Managing Non-Native Invasive Species within Ramsey County Parks and Open Spaces

Jonathan Sobiech[1, 2]
[1]*Department of Resource Analysis, Saint Mary's University of Minnesota, Winona, MN*
[2]*Ramsey County Parks and Recreation, 2015 Van Dyke St, Maplewood, MN 55109*

Keywords: native flora, invasive species, ArcView, *Alliaria officianalis,* eradicate, *Rhamnus cathartica*, ornamental tree, *Coronilla tectorum, Lotus conriculatus,* Minnesota Department of Natural Resources

Abstract

Analysis of non-native invasive species was completed for Ramsey County Parks and Recreation (RCPR). The study included three phases. The initial phase examined eleven different species that are troublesome species within the Ramsey County parks and open spaces. For each species, a fact sheet was created describing where the species originated, how it reproduces, where it is commonly found, criteria for levels of infestation, and potential control methods. The second phase was to create a data dictionary for the eleven species and three levels of severity associated with each. This information was imported into a Trimble GPS unit. Using this data, GPS locations were collected for each species. Levels of infestation were also noted at this time. Finally, this information was integrated into maps and tables for managing these invasive plants.

Introduction

Ramsey County Parks and Recreation Department (RCPR) has the responsibility of managing the natural resources for all of their properties. Their management plan addresses maintaining and/or reintroducing native flora. A major component of this plan is to achieve a better understanding and awareness of the invasive species that are occupying large portions of their properties.

Invasive species have been an increasing concern in the field of natural resources for many years. There are many invasive species that out-compete native species, whether for nutrients, sunlight, or space. Many natural resource specialists are studying these invasive species intensively. These specialists have devised strategies to lessen the impact of, control populations and/or completely eradicate the invaders. However, there are some exotics which do not respond to normal control strategies. Here there are no methods of control without harming native species. A good example is Garlic Mustard *Alliaria officianalis*. *Alliaria officianalis* is a species that generates hundreds of seeds per plant and can take over an area within ten years (Hiebert and Stubbendieck 1993).

There are several ongoing studies attempting to control this plant, but none has proven to work consistently (Appendix A). Regardless of method, the priority lies in determining which species are invasive, where they are, and how abundant they are. These are the

three key components this study addresses. By determining these components, natural resource managers can devise the strategies for creating management plans to control these species.

As a baseline for understanding management issues of exotic plants, several questions should be addressed. What makes a species an exotic? This is an often-asked question in the plant world. The answer is dependant on the geographic location of the particular plant. For the purpose of this project, exotics are defined as, a plant species that is non-native to the pre-settlement times of a given area (Hoffman and Kearns 1997).

How do exotics get here? Buckthorn, *Rhamnus cathartica*, for example, got its start at hundreds of different nurseries in the state (Dziuk, 1998). These nurseries sold the tree as an ornamental for people to plant in their yards. Since then, it has become one of the most problematic species for park managers, the Department of Natural Resources (DNR), and homeowners (Solecki, 1995). As another example, for years Crown Vetch, *Coronilla tectorum,* and Bird's foot trefoil, *Lotus conriculatus* have been used by highway departments and many others to prevent erosion. People knew little about how harmful these species are to the native flora. Other non-native plant seeds have been inadvertently packaged and brought overseas by accident. Finally, hundreds of exotic species are in Minnesota today that natural resource managers introduced accidentally or intentionally (Rendall, 1991). These are just a few examples of many where invasive species make their ways into Minnesota parks. Controlling exotics requires a major effort in reducing the number of non-native plants being introduced into parks, while at the same time eliminating existing invasives. This project has been a major step in the right direction for Ramsey County Parks and Recreation (RCPR) toward addressing the problem.

This project funded by Minnesota Department of Natural Resources (MNDNR), inventoried 11 of the higher priority invasive species present within (RCPR) parks and open spaces (Table 1). The list in Table 1 was created by Natural Resource Specialist for Ramsey County, John Moriarty, as part of the project proposal.

Table 1. Targeted species and their priority levels.

Common Name	Scientific Name	Priority
Black Locust	*Robinia pseudoacacia*	1
Crown Vetch	*Coronilla tectorum*	1
Garlic Mustard	*Alliaria officianalis*	1
Leafy Spurge	*Euphorbia esula*	1
Amur Maple	*Acer ginnala*	2
Bird's Foot Trefoil	*Lotus conriculatus*	2
Buckthorn	*Rhamnus spp.*	2
Oxeye Daisy	*Chrysanthemum leucanthemem*	2
Purple Loosestrife	*Lythrum salicaria*	2
Spotted Knapweed	*Centaurea maculosa*	2
Tansy	*Tanacetum vulgare*	2

Table 1 lists the Latin and common names of each invasive species. Also included are the priority levels for each species. The priority level is not calculated based on levels of importance, the species are equally important, instead it suggests an order of management priority. Species with Priority 1 are species that are extremely aggressive, but are newer to the area. The Level 2 species have already spread as far as possible or are known to be ubiquitous.

Prior to field observations and data collection, the eleven species had been researched extensively, and a description of each had been drafted (Appendix A). Included in these descriptions are: the species' native land, habitat the species are commonly found in, how or by what means the species reproduces, brief descriptions, and recommendations for control or eradication.

These recommendations include several proven strategies. The most common methods suggested include one or a combination of the following: chemical, burning, biological control, cutting, and/or digging. Two types of biological control that get the most support are the release of insects that will eat the invasive plant, and grazing of sheep and/or cattle. Biological control can only be effective if the insects, sheep, and/or cattle released will primarily eat the desired plant. Every manager has his/her preference of methods to use; some urge burning, others suggest chemicals or biological controls, and still others prefer combinations of these controls. All agree that each situation is case sensitive. For example, in areas littered with native sensitive plants, managers want to avoid spreading chemicals as much as possible. In these situations, they should cut the trees down and apply the chemical directly on top of the stump (Dziuk, Peter 1998). This method is more costly, but is more effective in preserving the natural environment.

Also included in the bios is a ranking system used to subdivide the infestation into different levels. The Handbook for Ranking Exotic Plants for Management and Control insists that there has to be order in what one is controlling (Hiebert and Stubbendieck 1993). The ranking system the project set up is a simple, but effective one. Each system caters to a particular species. Each species is divided into four ranking classes 1-4. A ranking of one is allotted if the plant has recently been introduced, and has not had time to become very dense in area or large in size. A ranking of two is used if the area where the plant populated was slightly denser, and the plants were larger if applicable. A ranking of three is used if the plant is so abundant in the area and is completely out-competing native flora. Finally, a ranking of four is used if the area has been treated and is under control; these areas will often times have to be retreated as many times as necessary. This particular ranking system is case specific and can change from site to site, depending on unique circumstances. Pictured on the next page is a good example of plots that would be ranked a three and a four (Figure 1). The plot to the right of the walkway is an area that is completely taken over by *Rhamnus cathartica;* this area has a ranking of three. The plot left of the walkway is an area that has been treated to eradicate *Rhamnus cathartica.* This plot has been ranked a four, which indicates, the area has already been treated and requires monitoring on a year-to-year basis.

Figure 1. Left side of walkway represents a plot that is given a ranking of four for an area that has been treated. Right side of the walkway represents an area that has been taken over by an invasive species and is given a ranking of three.

In most cases, level three areas will not be treated until levels one and two have been treated. Not everyone agrees with this strategy of attacking the smaller infestations first. Many people argue the larger stands have a tremendous seed source that will cause the species to rapidly spread. While this strong argument has been agreed to by many sources, it is dependant on the size of the areas being managed. This would be a good approach when managing areas that contain thousands of contiguous acres, but when managing more fragmented properties, infestation can only go so far. Therefore, attacking the newly infested areas before they establish their dominance is the better solution.

As mentioned, bios were created for each species listed in Table 1. These are the tools used for ranking the severity of the infestations, and for locating the species while in the field. These bios are attached as Appendix A**.**

Methods

The software used for this project was ESRI's ArcView 3.2, X-Tools Extension, Geoprocessing Wizard, DNR Tools, Pathfinder GPS software, Trimble GPS and DOQ/DRG Display Utilities. Each one of these components was essential for the completion of the project.

ArcView 3.2 was used throughout the project; to update, manipulate, and explore the data being collected. The files had to be updated daily to insure that the database was accurate and complete. The Department of Natural Resources Tools Extension, which was downloaded from the Minnesota Department of Natural Resources Data Deli (http://deli.dnr.state.mn.us), was used to

merge the different plant themes together to create one theme portraying all of the areas covered by exotics. ESRI's Geoprocessing Wizard was also used for merging themes, as well as for "unioning" different themes, for data management, and for grouping daily data into weekly data. The X-Tools Extension was used interchangeably with DNR Tools (they have similar capabilities), but DNR Tools was preferred for unioning polygons. Pathfinder GPS software was used to build the data dictionary used in the field. A Trimble GPS unit was used in the field for collecting the data.

Ramsey County Parks and Recreation provided both the Pathfinder GPS software and the Trimble GPS unit for the project. DOQ/DRG Display utilities were used to compare collected data with digital ortho quads (DOQQ's) of Ramsey County. This was imperative for larger sections that had to be mapped via onscreen digitizing. This was necessary in swampy areas too wet to carry the Trimble GPS unit, or in extremely large areas where it was unnecessary to walk the entire perimeter.

With the levels of severity and the variables involved established, a data dictionary was built that included each targeted species, and the different severity levels associated with each species. The data collection date was also included in this dictionary. This data was added to the data dictionary with Pathfinder GPS software. Finally, the information was downloaded into the Trimble GPS.

The majority of the data was collected during the months of May-August 2001; this made it easier to locate the targeted species. Each species monitored have very showy flowers making them easy to identify, they flower during different times of year making it possible to spread the effort out effectively during the entire monitoring period. For example, Garlic Mustard and Black Locust flower in May while Purple loosestrife flowers in August.

Figure 2. Flowering Black Locust (*Robinia pseudoacacia)*.

Figure 2 is an example of how showy some of the flowers can be. Pictured is a Black Locust (*Robinia pseudoacacia*) during its flowering stage. This scenario worked for the most part, but while examining each park, all plants had to be observed so it was important to correctly identify the listed species at all times of the growing season.

To get an accurate representation of the invasive species in each park, every foot of ground had to be observed. This required systematic patterns to be laid out and followed while in the field. This was done using a grid system starting at one corner working in toward another corner on the same side, continuing these strips until the entire area had been inventoried. Maintaining straight lines became difficult at times due to topography, swamps, ponds, etc. These obstacles were overcome by walking around them and resuming the transect from the opposite side of the obstacle.

After starting with this method, the project was modified by taking trails where applicable and plotting those first. Using this method, all of the segments directly off the trail were mapped first; this eliminated a lot of walking, while making better use of time. After the trails were finished, the areas that remained were covered. This system worked well, and was faster, but it was necessary to carry printed DOQQ's while in the parks. These were used as references and as a log so areas already visited were marked and areas yet to be visited were shown.

The identification process was made easier by knowing the habitat of each of the species. For example, the only exotics on the list that are commonly found in forested areas are *Rhamnus cathartica*, *Alliaria officianalis*, *Robinia pseudoacacia*, and *Acer ginnala*. These are the only species that should be concentrated on while in this habitat. This strategy saved time and energy.

Every time a targeted species was encountered the density, age, and size of the plant were observed. This would help dictate which level would be associated with it. This was the most difficult part of the project. There were many different scenarios encountered during the duration of the study; forcing the use of best judgment. As mentioned earlier, if the area was quite large it would be circled on a paper copy of the DOQQ's. Then shapefiles of these areas were manually digitized at the office using ArcView. Pictured below are examples of two different plots that were entered this way (Figure 3) Figure 3 shows examples of areas that are either too wet or too large to mark using a GPS, so they were mapped using the DOQQ's in the office. The photo on the left is a swampy area consisting of a level 3 infestation of *Lythrum salicaria*. The photo on the right is an example of a large area of *Rhamnus cathartica* that could be digitized on-screen.

The areas that were small enough or located where it was possible to walk around them were mapped on site with the Trimble GPS unit. These conditions made up over 90 percent of the data collected and recorded. After each day the data was downloaded at the office, the data was stored in daily folders, where the data was reviewed and edited as needed. Parks were worked on until completion, some taking a single day others close to one month. There were many days of overcast or other satellite interruptions including topography, tree cover, etc. These disruptions would

Figure 3. Example of a level 3 field of Purple Loosestrife *Lythrum salicaria* (left) and level 3 Buckthorn *Rhamnus cathartica* (Right) that were entered into the computer manually due to size.

interrupt the satellite connections skewing the data. Therefore, it was important to edit data frequently while the areas of interest were still clearly remembered.

After outliers were removed, the data was moved into the final project folder where all of the data would be brought together for analysis. The final park was completed in early August. This left time for revisits of the parks looking for species that are more easily located during the early fall months, especially *Lythrum salicaria*, which flowers in the fall. With these changes in place, the data was ready to be used to create maps to show the locations and abundance of the non-native invasive species.

The data was divided into a per park basis; this helped for clarity and data management. This also made it easier to make maps that were easy to read and understand.

Results

Figure 5 shows an example of the invasive species existing in the Battle Creek Regional Park. Here all areas that have exotic invasive species are highlighted by the colors allotted to each. This map gives quick reference to where the species are located and how large of an area each occupies. Notice that a large portion of this park is covered with invasive species. Many of the areas not covered by invasive species are actually water, turf, or infrastructures. This in itself is a finding but it leads to additional questions regarding the amount of overlapping species, the severity of the problem associated with each area, and what level of infestation are in these areas?

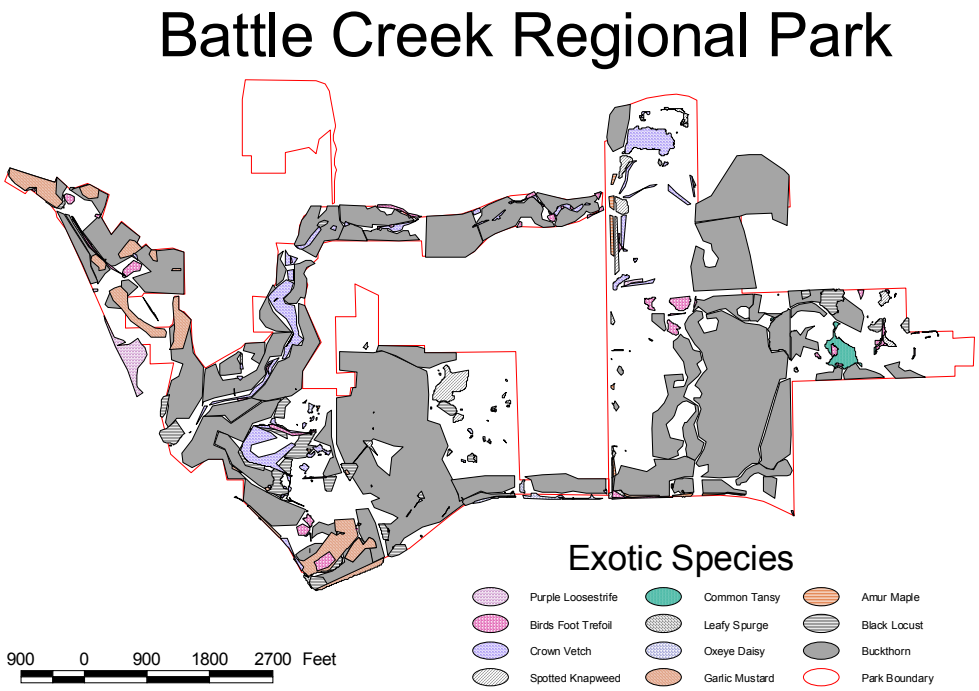

Figure 5. Battle Creek Regional Park.

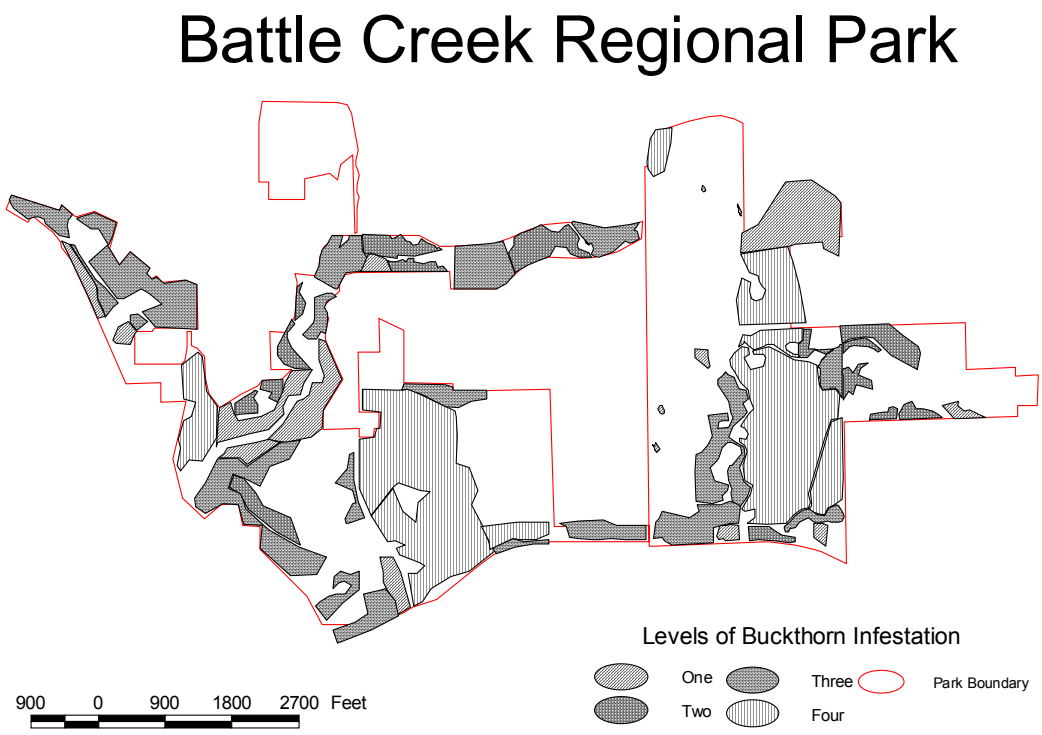

Figure 6. Levels of Buckthorn Infestation within Battle Creek Regional Park.

Figure 6 is an example of the maps created to show the different levels of single species infestation. This map portrays the four levels of buckthorn infestation in Battle Creek Regional Park. There are maps similar to this for each species within each park. There are some instances where overlap is not a problem where more than one species has been portrayed on the same map, but for ease of interpretation, it was not possible for all of the parks. These maps make it easier to derive a management plan for each species. There were also a series of maps created similar to this with the DOQQ's added so the managers can use topography and visual techniques to help in planning. These maps along with all of the other maps can be found at Ramsey County Parks and Recreation office 2015 N. Van Dyke Street Maplewood, MN 55109-3796.

These maps also provide managers with a great tool to help determine reasons for infestation, direction of spread, why some areas are not infested, and clues as to why some areas have been infested. The maps are also used for creating plans to treat infested areas, and for monitoring areas that have already been treated. These maps will be made available to the public at their request. Other maps were created where all of the files for each park were merged together; this made it possible to determine the total acreage of infestation on per park basis (table 2).

Table 2. Percentage of the acreage that is infested with exotic plants.

Park Name	Total Acres of infestation	Total Acres of park	% Of Acres Infested
Rice Creek	43	417	10
Long Lake	108	450	24
Tony Schmidt	59	202	29
Island Lake	32	130	24
Snail Lake	62	179	34
Grass Lake	59	267	22
Vadnais/Sucker	365	1204	30
Tamarack Nature Center	131	322	41
Otter Lake	96	397	24
Bald Eagle	40	143	29
Battle Creek	504	801	63

Table 2 shows the acreage infested in each park, the total park acreage, and percentage of acreage occupied by exotic or non-native plants that are on the list of this study (table 1). This table includes not only the actual number of acres that are covered with invasive species, but also the percentage of acreage covered by invasive species. These results do not take into consideration overlap, so some of the acreage can be counted for twice. For example, many times *Rhamnus cathartica* and *Alliaria officianalis* are found together so the same acreage is included twice.

Table 3 shows the extent of ground covered by invasive species; that excludes overlap. An example of this is with Battle Creek Regional Park. There are a total of 504 acres of species infestation (table 2) but there is only 459 acres of ground covered by infestation (table 3), this difference is due to overlapping of the different species, which is persistent in these parks, as many invasive species grow in similar habitats. To clarify, overlap describes a situation where two species occur in the same location, covering the same acreage. Consider an area that is four

Table 3. Percentage of ground covered by exotic plants.

Park Name	Total Acres of park	Acres of Ground Covered by Exotics	% Ground covered
Rice Creek	417	42	10
Long Lake	450	108	24
Tony Schmidt	202	58	29
Island Lake	129	24	18
Snail Lake	180	60	34
Grass Lake	267	52	19
Vadnais/Sucker	1204	304	25
Tamarack Nature Center	322	119	37
Otter Lake	397	95	24
Bald Eagle	143	39	27
Battle Creek	801	459	57

acres in size containing both *Rhamnus cathartica* and *Alliaria officianalis*, the total amount of ground covered is four acres, however table 2 reflects total acres of infestation, so in this case that result would be eight acres.

The database created from this project is an inventory of the selected non-native plants from table 1, for the parks listed in tables 2 and 3. These parks were chosen because they received the highest priorities. Not all Ramsey County parks were inventoried due to time constraints.

This database can be found at Ramsey County Parks and Recreation; it is complete with maps for all of the mentioned parks. Each park has as many as five maps showing the distribution of invasive species. Some parks have as few as two maps. The idea was to give a clear and easy way to interpret a map. Associated with each map is the database for each park. Included in these databases are dates, severity level of infestations (Appendix A), source theme, area of the infestation, perimeter of the infestation, acres of infestation, hectares of infestation, and location of infestation (Table 4). There are completed databases including the entire study, but for the purpose of this report, they have been consolidated to a per park basis. Table 4 is an example of part of a completed database for each park. Using these databases and existing maps, a catalogue of these parks were assembled. This information was given to the natural resource specialist and is now a resource in the control of non-native invasive species within Ramsey County Parks and Recreation boundaries. Currently these maps and databases are being used to attack the targeted species. As an area is treated, the level of invasion is changed to a level 4 meaning that the area has been treated and should now be monitored. The goal is to have all of the areas assigned the number 4.

Discussion

Throughout the study, patterns were uncovered revealing hints of where to expect, and at what levels to expect the eleven chosen non-native plants to thrive. These patterns could be studied

Table 4. An Example of a Database completed for Otter Lake

Date	Severity	Source Theme	Area	Perimeter	Acres	Hectares	Location
7/25/2001	One	Spottedk.shp	915.064	153.268	0.021	0.009	Otter Lake
7/25/2001	One	Spottedk.shp	11366.095	433.700	0.261	0.106	Otter Lake
7/24/2001	Two	Spottedk.shp	169451.449	1657.208	3.890	1.574	Otter Lake
7/24/2001	Three	Spottedk.shp	22352.966	599.199	0.513	0.208	Otter Lake
7/24/2001	Two	Spottedk.shp	10339.493	469.387	0.237	0.096	Otter Lake
7/24/2001	One	Spottedk.shp	6918.254	433.594	0.159	0.064	Otter Lake
7/24/2001	One	Spottedk.shp	8321.131	356.558	0.191	0.077	Otter Lake
7/24/2001	One	Spottedk.shp	7392.514	433.142	0.170	0.069	Otter Lake
7/24/2001	Two	Spottedk.shp	89141.928	2292.310	2.046	0.828	Otter Lake
7/24/2001	Three	Spottedk.shp	87013.710	1404.473	1.998	0.808	Otter Lake
7/24/2001	One	Spottedk.shp	69258.360	1178.606	1.590	0.643	Otter Lake

and proven vital in the continuing planning for management of invasive species. The obvious patterns observed during the study can be associated with the individual plant's biological makeup. Interesting patterns or findings noticed during the study include.

- *Rhamnus cathartica* and *Alliaria officianalis* were often found in the same areas, one area in particular is in Vadnais Lake Regional Park. Here there are large areas that are completely invaded by Buckthorn as a mid-story and Garlic Mustard as an under-story.
- *Coronilla tectorum* and *Lotus conriculatus* were often found near roadsides, trails, and/or disturbed sites.
- Amur Maple (*Acer ginnala*) was rarely found far from an area where it had been planted intentionally.
- *Rhamnus cathartica* was found in all habitat types.
- All of the exotics in this study contain very pretty or showy flowers and are popular with the park users, with the exception of *Rhamnus cathartica* and *Acer ginnala.*
- Many park users were very curious to what was being done and were very surprised when I told them of the plants that were non-native, but all seemed willing to help remedy the problem.

Conclusion

This paper outlines methods that were used to locate eleven non-native invasive species within Ramsey County parks and open spaces. This study created data dictionary that was used in this study to map all locations of the exotics, it provides background on the eleven chosen plants to be inventoried, criteria used to determine the levels of infestation taking place on a per species basis, and suggestions for controlling these species.

This is a starting point in the process of managing invasive species. With this information, the managers can formulate a long-term plan aimed at control.

The information and/or tools used for this study can be used for all areas containing invasive species; it has already been used by another municipality where they mapped their invasive species.

Acknowledgements

I would like to thank my graduate committee of Dean Mierau, Dr. David McConville, and Thomas Hoffman. I would also like to thank John Moriarty of Ramsey County Parks and Recreation for all of his technical guidance and vast knowledge of plants, and work invested during this study. Mr. Moriarty has been aggressive in his pursuits to control the non-native plants existing within Ramsey County parks and open spaces.

References

Bryant, Geof: et al. 1999. Trees and Shrubs. Botanica's. Gordon Cheers, pp.1008

Dziuk, Peter 1998. Buckthorn and its control. Minnesota Department of Agriculture, pp. 4

Foster, Steven and Duke A. James 1990. Easter/Central Medicinal Plants. Peterson Field Guides, pp. 366

Hiebert, Ronald and Stubbendieck, James 1993. Handbook for Ranking Exotic Plants for Management

Control. United States Department of the Interior. U.S. GOVERNMENT PRINTING OFFICE: 1993-- 839-257; now out of print.

Hoffman, Randy and Kearns, Kelly 1997. Wisconsin Manual of Control Recommendations for Ecologically Invasive Plants. Bureau of Endangered Resources Wisconsin Department of Natural Resources.

Mortenson, Carol 2000. Weeds of the Chippewa National Forest and Leech Lake Reservation. Dapartment of Agriculture.

Rendall, Jay Chair 1991. Minnesota Department of Natural Resources. Report and Recommendations of the Minnesota Interagency Exotic Species Task Force.

Solecki, Mary Kay 1995. Illinois Exotic Vegetation Management Manual. Overview of Vegetation Management Guidelines Volume 1, Number 3 through Volume 1, Number 27

Appendix A

Invasive Species Descriptions and Criteria for Different Levels of Infestations

Levels of Crown Vetch Infestations

Crown vetch is native to Europe, Southeast Asia, and North Africa. It has stems growing from 2-6 feet in length. This plant reproduces by either seed or a multi-branched creeper root system. The seeds can remain viable and dormant for over fifteen years. Crown vetch was commonly planted along roadways, trail ways and along riverbanks for erosion control. This plant serves its purpose well, however, it spreads like wildfire. It is important to find out if this species is still being planted for erosion control, if it is, it should be stopped. Crown vetch is most likely found in sunny areas, occasionally being found in minimal shade. A proposed criteria has been laid out below for review, the criteria contains three levels of infestations and their control methods.

Level I

- Crown Vetch has been accurately identified in small proportions.
- Less than 5 plants within 100 sq. ft. – no clumps larger than 10 sq. ft.

This level of infestation can be controlled by a foliar application of 2,4-D in early spring by a hand sprayer.

Level II

- Crown vetch has spread in a larger area.
- Less than 15 plants with 100 sq. ft. – no clumps larger than 25 sq. ft.
- Total infestation less than 1000 sq. ft.

Level III

- Crown vetch is abundant, covering most of the ground cover
- More than 15 plants within 100 sq. ft. Clumps greater than 25 sq. ft.
- Total infestation greater than 1000 sq. ft.

There hasn't been a lot of research done on the different effective methods for controlling this species. From the available information all three levels of infestation will have to be treated similarly. Both mowing and burning are successful treatments. Both methods require multiple applications. These include a regular fire regime, or repeat mowing in late spring.

Level IV

- Areas that have been treated with one or more of the mentioned methods

This level of infestation has already undergone some sort of treatment plan, this treatment will continue through the upcoming years. The removal will be monitored and evaluated, changes will be made as particular site and/or situation require.

Levels of Buckthorn in Wooded Situations

There are currently no criteria for assessing infestation levels of buckthorn. The three levels described below are a set of proposed criteria that will help standardize infestation terminology so that managers can assess sites and compare management areas.

Level I

- No buckthorn trees greater than 4" dbh
- Density of trees less than 1 per 100 sq. ft.
- Sapling density less than 5 per 100 sq. ft.
- Seedlings less than 3 per 10 sq. ft.

Pulling, cutting with stump treatment, and dormant spraying can treat this level of infestation or less. Follow up burns can also keep buckthorn in check.

Level II

- Scattered trees greater than 4" dbh
- Density of trees less than 5 per 100 sq. ft.
- Sapling density less than 10 per 100 sq. ft.
- Seedlings less than 10 per 10 sq. ft.

This level of infestation can be slowed by removal of larger trees (2+ dbh) and regular fires. Fires will open up the midstory and alter the species composition.

Level III

- Trees larger than 4" dbh are common
- Density of tree greater than 5 per 100 sq. ft.
- Sapling density greater than 10 per 100 sq. ft.
- Seedling density greater than 10 per 10 sq. ft.

This level of infestation is normally a pure stand of buckthorn. Removal will be very time consuming and expensive. The forest type will be greatly altered by removal and the need for very regular fires. The system will be shifted back to a grass system with large oak trees. This level of infestation should not be treated until level I and II sites have been treated.

Level IV

- Areas that have already been at least partially cleared of buckthorn
- Areas that consist of new plants after treatment.

This level of infestation has already undergone some sort of treatment plan, this treatment will continue through the upcoming years. The removal will be monitored and evaluated, changes will be made as particular site and/or situation require.

Levels of Amur Maple Infestation

Amur maple is native to Austria eastward across Europe and temperate Asia all the way to Japan and Far East Siberia. These trees grow 15-30 feet in height. This tree requires a well-drained soil and grows best in full sunlight, but it can be found in shady areas. A proposed criteria has been laid out below for review, the criteria contains three levels of infestations and their control methods.

Level I

- No Amur Maple trees greater than 4" dbh
- Density of trees less than 1 per 100 sq. ft.
- Sapling density less than 5 per 100 sq. ft.
- Seedlings less than 3 per 10 sq. ft.

This level of infestation can be treated by cutting down the trees and treating with stump treatment, this will require extensive monitoring and follow-up herbicide because cutting promotes suckering and seed germination.

Level II

- Scattered trees greater than 4" dbh
- Density of trees less than 10 per 100 sq. ft.
- Sapling density less than 10 per 100 sq. ft.
- Seedling density less than 10 per 10 sq. ft.

This level infestation can be slowed by cutting the trees to the stumps and treating with a hand application of Transline herbicide solution. This process will have to be repeated monitoring will be necessary.

Level III

- Trees larger than 4"dbh are common
- Density of trees greater than 5 per 100 sq. ft.
- Sapling density greater than 10 per 100 sq. ft.
- Seedling density greater than 10 per 10 sq. ft.

This level of infestation will require a complete over haul, which will take time and be quite expensive. Bulldozing and complete tree removals are an option if it is on a disturbed site. Fires will work if used with some chemical treatment. Levels II and I should be addressed first.

Level IV

- Areas that have been treated with one or more of the mentioned methods

This level of infestation has already undergone some sort of treatment plan, this treatment will continue through the upcoming years. The removal will be monitored and evaluated, changes will be made as particular site and/or situation require.

Levels of Bird's Foot Trefoil Infestation

Birds Foot Trefoil was introduced from Europe, it grows up to 24 inches tall and often grows in a mat-forming pattern. This plant reproduces by seed only. This plant is commonly found along roadsides, trails, forest openings, and prairies. This plant was frequently used in seed mixes and for erosion control because of its matting capability. This matting capability makes it extremely difficult for other plants to grow through; it also makes it difficult for birds to walk through, hence its name. A proposed criteria has been laid out below for review, the criteria contains three levels of infestations and their control methods.

Level I

- Birds Foot Trefoil has been accurately identified in small proportions
- Less than 5 plants within 100 sq. ft. – no clumps larger than 10 sq. ft.

This level of infestation can be treated with hand pulling being sure to get the long taproot. Mowing in June and late August is another effective control technique.

Level II

- Birds Foot Trefoil has spread in a larger area
- Less than 15 plants with 100 sq. ft. – no clumps larger than 25 sq. ft.
- Total infestation less than 1000 sq. ft.

Mowing in late spring or fire can also treat this level of infestation. Fires would have to be used for several years because fire stimulates germination.

Level III

- Birds Foot Trefoil is abundant, covering most of the ground cover
- More than 15 plants within 100 sq. ft. Clumps greater than 25 sq. ft.
- Total infestation greater than 1000 sq. ft.

Foliar application of broad-leafed selective herbicides such as 2-4,D amine or triclopyr and water solution in early spring will control this plant. Annual burning for several years will also help with this level of infestation.

Level IV

- Areas that have been treated with one or more of the mentioned methods

This level of infestation has already undergone some sort of treatment plan, this treatment will continue through the upcoming years. The removal will be monitored and evaluated, changes will be made as particular site and/or situation require.

Levels of Garlic Mustard Infestations

Garlic mustard is native to Europe and was first found in North America in 1868. This species grows up to 1.5 meters tall with an average height of 1 meter. This species can replace native plants within 10 years.
Garlic mustard reproduces by seed dispersal; the most common methods of seed dispersal are: mowers, animals, humans, and water run-off. This plant is most commonly found in open areas, floodplain forest, along roadsides and along trails, disturbed sites. A proposed criteria has been laid out below for review, the criteria contains three levels of infestations and their control methods.

Level I

- No areas of multiple Garlic mustard plants, few second year plants
- Density of plant is less than 5 plants per 100 sq. ft.

Cutting the plant at ground level, hopefully catching it during its first year so the plant hasn't had a chance to seed yet, can treat this level of infestation. Hand pulling the plant including the roots is also an effective way of getting rid of the plant. In either case remove the entire plant from the area. Continue to monitor for the next couple of years both spring and fall.

Level II

- Garlic mustard found in small clumps
- Density of plant less than 15 plants per 100 sq. ft
- Total area of infestation less than 1000 sq ft.

This level of infestation might require chemical treatment either in the fall or early spring, the better time being in the early spring. A follow up burn will also help in ridding the area of this plant. If the time is available cutting and pulling will also work.

Level III

- Several plants in large clumps spread out over a significant area (greater than 1000 sq. ft.)
- Density greater than 15 plants per 100 sq. ft.

This level of infestation will require chemical treatment followed by burns. The level is too far out of control to be able to hand pull or cut. The burning should be continued either in the fall or early spring. Follow up spot herbicide application with round-up will help aid in the control.

Level IV

- Areas that have been treated with one or more of the mentioned methods

This level of infestation has already undergone some sort of treatment plan, this treatment will continue through the upcoming years. The removal will be monitored and evaluated, changes will be made as particular site and/or situation require.

Levels of Leafy Spurge Infestations

Leafy spurge is native to Europe and Asia. It can grow up to 3 feet in height often times many stems per plant. It reproduces with seeds and vegetatively with buds and lateral roots. Seeds are transplanted by wildlife, water run-off, humans, and by the seed capsules shattering sending the seeds up to 15 feet away from the plant.
This plant is commonly found along roadsides, right-of-ways, pastures, and other open areas. Leafy spurge is an invader that needs immediate attention; it is hard to control once established mainly because of its extensive root system, sometimes as deep as 21 feet deep. A proposed criteria has been laid out below for review, the criteria contains one level of infestation and its control methods.

Level I

- Any sighting of Leafy Spurge is cause for concern.
- Fewer than 10 plants per 100 sq. ft. – total area less than 1000 sq. ft.

Level II

- Fewer than 20 plants per 100 sq. ft.
- No large clumps – total area less than 1000 sq. ft

Level III

- More than 20 plants per 100 sq. ft.
- Large clumps, extensive coverage.

Since this plants root system is so extensive it has no effective mechanical control. Digging, pulling, cutting, and burning have been tried, but to no avail.
There has been some success with both chemical and biological controls.

Chemical: Glyphosate is a good chemical to use when dealing with smaller patches.

Biological: Aphthona beetles are the most environmentally safe means for long-term control.

Level IV - Areas that have been treated with one or more of the mentioned methods

This level of infestation has already undergone some sort of treatment plan, this treatment will continue through the upcoming years. The removal will be monitored and evaluated, changes will be made as particular site and/or situation require.

Levels of Ox-eye Daisy Infestations

Ox-Eye Daisy is a plant that is native to Europe. This plant is assumed by many people to be native, but it is not. This plant is an invader that has been spreading at a more rapid pace lately. This species will crowd out other native species.
The Ox-Eye Daisy grows from 1-3 feet tall. It reproduces by seed and rhizomes. The roots are fibrous and new shoots sprout from underground stems. This plant is commonly found in clearings, trail corridors, open fields, along roadways, and pastures, especially if over-grazed. A proposed criteria has been laid out below for review, the criteria contains three levels of infestations and their control methods.

Level I

- Ox-Eye Daisy has been accurately identified in small proportions
- Less than 5 flowering plants within 100 sq. ft.

Mowing can control this level of infestation, which will reduce seed production. This level can also be controlled by hand pulling, or hand cutting.

Level II

- Ox-Eye Daisy has spread in a larger area
- Less than 15 flowering plants with 100 sq. ft. –
- No groups of plants in areas larger than 10 sq. ft.
- Total infestation less than 1000 sq. ft.
- Non-flowering plants visible

Level III

- Ox-Eye Daisy is abundant, covering most of the ground cover
- More than 15 plants within 100 sq. ft.
- Plants are grouped in Areas greater than 10 sq. ft.
- Total infestation greater than 1000 sq. ft.
- Non-flowering plants are common

For levels II and levels III applications of herbicides such as glyphosate and picloram in the fall for several years will reduce infestation. Since picloram is very persistent in the environment it should be used as a last result.

Level IV

- Areas that have been treated with one or more of the mentioned methods

This level of infestation has already undergone some sort of treatment plan, this treatment will continue through the upcoming years. The removal will be monitored and evaluated, changes will be made as particular site and/or situation require.

Levels of Spotted Knapweed Infestation

Spotted Knapweed is native to Europe and was introduced to the U.S. in approximately 1890's. It stands 1-4 ft tall with short spines or bracts. Spotted knapweed reproduces by seed only. Each plant can produce as many as 30,000 seeds annually. The flower heads bloom in late June into early August. Once the seeds are dropped they can stay viable in the ground for up to 5-7 years. Its long taproot may emit chemicals into the ground that may inhibit the growth of surrounding plants. This plant is most commonly found in disturbed areas such as gravel pits, ditches, or on dry gravelly or sandy soils. However, recently this plant has been discovered in less disturbed sites such as dry prairies, oak and pine barrens, and on sandy ridges. This plant thrives on wild sunny lands. A proposed criteria has been laid out below for review, the criteria contains three levels of infestations and their control methods.

Level I

- Spotted Knapweed has been accurately identified in small proportions
- Less than 5 flowering plants within 100 sq. ft.

This level of infestation can be controlled by hand pulling or digging. When pulling this species be sure to wear gloves, the sap from this plant can cause harm if entering an open wound. Make sure to get the entire root.

Level II

- Spotted Knapweed has spread in a larger area
- Less than 15 flowering plants with 100 sq. ft.
- Total infestation less than 1000 sq. ft.

Hot prescribed burning can control this level of infestation. After the burn a follow up pulling and digging up of plants that survived the burn will be necessary. Planting native seeds should also follow up the burn. Repeat burns are necessary.

Level III

- Spotted Knapweed is abundant, covering most of the ground cover
- More than 15 flowering plants within 100 sq. ft.
- Total infestation greater than 1000 sq. ft.

This level of infestation will also require burns that should be followed up by herbicide applications of either transline or glyphosate. Other possibilities would be biological methods. The most effective biological method has been the Urophora flies. These flies have been known to decrease seed production by 95% in experimental populations.

Level IV - Areas that have been treated with one or more of the mentioned methods

This level of infestation has already undergone some sort of treatment plan, this treatment will continue through the upcoming years. The removal will be monitored and evaluated, changes will be made as particular site and/or situation require.

Levels of Common Tansy Infestation

Common Tansy is a plant that is native to Europe, but has found its way to the United States, and is now found throughout the U.S. It is an erect perennial, which grows from 4-6 ft. in height. It has yellow flattened flowers; leaves are fernlike with a spicy aroma. This plant is commonly found along roadsides, trail corridors, meadows, waste areas, fields, pastures, gravel pits, and other open or disturbed areas. This plant reproduces either by seeds or its rhizomes. This plant has very strong fibrous roots. A proposed criteria has been laid out below for review, the criteria contains three levels of infestation and their control methods.

Level I

- Common Tansy plants have been correctly identified
- Less than 5 plants per 100 sq. ft.

Control methods for this level of infestation include cutting or mowing to reduce seed production. The mowing or cutting should be followed by an application of 2,4-D ester. Both methods would have to be repeated for no fewer than three years.

Level II

- Common Tansy has spread in a larger area
- Less than 15 plants with 100 sq. ft. – no clumps larger than 10 sq. ft.
- Total infestation less than 1000 sq. ft.

Level III

- Common Tansy is abundant, covering most of the ground cover
- More than 15 plants within 100 sq. ft. Clumps greater than 10 sq. ft.
- Total infestation greater than 1000 sq. ft.

Control methods for these levels of infestation will require systematic mowings followed by an application of 2,4-D ester. These should be repeated every year.

Level IV - Areas that have been treated with one or more of the mentioned methods

This level of infestation has already undergone some sort of treatment plan, this treatment will continue through the upcoming years. The removal will be monitored and evaluated, changes will be made as particular site and/or situation require.

Notes: In trials in Alberta it was found that Escort (metsulfuron-methyl) applied at pre-bud controlled tansy into the third year after application. Also, fertilizer (NPKS) tripled grass production and substantially reduced tansy shoot numbers through competition.

Levels of Purple Loosestrife Infestation

Purple loosestrife is native to Europe; it stands from 3-7 ft tall but may reach up 12 feet. This plant reproduces mainly by seed, but can also reproduce vegetatively from root or stem segments. This plant can produce over 2,000,000 seeds per year; these seeds are spread by wind, water, or wildlife. This plant replaces native wetland vegetation, the more rare species are the first to go; eventually this plant can take over an entire wetland. This plant is most commonly found in wetlands, sunny or partly shaded areas are the most common areas for this plant to germinate. This plant will slowly build a seed base over the years and take over whenever there is a disturbance. Shorelines are another common area to find this plant. A proposed criteria has been laid out below for review, the criteria contains three levels of infestations and their control methods.

Level I

- Purple loosestrife has been accurately identified in small proportions
- Less than 5 plants within 100 sq. ft. – no areas larger than 10 sq. ft.

This level of infestation can be removed by hand, remove old seed heads first and put them into a plastic bag, dig up the entire root system and burn all remains. Continue to monitor area for any new plants or some you may have missed.

Level II

- Purple loosestrife has spread in a larger area
- Less than 15 plants with 100 sq. ft. – no areas larger than 25 sq. ft.
- Total infestation less than 1000 sq. ft.

This level of infestation should be either hand removed or with a shovel, again being sure to get the entire root system. Make sure to dry and destroy all remains of the plant. Mowing has not been proven to work, so this method should not be used. Glyphosate is the most commonly used chemical to control this species, but must be careful because of the wet habitat where the plant is found. Only use the formula designed for these areas.

Level III

- Purple loosestrife is abundant, covering most of the ground cover
- More than 15 plants within 100 sq. ft. Areas greater than 25 sq. ft.
- Total infestation greater than 1000 sq. ft.

The control method to be used for this level of infestation is biological. The common insects that have been known to work are *Galerucella* beetles and a species of the weevil (*Hylobius transversovittatus).* The weevil species lays eggs in the stem and the upper root system of the plant, as the larvae develop they feed on the root tissue of the plant. The beetles feed on the foliage of the plants.

Level IV

- Areas that have been treated with one or more of the mentioned methods

This level of infestation has already undergone some sort of treatment plan, this treatment will continue through the upcoming years. The removal will be monitored and evaluated, changes will be made as particular site and/or situation require.

Levels of Black Locust Infestations

Black locust is a tree that is commonly found in the southern Appalachian Mountain Range. However, this tree has been heavily planted because it is a good species for erosion control, provides forage for bees, and for its high fuel value. This tree is not native to Minnesota, but has been growing and spreading rapidly throughout the state. This tree grows up to 100 feet tall and is armed with thorns between ½" and 1 ½" long. This tree reproduces vegetatively by stump or root suckering and also by seed dispersal, root-suckering being the most common. This species is most commonly found in disturbed habitats, old fields, degraded woods, and roadsides. This tree grows in such dense stands it will shade out the natural under story flora, making it a real problem for resource managers. A proposed criteria has been laid out below for review, the criteria contains three levels of infestations and their control methods.

Level I

- No Black locust trees greater than 6" dbh
- Density of trees less than 1 per 100 sq. ft.
- Sapling density less than 5 per 100 sq. ft.
- Seedlings less than 3 per 10 sq. ft.

This level of infestation can be treated by cutting down the trees and treating with stump treatment, this will require extensive monitoring and follow-up herbicide because cutting promotes suckering and seed germination

Level II

- Scattered trees greater than 6" dbh
- Density of trees less than 10 per 100 sq. ft.
- Sapling density less than 10 per 100 sq. ft.
- Seedling density less than 10 per 10 sq. ft.

This level infestation can be slowed by cutting the trees to the stumps and treating with a hand application of Transline herbicide solution. Heavy sprouting will continue to occur so this will have to be done for a couple of years. Sprouts can be treated using foliar application of Transline. Monitoring is required.

Level III

- Trees larger than 6"dbh are common
- Density of trees greater than 5 per 100 sq. ft.
- Sapling density greater than 10 per 100 sq. ft.
- Seedling density greater than 10 per 10 sq. ft.

This level of infestation will require a complete over haul, which will take time and be quite expensive. Bulldozing and complete tree removals are an option if it is on a disturbed site. Fires will work if used with some chemical treatment, but fire stimulates sprouting. Levels I and II should be addressed first.

Level IV

- Areas that have been treated with one or more of the mentioned methods

This level of infestation has already undergone some sort of treatment plan, this treatment will continue through the upcoming years. The removal will be monitored and evaluated, changes will be made as particular site and/or situation require.