Enhancing Priority Invasive Species Management in Cortland County

Dwyer Memorial Park Terrestrial Invasive Species Survey Report

Summer 2020

Cortland County Soil and Water Conservation District

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Project Background

Dwyer Memorial Park is located in the northwest quadrant of Cortland County in the Town of Preble. The 55-acre public park is uniquely situated between Green Lake and Upper Little York Lake in the Tioughnioga River watershed. Dwyer Park provides the surrounding community with tremendous recreation opportunities including: boating, fishing, walking, biking, picnicking and more. Its natural beauty and recreation amenities make Dwyer Memorial Park a favorite for Cortland County residents, as well as those from adjacent counties.

While the park is a widely used resource, there is little record of the ecological makeup of the property. Plans for a future urban forestry management project at Dwyer Park are in place; however an exploratory survey must be conducted before such plans can proceed. Due to the aggressive nature of invasive species, early detection is essential for identifying and eradicating species that may become widespread and threaten future ecological conservation. When early detection and eradication are not an option, management and monitoring are very important to control invasive populations and protect native ecosystem assets and functions.

Cortland County Soil and Water Conservation District has partnered with Finger Lakes Partnership for Regional Invasive Species Management (PRISM) to conduct an exploratory terrestrial invasive species survey throughout the park in order to record which invasive species are present and to understand their population distributions. Finger Lakes PRISM has provided funding for this survey through a grant titled, "Enhancing Priority Invasive Species Management in Cortland County", which has three main goals: 1) Early Detection – Assessment and Mapping, 2) Control – Invasive Species Control and Management, and 3) Enhancing Public Awareness and Prevention. This survey meets the terrestrial facet of the grant's first goal by assessing the status of invasive species in Dwyer Memorial Park. The survey was conducted to provide local land managers and environmental decision makers with essential baseline data in order that they may understand and properly address the current conditions of the park.

Methods

In order to conduct this survey, a list of 55 target species was extracted from the terrestrial invasive species list provided by the Finger Lakes PRISM (Appendix A). A modified line transect method was utilized for the survey. Based on the size and shape of the park, six north-south lines were created and spread across the park evenly 150 feet apart (Appendix B). Transect 1 was located furthest to the east, while Transect 6 was the shortest on the western side of the park. Using the Google Maps app to navigate, the lines were surveyed over a 3 day period in early August, 2020. Invasive species were identified and recorded along with their GPS (X, Y) coordinates if located within fifteen feet of a transect (Appendix E1). By using this 30-foot swath, more data was collected along the transect line, increasing the survey area and offering a more accurate representation of the plant community. After surveying the length of all six transects, the data was digitized and each invasive species encountered was then categorized as a woody plant, an herbaceous plant, or an insect. The location of each record was mapped using ArcMap according

to the GPS location (Appendix E). Further data analysis was then conducted to obtain the number of occurrences for each species and their frequency throughout the survey. All encounters were reported in NY iMapInvasives, however photographs were not recorded.

Results

Fourteen invasive species were identified and recorded along the six transects in Dwyer Memorial Park. Seven woody plant species were found: autumn olive, black locust, common buckthorn, common barberry, non-native honeysuckle, Norway maple, and multiflora rose. Seven herbaceous species were identified: ground ivy, garlic mustard, Japanese knotweed, purple loosestrife, reed canary grass, swallowwort, and wild teasel. (See Appendix C & F 2-4). Despite finding numerous target plant species, none of the target insect species were found. Garlic mustard was the most commonly encountered species in Dwyer Park with 21 occurrences, making up 19% of all plants recorded. Common buckthorn and non-native honeysuckle were also found in abundance, with 20 occurrences (18% frequency) and 19 occurrences (17% frequency respectively). Together, autumn olive, black locust, reed canary grass, and wild teasel only made up 7% of the invasive plants found (see Figure 1.1).

Figure 1.1: Frequency of each invasive species encounter throughout Dwyer Memorial Park. Occurrence is the number of times the species was identified along the transects, and relative frequency is the ratio of a species' occurrence among all identified plants.

Species	Occurrence	Relative Frequency
Autumn Olive	1	1%
Black Locust	2	2%
Common Buckthorn	20	18%
Common Barberry	5	7%
Ground Ivy	10	9%
Garlic Mustard	21	19%
Multiflora Rose	9	8%
Japanese Knotweed	3	3%
Norway Maple	4	4%
Non-Native Honeysuckle	19	17%
Purple Loosestrife	3	3%
Reed Canary Grass	2	2%
Swallowwort	10	9%
Wild Teasel	2	2%
Total # observed:	111	100%
50 points sampled total		

The highest number of invasive species encounters was along Transect 1 on the east side of the park, which is the longest and most densely vegetated section of the park. Transect 4, on the west side of the park, had the least number of species encounters. Its' shorter distance and coverage over mowed grass and pavement contributed to the lack of invasive species.

Figure 1.2: Distribution of encountered invasive species throughout Dwyer Memorial Park as observed along designated transects.

Species Descriptions

Every target species identified in Dwyer Memorial Park has different growth habits and life cycle mechanisms. Each invasive species interacts differently with its surroundings, affecting the ecosystem in a variety of ways. Therefore, it is important to understand the general characteristics of each invasive in order to understand their threat and respond effectively. Below are general profiles of each species found within Dwyer Park based on information from Finger Lakes PRISM and U.S. Fish and Wildlife (Swearingen et al. 2017).

Autumn olive (*Elaeagnus umbellate*): A deciduous shrub up to 20ft high. Leaves are lance-shaped with smooth margins. Leaves, stems, and fruits covered with silver to rust covered scales. Flowers are yellow with four petals that are joined at the base. Fruits emerge August through October, are reddish-brown and covered in similar silver scales. Autumn olive is a nitrogen fixer, allowing it to establish on poor soils, where other plants cannot. This species is a threat because it out-competes and displaces native plants, and provides low nutrition to wildlife compared to native shrubs. It also creates dense shade interfering with plant/forest regeneration.

Black locust (*Robinia pseudoacaia*): This species is a tree native to the Appalachian Mountains with deeply furrowed dark brown to black bark, and pinnately compound leaves with 7-19 light green oval shaped leaflets. Their flowers are white and give rise to bean-like seed pods 2-4 inches long containing up to 25,000 seeds each. When not managed, black locust is considered weedy and undesirable in New York, due to its sharp spines, highly aggressive root system, and abundant seed production. It is also a nitrogen fixer, so it can establish itself in nearly any substrate and alter local nutrient cycling.

Common buckthorn (*Rhamus cathartica)*: Buckthorn is a multi-stem shrub with sharp terminal spines. Its leaves are round with distinct veins and serrated edges, and its flowers are greenish yellow and give rise to round, black berries. The seeds are spread by wildlife that eat the berries and excrete the seeds. This shrub grows thickly and crowds out other understory plants and inhibits natural forest regeneration. Aside from these competitive threats, the buckthorn berries and other plant parts contain a laxative that can cause severe diarrhea. It is listed as a poisonous plant in the United States and Canada. Common buckthorn is also an alternate host for crown rust effecting oats, and the alfalfa mosaic virus.

Common barberry (*Berberis sp.)*: This multi-stem shrub grows dense foliage over three feet high. The stems are lined with sharp three pronged spines, and its leaves are small and toothed arranged in alternate bundles. It has yellow flowers in spring and red hanging fruits are produced in the fall. Due to its dense growth and spines, it makes land impassable for humans and wildlife, and prevents natural forest regeneration. It is also an alternate host for the black stem rust effecting wheat crops.

Garlic mustard (*Alliaria petiolate)*: This plant is a prolific herbaceous species with two growth forms. In the first year it is a low growing cluster of kidney shaped leaves, and then in the second year the plant sends up a flowering stalk topped with white flowers and eventually long, thin seed pods. This second year plant has kidney shaped leaves near the stem while appearing more triangular towards the tip. Garlic mustard is one of the most prolific herbaceous species throughout the eastern half of the U.S. It is shade tolerant and grows densely, crowding out spring ephemerals and harming native wildflower communities. It is also not eaten by deer and is a decoy species for West Virginia White Butterfly, which mistakes it for toothworts. The caterpillars that hatch on garlic mustard cannot eat it and die. There is also evidence it is allelopathic, releasing compounds that hinder native tree seedling growth.

Ground ivy (*Glechoma hederacea)*: This plant is a low growing herbaceous species, with square stems, scalloped heart shaped leaves, and purple flowers. It is highly competitive and can take over other herbs as well as grasses. It is also toxic to horses and cattle in large amounts, so control is especially important on grazing and hay land.

Japanese knotweed (*Reynoutria japonica)*: This plant is an upright shrubby perennial that forms dense thickets 5 feet high or more. The stems are stout and hollow with broad heart shaped leaves. In summer sprays of yellowish white flowers hang down and in late summer triangular dark brown seeds emerge in winged seed pods. Knotweed spreads easily via vegetative fragmentation, and deep rhizomes in soil. This plant is especially common in ditches and riparian areas where it crowds out other woody species that provide more stability and ecosystem benefits.

Multiflora rose (*Rosa multiflora)*: This shrub is most easily recognized by its toothy compound leaves which are lined with spines, as are the stems. It also has fringed, wing-like structures at the base of the leaf stalks (see image left). Flowers are white to pink in spring with red “hips” produced in summer which remain on the plant through the winter. It produces seeds abundantly, and can root from stem tips curved into the ground. Due to its aggressive spread and prickly growth habit, it can overrun forest edges and fields and inhibit human and wildlife movement.

Norway maple (*Acer platanoides)*: This tree species introduced from Europe looks similar to the Native Sugar Maple but has larger broader leaves and long leaf stalks/petioles. It can also be identified by black tar spots on its leaves and a milky sap where leaves are detached from branches. Fall foliage is yellow and seeds are paired winged samaras attached at a 180 degree angle. By sprouting from root fragments in soil, this species often spreads from areas of intentional planting into natural areas where is competes with native sugar maple, and prevents regeneration.

Non-native honeysuckle (*Lonicera sp.)*: There are several species of honeysuckle imported from Europe and Asia that have escaped planting areas and have overrun natural lands, parks, and gardens. All species have small opposite leaves and white to yellow colored flowers in late spring. Red and orange berries are produced summer through fall. A key distinguisher from native species is their hollow pith in the center of broken stems. The berries are dispersed by birds, but provide poor nutrition compared with berries of native shrubs. Their thick growth displaces native plants and also disrupts nesting bird habitat.

Purple loosestrife (*Lythrum salicaria)*: This herbaceous flowering species favors wet lowlands along rivers, lakes, and in drainage ditches. It is easily recognized by bright pinkish purple spikes of flowers on square hairy stems in bloom from June through September. Leaves are lance shaped and arranged in whorls on stem. It spreads easily by abundant seeds and underground vegetative expansion. This plant is a threat to native wetland species and more valuable native wildflowers as it forms expansive monocultures in a variety of habitats.

Reed canary grass (*Phalaris arundinacea)*: This tall upright grass grows well in wet and dry areas, and is one of the first grasses to sprout in the spring. It has smooth stems and long course leaves. It spreads via abundant seeds and through underground root system. Growth is particularly problematic in wetlands, where it spreads throughout the landscape and chokes out native growth.

Swallowwort (*Vincetoxicum spp)*: There are two species of invasive swallowwort both imported from Europe: black swallowwort and pale swallowwort. Flowers are at the tip of the plant with five fleshy petals. Black swallowwort has dark purple to black flowers while pale swallowwort has crème to pink flowers. This climbing vine has dark green, glossy leaves, tapered to a point and arranged oppositely on the stem. This plant spreads rapidly, via abundant seeds released from long pointed pods, and by rhizome. It can quickly take over forest understory, cliff faces, and open fields. It has a similar growth pattern to native milkweed, which confuses and threatens native monarch butterflies who lay their eggs on its leaves. Unlike native milkweed, caterpillars cannot properly feed on swallowwort.

Wild teasel (*Dipsacus fullonum)*: This species is a robust herbaceous perennial. It grows as a basal rosette of entire prickly oblong leaves. In the second or third year, it shoots up a flowering stalk of 2 to 6 feet tall. On this stalk leaves curve around and cup the stem. Flowers are purple and arranged on a prickly egg shaped head. Long sharp bracts (leaves at the base of the flower head) curve upward and are longer that the head itself. After flowering, many seeds form in the beige flowering head and are dispersed by wind. It can quickly cover disturbed open areas like fields and roadsides, displacing important native species that offer much greater ecosystem value.

Conclusions and Management Recommendations

It is worth noting that this survey was conducted in mid-August and therefore would not have encountered the full assemblage of plants that may be present throughout the growing season. Some target species, including fig buttercup and star of Bethlehem, are spring flowers that have already died back for the year. A further springtime survey may discover species not encountered in Dwyer Memorial Park during late summer.

The Finger Lakes PRISM tier list, which we used to create our target species list, ranks species by possible control measures based on distribution and population in the region. Tier 1 species have high or very high ecosystem impact and are not yet know in the region, so action is focused on early detection and spread prevention. Tier 2 species are those present in the region in low numbers and discrete populations, so eradication is possible with proper action. Tier 3 species have large populations within the region and eradication is not possible due to expense and physical limitations, but the species should be actively contained to keep numbers down and prevent spread to new areas. Tier 4 species are widespread and eradication is not a goal, management to protect natural resources and assets is the objective.

The invasive species at Dwyer Park can be categorized using this same ranking system in order to devise a management approach for each species. The encountered species can be seen in Figure 2.1 along with their corresponding tier ranking form the PRISM list.

Figure 2.1: Tier ranking for invasive species threat within Dwyer Memorial Park

Species Common Name	**Tier Ranking in Dwyer Memorial Park**
Autumn olive	2
common barberry	2
Japanese Knotweed	2
wild teasel	2
swallowwort	3
black locust	4
common buckthorn	4
ground ivy	4
garlic mustard	4
purple loosestrife	4
multiflora rose	4
Norway maple	4
non-native honeysuckle	4
reed canary grass	4

Before moving forward with a comprehensive management plan for a species, it may be necessary to do further delineation surveys to completely outline invaded areas and to understand population size and distribution. Once the full extent of the species is known, management can operate more efficiently and effectively.

Autumn olive, common barberry, Japanese knotweed, and wild teasel are all present in low enough numbers that eradication may be possible. If that is the goal, it is important to address every single individual as these species spread easily. Autumn olive and barberry are shrubs that can be cut and stumps can be treated with herbicide, which should kill the plant. Japanese knotweed can also be cut and chemically treated, but spreads easily by fragmentation so tools must be decontaminated before used elsewhere. Wild teasel can be dug up, using care to remove as much of the root as possible.

The swallowwort species has large populations and should be aggressively controlled to prevent spread within the park. This plant can be dug up and pulled by hand, removing the root crown to hinder regrowth. Later in the season it may be most efficient to clip off the seed pods and dispose of them to prevent spread. This is something public volunteer groups and community members can do to get involved and improve the natural ecosystem health of their local park.

Garlic mustard is the most abundant and widely distributed invasive species in Dwyer Memorial Park, and while it's an aggressive spreader, its control methods are often more simple. The plants can be pulled up in the rosette or flowering stage easily, and it is something the public could do to manage this plant effectively within the park as part of a conservation event or volunteer project.

The rest of the species present in the park are shrubs and weedy trees: black locust, Norway maple, common buckthorn, multiflora rose, and non-native honeysuckle. These species can all be dealt with in the same way: by cutting and treatment of stumps with herbicide. If these shrubs were removed and appropriate natives were replanted, it would support natural regeneration within the ecosystem and greatly improve the health of the forest understory for humans and wildlife.

There is no management recommended for reed canary grass or ground ivy as they are mainly problematic on agricultural land and routine mowing will keep them from overtaking areas in the park. Purple loosestrife is only on the lake's edge, and there is a biocontrol beetle available that may already be in the area to help limit the impact of loosestrife. If serious issues arise regarding purple loosestrife, a special release of these insects can be recommended.

For every management tactic used, it is important to dispose of all removed plant material in the garbage, rather than being composted, which would merely move the invasion elsewhere. It is also important to thoroughly clean mowers and equipment when moving from site to site in order to prevent introducing invasive species to new areas.

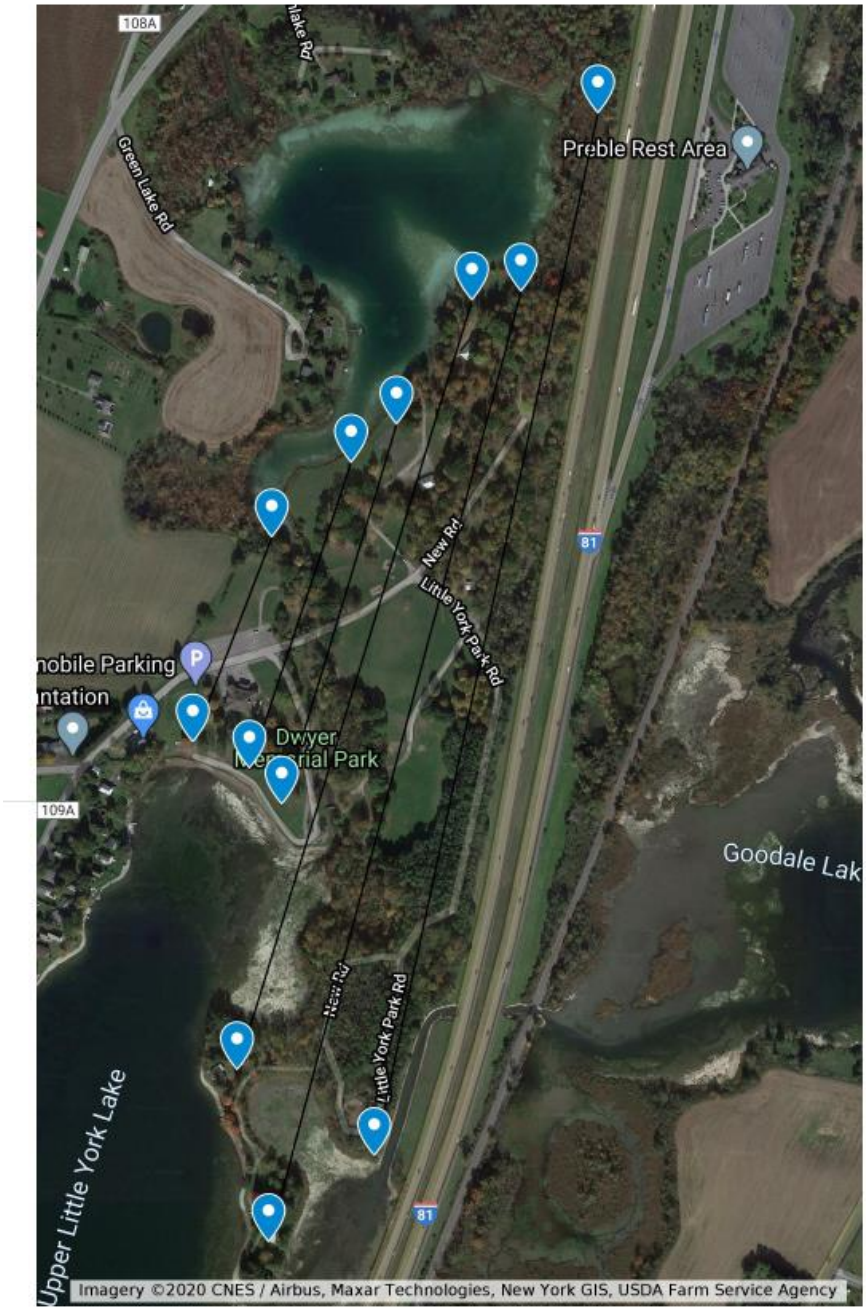
Appendix

Appendix A: List of target terrestrial invasive species taken from Finger lakes PRISM tiered invasive species list. Plant reference location refers to the page number in Plant Invaders of Mid-Atlantic Natural Areas (Swearingen et al. 2017) and fact sheet (FS) located online, or page number in Finger Lakes PRISM Invasive Species Field Guide (P#).

Species number and reference location	Scientific Name	Common Name	Data Sheet Abbreviation
1- 82	*Acer platanoides*	Norway Maple	NM
2-FS	*Acer pseudoplatanus*	Sycamore Maple	SM
3-FS	*Adelges tsugae*	Spotted lantern Fly	SLF
4-87	*Ailanthus altissima*	Tree of Heaven	TOH
5-45	*Alliaria petiolata*	Garlic Mustard	GM
6-118	*Ampelopsis brevipedunculata*	Porcelain Berry; Amur Peppervine	PB
7-P12	*Anoplophora glabripennis*	Asian Longhorn Beetle	ALB
8-FS	*Anthriscus sylvestris*	Wild Chervil	WC
9-137	*Aralia elata*	Japanese Angelica Tree	JAC
10-FS	*Artemisia vulgaris var vulgaris*	Mugwort	MT
11-64	*Berberis sp.*	Japanese Barberry or Common/European Barberry	JB or CBB
12-FS	*Brachypodium sylvaticum ssp sylvaticum*	Slender Falsebrome	SFB
13-FS	*Cardamine impatiens*	Narrowleaf Bittercress, Bushy Rock-cress	NB
14-FS	*Carum carvi*	Common Caraway	CC
15-115	*Celastrus orbiculatus*	Oriental Bittersweet	OB
16-37	*Cirsium arvense*	Canada Thistle, Creeping Thistle	CTH
17-120	*Clematis terniflora*	Japanese Virgin's-bower, Sweet Autumn Clematis, Yam-leaf clematis, Japanese virgin's bower	JVB
18-139	*Dioscorea polystachya*	Chinese Yam, Air Potato	CY
19-FS	*Dipsacus fullonum*	Wild Teasel; Fuller s Teasel	WT
20-FS	*Dipsacus laciniatus*	Cut-leaved teasel; Cutleaf teasel	CT
21-62	*Elaeagnus umbellata*	Autumn Olive	AO
22-73	*Euonymus alatus*	Burning Bush, Winged Euonymus, Winged Burning Bush, Winged Spindletree	BB
23-121	*Euonymus fortunei*	Winter Creeper	WC
24-FS	*Euphorbia cyparissias*	Cypress Spurge	CS
25-FS	*Euphorbia esula*	Leafy Spurge, Wolf's Milk	LS
26-44	*Ficaria verna ssp verna*	Lesser celandine, Fig Buttercup	LC
27-FS	*Frangula alnus*	Glossy Buckthorn, European Buckthorn,	EB

		Smooth buckthorn	
28-47	*Glechoma hederacea*	Ground Ivy; Gill-over-the-ground	GI
29-131	*Hercaleum mantegazzianum*	Giant Hogweed	GH
30-108	*Humulus japonicus*	Japanese Hops	JHP
31-FS	*Koelreuteria paniculata*	Golden-rain Tree	GRT
32-71	*Ligustrum spp*	Privet	PT
33-107	*Lonicera sp.*	Japanese Honeysuckle, Amur Honeysuckle, Morrow's Honesuckle	NNH
34-FS	*Lychnis floscuculi*	Ragged Robin	RR
35-P16	*Lycorma delicatula*	Hemlock Wooly Adelgid	HWA
36-FS	*Lysimachia vulgaris*	Garden Loosestrife, Yellow Garden Loosestrife	GL
37-51	*Lythrum salicaria*	Purple Loosestrife	PL
38-FS	*Macleaya cordata*	Plume Poppy	PP
39-28	*Microstegium vimineum*	Japanese Stiltgrass, Nepalese Browntop, Japanese stilt grass, Nepalgrass	JSG
40-129	*Miscanthus sinensis*	Chinese Silver Grass; Eulalia; Chinese Silvergrass; Maiden Grass	CSG
41-50	*Ornithogalum nutans*	Drooping Star-of-Bethlehem; Star-of-Bethlehem	SB
42-113	*Persicaria perfoliata*	Mile-a-minute Weed, Mile-a-minute Vine, Asiatic Tearthum, Mile a minute weed	MM
43-FS	*Phalaris arundinacea*	Reed Canary Grass	RCG
44-137	*Phellodendron amurense*	Amur Corktree	AC
45-26	*Phragmites australis ssp australis*	Common Reed	CR
46-80	*Pyrus calleryana*	Callery Pear; Bradford Pear	CP
47-FS	*Reynoutria japonica*	Japanese Knotweed	JK
48-FS	*Rhamus cathartica*	Common Buckthorn	CB
49-FS	*Robinia pseudoacaia*	Black Locust	BL
50-69	*Rosa multiflora*	Multiflora Rose	MR
51-72	*Rubus phoenicolasius*	Wineberry, Japanese Wineberry, Wine Raspberry	WB
52-24	*Schoenoplectiella mucronatus*	Bog Bulrush	BBR
53-FS	*Silphium perfoliatum var perfoliatum*	Cup-plant, Indian Cup-plant, Cup plant	CP
54-FS	*Silybum marianum*	Blessed Milkthistle; St. Mary s Thistle; Milk Thistle	BMT
55-99	*Vincetoxicum spp*	Swallowwort	SW

Appendix B: Transects through Dwyer Memorial Park laid out in Google Maps, transect 1 being the longest on the right, and Transect 6 being the shortest on the left.



Appendix C: Survey point data including, transect # and point #, GPS (X, Y) coordinates, and invasive species encountered collected while walking transects in Dwyer Memorial Park.

FID	Transect - point	X	Y	Woody Species	Herbaceous Species	Insect Species
1	1-1	42.714207	-76.148147	MR		
2	1-2	42.714054	-76.148109	CB		
3	1-3	42.714106	-76.148179	MR, CB		
4	1-4	42.713287	-76.148432		GI	
5	1-5	42.712939	-76.148473		JK	
6	1-6	42.713067	-76.148539	CBB		
7	1-7	42.711225	-76.149045	CB, CBB	GM	
8	1-8	42.710971	-76.149143	MR, CB	WT, GM	
9	1-9	42.710755	-76.149167		WT, GI	
10	1-10	42.710557	-76.149127		GM	
11	1-11	42.709797	-76.149404	BL	GM	
12	1-12	42.709631	-76.149485	NNH	GM	
13	1-13	42.709455	-76.149533	NNH	GM, SW	
14	1-14	42.709269	-76.149547	AO, NNH, CB	SW	
15	1-15	42.709066	-76.149631	BL, NNH		
16	1-16	42.708832	-76.149674	NNH		
17	1-17	42.70871	-76.149814		JK, GI, GM	
18	1-18	42.708561	-76.149799	NNH, CB	GM	
19	1-19	42.708102	-76.149928	NM, NNH	SW, GI, GM	
20	1-20	42.70787	-76.149949	MR		
21	1-21	42.707763	-76.149997	CB	GM	
22	1-22	42.707401	-76.150133	NNH, CB		
23	1-23	42.707115	-76.150226	NM	SW, GM	
24	1-24	42.706848	-76.150355		SW, GM	
25	1-25	42.706523	-76.150401		SW, GM, GI	
26	1-26	42.706464	-76.150349	NNH, CB	SW	
27	1-27	42.705994	-76.150539	NNH, CB	SW	
28	1-28	42.705674	-76.150617	NNH	SW, PL	
29	2-1	42.706382	-76.151458	NNH, CB		
30	2-2	42.707294	-76.151179	NNH		
31	2-3	42.707481	-76.151067	NNH, CB	SW	
32	2-4	42.707616	-76.1515034	MR, CB		
33	2-5	42.708474	-76.150679	NNH, MR	GI	
34	2-6	42.70862	-76.150667		GM, GI	
35	2-7	42.708785	-76.150667		RCG	
36	2-8	42.709064	-76.15052		RCG, GM, GI	
37	2-9	42.712359	-76.149366	CB		

38	2-10	42.714121	-76.148682	CB	
39	3-1	42.709968	-76.151065	NM, CB	GM, GI
40	3-2	42.710083	-76.15095	NNH	GM
41	3-3	42.711699	-76.150316		GI
42	3-4	42.71408	-76.149363	NNH, CB, MR	PL
43	4-1	42.710084	-76.151442	CB, CBB	
44	5-1	42.710499	-76.151832	CB, NNH	GM
45	5-2	42.710591	-76.151778	MR	GM
46	5-3	42.710719	-76.151705	CB, CBB	GM
47	5-4	42.711273	-76.151477	CB,NM,CBB	SW, GM
48	5-5	42.712527	-76.150929		PL
49	6-1	42.711505	-76.15213	CB, MR, NNH	
50	6-2	42.709717	-76.153556		JK

Appendix D: Photos taken during the Terrestrial Invasive Species Survey at Dwyer Memorial Park.

1) Field Biologist Hanna Whalen Recording Data

2) Common Buckthorn shrub

3) Autumn Olive shrub

4) Large population of swallowwort and garlic mustard along road

References

Swearingen, J., Slattery, B., Reshetiloff, K., & Zwicker, S. (2017). *Plant Invaders of Mid-Atlantic Natural Areas*. Washington, D.C.: National Park Service.