://www.nysaes.cornell.edu/ent/biocontrol/. (31 July 2002).

Westbrooks, R. G. 1998. Invasive plants: changing the landscape of America: fact book. Federal Interagency Committee for the Management of Noxious and Exotic Weeds., Washington, D.C. . USA.

Williams, C. E. 1999. Fruits of alien shrubs and deer mice: A test of the persistent fruit defense hypothesis. Journal of the Pennsylvania Academy of Science. 73:33-37.

[WIS] Wisconsin State Herbarium: University of Wisconsin - Madison. Checklist of the vascular plants of Wisconsin. *Wisconsin State Herbarium*. http://www.botany.wisc.edu/wisflora/. (15 July 2002).

Wyckoff, P. H. and S. L. Webb. 1996. Understory influence of the invasive Norway maple (*Acer platanoides*). Bulletin of the Torrey Botanical Club. 123:197-205.