COLLEGE OF
AGRICULTURE &
NATURAL RESOURCES
Department of Plant Science and Landscape Architecture

Proposals for Addressing Exotic Invasive Species: The Middle Patuxent Environmental Area and Surrounds

Landscape Architecture 452: Green Infrastructure & Community Greening
Fall 2015

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Contents

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Executive Summary

This report describes efforts undertaken by students as part of LARC 452 Green Infrastructure and Community Greening, Fall 2015. The course is divided into three sections. Section one focuses on land preservation principles and programs in the State of Maryland. Section two focuses on greening standards in the site development process including the implementation of the Maryland Forest Conservation Act and the District's Green Area Ratio. Section three focuses on green interventions related to stormwater efforts and the implementation of Maryland ESD requirements. This research served as the project for the primarily lecture-based course.

This research served two purposes for the overall course. First, it provided students with the opportunity to review and propose solutions to practical, real world invasive species issues. Secondly, the two field trips allowed students, particularly those with minimal vegetation or plant science background, real field experiences and the opportunity to learn from Howard County staff and other students. This was a valuable experience.

The overall document provides three primary outcomes. The results of the field days provided data from sampling of 20 permanent vegetation plots in the northern section of Northern Conservation Area. The Northern Conservation Area has approximately 34 plots. Invasive species occurred in 100% of the 20 plots. The most prevalent species were *Lonicera japonica, Microstegium vimineum, and Rosa multiflora.*

The second outcome is a series of proposals for addressing invasive species. The proposals draw on the adjacent land uses—schools, golf course and residential.

The third outcome is a compilation of reference annotations that were investigated to support the development of the proposals.

In the discussion of invasive species, students gained an acute and tangible understanding of the problem of invasive species and the challenges of addressing this widespread problem. The proposals reflect a consensus that public-private partnerships supported by both public and private leadership are needed to address the quality of forest environments and a difficult problem such as invasive species.

Introduction

Invasive species pose a significant threat to the quality of the environment. The purpose of this report is to document the processes, activities, and products of the students in LARC 452: Green Infrastructure and Community Greening. The activities were twofold: field work in the Middle Patuxent Environmental Area (MPEA) and the collection of information and creation of proposals intended to support ideas for dealing with invasive species.

Organization

The general approach to understanding and creating proposals that support invasive species management was based on the land uses surrounding the Middle Patuxent Environmental Area (MPEA). There are four main land uses surrounding the northern sections of the MPEA. They are a golf course, an educational facility, and high- and low-density residential land uses.

The students were divided into these four land use groups. They were also divided on the basis of disciplinary backgrounds to create multidisciplinary teams. One student was assigned to document the land use type to help inform the team about the land use characteristics. The other students were asked to develop proposals that address concerns with invasive plant management in the MPEA.

Field Work

Chapter 1: Field Days Methods

Permanent plots are located in the Northern Conservation Area of the MPEA (Figure 1). There are approximately 35 permanent plots that are noted in the Northern Conservation Area (on or inside the yellow boundary). Of these 35 permanent plots, 20 plots were sampled. These are circled in red in Figure 1.

Twenty plots were sampled: 1, 2, 3, 4, 6, 7, 8, 10, 13, 15, 16, 18, 19, 20, 23, 24, 25, 30, 31, and 32. The focus was on sampling as many plots as possible in the two day time frame.

After the numbered plot was located, eight one-meter^2 plots were established for each numbered plot. From the center of the plot pin or tree, 10m was measured in each cardinal direction to create a 20m x 20m plot. One-meter^2 plots were established at 5m and 10m for each cardinal direction yielding eight plots. Data was recorded in the following order N5, N10, S5, S10, E5, E10, W5 and W10.

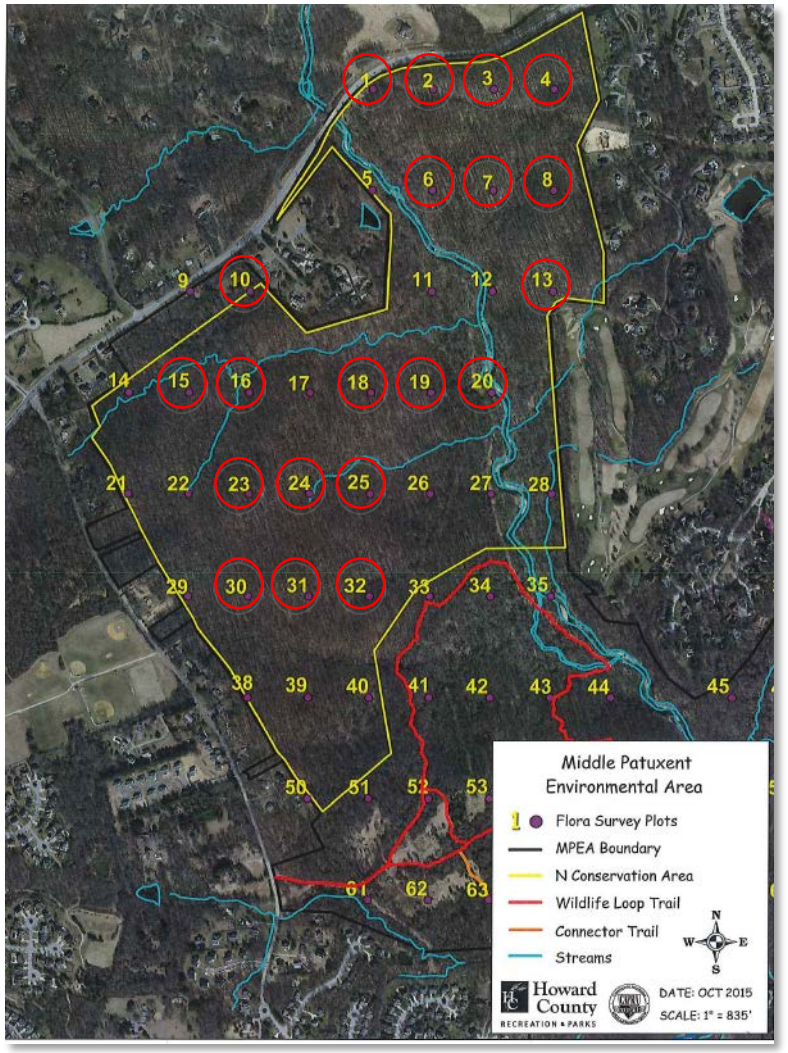

Figure 1: Permanent plots in the MPEA

Chapter 2: Field Days Results

Table 1 reports the invasive species cover classes for the 20 plots. Table 2 reports invasive species height classes. Table 3 reports cover coefficients. A total of nine invasive species were found:

- *Berberis thunbergii* (Japanese barberry)
- *Celastus orbiculatus* (Oriental bittersweet)
- *Elaeagnus umbellata* (autumn olive)
- *Ligustrum vulgare* (common privet)
- *Lonicera japonica* (Japanese honeysuckle)
- *Microstegium vimineum* (Japanese stiltgrass)
- *Oplismenus hirtellus ssp.undulatifolis* (wavyleaf basketgrass)
- *Rosa multiflora* (multiflora rose)
- *Rubus phoenicolasius* (Japanese wineberry)

Cover Clasess: Sum Value / 8 Plots																					Plot Presence	Plot Presence
Plot	1	2	3	4	6	7	8	10	13	15	16	18	19	20	23	24	25	30	31	32	AVG	Absolute	Relative
Species																							
Berberis thunbergii	0.00	0.00	0.25	0.25	0.63	0.00	0.00	0.13	0.50	0.25	0.13	0.00	0.38	0.00	0.13	0.00	0.25	0.00	0.00	0.00	0.14	10	50.00%
Celastus orbiculatus	0.50	0.50	0.00	0.00	0.75	0.00	0.00	0.13	0.00	0.63	0.00	0.00	0.13	0.13	0.00	0.00	0.00	0.13	0.02	0.13	0.15	10	50.00%
Elaeagnus umbellata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.06	2	10.00%
Ligustrum vulgare	0.13	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.03	3	15.00%
Lonicera japonica	1.75	1.38	0.25	0.75	0.38	0.38	0.88	1.38	0.75	0.13	0.50	0.00	1.00	0.50	0.63	0.00	0.63	1.00	0.13	0.25	0.63	18	90.00%
Microstegium vimineum	5.50	5.63	0.00	0.75	0.50	0.13	0.25	1.00	0.75	0.00	0.00	0.00	0.13	1.88	0.00	0.13	1.00	0.38	0.05	0.13	0.91	15	75.00%
Oplismenus hirtellus ssp.undulatifolis	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.00	0.00	0.04	2	10.00%
Rosa multiflora	0.88	0.00	0.00	0.50	0.00	0.00	0.13	0.25	0.38	0.13	0.00	0.25	0.88	0.38	0.13	0.00	0.38	0.13	0.02	0.00	0.22	13	65.00%
Rubus phoenicolasius	0.00	0.75	0.00	0.00	0.25	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	4	20.00%
	0.97	0.92	0.10	0.25	0.33	0.07	0.14	0.43	0.26	0.13	0.07	0.03	0.29	0.33	0.10	0.01	0.25	0.22	0.02	0.08	0.25		
Absolute Presence of Found 9 (Nine) Species	5	4	3	4	6	3	3	6	4	4	2	1	6	5	3	1	4	5	4	4	9		
Relative Presence of Found Species	55.60%	55.60%	33.30%	44.40%	66.70%	33.30%	33.30%	66.70%	44.40%	44.40%	22.20%	11.10%	66.70%	55.60%	33.30%	11.10%	44.40%	55.60%	44.40%	44.40%	100.00%		

Table 1: Summary Characteristics of Cover Class by Invasive Species found. Values of 50% and above are shown in red. Lower values are shown in green. Cover Classes: 1 = 1-5%; 2 = 6-15%; 3 = 16-30%; 4 = 31-50%; 5 = 51-75%; 6 = 76-100%.

Height Average: Sum of Values / # Present in Plot																				
Plot	1	2	3	4	6	7	8	10	13	15	16	18	19	20	23	24	25	30	31	32
Species																				
Berberis thunbergii	0.00	0.00	1.00	2.00	6.60	0.00	0.00	2.00	5.75	3.50	1.00	0.00	4.00	0.00	1.00	0.00	2.00	0.00	0.00	0.00
Celastus orbiculatus	2.60	0.00	0.00	0.00	1.83	0.00	0.00	2.50	0.00	1.60	0.00	0.00	2.00	2.00	0.00	0.00	0.00	4.00	4.00	1.00
Elaeagnus umbellata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00
Ligustrum vulgare	7.00	0.00	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00
Lonicera japonica	3.43	2.60	1.50	1.66	2.67	2.66	1.85	0.25	2.66	3.00	1.25	0.00	3.00	5.50	1.40	0.00	1.80	1.75	3.00	2.50
Microstegium vimineum	3.75	5.00	0.00	1.60	1.50	4.00	1.50	2.00	1.50	0.00	0.00	0.00	1.00	3.25	0.00	1.00	1.00	4.00	2.00	1.00
Oplismenus hirtellus ssp.undulatifolis	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00
Rosa multiflora	7.50	0.00	0.00	5.00	0.00	0.00	2.00	3.50	5.00	5.00	0.00	1.00	5.66	8.50	6.00	0.00	5.66	4.00	2.00	0.00
Rubus phoenicolasius	0.00	5.00	0.00	0.00	7.00	7.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 2: Summary Characteristics of Height Class by Invasive Species found. Values of 6 and above are shown in red.
*Height Classes: **1** = 0 - 0.1m; **2** = 0 .1 - 0.2m; **3** = 0.2 - 0.3m; **4** = 0.3 - 0.4m; **5** = 0.4 - 0.5m; **6** = 0.5 - 0.6m; **7** = 0.6 - 0.7m; **8** = 0.7 - 0.8m; **9** = 0.8 - 0.9m; **10** = 0.9 – 1.m; **11** =>1.0m.*

Cover Coefficient Average: Sum of Values / # Present in Plot																				
Plot	1	2	3	4	6	7	8	10	13	15	16	18	19	20	23	24	25	30	31	32
Species																				
Berberis thunbergii	0.00	0.00	1.00	1.00	1.80	0.00	0.00	1.00	2.00	1.50	1.00	0.00	1.00	0.00	1.00	0.00	2.00	0.00	0.00	0.00
Celastus orbiculatus	2.60	0.00	0.00	0.00	3.33	0.00	0.00	2.00	0.00	1.80	0.00	0.00	1.00	1.00	0.00	0.00	0.00	1.00	1.80	1.00
Elaeagnus umbellata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Ligustrum vulgare	2.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Lonicera japonica	2.40	3.40	1.00	3.33	3.00	3.33	4.71	3.87	3.00	3.00	1.50	0.00	3.00	2.00	3.40	0.00	4.20	4.00	5.14	4.00
Microstegium vimineum	6.75	8.00	0.00	4.20	2.00	4.00	2.00	3.75	3.33	0.00	0.00	0.00	1.00	6.00	0.00	1.00	6.00	4.00	3.00	3.00
Oplismenus hirtellus ssp.undulatifolis	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00
Rosa multiflora	2.25	0.00	0.00	3.33	0.00	0.00	3.00	2.00	3.66	1.00	0.00	1.00	2.00	3.00	7.00	0.00	1.66	2.00	1.00	0.00
Rubus phoenicolasius	0.00	3.00	0.00	0.00	2.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 3: Summary Characteristics of Cover Coefficient by Invasive Species found. Values of 5 and above are shown in red.
*Cover Coefficient Classes: **1** = few stems in only 1 quarter of quadrant; **2** = many stems in only 1 quarter of quadrant; **3** = few stems in 2 quarters of quadrant; **4** = many stems in 2 quarters of quadrant; **5** = few stems in 3 quarters of quadrant; **6** = many stems in 3 quarters of quadrant; **7** = few stems in 4 quarters of quadrant; **8** = dominates entire quadrant.*

Cover Class

Based on a summation of descriptive characteristics of cover, *Lonicera japonica* and *Microstegium vimineum* occurred in at least 75% or more of the sampled plots. *Rosa multiflora* occurred in 65% of the sampled plots. *Elaeagnus umbellata* and *Oplismenus hirtellus ssp.undulatifolis* occurred in only 10% of the sampled plots.

Plots 1 and 2 have the most cover: *Microstegium vimineum* at 5.5 and 5.6 respectively (shown as red cells). Plots 1, 2, 6, 10, 19, 20, and 30 had 55% or greater cover of the nine exotic species. Plots 1, 2, and 10 are located along the edge of the MPEA. Plots 6 and 20 are located near the larger Middle Patuxent River, which creates a break in the forest canopy, and Plot 19 is adjacent to Plot 20. Plot 30 is located relatively close to the edge of the MPEA. Plots 16, 18 and 24 had the lowest cover, ranging from 11.1% to 22.2%, with two or fewer invasive species. These plots have a somewhat more interior location.

Height Class

Invasive species equal to or greater than 0.5 meter in average height (shown as red cells) were found in six plots or 30% of the total plots: Plots 1, 6, 7, 10, 20, and 23. Species that were equal to or greater than 0.5 meter in average height included *Berberis thunbergii* (0.5 - 0.6m in Plot 6)*, Elaeagnus umbellate (*0.5 - 0.6m in Plot 10)*, Ligustrumm vulgare (0.6* - 0.7m in Plot 1), *Rubus phoenicolasius (*0.6 - 0.7m in Plots 6 and 7)*, Rosa multiflora (*0.6 - 0.7m, 0.7 - 0.8m, and 0.5 - 0.6m in Plots 1, 20 and 23 respectively)*. Rosa multiflora* had the highest average value; 8.5 (8 = 0.7 - 0.8m) in Plot 20.

Cover Coefficient

Average cover coefficient values of 5 or greater for invasive species (shown as red cells) were found in seven plots or 35% of the total plots: Plots 1, 2, 19, 20, 23, 25, and 31. A value of 5 represents an estimate of a few stems in 3 quarters of the quadrant. Species with a value of 5 or greater included *Lonicera japonica* (few stems in 3 quarters of quadrant in Plot 31), *Microstegium vimineum* (many stems in 3 quarters of quadrant in Plots 1, 20 and 25; dominates entire quadrant in Plot 2), *Rosa multiflora* (few stems in 4 quarters of quadrant in Plot 23), and *Rubus phoenicolasius* (few stems in 3 quarters of quadrant in Plot 19). *Microstegium vimineum* had the highest average value; 8.0 (8 = dominates entire quadrant) in Plot 2.

Proposals

Chapter 3: School Land Use Proposal: Leveraging the Science Fair

Kontessa Roebuck

Introduction

Most primary and secondary schools host an annual science fair that encourages students to explore concepts in physics, chemistry, and the natural world. **Science fairs provide an opportunity for students to apply scientific methods and conduct independent research on invasive species. Students' efforts have the potential to inform a broader audience about invasive species in the MPEA and invasive species in general.**

Proposal

To help younger children become more knowledgeable about invasive species in their communities, **the school science fair should include or promote a section focused on invasive species and plant biodiversity.** This proposal suggests various aspects of a science fair that will educate students about invasive species, specifically:

- stakeholders
- general timeline of a science fair
- possible topics for invasive species experiments
- budget and resources

Stakeholders

- Students will research the consequences of invasive species through experimentation.
- Schools will be getting a head start on the curriculum for invasive species.
- Local nurseries and landscape companies can participate as judges.

General Timeline of a Science Fair

In the early fall, shortly after the school year begins, preparation for the science fair should also begin. This means choosing topics students would be interested in researching. Students should also explore their topic to ensure there are enough sources to do a thorough experiment.

About halfway through the semester students should be expert on their topics and moving toward the hypothesis stage—where they pose a question or problem to solve or prove.

Students should begin their experiments either over the winter break or by the beginning of the spring semester. The competition is generally held in late March.

Possible Topics for Invasive Species Experiments

Elementary

- Plant inventory of their front and back yard: document with pictures and observations plant species throughout the seasons. Compare inventory from late summer to early spring to see if there is an invasive near their home.
- Find a native species and an invasive species in the community. Research if the invasive could be a threat to the native.

Junior High

- Prove biodiversity in a local forest: take observations and compare native plants to non-native plants.
- Prove an invasion of a certain species in your local forest.

High School

- Experiment with effective ways to control invasive species in a local forest: physical removal vs. herbicides.
- Document the rate of invasion (encroachment) and

determine the source of invasion.

- Determine if more diverse plant communities are more productive, stable, and resistant to invasion.

Budget

The students will fund a majority of the budget because they will be the ones buying supplies for their experiments and presentations.

Schools will provide ribbons to finalists in each category, totaling $40 maximum. Possible transportation to the next level of the science fair (regional or state) would total roughly $100 for gas and food.

Outcomes

Science fairs finalists may advance to a state, regional, and even national level competitions. Winners at each stage are usually awarded a monetary prize whether the project was completed by an individual or complex enough to be done in a group.

Schools can encourage sponsors from local nurseries or invasive management companies to judge projects in this category. For junior division projects, money can be awarded to extend the project into a fellowship or to help with school supplies. Senior division projects can be awarded scholarships for college.

References

- http://www.csun.edu/~lg48405/vsf/ch1/ch1_wha.html
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Chapter 4: School Land Use Proposal: Invasive Day Treasure Hunting

Bisheng Xu

Introduction

Educational institutions use creative methods to engage students. Invasive Day Treasure Hunting can be a day dedicated to outdoor activities that focuses on identifying native and invasive plants. **Combining a fun outdoor activity like geocaching with learning about invasive is a great opportunity.** A school event should follow Howard County Recreation and Parks' geocaching policy.

Proposal

An Invasive Day Treasure Hunt is an opportunity to educate students in basic knowledge about invasive plants and motivate them to remove them in their neighborhoods. Not only students will be involved, but their parents and relatives can learn either from them or by directly participating in this activity.

Stakeholders

Participants are not only students, but also their family members or friends from outside school. On the Invasive Day itself, the more people who participate, the more interesting the activities will be and the more positive the effects on the community. From the school's perspective, more participation means that more people learn about the school and help the school improve its reputation and expand its source of students. Socially and economically, the school can benefit a lot.

Timing of Event

Since most plants drop their leaves during fall and winter, spring and summer will be more appropriate time for the Invasive Day to take place. Because the Day is oriented to the whole community; it should be held on a weekend to limit conflicts with work schedules. However, from students' point of view, if the Invasive Day is during their free weekend time, their passion may decrease and they may not be willing to come. Therefore, the Day should be one-and-a-half-days long. For example, the school can schedule it for Friday afternoon and Saturday. Students can choose to attend one or both sessions.

Incentive Program or Rewards

To encourage more students to sign up, incentive programs or rewards can be a good motivator, with items such as extra credit, T-shirts, and lottery prizes. But to attract the most students on a Saturday, the incentive program and rewards on Saturday should be more attractive and valuable.

Activities

Geocaching can create feasible, suitable and interesting activities. Geocaching is an outdoor recreational activity, in which participants use a Global Positioning System (GPS) receiver or mobile device and other navigational techniques to hide and seek containers, usually with exchangeable objects in them for people to find.

It is not necessary for the school to provide GPS to guide people. Instead, participants can use simple map photos showing the surrounding area and the invasive plant samples they are seeking.

To make it more difficult and challenging, the final task may depend on the samples they find; they need to find a certain amount of plants in a certain area and correctly remove them. Thus, a quick training in removing is necessary prior to the game so that invasive plants aren't spread. Finally, participants who finish fastest can win rewards; the quantity and quality of rewards can depend on school's budget.

If the number of participants is large enough, setting up more events and different activity ranges will be helpful. Events should consider people with different physical conditions, and include some less competitive activities, such as an invasive plant field learning tour or a game of distinguishing native and invasive plants. The more activities and games a school provides, the more enjoyable Invasive Day can be.

Outcomes

Participants can learn about invasive plants, socialize and have fun with each other, and have a chance to win rewards. This type of activity improves connections between MPEA and the schools. The MPEA will directly benefit from participants removing invasive plants to preserve the local ecosystem.

References

Geocaching in Howard County. 2016. https://www.howardcountymd.gov/hcrpcaches

Geocaching. 2016. https://www.geocaching.com/play.

Chapter 5: Golf Course Land Use Proposal: Environmentally Friendly Fairways Program & Green Golfer's Trade Show

Laura Robinson

Introduction

Golf courses typically use Integrated Pest Management (IPM) to address pest plants and these methods of controlling invasive species are familiar to golf management professionals. **This proposal presents an opportunity to communicate to golf managers and golf course users the issues related to invasive species in the MPEA—an adjacent neighbor.**

(Though it was beyond the scope of this proposal, it would be helpful to discuss an invasive species management plan with the adjacent property, if sufficient resources become available.)

If the golf course uses invasive species in its landscaping without properly maintaining and managing the species, adjacent areas could be invaded. Together, the two properties could support their respective management goals. Can a golf course contribute to both on-site invasive species programs and also support invasive species programs for adjacent properties such as MPEA?

Proposal

Developing an "Environmentally Friendly Fairways" (EFF) label program, working with the golfing community, would help communicate invasive species issues. The EFF program, supported by a grant, could offer benefits to golf courses that use the collaborative program at a selected golf course and MPEA. Annual Maryland golf events could also provide opportunities for environmental education, discussion and commerce.

<u>Steps for implementation:</u>

1. MPEA and a selected golf course seek grant funding.
2. Golf courses should promote the following requirements to be considered for the "Environmentally Friendly Fairways" label:
    a. Promote natural habitat corridors throughout the course
    b. Display educational materials to course patrons with information on the EFF program as well as invasive species practices.
    c. Review and remove invasive species, if feasible.

If a golf course meets all the requirements, it could be included on Howard County's Environmentally Friendly Fairway's website and brochure, and may display the EFF logo on its own website and premises.

An annual golf trade show could advertise EFF golf courses to promote awareness of invasive species. EFF courses must display evidence of their sustainable and environmentally friendly practices to consumers.

Stakeholders

- Golf courses will receive publicity in County brochures and websites; they will receive booths and participation in local environmental events, as well as access to an annual Green Golfer's trade show hosted by Howard County. Golf courses will likely receive positive interest from potential clients and the community by being labeled as an environmental steward.
- The County's Department of Recreation and Parks will receive funding from golf courses to participate in the Green Golfer's trade show. Land surrounding Howard County golf courses will likely see a reduction in introduced invasive plants, runoff, and have more corridors for wildlife.
- Local and non-local golfers will be able to attend the Green Golfer's trade show where they will have access to numerous vendors while also receiving education in invasive species.

Budget

A grant might be the best method for funding this proposal.

Outcomes

The EFF program could leverage golf course managers and users to communicate invasive plant issues. Howard County's EFF program could create collaboration between golf course managers, golfers, and MPEA managers.

Chapter 6: Golf Course Land Use Proposal: Certificate Program to Identify and Manage Invasive Species on a Golf Course

Lionel Wilson

Introduction

Invasive species are plants, animals, or pathogens that are non-native (foreign) to an ecosystem and whose introduction to an ecosystem can cause harm (NISIC, 2015). An effective way to decrease the rate at which invasive species emerge or to prevent them entirely is to educate individuals on what invasive species are. **Education and knowledge provide an opportunity for golf course managers and golfers to identify and manage invasive species**.

Not only will we educate the people who manage the golf course and their employees, but we want to integrate a system that enables the general public to help manage the golf course too. We know that the Audubon Cooperative Sanctuary Program for Golf Courses (ACSP) assists golf course managers in their efforts to incorporate environmentally responsible maintenance practices into the day-to-day inspections. This program, which consists of expert golf course superintendents, golf industry experts, university researchers, and environmental experts, has developed Standard Environmental Management Practices that all golf courses should apply (Audubon International, 2015).

Proposal

Partnering with a local golf course to educate managers and employees on invasive plants will help them identify and remove invasives surrounding their golf course**.** ***Developing a certificate program for managers and employees to be certified on the identification and management of invasive species will add value to this training.***

Stakeholders

The objective is to create an environment and community that cares for and protects the golf course as well as the plants and animals that inhabit land around the golf course. To start this proposal, we would contact stakeholders who support these management practices for the golf course. Groups would include golf courses such as the University of Maryland Golf Course, Paint Branch Golf Course, Calvert Road Park Disc Golf, etc., as well as environmental management companies and organizations that have knowledge on pesticide and fertilizer use on invasive plants (environmental scientists

or Maryland Department of Agriculture), and community members interested in helping with this project.

This project won't succeed unless there are incentives for both the golf course managers and community members. Incentives could include discounts to people who help out, a set of free balls to play at their course, a $20 discount to play at their course, or a free round of golf.

To get these discounts, an individual or group would physically help with removing invasives. Golf managers would be trained on removal as well as applying pesticides and fertilizers. The general public would not necessarily be responsible for applying chemicals to remove invasives. Community members would have to complete a course on invasive issues and identification. Once the general public is trained, the discounts would go into effect and would depend on the amount of hours an individual or group spends removing the invasives.

Budget

Golf courses require a great deal of maintenance and apply pesticides and fertilizers to maintain a beautiful and healthy course. It is crucial that the right amounts of chemicals are applied because overuse can result in environmental impacts. These impacts can be reduced with integrated pest management (IPM) and also with golfer involvement. Golfers have a lot of power over what happens on courses; if they see an invasive species near the edge of the course they can remove it. Many golfers see the perfect greens and fairways of the PGA tour on television and expect every course they play to look as good. This is not only unrealistic, but pressures course managers to unnecessarily increase pesticide and fertilizer use (Bloomington, 2015). Course superintendents should attempt to educate golfers about their efforts to create a more environmentally friendly course. This will improve golfer-management communication and help golfers understand what is happening on the course. Funding for this project could come from the Maryland Department of Agriculture or the golf course itself. The Audubon Cooperative Sanctuary Program could also help fund the project.

Outcomes

Project outcomes could result in golf course managers being more aware of invasive species and management. Golfers who volunteer would become educated on what invasive species are and the best ways to remove them. They would also help by physically removing invasives surrounding the golf course by devoting a few hours once a week to help control and even eliminate invasives surrounding the course.

Chapter 7: Residential Land Use Proposal: Grow Native Plants, Go Green

Delath Mendis

Introduction

Annual events provide opportunities to communicate information about invasive species to a wide audience, including homeowners. Howard County has organized a GreenFest each year since 2008. It draws more than 2,000 people who enjoy workshops, outdoor activities, a native plants sale, opportunities for learning about the environment, nature play spaces, local food and access to over 100 green vendors.

Proposal

The main goal of this proposal is to persuade and motivate people to grow native plants and manage invasive species in residential communities around the MPEA. **Three events would persuade and motivate people to grow native plants and learn about invasive species.** The County could organize competitions among homeowners, gardening shops and nurseries, and children. Representatives of the three groups can sponsor booths supporting native plants for Howard County at GreenFest.

In the first event, Howard County would invite homeowners to participate in a native garden competition. The competition would be open to any resident in a low-density residential home. Residents would focus on an available planting area and the number of native plants in their home garden. The homeowner with the highest quantity and quality of native plants would win. Howard County could provide list of native plants.

This competition could be managed by the County or a volunteer with County supervision. Garden and nursery associations could help by sponsoring event prizes such as gardening accessory gift vouchers. Garden shops would profit from selling native plants for the competition, which would give them incentive to sponsor the competition. The County could select winners in different categories: highest number of plants grown in three months, highest number of native plants grown in a year. Prizes would include County certificates of recognition for all participating homeowners. The main idea of this competition is to motivate and educate homeowners about native plant species.

A second competition would be among garden shops to select the shop that supplies the highest quality and

widest variety of native plants. This competition would be open to any native plant selling garden shop that participates in GreenFest. The County could encourage people to buy native plants from these shops since they are sponsoring the competition. County staff or volunteers could supervise the competition and record homeowners information on where they bought their plants—the receipts from gardeners. This competition could be managed by the same group supervising the homeowners' competition.

The third competition would be open to all Howard County school children. The County could make an open announcement to all school children to participate in GreenFest.

Art and essay competitions would be held separately, on the topic of native plants. The competition should establish a Maryland scholarship program for best performance. Having children participate in this competition improves their awareness of the importance of protecting the MPEA.

Children's participation attracts different populations to the festival. Everyone in the community can be involved in growing native plants in the low-density residential communities around the Patuxent. Participation of school children is appropriate since they are the green infrastructure network builders of the future.

Outcomes

This proposal will leverage an ongoing event, GreenFest, to promote planting native species and to educate homeowners about invasive species.

Chapter 8: Residential Land Use Proposal: Incentive and Reimbursement Programs of Removal of Invasive Plants

Yung-Ting Hsu

Introduction

Invasive species are non-native to an ecosystem and are likely to cause harm to our natural heritage through habitat loss and degradation. Non-native plants occur along forest, field, stream and wetland edges, preferring moist habitats. Invasive plants can displace native species, eliminate food and habitat for wildlife, alter natural fire regimes and nutrient cycling in soils, and inhibit native plant regeneration *(The Nature Conservancy)*. **A review of the available regulations and policies for incentive or reimbursement programs provides an opportunity to address invasive species.**

Proposal

Reviewing the available regulations and policies for incentive or reimbursement programs to help residents to remove invasive plants around their houses and neighborhoods in Howard County, will achieve two goals:

- Explaining the criteria for incentive or reimbursement programs that can help residents access programs that can benefit them the most.
- Creating a brochure for residents showing them how to save money and protect the environment at the same time, which includes:
  - local and state incentive and reimbursement programs
  - ecological threats and images of invasive plants.

To become a green city, a sustainable community, one of the factors is the habitat that makes up the community's ecology and biodiversity. Planting trees is one way everyone can contribute to a shared sustainable vision. Trees provide many aspects of a sustainable future. For example, it is ecologically valuable to have green spaces such as parks and open spaces because they link multi-use corridors that provide opportunities for human use, as well as wildlife movement, feeding and shelter.

Economically, beautifying neighborhoods with plants and wildlife species can attract buyers. Finally, and the most importantly, trees protect air and water quality, reducing energy costs, reducing the heat island effect, and decreasing pollution from greenhouse gas emissions.

To engage residents, policies should provide incentives to support them in developing a good living environment. At the same time, researchers can help determine which regulatory or incentive based policies work best at engaging built environment professionals and residents.

Governments provide many incentives to assist in managing invasive species.

To Apply

Marylanders can use three programs to help them use native plants.

- The Maryland Urban & Community Forest Committee (MUCFC) is a grant program that helps community groups fund tree planting and education projects statewide to enhance Maryland's urban forest. The maximum grant is $1,500. Applications are due to the Grants Chair, with a forestry board member's original signature.
- TREE-MENDOUS Maryland is a state program that offers $25 discount coupons for native trees costing $50 or more at participating retail nurseries and garden centers.

Howard County residents can get reimbursement through the County's CleanScapes Program for planting native species two ways.

- Conservation Landscaping replaces turf grass with native plantings that provide greater water infiltration and habitat, requiring less water and fertilizer compared to turf grass. The maximum residential reimbursement is between $250 and $750, measured at $1/square foot, with a minimum treatment area of 25 square feet.
- Urban Tree Canopy in Howard County is a program designed to establish and increase urban tree canopy. Homeowners may have canopy trees planted anywhere on their property, except a utility right-of-way or within existing heavy canopy coverage. The maximum residential reimbursement is $600, based on $150/tree for at least of 2-inch caliper (deciduous) or 6-foot tall (evergreen) trees.

Outcomes

Greening a community underscores the importance of its living infrastructure with goals targeting trees, sustainable food systems, recreational space, and ecological health.

Moreover, communities rely on ecosystem services. Urban trees are valuable for wildlife, especially when incorporated into green space. However, invasive species can displace native plants and significantly alter habitat structure. We must protect our natural heritage because green open spaces provide benefits to human beings and wildlife species. A healthy habitat structure can make communities more resilient and provide interconnected networks between wildlife and human beings.

To be sustainable, we need to remove species that threaten ecological systems, and move toward resilient communities with a high quality of life, not only for human beings, but also for wild animals.

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Chapter 9: Residential Land Use Proposal: Native Planting/Invasive Plants Removal Day

George Sorvalis

Introduction

An annual removal day in approved areas adjacent to the most natural areas of MPEA is an opportunity to reduce exterior invasive plants that might colonize the interior forest patches.

Proposal

A Native Planting/Invasive Plant Removal Day that enlists the support of philanthropic organizations, local businesses and homeowners will help solve the growing threat that invasive plant species pose to the treasured habitat in the MPEA. This would be an annual event that would take place the weekend before Thanksgiving. The event's primary function would be to enlist the help of low-density residential homeowners, whose land abuts the MPEA, to remove invasive plant species from their properties, and replace them with native plant species.

Logistics

The Howard County Recreation and Parks Department would seek a grant from the Maryland Department of the Environment, or local philanthropic organizations to hire an organizer to plan this event. The organizer would reach out to homeowners by mailing fliers, and home visits, to educate homeowners about the event.

The organizer would also reach out to local nurseries for donations of native plants, and to local hardware stores for donations of gardening gloves and shovels. The organizer would provide these items to homeowners in the form of a "Replace Invasives with Natives Toolkit." Homeowners would receive this kit at no cost, and use it to replace the invasives in their yards with natives.

The organizer would reach out to local media outlets with a press release encouraging the media to cover the event by interviewing participating homeowners. Coverage would take the form of video news on local television, or local print media. This coverage would enhance the visibility of the MPEA as a treasured resource in Howard County and the coverage could be leveraged to raise additional funds for future Native Planting/Invasive Plants Removal Day, or similar events.

Objectives

Residents abutting the MPEA will:

1. become more knowledgeable about identifying non-native invasive plant species
2. become more knowledgeable about native planting alternatives for their yards
3. become more knowledgeable about the habitat and ecological value of the MPEA
4. remove non-native invasive species from their property, reducing the impact non-native invasive plant species have on the ecological integrity of the MPEA
5. plant native plant species to help improve the ecological health of the MPEA.

Stakeholders

A variety of stakeholders will be engaged in this event.

Stakeholder	Function	Benefit
Low-Density Residential Homeowners Abutting MPEA	Buffer MPEA with better performing landscape by removing invasives and installing natives on their properties	Learn about ecological value MPEA, natives and invasives, and modify their yards to become better stewards of the MPEA
Local Hardware Store	Donate garden gloves and shovels	Advertise and demonstrate its value to the environment for good PR
Local Nursery	Donate Native Plants	Advertise and demonstrate its value to the environment for good PR
Howard County Recreation and Parks	Perform site visits to the homeowners' properties on planting day	Help develop relationships with homeowners abutting MPEA to educate and enlist them as stewards and monitors of the MPEA
Maryland Department of the Environment	Provide a grant to Howard County Recreation and Parks to hire an organizer	Enhance relationship with Howard Recreation and Parks while more effectively managing the MPEA
Local News Media	Cover the planting day	MPEA receives more visibility that can be leveraged for more resources for more effective management of

		the MPEA

Budget

Item	Hours/ Quantity	Rate/ Cost	Total
Organizer	$50/hour	100 hours	$5,000
Fliers	100	$1/flier	$100
Garden Gloves	10 pairs	$5/pair	$0 (seeking donation)
Native Plants	50 plants	$20/plant	$0 (seeking donation)
Total			$5,100

Outcomes

Native Planting/Invasive Plants Removal Day is a low-cost and immediately effective way to educate low-density residential property owners that abut the MPEA about the value of native species, the harmful effects of invasive plants, and the ecological value of the MPEA. It will empower homeowners to play a beneficial role in providing a higher level of stewardship for Howard County's prized ecological resource: the MPEA.

Chapter 10: Residential Land Use Proposal: Weed Warriors Revamp

Kevin Friant

Introduction

The first link that appears when you Google “weed warriors” will be ”Weed Warriors - Montgomery Parks.” This program is the preeminent weed warriors group in Maryland and much can be learned from their program. Carole Bergmann started this project over 15 years ago. As a natural resource manager, she was at the forefront of noticing the detrimental effects non-native invasives were having on forest ecosystems. Trees were falling due to invasive vines, and birds moved on, leaving the park desolate and disturbed. She worked with friends, groups, and volunteers to lay the foundation for one of the country’s most outstanding non-native invasive species control programs. **There is an opportunity to review the Howard County weed warriors group and incorporate best practices from exemplary programs from other parts of Maryland.**

Proposal

Emulate the Montgomery County weed warriors program by providing incentives to students and horticultural enthusiasts who would like to become certified as weed warriors. This program is approved for Student Service Learning (SSL), which means they regularly have high school students participating on workdays. According to their website, Montgomery County Weed Warriors have had 48 volunteers certified this year (with another 35 working on completing training). In 2015, their team completed over 4,000 hours of service, providing native habitats on parkland and eradicating vast areas of invasive plant species. They also work with various departments, such as natural resources, and other governmental groups in the County. They seek to work with businesses, community groups, religious groups, scout troops and other service organizations that are eager to participate in parkland stewardship. With a limited budget, a strong volunteer program is paramount to eradication efforts at no cost but people's time and sweat. The ideal program for Howard County and the MPEA would be one that integrates weed warrior certification, events with the existing groups, and partnerships from the original program.

Stakeholders

The stakeholders of this proposal are residents, the Montgomery County Weed Warriors, the Howard County Weed Warriors, business sponsors, various volunteer groups, state government departments, and federal agencies.

Invasive species face no boundaries; they are dispersed by birds and mammals. Due to this, the efforts of the stakeholders must be continuous until the goals of invasive eradication are met. All of these stakeholders value the weed warriors organization, which provides events to motivate and develop a sense of pride and environmental stewardship by volunteering their time to eradicate invasives in at-risk areas.

Outcomes

Many weed warrior groups in Maryland have much to learn from what Montgomery County has accomplished.

To address the issue of invasive species within the MPEA, Howard County's weed warriors organization must adopt proven strategies to generate more participation. By increasing participation in volunteer programs the County's limited budget can be stretched and removal efforts can be more effective.

In the future, a promising new program called Adopt-an-Acre, could prove effective at small-scale eradication and is currently being tested in Leakin Park by the Weed Warriors Baltimore group. This program allows citizens to care for a forested acre with light-to-moderate invasive plant presence while also gaining their weed warrior certification. With a focus on raising participation in the weed warriors' program, great strides in invasive eradication will be made in the MPEA.

Appendixes

Appendix 1: Annotations

1. DiEnno, Cara Marie and Sunita C. Hilton. 2005. High Scholl Students' Knowledge, Attitudes, and Level of Enjoyment of an Environmental Education Unit on Non-Native Plants. The Journal of Environmental Education. 37(1):13-25.

This article reports the findings of a study on the effectiveness of constructivist learning theory on high school students, to measure the increase in knowledge, engagement and improvement of attitudes toward environmental education, specifically a unit on invasive plant species, versus traditional teaching approaches.

The article begins by addressing what grade level was the best to target for this type of environmental education (EE). Their research found that students from 8th to 11th grade aged 13-18 were seen as the most appropriate group for understanding and appreciating our natural world. High school students are seen as appropriate because they are mentally equipped to understand the complexities of environmental issues. The constructivist learning theory can be defined as an understanding that each student comes to class with his or her own assumptions about how the world works; for knowledge to be retained, it needs to be presented in a way that fits this new knowledge into the student's existing worldview. It was also noted that if students are involved in relevant, local issues and not distant, global problems, they are more likely to recognize the importance of community and personal action. This method allows students to construct knowledge based on personal experience and adds to existing knowledge.

The study used two groups (traditional and constructivist) and presented each with the same educational content, taught by the same person. A one-week unit on non-native plants was titled "Which Ones Do Not Belong? An Exploration of Non-Native Plant Species." A survey was conducted that applied a pre- and post-test on the material, and additional items like levels of enjoyment.

The traditional teaching methods included lecture formats with overheads, time for worksheet completion from a workbook, and answer sessions. Classroom discussion was allowed but not encouraged. Students worked individually and did not share with others.

The constructivist group involved an introduction to the day's material and a brief explanation of the tasks or experiment to be done in a workbook. Students worked in groups and recorded notes in books and also blank overheads for later presentations. The end of classes involved informal presentations by students based on their notes.

For the study three hypotheses were made:

- that constructivist students would have a greater knowledge gain than traditional taught students
- that constructivist students would have a greater attitude change when compared to traditional students
- that constructionist students would be more engaged than traditionally taught students.

Results supported the first two hypotheses, while for the third hypothesis, results did not show significant support.

Based on the results, the application of the constructivist learning theory proves to be an effective teaching method for environmental education. Knowledge gains and attitudes were higher than the students taught by traditional means. This study proves that the constructivist method is just as effective at increasing students' knowledge as the traditional approach but also has the added benefit of the affective domain. By engaging the students and building on existing knowledge, they see their input as important as the instructor's and this can give students a stronger possession of their knowledge. This study showed that increased knowledge can lead to more sensitive attitudes among students with regard to the environment such as non-native plants and their control.
Annotation by Nathan Allen

2. Mortensen, David A. et al. 2009. Forest Roads Facilitate the Spread of Invasive Plants. Invasive Plant Science and Management 2.3: 191–199.

This article summarized the research conducted in a 32,000-hectare deciduous forest managed by The Nature Conservancy. The goal was to conduct a large-scale invasive plant survey with a patch-scale expansion experiment. The survey portion transected the forest while the patch experiment was conducted by initiating invasion on different habitats such as roadsides, wetlands, disturbed areas and intact forest.

The survey found that the presence of Microstegium (Japanese Stilt Grass) was closely related to the proximity of roads. This article continued by explaining the relationship of roads to spreading invasive species, where roads acted as corridors that supported the dispersion of invasive plants.

For the patch experiment, the researchers wanted to see the effects of site conditions on the spread of the plant. Patches were allowed to grow for a four-year period before being controlled.

Results showed that the natural rate of spreading for Stilt Grass was actually quite slow, many times slower than what was observed by forest managers the researchers spoke with. The study showed that spread of invasive species was most severe in habitats next to forest roads. They proposed that this

was the direct result of management practices such as periodic grading of gravel and dirt roads within the forest.

As a result of the study, researchers suggest that management of this invasive plant can be aided by an integrated approach to management. They suggest paying close attention to existing infestations and avoid disturbance along the roads near them, especially road edge disturbance, which can provide optimum seed bed locations for the plant.
Annotation by Nathan Allen

3. Thelen, Giles C. et al. 2005. Insect Herbivory Stimulates Allelopathic Exudation By An Invasive Plant and the Suppression of Natives. *Ecology Letters* 8.2: 209-217

In this study, scientists researched the effects of biocontrol insects and parasitic fungi on invasive plants. Centaurea maculosa, also known as spotted knapweed, has its origins in Eastern Europe, and is currently categorized as an invasive plant species throughout the United States and a majority of Canada. This has led to the widespread introduction and use of biological control (biocontrol) insects to reduce the number of exotic knapweed present in a system. However, C. maculosa has several defensive strategies to survive against herbivorous biocontrols and fungi.

To quantify this response, the researchers measured rhizosphere concentrations of an allelopathic chemical—called (±)-catechin—that harms native vegetation in North America.

Damaged C. maculosa leaves did not affect chemical concentrations of (±)-catechin in the soil. When infected with a parasitic fungus, spotted knapweed released double the amount of (±)-catechin, and when attacked at the roots, the invasive plant released four times as much of the damaging chemical. Predictably, a combination of root herbivore insects and parasitic fungi resulted in greater (±)-catechin secretions and no net reduction in total biomass or plant production of flowers. A third experiment yielded smaller native grass growth when next to infected spotted knapweeds, and greater native plant production when next to uninfected spotted knapweeds, with similar results in the field. These results show that, contrary to expectations, root herbivory caused by biocontrol insects and parasitic fungi increases the amount of allelopathic chemical exudates from invasive spotted knapweeds. This response has a consequently negative effect on native grass species.
Annotation by Ann Michelle Bolabo

4. Cubino, Josep P., J.V. Subirós, and C.B. Lozan. 2015. Propagule Pressure from Invasive Plant Species in Gardens in Low-Density Suburban Areas of the Costa Brava (Spain). Urban Forestry & Urban Greening 14.4: 941-951

A majority of domestic gardens in urban settings predominantly feature exotic plants. A significant number of these cultivated species may be invasive and negatively affect their natural surroundings as a result. Therefore, urban environments would greatly benefit from detecting these invasive species in advance and accurately assessing propagule pressure when necessary. Those conducting the study analyzed flora within 258 Costa Brava domestic gardens to research the significance of invasive detection and propagule pressure assessment in urban ecosystems. Of the 635 identified taxa, 68% proved exotic (or 77%, if only accounting for cultivated species). Spain identifies 39 of the species as invasive, 25 of which appear within a nearby Natural Park.

Several regression models indicated that all of the plant biodiversity limitations (such as the respective plant richness of exotic and native species, as well as plants as a whole) correlated strongly to garden area, house occupancy rate, and various socio-economic or cognitive characteristics of household members. An analysis for distance-based redundancy known as dbRDA indicated that invasive species composition related to garden area, building age, level of income and the ratio of residents who do not work.

Overall, garden centers housed a greater number of horticultural species even though replacement and renewal of garden plants occasionally occurred. Thus, influencing the preferences of homeowners may result in the creation and restructuring of private landscapes with increasingly more native and environmentally friendly species. To accomplish this, homeowners must have access to detailed information about the species present in garden centers and nurseries.
Annotation by Ann Michelle Bolabo

5. Gavier-Pizarro, Gregorio I., et al. "Housing is positively associated with invasive exotic plant species richness in New England, USA." Ecological Applications20.7 (2010): 1913-192.

This paper studies how different housing developments can lead to the spread of invasive species, looking particularly at the New England region of the United States. The authors argue that housing development facilitates invasions by disturbing land cover, introducing non-native landscaping plants, and facilitating dispersal of propagules along roads.

They also proposed three questions to better understand the phenomenon. How strongly is housing associated with the spatial distribution of invasive exotic plants compared to other anthropogenic and environmental factors? What type of housing pattern is related to the richness of invasive exotic

plants? Do invasive plants represent ecological traits associated with specific housing patterns?

The case study found that invasive exotic plant richness was equally or more strongly related to housing variables than to other human (e.g., mean income and roads) and environmental (e.g., topography and forest cover) variables at the county level across New England. Richness of invasive exotic plants was positively related to area of wildland–urban interface (WUI), low-density residential areas, change in number of housing units between 1940 and 2000, mean income, plant productivity (NDVI).

They give the economic incentive that biological invasions in the United States have resulted in an estimated economic loss of 120 billion dollars per year, out of which exotic plants alone account for 25 billion dollars (Pimentel et al. 2005). They used a model of 18 variables sub-categorized into explanatory variables into three categories: housing, other human influence, and environmental. They concluded that richness of invasive exotic plants showed a strong association with specific housing patterns. They also found that housing variables were strongly and positively related to county level invasive exotic plant richness in New England. Finally they concluded that richness of plant types largely followed the pattern that they found for total invasive exotic plant richness in their relationship to housing and other human and environmental variables.
Annotation by Kevin Friant

6. Hulme, Philip E. 2012. Weed risk assessment: a way forward or a waste of time? Journal of Applied Ecology 49.1: 10-19.

This article is about weed risk assessments (WRAs), a tool used to identify the impacts of invasive plant species and rank the current and future threats they pose to the environment and native species. WRAs are used to justify the means needed for various levels of eradication, from spraying with herbicides to simple pulling methods.

This article addresses the benefits and shortfalls of various WRA methods. Three broad approaches have been adopted: quantitative statistical models, semi-quantitative scoring, and qualitative expert assessment. Quantitative statistical models apply linear models, discriminant functions or decision trees across a large number of species to assess the extent to which one or more life-history traits account for observed variation in one or more measures of invasiveness (Pyšek & Richardson 2007).

The most widely applied approach is the Australian Weed Risk Assessment (AWRA) protocol which is semi-quantitative scoring that uses 49 questions about biology, biogeography, and behaviour elsewhere, to classify a plant species according to its risk of becoming invasive (Pheloung, Williams & Halloy 1999). Qualitative expert assessment is usually undertaken by decision panels with the experience to answer broad questions about likelihoods of introduction, establishment, impact and management on a qualitative scale (negligible, low, medium

and high) and then summarize the overall risk based on these answers (FAO, 2004).

The MPEA would be an ideal place for funding research into new WRAs in Maryland. This article concludes by approving of weed risk assessments but considers past WRA methods biased and lacking. The authors decided that addressing these issues would require a new WRA that draws on other perspectives from statistics, complexity theory, bioeconomics and cognitive psychology. The goal of this new WRA is to present an interdisciplinary appraisal of weed risk assessment that can better minimize bias.
Annotation by Kevin Friant

7. Pacific Northwest Research Station. *Invasive Species*. Web. 18 Nov. 2015

When people hear the word invasive species they immediately think of animals. While this is true, the concept of species involves animals, plants and organisms; invasive species are environmental aspects introduced into a particular ecosystem after being relocated from its natural habitat. It is from this point that the species start to cause harm and dysfunction in their new habitat because non-native organisms cause changes in their new ecosystem and in turn cause the native wildlife to adapt. Since species are not always able to adapt many native species die off or migrate elsewhere. From this point on, the once-invasive species become “native” species; they begin to reproduce and claim the area as their own.

In the Pacific Northwest invasive species include the white pine blister rust (disease), Atlantic salmon, European crab, Himalayan blackberry and many others. In addition to displacing the native species, invasive species may also degrade recreational areas, reduce the health and productivity of forests and, most importantly, alter the natural processes of the ecosystem and services it provides to humans, services that often go unnoticed and unappreciated. To help with invasive species we can all begin to educate ourselves on and learn about what we can do to preserve our environment for as long as possible.
Annotation by Tyreese Garrick

8. Gavier-Pizarro, Gregorio I., Volker C. Radeloff, Susan I. Stewart, Cynthia D. Huebner, and Nicholas S. Keuler. 2010 Housing is positively associated with invasive exotic plant species richness in New England, USA. Ecological Society of America. Ecological Applications.

Invasive species become known as such because they invade the life and territory of species, plants and organisms that are native to an area or ecosystem. Invasive species can be found just about anywhere they should not be. One of these locations is in residential areas. According to Gavier-Pizarro et al, housing is positively associated with invasive and exotic plant species richness in the U.S.

The key to understanding and stopping invasive species is to first grasp exactly how these species are not only leaving or escaping their natural habitat, but to also examine on what scale and magnitude these organisms operate on, and perhaps, whom they are operating with.

It is common to introduce invasive species into an area through construction. During construction, workers and contractors dig up the ground to build a structure's foundation; disturbing the land cover introduces non-native plants and organisms to the area then causes these species to multiply. As a result, they end up taking over and altering the function of the ecosystem. It is our job, as land and homeowners, to be smart about what and where we build, as well as the materials we use to build. If we do not start to monitor and find solutions, all native species will be destroyed.
Annotation by Tyreese Garrick

9. Coutts, Shaun R., et al. 2011. What are the key drivers of spread in invasive plants: dispersal, demography or landscape: and how can we use this knowledge to aid management? Biological Invasions 13.7: 1649-1661.

Invasive plants damage ecosystems from local to landscape scales. Reduction or reversal of spread is an important goal of many invasive plant management strategies, but few general guidelines exist on how to achieve this. The study team identified dispersal as the main factor that drives spread, and using a spatially simulation model, tested different life history categories in different spread and landscape scenarios. Also, they used boosted regression trees to determine the parameters that most affected spread.

The study team concludes four management guidelines from their simulation model:

- manage dispersal to manage spread, as mean dispersal could be managed by controlling dispersal vectors directly
- decide the type of spread to slow; short bursts of rapid spread or more usual year-on- year spread can have different drivers
- targeting demographic rates will have variable effectiveness in controlling spread
- manage spread with context dependent drivers.

In sum, study team found that different types of spread may be driven by different factors, and thus spread needs to be narrowly defined to target management or determine its key drivers**.**
Annotation by Yung-Ting Hsu

10. Gavier-Pizarro, Gregorio I., et al. 2010. Rural housing is related to plant invasions in forests of southern Wisconsin, USA. Landscape Ecology 25.10: 1505-1518.

Many factors determine invasion patterns, but most biological invasions are facilitated by human activities. The goal of this paper is to evidence the hypothesis that rural housing is a significant factor explaining the distribution of invasive non-native plants. Study areas in three categories represent forests in a total of 150 plots with no housing (3,825 hectares), low-density housing (6,141 hectares), and high-density housing (1,269 hectares) for the year of 2006-2007 in southern Wisconsin.

The study team recorded richness and abundance of the most common invasive and non-native plants, and measured rural housing, roads and forest edges, forest structure and topography. They hypothesize that rural housing facilitates non-native invasion at the landscape scale, because houses are sources of propagules for plants used in landscaping and because disturbances around homes facilitate invasion plant colonization.

The team used regression analysis to identify the variables more related to the distribution of invasive non-native plants. It turns out that invasive non-native plants were widespread in the study area. Moreover, they found that the richness of invasive non-native plants was greater in plots surrounded by more houses, closer to forest edges, at lower elevations, and closer to houses and roads. Non-natives also tended to increase in plots with greater cover of native plants. Thus, housing development inside or adjacent to forests of high conservation value and the use of non-native invasive plants for landscaping should be discouraged.
Annotation by Yung-Ting Hsu

11. Oduor, Ayub M. O. 2013.Evolutionary responses of native plant species to invasive plants: a review. New Phytologist 200, no. 4 (December 2013): 986-992.

The meta-analysis in this paper was done to support the hypothesis that native plant species can respond evolutionarily to selection pressures exerted by invasive plant species. Invasive plants species can only survive under certain criteria, therefore, Invasive plant species can dramatically alter the structure of the ecosystems, and dynamics of the native communities. The research evidence support that native plants can undergo evolutionary process to survive under the altered adverse conditions.

However, the research explains that certain criteria need to be met to be successful in this evolution process. First, the native plant population must have heritable genes that can survive during the selection pressure. Second, the selection pressures exerted by the invasive plant must sufficiently strong, consistent, and affect the fitness of the native plants (Strauss et al., 2006; Leger & Espeland, 2010). The results show that

the level of growth/reproductive traits of the native plants is higher than that of the invasive plants.

An awareness of population genetics and demographic processes will be key to understanding the adaptive evolutionary responses of native plant species to invasion by exotic plant species.

One of the paper's examples explains how critical genetic differences between natives and invaders behave under altered environmental conditions. Using a neutral genetic marker, research evidence showed that four native grass species collected from native habitats that were invaded by Ascription repens and Cardaria drab were different from conspecifics collected from adjacent un-invaded habitats.

This example provides a useful framework upon which to build and expand. Modern molecular genetic technologies were used to support this evidence. Further, habitat quality—the level of light, moisture, temperature and nutrients under which plants grow—may influence the evolutionary responses of native plant species to invasion. It is widely accepted that native plant species use limited growth resources more efficiently than invasive plant species. This supports the idea that natives have a higher ability to compete against the invasive plant species in resource-poor habitats. The hypothesized ability of experienced natives to resist and tolerate strong competition from invasive plant species has led to suggestions that seeds and plant material from the experienced natives should be preferentially used to restore invaded ecosystems. Further studies similar to this might analyze across taxonomic groups covering a broad range of habitats to capture the variability in evolutionary responses by native plant species. Such further study would solidify the Darwinian concept underlying these phenomena.
Annotation by Delath Mendis

12. Newcomer Johnson, Tamara, et al. 2014. Effects Of Stormwater Management And Stream Restoration On Watershed Nitrogen Retention." Biogeochemistry 121.1 (2014): 81-106.

Restoring urban infrastructure and managing the nitrogen cycle represent emerging challenges for urban water quality. Nitrogen inputs to watersheds have doubled globally (Vitousek et al. 1997), and urbanizing landscapes are becoming important sources of nonpoint source pollution in streams and rivers. Nitrogen inputs can contribute to coastal eutrophication and contamination of major drinking-water supplies; increased organic carbon from bioavailable sources can also contribute to coastal hypoxia (Mallin et al. 2004; Sickman et al. 2007).

Urban watersheds receive a mix of nitrogen and carbon inputs from external sources such as atmospheric deposition, fertilizer, and food, which supply internal nitrogen and carbon loading from human and pet waste, leaky septic systems, and

aging sanitary infrastructure (e.g., Bernhardt et al. 2008; Kaushal et al. 2011; Fissore et al. 2012).

In urban watersheds, both aboveground and below-ground modifications of hydrologic connectivity contribute to impaired water quality. Aboveground human modifications of the land surface such as impervious surfaces, gutters, and storm drains collect and convey carbon and nutrients in ways that can bypass natural flow paths (Kaushal and Belt 2012). These modifications can disconnect the riparian zone from the drainage network and contribute to decreased opportunities for retaining and removing nitrogen from surface runoff (Walsh et al. 2005).

Considerable public funds have been spent on stream restoration strategies to reduce river nitrogen loads (Bernhardt et al. 2005). In addition to stream restoration, there is also growing interest in the potential for stormwater management to reduce nitrogen loads, but there are still many uncertainties (Collins et al. 2010).

The majority of the stream network was buried in underground pipes during development. The study site has a long history of industrial use and pollution, and was identified by Baltimore City as one of its two most degraded streams (Fisher 2001). Baltimore City was required by Civil Action No. Y-97-4185 to construct the Gwynns Run Pollution Control Facility, a lowland oxbow SCM system, at a cost of $1.7 million. Its purpose was to reduce downstream transport of suspended solids, metals, oil, grease, nitrogen, and phosphorus. The SCMs were completed in 2004 and consisted of a reinforced concrete flow diverter, forebay, oxbow wetland (SCM 1), and wet pond (SCM 2; Fig. 2). They were designed to treat 40% of flow during 1.4–3.2 cm rain events (capacity of 7,380 m3; Baltimore City 2005). The major predictors for N retention at the watershed scale were stream water and groundwater flux through stream restoration or storm water management controls, hydrologic residence times, and surface area of hydrologically connected features.
Annotation by Delath Mendis

13. Emily S. Minor and Robert H. Gardner 2011. Landscape connectivity and seed dispersal characteristics inform the best management strategy for exotic plants. Ecological Applications. 21:739–749

Minor and Gardner's invasive species management approach focuses on individual species and their varying traits and abilities within specific landscapes. The study seeks to explain the relationship between pattern and process when preventing potential invaders or the spread of established invaders.

The study focuses on species dispersal and landscape characteristics to create unique management techniques for individual species. The study site, Antietam National Battlefield, was chosen because of its multi-purpose land qualities: forest, agriculture and pasture. Invasion simulations were created with CAPS. The simulations used hypothetical

species rather than actual species because the data needed to be realistic and widely relevant, not species specific. The results show that species with a high probability of random long-term dispersal will spread farther than those with a lower probability of random long-term dispersal. It also showed that the rate of invasion is highly connected to entry point. If a species is introduced in a disconnected patch, it will not invade as rapidly as if it had been introduced in a well-connected patch.

In terms of management simulations, programs in well-connected areas slowed invasion better than those plans introduced to disconnected areas. It also shows that species that frequently disperse seeds over long distance are not affected by landscape connectivity, so a management plan would need to focus on removing large patches to decrease the largest population areas. To reduce invasion by plants that are affected by connectivity and do not have long seed dispersal ranges, a bottleneck or blocking approach works to constrict movement between patches.
Annotation by Laura Robinson

14. J. Scott McElroy, Fred H. Yelverton, Leon S. Warren Jr. 2005. Control of Green and False-Green Kyllinga (Kyllinga brevifolia and K. gracillima) in Golf Course Fairways and Roughs. Weed Technology. 19(4):824-829.

McElroy, Yelverton and Warren evaluated the control of green and false-green kyllinga on golf courses. Green and false green kyllinga are rhizomatous weeds to turf grass. They are difficult to kill with herbicides because rhizomes are difficult to eliminate. While physically similar, green and false-green kyllinga respond differently to herbicides.

The experiments were conducted at Fairfield Harbour Country Club and Reedy Creek Golf Course in North Carolina. The fairways consisted of almost all Bermuda grass. Twelve different herbicide treatments and a control were used to test patches of green or false-green kyllinga. Imazaquin combined with MSMA reduced the largest percentage of the green kyllinga population at 80% up to one year after the application. False-green kyllinga was most affected by Trifloxysulfuron, which decreased the population by 90% up to a year after the initial treatment. More research needs to look at the effectiveness of multi-applications of the pesticides.
Annotation by Laura Robinson

15. Moon, Katie, Deborah A. Blackman, and Tom D. Brewer. "Understanding and Integrating Knowledge to Improve Invasive Species Management." Biol Invasions Biological Invasions (2015): 2675-689.

This source is an article from the UMD library database and examines how most programs to eradicate invasive species are successful only because they are implemented in uninhabited regions. The article identifies the challenge of controlling and eradicating species in inhabited regions.

Using a case study done in Tasmania, Australia, the goal was to understand how scientific evidence and community knowledge and preference should determine how to detect and eradicate invasive species. Respondents perceived that scientific evidence was best used in determining the need to act, assessing risks, designing eradication operations and monitoring progress.

This is useful in finding a socially and environmentally acceptable way to eradicate invasive species. We cannot just destroy the entire forest because native plants will be eradicated in the process as well. The researchers concluded that a functional approach with a co-governance system that included the community and scientific knowledge would be best. This article is helpful in the politics of managing invasive species. It emphasizes that there has to be a plan and process to meet the end goal.
Annotation by Kontessa Roebuck

16. Pfister, Scott. 2015. Hungry Pest Invade Middle School. IN Hungrypest.com. United States Department of Agriculture. Web. 19 Nov. 2015. <http://www.hungrypests.com/resources/HP_InvadeMS_Curriculum.pdf>

This website is a USDA-approved curriculum for middle school students in grades 6-8. It provides four lesson plans for science teachers to engage students on invasive species. The activities can also be integrated into other subjects like biology. Lesson one focuses on defining invasive species and analyzing how they can be harmful to the environment. Lesson two helps children identify invasive species, where they currently exist and where they could potentially pose a threat. Lesson three describes how invasives are spread throughout a community and their negative impacts, including agriculture and forests. Students learn about local agencies working to stop the spread of invasives and begin to learn local policies. The final lesson plan is how to eradicate invasive species and create awareness in the rest of the community. Students learn what they can do even on a small scale to help their environment.

There are handouts for the students to complete and each lesson provides learning objectives and suggested games to make sure students fully grasp the information. These lesson plans not only focus on plants but invasive pests and animals as well. But for the purpose of our project we can focus solely on plants.

The curriculum is a great example of how invasive species can be taught in schools, especially to younger children. This source provides other helpful sources and maps. The projects and activities can be continued at home. It is a good way to get young children involved in the community at a young age.
Annotation by Kontessa Roebuck

17. Federal Interagency Committee for the Management of Noxious and Exotic Weeds and Westbrooks, Randy G., "Invasive Plants: Changing the Landscape of America" (1998).

We define “invasive species” as an organism that causes an ecological or economic harm in a new environment. As new species are introduced into Maryland and the conditions are favorable, a massive expansion of these species takes over entire ecosystems.

Invasive species are a problem everywhere but this article examines the Kenilworth Marsh, a 77-acre tidal area in Washington D.C. that has been invaded by purple loosestrife in recent years. Purple loosestrife is a wetland plant primarily in Europe and Asia that was introduced to the U.S. in the 1800s. It is an exotic invasive plant that has spread to 40 states and along the Canadian border. In response to this threat, the National Park Service has launched a multifaceted control program to protect the Marsh, the last vestige of a once prominent freshwater wetland along the Anacostia River.

Washington D.C. has created hundreds of acres of parkland throughout the metropolitan area. Today, over 3,000 acres of this parkland is managed as natural areas and serve as sanctuaries to diverse groups of native plants and animals.

In Maryland, in recent years, forest edges, streams banks, and other areas of disturbance have been invaded by aggressive non-native plants such as Oriental bittersweet, English ivy, porcelain berry, and Japanese honeysuckle. Also, two Asian vines, porcelain berry and Oriental bittersweet, which are still sold as landscape ornamentals, are damaging hardwood forests and shorelines.

The article discusses the gravity of the invasive aquatic plants and the measures to control and transform parkland.
Annotation by Edy Ruano

18. Colding, Johan, and Carl Folke. 2008. The Role of Golf Courses in Biodiversity Conservation and Ecosystem Management.

This article examines the ecological value of golf courses and the quantitative amount of biota in green-area habitats within golf course land uses. The article notes that golf courses had higher ecological value in 64% of comparative cases. Due to their open space and the creation of different habitats, golf courses contribute to the diversification and richness of birds and insects. Many courses contribute to the preservation of fauna of conservation concern. Also, they serve as stopping points for migrating birds. More broadly, the article finds that the ecological value of golf courses significantly decreases with land types having low levels of pollutant impact, like natural and nature-protected areas. Conversely, the value of golf courses significantly increases with land that has high

levels of anthropogenic impact, like agricultural and urban lands.

Also, the article discusses ecosystem management perspectives; golf courses represent a promising way to restore and enhance biodiversity in ecologically simplified landscapes. In the creation of scenery throughout a course, the individual landscapes create small habitats for local species. Furthermore, the review suggests that golf courses hold real potential to be designed and managed to promote critical ecosystem services, like pollination and natural pest control, providing an opportunity for joint collaboration among conservation, restoration and recreational interests by using different settings throughout the landscape. The article discusses the value of golf courses based on their land use and the way they enhance biodiversity throughout the landscapes.
Annotation by Edy Ruano

19. Brenda Molano-Flores. 2014. An Invasive Plant Species Decreases Native Plant Reproductive Success. Natural Areas Journal. Vol. 34, Issue 4: 465-469.

Invasive plants may have negative, positive, or neutral effects on the reproductive success of native plant species. This study investigated the impact of the rhizomatous invasive species on the reproductive success of the native prairie species Tradescantia ohiensis. It particularly examined how T. ohiensis plant height, fruit set, seed set, and stigma pollen load differed inside or at the edge of crown vetch patches and within native prairie not invaded by crown vetch.

A significant reduction in reproductive success and pollen deposition was detected among T. ohiensis plants in the interior of a crown vetch patch compared to those at the edge. These, in turn, had lower reproductive success and pollen deposition than plants in the native prairie areas. Also, T. ohiensis plants were taller inside crown vetch patches. The results of this study suggest that rhizomatous invasive species such as Securigera varia can have direct and indirect impacts on the reproductive success of native species.
Annotation by Lucas Scott

20. Mcphie, Jamie, and David Andrew George Clarke. 2015. A Walk In The Park: Considering Practice For Outdoor Environmental Education Through An Immanent Take On The Material Turn. Journal Of Environmental Education 46.4: 230.

This article considers practice for environmental education from the perspective of the material turn by taking the reader on an outdoor learning session in a park. On this fictional walk the reader encounters plants, trees, wasp-orchids, stones, walking sticks, plastic bags, people, weather, and kites, each of which has a story to tell that demonstrates ontological immanence and the material process of being alive. These stories help suggest some practical ways in which environmental education can be reoriented from an essentialist paradigm to one of becoming, tackling prevailing

conceptions of the human mind as disembodied from the world.
Annotation by Lucas Scott

21. Minor, S. Emily, et al. "The role of landscape connectivity in assembling exotic plant communities: a network analysis. *Ecology* 90:7 (2009):

This article analyzes the relationship of invasive species to exotic species related to habitat fragmentation. The research suggests that native invasive species can spread more easily than native species in fragmented landscapes. Since direct observation of movement of species through landscape is preferable but impractical, the researchers applied the technique of network analysis, which uses graph theory, to theorize how landscape connectivity affects communities of native and exotic plants in the eastern U.S., providing insights into the processes that drive exotic plant invasions in fragmented landscapes.

The site chosen for the study was Antietam National Battlefield, a 1,300-hectare park in the Appalachian Ridge and Valley province, in Washington County, MD. The site is an ideal fragmented landscape, as it contains a mixture of farmland, pasture, and woodlands. The study examined 58 .04-hectare plots were inventoried for the presence of plant species, which were identified as native, invasive exotic, non-invasive exotic, and placed in one of four dispersal groups: wind, ingestion, adhesion and unassisted dispersal. Based on observations and the literature, discrete forest patches within 50 meters of each other may be considered connected for plants, based on plants' dispersal capabilities.

Environmental variables were gathered for each plot, as well as soil data, and Mantel tests were used to examine changes in plant community composition relative to spatial location and environmental variables. The study looked at 208 plant species, 61 of which were exotic. Dispersal factors among the exotic and native plants seemed to be similar, however when exotics were split into invasive and non-invasive, different patterns emerged. The article also provides data on which dispersal modes are more likely to affect native, exotic-invasives and exotic non-invasives.
Annotation by George Sorvalis

22. Radeloff, V.C., et al. 2005. The Wildland-Urban Interface in The United States. Ecological Applications 15:3: 799-805.

This article provides a framework for studying how a growing housing stock affects the health of the surrounding environment, particularly where housing meets undeveloped wildlands. The article focuses on how housing in the Wildland-Urban Interface (WUI) affects species and plant communities, as well as the threats to human inhabitants posed by wild fires.

The researchers sought to fill in lacking data on the WUI by conducting a spatially detailed national assessment of the WUI to provide policy makers, land managers and planners a framework for studying this housing/wildlands interface area.

They found that a significant portion of new development across the U.S. occurs at low or medium density and tends to be more dispersed, affecting a greater area, and generally increasing environmental problems.

Housing was based on the 2000 U.S. census. Vegetation information was derived from USGS National Land Cover Data (NLCD), and 30-m resolution Landsat TM satellite data from 1992 was used to identify and map the WUI across the 48 conterminous states. For the study, thresholds for housing density were set at 12.34 housing units/km^2, 6.17 houses units/km^2 and 3.09 housing units/km^2.

The research found that across the lower 48 states, the WUI covers 719,156 km^2, or 9.4% of the land, and contains 44,348,628 housing units, or 38.5% of all housing units in the U.S. Researchers also conducted a state-level analysis, and include tables that analyze the number and density of housing units in the WUI, and relates this information to incidents of wildfires, biodiversity, and invasive species issues. The study underpins the importance of undisturbed areas and the need to identify priority conservation sites in the face of development pressures.
Annotation by George Sorvalis

23. Garrison, Mark A., et al.2009. Cool-Season Turfgrass Survival on Two Former Golf Courses in Michigan. *Invasive Plant Science and Management* 2.4 (2009): 396-40

Turfgrass species exist in almost every inhabited and uninhabited region of the United States. They were introduced from Eurasia during the colonial period; they are able to form contiguous plant communities when mowed and were formally used for forage. Most turfgrass species have been listed as either invasive or potentially invasive species in the U.S., but few data exist to verify their invasiveness. The object of this study was to determine cool-season turfgrass survival on two abandoned golf courses to assess their invasive potential in unmanaged sites. Two former golf courses in Michigan were examined for their frequency and abundance of creeping bentgrass, Kentucky bluegrass, and fine fescues.Quadrants along transects were recorded and compared to other cover such as herbaceous dicots and bare soil in 2005 and 2007.

Turfgrasses at both courses were unable to maintain monocultures. At one site, all turfgrasses were nearly absent five years after maintenance operations ceased. The other site had creeping bentgrass comprising less than 25% cover on former putting greens by 2007, and it was rarely found outside of former putting green areas. Kentucky bluegrass cover ranged from 5% to 75% on the former fairways. Herbaceous dicots usually dominated the former turf areas at both sites, and included noxious weeds such as Canada thistle and invasive weeds such as spotted knapweed.
Annotation by Meredith Wallace

24. Holmes, Thomas, and Juliann Akema. "Economic Impacts of Invasive Species in Forests." 2009.

Biological invasions are among the most serious environmental problems currently facing society. Economic activity such as trade and transportation of products and people introduce nonnative species into new ecosystems. Because non-indigenous organisms have not coevolved with native biota, they threaten the structure and functioning of native ecosystems. While most of the new species do not have a large impact on the environment, certain species have profoundly altered their invaded environments, affecting ecosystem processes and ultimately human societies. Policy or management can reduce the probability of successful invasion or reduce the associated damages. Assessments of the economic costs and losses induced by non-native forest pests are required for policy development and need to account for all of the economic impacts induced by rare, highly damaging pests. The greatest economic impacts of invasive species in forests are due to the loss of nonmarket values. New methods for evaluating economic damages from forest-invasive species need to be developed that quantify market and nonmarket impacts.
Annotation by Meredith Wallace

25. The University of Texas at San Antonio utsa edu>lrsg>projects>vandana doc

This article looks at ways to control and manage invasive species by mapping and monitoring their spread. Remote sensing can help land managers control and monitor invasive plants by providing detailed information on plant location, and the extent of the plants' spread.

While digital multiband remote sensing and aerial photography have been available for many years, newer detector technologies have made it possible to accurately acquire a detailed laboratory-like spectrum of each pixel in an image from space. This study used NASA's advanced infrared imaging spectrometer to compare different methods of dealing with invasive plants. There is continuum of removal and band ration indices. They compared the success in determining the spatial extent of these invasive plants and found that a continuum removal method is an efficient way to characterize the presence and absence of invasive plants. This study showed that the invasive plants iceplant and jubata grass in California's Mediterranean-type ecosystems can successfully be mapped using hyper spectral imagery.

The immediate benefit of this research has been expanding the knowledge base of land managers by providing improved information on the spatial extent and the density of the ice plant and jubata grass, which will lead to better protection of the native biodiversity. This research also described some encouraging findings for applying hyper-spectral imagery to mapping iceplant, using a method that can be repeated over time to detect change and to monitor control efforts.
Annotation by Cristen Williams

26. National Invasive Species Information Center. www.invasivespeciesinfo.gov

The National Invasive Species Information Center was established to meet users' information needs, including the native invasive species council. NISIC manages the invasivepseciesinfo.gov website. The website is a reference gateway to information, organizations, and services about invasive species.

NISIC grew out of the USDA National Agricultural Library's (NAL) leadership in the development of the invasive species.gov website for the Council. It was launched as a joint collaboration between NAL, the U.S. Geological Survey, National Biological Information Infrastructure, and the council. The site began with less than 200 external resources, but now has more than 12,000 unique resources.

A major redesign enhanced access to this growing wealth of resources. The website is managed by the NISIC and was launched in 2005, built largely on the general content from the original invasive species website. It also communicates and facilitates needs related to the business and activity of the Council. The Council's specific focus is to ensure that Federal agency activities concerning invasive species are coordinated, complementary, cost efficient and effective. The Council is also responsible for producing a National Invasive Species Management Plan.

A news and events section links to news, conferences, conference proceedings, emerging issues, press releases and other information sources reporting on invasive species issues. It includes "spot lights," a special section of news highlights and events. The site is organized so people can easily see what is new and how to get involved in community action.
Annotation by Cristen Williams

27. Maryland Department of Agriculture. 2005. "Invasive Species of Concern in Maryland." http://www.mdinvasivesp.org/invasive_species_md.html

This source highlights an extensive list of invasive species found in Maryland and includes species that have the potential to be invasive if not regulated. These species are currently regulated by a state or federal law and are recognized by biologists and resource managers to impact natural ecosystems in a negative way. The listed Invasive species can affect Maryland's economic and agricultural industries if not handled appropriately. The article goes into detail about the number of invasive species in Maryland and their effects on human health as well as the environment. The article also reviews the ground management practices for existing invasive species and which methods should be modified.

Maryland is looking for proper funding, regulatory prevention, and education on the issue of invasive species. Although Maryland is trying to regulate most of the invasive species, the plants do have some beneficial components. For example,

some invasive species are important to the nursery industry, and are sold and planted in Maryland. The article discusses alternative ways to use these invasive species to benefit from them. Maryland Invasive Species Council (MISC) advises the public to follow this six-step action plan for invasive species.

1) Scout for invasive species
2) Avoid introducing invasive species
3) Keep wildlife wild
4) Avoid transporting invasive species.
5) Check that your gear or boat is clean
6) Leave species in their natural habitats.

Annotation by Lionel Wilson

28. Binkholder, K.M., Fresenberg, B.S., Tentun, T.C., Xiong, X., & Smeda, R.J. (2011). Selection of glyphosate-resistant annual bluegrass (poa annual) on a golf course. Weed Science Society of America, 59(3), 287-289.

Bluegrass is an invasive species present on golf courses, a pervasive weed in the Transition Zone of the U.S., which is difficult to selectively remove. This has been a problem for management for years; superintendents have applied glyphosate on dormant zoysia grass to remove cool-season weeds. In 2007, a population of annual bluegrass in Columbia, MO, was not controlled with glyphosate after more than 10 years of continuous applications. There have been many studies on bluegrass, and as a result, greenhouse studies were established to compare the response of suspect glyphosate-resistant (CCMO1) and susceptible annual bluegrass to glyphosate.

Seedling plants were treated with glyphosate because of the high presence of bluegrass. After 21 days of treatment, reductions in biomass for susceptible annual bluegrass reached a maximum at glyphosate rates of 0.78 kg ha−1 or higher. The biomass of CCMO1 plants was only reduced by 50% at 0.78 kg ha−1, and reductions did not exceed 60% at rates up to 6.27 kg ha−1, which is eight times the labeled rate.

To reduce plant dry weights by 50%, the resistance factor (RF) for CCMO1 was 5.2. Twenty-one days following biomass assessment, regrowth of plants was non-existent on susceptible plants at 0.78 kg ha−1 glyphosate or above, but CCMO1 plants reached 1.7 cm regrowth at the 6.27 kg ha−1 rate. Based on the regrowth, the RF for CCMO1 was 5.2.

These results indicate a new species has been identified with resistance to glyphosate, and this represents the first instance of glyphosate resistance in turf grass.
Annotation by Lionel Wilson

29. Westbrooks, Randy G., and United States. "Invasive Plants: Changing the Landscape of America: Fact Book". Washington, D.C.: Federal Interagency Committee for the Management of Noxious and Exotic Weeds, 1998

This report is intended to raise awareness of the destruction and economic losses caused by invasive plants in the U.S.. It lists different facts about this threat to the integrity of the nation's ecosystems to encourage individual and collaborative efforts.

The report compares invasive species to a wildfire. Although both can seriously damage native plant and animal communities, increase soil erosion and sedimentation, and interfere with outdoor recreation, a wildfire heals after a period of time. Invasive plants last longer and even become worse over time.

The report gives different definitions of invasive plants depending on their impact. On agriculture lands, invasive plants are weeds that interfere with crop production or other uses of the land. They can grow out of place and are competitive, persistent, and pernicious. In natural areas, invasive plants include introduced aggressive plants that produce a significant change in ecosystem composition, structure, or function.

Some common characteristics of invasive plants that makes them rapidly spread rapidly are early maturation; profuse reproduction by seeds; long life in soil; seed dormancy that ensures periodic germination and prevents seedlings from sprouting during unfavorable conditions; adaptations for spread with crop seeds, by natural agents, and by humans; production of biological toxins that suppress the growth of other plants; prickles, spines, or thorns that can cause physical injury and repel animals, the ability to parasitize other plants; seeds that are the same size and shape as crop seeds, which makes cleaning difficult; roots or rhizomes with large food reserves; survival and seed production under adverse environmental conditions; and high photosynthetic rates.

The report also list examples of invasive plants impacts on croplands, yards and gardens, rights-of-way, rangelands and pastures, forests, deserts, wetlands and waterways. It also addresses particular areas like Florida, Hawaii, and human built areas like parks/refuges, recreational areas, and how invasive plants relate to human and animal health.
Annotation by Bisheng Xu

30. Philip Weyhe, "Theater Company To Educate County Schools On Aquatic And Invasive Species". http://www.southernminn.com/le_sueur_news_herald/news/article_0ae564ee-6108-54aa-b7b0-2849bd576e8a.html

This case study of "Climb," a touring company educating youth about invasive species examines their efforts to educate youth and encourage them to act positively for themselves and the community.

In November 2015, elementary schools in Le Sueur County contracted with Climb Theatre Company to present classes. Climb Theatre usually sends their actor/educators to teach students about bullying, prevention, self-control, respect and other character-based learning. Since last year, the company has provided invasive species programs.

The classes help students learn from games instead of a conventional lecture. The company hopes that by educating students about invasive species, students will educate their parents so that classes can reach beyond the classroom.

Currently, a few specific species are causing problems in County lakes, such as Eurasian watermilfoil and curly-leaf pondweed. The most common aquatic invasive species is zebra mussels, which bottom feed and can clog pipes. It not only affects lakes, but is starting to enter the County.

The goal of CLIMB Theatre is to educate the public on how to prevent the invasive species from keep growing everywhere, by reminding students and their parents to clean and dry boats and other equipment when they are out on the water. The response has been positive from students and teachers.

Appendix 2: School Land Use: Inventory

Nate Allen

Introduction

This chapter documents the feasibility of leveraging schools in the education and management of invasive plant species around the MPEA and Howard County. **Adjacent schools could play a larger role in supporting invasive removal activities and more distant schools could support invasive removal and education efforts through a variety of means.** Schoolyard resources should also be considered. There are many constraints to leaving school grounds for activities. Using schoolyard resources, in addition to off-site activities, would increase capacity. Many schools are Green Schools, or are working toward Green School certification, which often involves schoolyard habitats. Invasive species education could be a part of this process.

Local Site Context

The two Howard County Public School closest to the MPEA are:

- Clarksville Elementary
- River Hill High School.

Due to their proximity, these two schools offer an opportunity to get faculty, students and family members involved in environmental education and specifically, understanding the threat of invasive plants on the MPEA's delicate ecosystem.

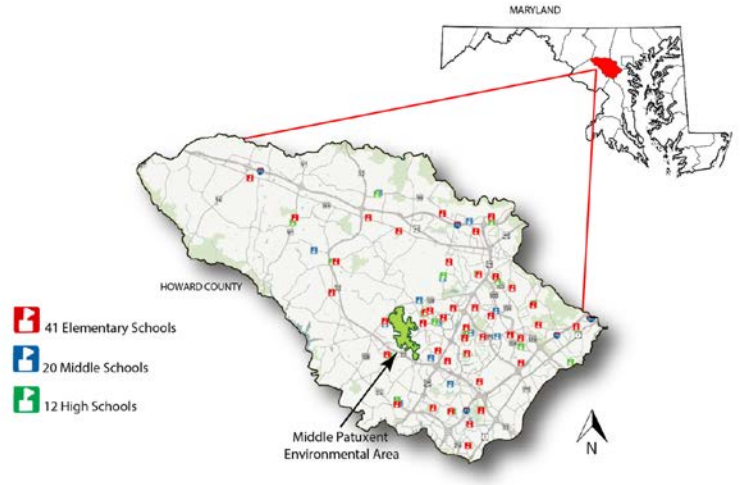
While the focus of deliverables was on River Hill High School and Clarksville Elementary, these ideas and concepts can be used throughout the Howard County Public School System.

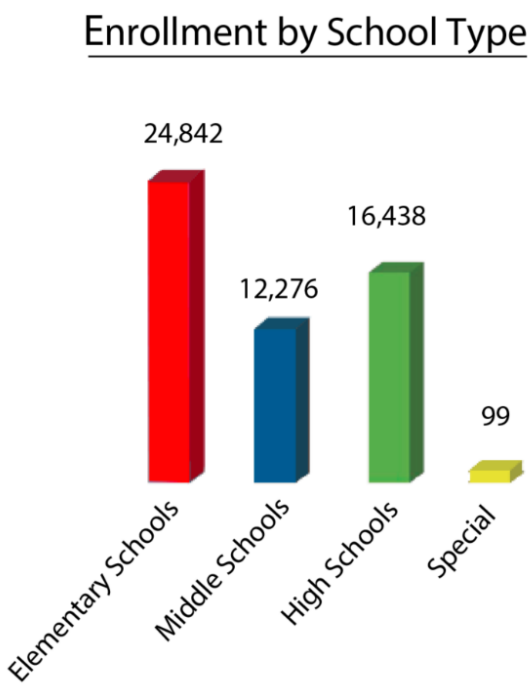
The two concepts we conceived include a variety of techniques that focus on educating students about the importance of invasive plant management, how to identify invasives, and management options. Each of the four team members researched peer-reviewed scientific papers related to invasive plant education material and used this information to guide the concepts:

1. **School Science Fair** – A plan that identifies a basic timeline for elementary, middle and high school students to participate in a science fair with specific topics on invasive plants.
2. **Invasive Day** – A day dedicated to outdoor activities that raise awareness of invasive plants. Activities like geocaching could be a fun way to locate invasives in the MPEA. Students and others could use cell phones to scan bar signs placed to provide information on invasive plants.

Regional Context

These program suggestions designed for the MPEA could also lead to a substantial impact on the presence of invasive plants throughout Howard County. With over 76 schools enrolling some 52,500 students (not including staff), the Howard County Public School System could play a significant role in increasing awareness of and taking action to reduce invasive plants in Maryland.





The state fully supports environmental literacy in public school systems. In 2008 Governor Martin O'Malley issued an Executive Order to establish the Maryland Partnership for Children in Nature (01.01.2008.06) to promote outdoor activities and environmental education for young generations.

In 2011 students entering high school must complete a locally designed program to promote environmental literacy (COMAR 13A.04.17). These suggested programs will augment these requirements and provide education about an issue that is threatening the ecosystems in which we spend our lives. The sooner we can educate kids on this topic, the more likely we will have a future generation that understands and responds to the difficult decisions that need to be made about invasive plant management.

Outcomes

This inventory lays a framework for implementing the concepts provided in the following pages.

Appendix 3: 2015 MPEA Invasive Plant Survey

2015 MPEA Invasive Plant Survey

			Plot #1	Date: 11/15/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Microstegium vimineum*	6	8	3
	N10	*Lonicera japonica*	2	3	6
		Microstegium vimineum	6	7	3
		Rosa multiflora	1	1	3
	S5	*Rosa multiflora*	2	3	9
		Lonicera spp.	2	2	4
		Microstegium vimineum	6	8	5
	S10	*Ligustrum vulgare*	1	2	7
		Microstegium vimineum	2	7	2
		Lonicera japonica	3	2	1
	E5	*Lonicera japonica*	2	3	4
		Microstegium vimineum	6	7	4
		Rosa multiflora	1	2	7
	E10	*Celastus orbiculatus*	2	3	1
		Lonicera japonica	2	1	1
		Microstegium vimineum	6	6	3
	W5	*Microstegium vimineum*	6	5	5
		Lonicera japonica	1	2	5
		Rosa multiflora	3	3	11
		Celastus orbiculatus	1	2	5
	W10	*Microstegium vimineum*	6	6	5
		Lonicera japonica	2	4	3
		Celastus orbiculatus	1	3	3

2015 MPEA Invasive Plant Survey

			Plot #2	Date: 11/15/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Lonicera japonica*	1	7	2
		Berberis thunbergii	1	3	1
	N10	*Elaeagnus umbellata*	1	1	2
		Berberis thunbergii	1	1	1
	S5	None	0	0	0
	S10	*Microstegium vimineum*	5	8	5
	E5	*Lonicera japonica*	1	1	1
	E10	*Lonicera japonica*	1	1	4
	W5	*Lonicera japonica*	1	1	4
		Celastus orbiculatus	1	1	3
	W10	*Rubus phoenicolasius*	2	3	5
		Lonicera japonica	3	7	2

2015 MPEA Invasive Plant Survey

			Plot #3	Date: 11/15/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Lonicera japonica*	1	1	2
	N10	None	0	0	0
	S5	*Berberis thunbergii*	1	1	1
	S10	*Berberis thunbergii*	1	1	1
	E5	*Ligustrum vulgare*	1	1	2
	E10	*Ligustrum vulgare*	1	1	1
	W5	*Lonicera japonica*	1	1	1
	W10	*Ligustrum vulgare*	1	1	2

2015 MPEA Invasive Plant Survey

			Plot # 4	Date: 11/15/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Lonicera japonica*	1	3	1
		Berberis thunbergii	1	1	1
	N10	*Lonicera japonica*	1	1	3
		Microstegium vimineum	2	5	4
	S5	*Microstegium vimineum*	1	1	1
		Rosa multiflora	1	5	6
	S10	*Lonicera japonica*	1	1	1
		Rosa multiflora	2	3	6
		Microstegium vimineum	1	1	1
	E5	*Rosa multiflora*	1	2	3
		Microstegium vimineum	1	7	1
		Lonicera japonica	1	1	1
	E10	*Lonicera japonica*	1	7	3
		Microstegium vimineum	1	7	1
	W5	None	0	0	0
	W10	*Lonicera japonica*	2	7	1
		Berberis thunbergii	1	1	3

2015 MPEA Invasive Plant Survey

			Plot #6	Date: 11/15/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Berberis thunbergii*	1	2	11
		Microstegium vimineum	1	1	1
	N10	*Rubus phoenicolasius*	1	3	6
		Celastus orbiculatus	1	1	1
		Microstegium vimineum	1	1	1
		Berberis thunbergii	1	1	4
	S5	*Lonicera japonica*	1	1	2
	S10	*Celastus orbiculatus*	1	1	2
		Rubus phoenicolasius	1	1	7
		Lonicera japonica	1	1	1
	E5	*Microstegium vimineum*	1	1	2
		Berberis thunbergii	1	1	3
		Celastus orbiculatus	1	1	1
	E10	*Oplismenus hirtellus ssp.undulatifo*	4	4	5
		Celastus orbiculatus	1	3	3
	W5	*Microstegium vimineum*	2	5	2
		Berberis thunbergii	1	1	4
		Celastus orbiculatus	1	7	1
	W10	*Celastus orbiculatus*	1	7	3
		Lonicera japonica	2	7	5
		Berberis thunbergii	4	4	11

2015 MPEA Invasive Plant Survey

			Plot #7	Date: 11/15/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	None	0	0	0
	N10	*Lonicera japonica*	3	6	2
	S5	None	0	0	0
	S10	None	0	0	0
	E5	None	0	0	0
	E10	None	0	0	0
	W5	*Lonicera japonica*	1	3	4
		Microstegium vimineum	3	4	4
	W10	*Rubus phoenicolasius*	1	1	7
		Lonicera japonica	1	1	2

2015 MPEA Invasive Plant Survey

			Plot # 8	Date: 11/15/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Lonicera japonica*	1	1	1
	N10	*Lonicera japonica*	1	3	1
	S5	*Lonicera japonica*	1	7	3
		Microstegium vimineum	1	1	1
	S10	*Microstegium vimineum*	1	3	2
		Rosa multiflora	1	3	2
		Lonicera japonica	1	7	2
	E5	*Lonicera japonica*	1	5	2
	E10	*Lonicera japonica*	1	3	2
	W5	None	0	0	0
	W10	*Lonicera japonica*	1	7	2

2015 MPEA Invasive Plant Survey

			Plot # 10	Date: 11/15/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Microstegium vimineum*	1	3	2
		Elaeagnus umbellata	1	1	4
		Lonicera japonica	1	3	3
		Celastus orbiculatus	1	3	3
	N10	*Microstegium vimineum*	5	8	3
		Celastus orbiculatus	2	1	2
		Lonicera japonica	3	4	3
	S5	*Lonicera japonica*	2	5	5
		Elaeagnus umbellata	1	1	3
	S10	*Lonicera japonica*	1	3	1
		Microstegium vimineum	1	1	2
	E5	*Elaeagnus umbellata*	1	1	11
		Rosa multiflora	1	1	4
		Lonicera japonica	1	3	4
	E10	*Microstegium vimineum*	1	3	1
		Lonicera japonica	2	5	3
		Elaeagnus umbellata	5	1	11
		Rosa multiflora	1	3	3
	W5	*Elaeagnus umbellata*	1	1	4
		Lonicera japonica	1	5	3
		Berberis thunbergii	1	1	2
	W10	*Elaeagnus umbellata*	1	3	4
		Lonicera japonica	1	3	2

2015 MPEA Invasive Plant Survey

			Plot # 13	Date: 11/25/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Berberis thunbergii*	1	1	10
		Lonicera japonica	1	7	2
		Microstegium vimineum	1	7	2
	N10	*Microstegium vimineum*	1	5	2
		Lonicera japonica	1	5	2
	S5	*Rosa multiflora*	1	5	5
		Microstegium vimineum	1	1	1
		Lonicera japonica	1	1	1
	S10	*Berberis thunbergii*	1	1	2
		Lonicera japonica	1	1	5
	E5	*Lonicera japonica*	1	1	5
	E10	*Berberis thunbergii*	1	3	3
		Microstegium vimineum	1	1	1
	W5	*Berberis thunbergii*	1	3	8
		Microstegium vimineum	1	5	2
		Rosa multiflora	1	5	6
	W10	*Lonicera japonica*	1	3	1
		Rosa multiflora	1	1	4
		Microstegium vimineum	1	1	1

2015 MPEA Invasive Plant Survey

			Plot #15	Date: 11/25/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Celastus orbiculatus*	1	1	2
	N10	None	0	0	0
	S5	None	0	0	0
	S10	*Celastus orbiculatus*	1	1	1
	E5	*Celastus orbiculatus*	1	5	2
		Berberis thunbergii	1	2	6
	E10	*Rosa multiflora*	1	1	5
		Berberis thunbergii	1	1	1
		Celastus orbiculatus	1	1	1
	W5	*Lonicera japonica*	1	3	3
		Celastus orbiculatus	1	1	2
	W10	None			

2015 MPEA Invasive Plant Survey

			Plot # 16	Date: 11/25/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Lonicera japonica*	1	1	1
	N10	None	0	0	0
	S5	*Lonicera japonica*	1	1	1
	S10	*Lonicera spp.*	1	1	2
		Lonicera japonica	1	3	1
	E5	None	0	0	0
	E10	None	0	0	0
	W5	None	0	0	0
	W10	*Berberis thunbergii*	1	1	1

2015 MPEA Invasive Plant Survey

			Plot #18	Date: 11/25/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Rosa multiflora*	1	1	1
	N10	None	0	0	0
	S5	*Rosa multiflora*	1	1	1
	S10	None	0	0	0
	E5	None	0	0	0
	E10	None	0	0	0
	W5	None	0	0	0
	W10	None	0	0	0

2015 MPEA Invasive Plant Survey

			Plot #19	Date: 11/25/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Lonicera japonica*	2	7	5
		Rubus phoenicolasius	1	5	3
	N10	*Celastus orbiculatus*	1	1	2
	S5	*Rosa multiflora*	1	5	6
		Lonicera japonica	1	5	3
	S10	*Rosa multiflora*	1	1	11
		Lonicera japonica	1	1	2
		Lonicera spp.	1	1	8
		Berberis thunbergii	1	1	5
	E5	*Lonicera japonica*	1	1	1
		Microstegium vimineum	1	1	1
		Rosa multiflora	1	1	7
	E10	*Rosa multiflora*	1	3	5
		Lonicera japonica	1	1	1
	W5	*Rosa multiflora*	1	1	3
		Berberis thunbergii	1	1	3
		Lonicera japonica	1	3	1
	W10	*Rosa multiflora*	1	1	2

2015 MPEA Invasive Plant Survey

			Plot #20	Date: 11/25/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Microstegium vimineum*	6	8	3
	N10	*Microstegium vimineum*	6	8	3
		Rosa multiflora	1	3	6
		Lonicera japonica	1	1	2
	S5	*Microstegium vimineum*	1	5	3
		Lonicera japonica	1	5	11
	S10	*Microstegium vimineum*	1	1	1
		Celastus orbiculatus	1	1	2
		Lonicera japonica	1	1	4
	E5	*Rosa multiflora*	1	3	11
		Microstegium vimineum	4	8	3
		Lonicera spp.	1	1	5
	E10	*Ligustrum vulgare*	1	1	4
	W5	None	0	0	0
	W10	None	0	0	0

2015 MPEA Invasive Plant Survey

			Plot #23	Date: 11/25/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Lonicera japonica*	1	1	1
	N10	*Lonicera japonica*	1	5	1
	S5	None	0	0	0
	S10	*Lonicera japonica*	1	3	1
	E5	None	0	0	0
	E10	*Rosa multiflora*	1	7	6
	W5	*Lonicera japonica*	1	5	3
	W10	*Berberis thunbergii*	1	1	1
		Lonicera japonica	1	3	1

2015 MPEA Invasive Plant Survey

			Plot # 24	Date: 11/25/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	None	0	0	0
	N10	None	0	0	0
	S5	None	0	0	0
	S10	None	0	0	0
	E5	None	0	0	0
	E10	None	0	0	0
	W5	*Microstegium vimineum*	1	1	1
	W10	None	0	0	0

2015 MPEA Invasive Plant Survey

			Plot # 25	Date: 11/25/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Rosa multiflora*	1	1	4
		Lonicera japonica	1	5	1
	N10	*Berberis thunbergii*	1	1	3
		Lonicera japonica	1	5	1
		Rosa multiflora	1	1	6
	S5	*Microstegium vimineum*	1	5	1
		Lonicera japonica	1	1	1
		Rosa multiflora	1	3	7
	S10	*Microstegium vimineum*	1	7	1
		Berberis thunbergii	1	3	1
		Lonicera japonica	1	5	4
	E5	*Microstegium vimineum*	2	7	1
	E10	*Lonicera japonica*	1	5	2
	W5	*Microstegium vimineum*	1	3	1
	W10	*Microstegium vimineum*	3	8	1

2015 MPEA Invasive Plant Survey

			Plot #30	Date: 11/25/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	None	0	0	0
	N10	None	0	0	0
	S5	*Oplismenus hirtellus ssp.undulatifo*	3	4	2
		Lonicera japonica	3	3	2
		Rosa multiflora	1	2	4
	S10	*Lonicera japonica*	2	4	2
	E5	*Celastus orbiculatus*	1	1	4
	E10	None	0	0	0
	W5	*Lonicera japonica*	2	2	1
		Microstegium vimineum	3	4	4
	W10	*Lonicera japonica*	1	7	2

2015 MPEA Invasive Plant Survey

			Plot #31	Date: 11/25/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Elaeagnus umbellata*	3	1	10
		Celastus orbiculatus	1	1	5
	N10	*Elaeagnus umbellata*	3	2	11
		Lonicera japonica	1	3	3
		Celastus orbiculatus	1	1	3
	S5	*Lonicera japonica*	5	8	5
		Celastus orbiculatus	3	3	6
	S10	*Lonicera japonica*	4	7	3
		Elaeagnus umbellata	2	1	8
	E5	*Lonicera japonica*	1	3	2
		Elaeagnus umbellata	1	1	1
	E10	*Lonicera japonica*	1	7	3
		Celastus orbiculatus	1	3	4
	W5	*Lonicera japonica*	1	7	3
		Berberis thunbergii	1	3	2
	W10	*Microstegium vimineum*	1	3	2
		Lonicera japonica	1	1	2
		Celastus orbiculatus	1	1	2
		Rosa multiflora	1	1	2

2015 MPEA Invasive Plant Survey

			Plot #32	Date: 11/25/15	
	Quadrant	Species	Cover Class	Cover Co	Height Cl
	N5	*Lonicera japonica*	1	7	3
	N10	*Elaeagnus umbellata*	2	1	4
	S5	*Celastus orbiculatus*	1	1	1
	S10	*Microstegium vimineum*	1	3	1
	E5	None	0	0	0
	E10	None	0	0	0
	W5	*Lonicera japonica*	1	1	2
	W10	None	0	0	0