INVASIVE SPECIES MANAGEMENT PLAN FOR UMBC FACILITIES MANAGEMENT

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1 EXECUTIVE SUMMARY

This is an invasive species management plan document for the use of the University of Maryland Baltimore County (UMBC) Facilities Management, Landscape and Grounds Department, and the Office of Sustainability. This document was prepared by Isabel Dastvan, a Strategic Energy Innovations (SEI) Climate Corps Sustainability Fellow working for the UMBC Office of Sustainability (2022-2023).

This management plan specifically addresses invasive plants and insects that are especially a threat to the forested areas on campus. UMBC campus consists of 512 acres. About 100 acres are forested areas including the 67 acres that comprise the Conservation and Environmental Research Area (CERA), and about 24 acres are part of the Forest Conservation Act Easements. The purpose of this document is to develop a management plan to implement in order to manage and control the spread of invasive species to protect our natural resources so that our forests are sustainable and resilient in the face of climate disruption.

According to the U.S. Department of the Interior (DOI), invasive species are “non-native species whose introduction does or is likely to cause ecological or economic harm, or is a threat to human health.” Invasive species can outcompete native species for natural resources (including water, light, nutrients, space), disrupt the food chain, draw pollinators away from native plants, have the potential to push rare species closer to extinction, and cause an overall reduction in biodiversity. Biodiversity is necessary for functioning and resilient ecosystems in the face of climate disruption. Invasive species impose substantial costs on society. For example, they can drive native species onto the Endangered Species list, resulting in associated regulatory costs; exacerbate the threat of wildland fire that destroys property and threatens lives; increase the cost of delivering water and power; damage infrastructure; and degrade recreation opportunities and discourage tourism. They also disrupt ecosystem functions including pollination, water filtration, pest control, and protection from erosion, wildfires, and other natural hazards. Invasive species can also deplete resources important to cultural heritage and subsistence living. They cause damages that impact the global economy, including an estimated $120 billion in environmental damages and losses annually in the United States. In Fiscal Year 2020, the DOI invested an estimated $143 million to manage invasive species. An invasive species management plan is necessary to preserve our natural resources.

The United States Department of Agriculture (USDA) states that “forests and grasslands provide a wide range of ecosystem services. In addition to providing food, fuel and fiber, forests clean the air, filter water supplies, control floods and erosion, sustain biodiversity and genetic resources, and provide opportunities for recreation, education, and cultural enrichment. Sequestering (or releasing) carbon is a form of climate regulation, which is another important ecosystem service provided by forests and grasslands.” On campus, there are a significant amount of invasive plant species displacing the native vegetation while slowly damaging and ultimately killing native trees. The forests cannot sustain themselves sufficiently when they are

already facing stresses including urbanization, land development, and the impacts of climate disruption.

When a forest is under threat of stresses including invasive species infestations, the forest cannot provide these ecosystem services at full capacity. Especially now with air pollution impacts, we need to preserve these natural resources to continue to live in an environment that provides all of us clean air. Not only are invasive species an environmental hazard, but they are a safety hazard. When invasive plants kill trees, these trees can fall onto people, infrastructure, roadways, and property. Through the use and implementation of this management plan, invasive species can be prevented from introduction and spread, removed, managed, and controlled so that they cannot further their harm onto our natural resources and ultimately us.

This invasive species management plan will address the Environmental Enhancement & Education, and Stormwater Management focus areas of the master plan. It is important to note that the 2023 Master Plan is in progress, and it would be safe to assume that these focus areas mentioned will continue to be addressed and reinforced as the campus continues to develop.

According to the UMBC 2018 Facilities Master Plan Executive Summary, the fifth measure of success states an advancement of carbon neutrality and protection of the natural environment through responsible stewardship. In this section of the master plan, it states:

> "As a public institution, UMBC serves as a model for exemplifying operating efficiency, preserving open space, controlling and improving the quality of water run-off, and encouraging alternatives to single occupancy commuting. The importance that the university places on sustainability and highlights efforts to reduce our environmental impact and strengthen our resilience to the effects of climate change strongly influenced the 2018 Facilities Master Plan." Out of the four focus areas listed, two of these areas are most relevant to this management plan:
>
> - Environmental Enhancement and Education: protecting our abundant natural environment and resources, continued management of wooded research areas, and implementing programs and practices to educate students, faculty, and staff which hones environmental consciousness.
> - Stormwater Management: integrating new wetlands, working landscapes, and green roofs to control and treat run-off and proposes to treat and reduce untreated paved areas throughout the campus.

The goals of this management plan are to:

1. Collaborate across the UMBC campus community to optimize operations through leveraging partnerships, joint educational efforts, and funding for invasive species management efforts.
2. Cost-effectively prevent the introduction and spread of invasive species into and within UMBC campus.
3. Implement Early Detection Rapid Response (EDRR) efforts to reduce potential damage and costs from new infestations becoming established.

4. Cost-effectively control and/or eradicate established invasive species populations to reduce impacts and help restore ecosystems.
5. Improve invasive species data management for decision-making within the Office of Sustainability and Facilities Management.[1]
6. Prioritize invasive species control and removal in the North and Northeast portion of the campus.
7. Manage invasive species removal in areas close to roads, walkways, and buildings to prevent safety hazards from occurring.
8. Conserve UMBC's natural resources including the Herbert Run stream and surrounding riparian forest buffer, Conservation Environmental Research Area, and the Knoll.
9. Establish short term and long term monitoring practices for established, new, and potential invasive species that could infest the area.
10. Prioritize the implementation of best management practices to ensure appropriate environmental restoration efforts with the least amount of disturbance and contamination to the campus environment.

This management plan was developed by examining state and government management plans and best management practices, the UMBC master plan and relevant resources that address environmental stewardship on campus, and the use of ArcGIS products to create the invasive plant species maps on campus.

This management plan includes an introduction with more information about how the campus addresses sustainability and environmental stewardship efforts. There is information about the land use history of campus and before campus was developed in order to understand how a history of agricultural and urbanized land use impacts the existing site conditions today. Management priorities are listed to specify the areas on campus that need the most management attention: the North and Northeast portion of campus that includes the Forest Conservation Easement Areas (CERA), Herbert Run, riparian forest buffers, areas near roadways; CERA, and the Knoll. These priorities also emphasize the use of best management practices so that the university is implementing management and control methods that minimize environmental disturbance while still being effective. Short term and long term monitoring practices are mentioned so that the university can monitor campus on a yearly and/or bi-yearly basis to keep track of invasive plant coverage and the potential introduction of new invasive species. The methodology of the invasive plant survey is included so that this can be replicated for future monitoring purposes. Maps of the forested areas are included to distinguish the forested areas of Herbert Run, the Knoll, CERA, and the Forest Conservation Easement Areas. Multiple maps have been created to display the estimated coverage of invasive plant species on campus so we can prioritize areas for short term and long term management practices. About 100 invasive plant species were identified on campus, so this was narrowed down to the top 40 invasive plant species that need management attention. Invasive plant species descriptions, biology, and methods of spreading are included in this chapter. Best management practices are listed which include manual, mechanical, biological, and chemical methods. Those practices

[1] Adapted from Invasive Species Strategic Plan 2021-2025 by the Department of the Interior https://www.doi.gov/sites/doi.gov/files/doi-invasive-species-strategic-plan-2021-2025-508.pdf

that minimize environmental disturbance are emphasized. Disposal methods are included so that invasive plant species material can be removed properly without introducing further spread of that species. The chapter on precautions, equipment, constraints and restrictions specifies which areas are considered environmentally sensitive so that best management practices are established, equipment needed for the different methods of control and removal of invasive species, and any restrictions that the university needs to be aware of. The cost estimates chapter will give a brief breakdown of the costs associated with labor, equipment use, and time involved to control and manage invasive species on campus. The appendix contains more information including acknowledgements to key partners and stakeholders who helped develop this management plan, a list of native plant and trees to replace invasive plants, a list of southern invasive plant species to monitor for with the shift of growing zones due to climate change, more information on the best management practices reference documents, alternative control options, and funding opportunities and resources.

2. INTRODUCTION

At UMBC sustainability is more than just “going green.” For us, sustainability is about considering the complexity and integration of natural, human, and social systems that maintain our thriving world. UMBC’s Office of Sustainability collaborates across campus to effectively catalyze and implement sustainable practices and strategies. We serve as a resource to the campus community to empower every member of the campus community to investigate, experience, and share in our sustainability journey. We encourage our campus to serve as a model for integrated environmentally responsible practices, generated through collaboration, innovation, and shared governance. We work to support our campus in reducing our collective environmental impact while creating and maintaining a healthy and just environment for all, today and into the future. UMBC is committed to on-going and planned sustainability efforts to reduce its environmental impact and to strengthen resilience to the effects of climate change. The university is targeting specific improvements including environmental stewardship. This management plan serves as one of many ways to address and achieve environmental stewardship.

A holistic approach to campus development and sustainability will reinforce the existing natural systems of the campus including our approach to the treatment of stormwater management. The approach is to protect, enhance, and create functional landscapes that demonstrate and celebrate the way water serves as a resource. These landscapes also provide important habitat, microclimate, and aesthetic benefits that will be consistent with their specific locations on campus. Through a combination of forest preservation, stream rehabilitation, landscape conversions and progressive water management solutions, like the creation of wetlands, the campus moves closer to a level of ecological balance.

UMBC is a responsible steward of the university’s natural environment and related resources. The university has been recognized for its leadership and innovation in programs that promote, educate, and create a more sustainable campus environment. The campus is implementing programs and practices to hone environmental consciousness and educate students, faculty, and staff. The university is committed to the development of the next generation of leaders to tackle global climatic issues. Specific opportunities for responsible stewardship and appropriate engagement of the natural environment include:

- Extending the 15-acre forest conservation bank into additional areas of mature contiguous forests
- Preserving other forested natural areas for environmental instruction and research
- Installing interpretive signage along paths of the Herbert Run Greenway, a natural stream corridor
- Stabilizing streams running through campus
- Removing invasive plant species that overwhelm the existing native understory
- Providing signage to illustrate how our investments and practices impact the stability of the natural environment
- Targeting areas where mown turf can be converted to ecologically robust meadows

Land use changes are proposed to respond to enrollment growth, advance strategic planning goals, and align with the facilities master planning guidelines. Proposed projects relevant to this management plan include:

New Informal Recreation Park
A low lying, overused informal field will be transformed into a park-like setting for student recreation. Project elements may include a shortened play field, a variety of smaller game courts, a pavilion for outdoor events, and outdoor seating. With this proposed project, UMBC's goal is to extend outdoor recreation north of residential housing while preserving forested areas and stream buffers.

New Outdoor Recreation Area
UMBC is fortunate to have abundant natural areas surrounding the academic and residential core of campus. Yet, these areas are underutilized due to limited access. In response to student requests for additional recreation opportunities on campus, a new outdoor recreation area is proposed north of Hilltop Circle adjacent to residential communities. A new facility has the potential to challenge students with recreational activities for personal growth and team building, while fostering a greater appreciation for the outdoors and nature. Project elements may include low ropes courses and ziplines, bicycle and walking paths, and other outdoor adventure challenge features.

Many active outdoor spaces will be transformed in conjunction with other capital projects. Each redevelopment and new development of quadrangles, courtyards, plazas, and walkways will target opportunities to incorporate working landscapes that enhance ecology and water management. Proposed ecological transformations to improve campus stormwater management and open space include:

1. Extension of an existing stream bed into a new 10-acre wetland, enhancing stormwater treatment, habitat, and ecological function of the south of the campus within an existing low-lying stream buffer
2. Improvements to the Central Green to improve the integration of stormwater management into existing outdoor spaces to control erosion, improve drainage, and enhance functionality
3. Transformation of existing mowed grass areas, especially on steep slopes, into working native landscapes, to support pollinators and improve local water quality
4. Increased engagement with the surrounding natural areas for recreation, research, and education
5. Growth of forest conservation areas that will preserve existing wooded areas and protect our stream valleys

There are a number of proposed projects involving renovation of existing buildings, construction of new academic and residential buildings, parking lots and garages, and pedestrian walkways on campus. Land development comes with land disturbance, so it is important that the university approaches these developments with adequate environmental restorative practices in mind in order to prevent and manage the spread of invasive species that coincides with disturbed land.

UMBC LAND USE HISTORY

The land has been continuously disturbed from the past history of agricultural land use and the continuation of urban land development that is still happening to this day. Part of this urban land development includes the land use from the Stabler family, the construction and destruction of the Manual Labor School for Indigent Boys, and a psychiatric institution (see below photos for more information). Before the university was established, the land was farmed and grazed in support of the neighboring Spring Grove State Hospital. The Maryland State Legislature passed a bill in 1963 to establish an undergraduate and graduate campus on the 432-acre tract of land operated by the hospital. In 1965 some 400 acres, most of which had been farmland tilled by Spring Grove patients for growing produce and managing livestock, were transferred from Spring Grove to the University of Maryland to allow for the establishment of the UMBC campus.[2] Subsequent land acquisitions have increased the university's holdings to nearly 500 acres. Remnants of its agrarian past are still somewhat evident on campus, particularly with respect to riparian corridors, woodlands, and soil condition. With agricultural land use, there is soil disturbance including erosion and changing of the soil composition. The extensive land use history of UMBC land reflects a continuation of land disturbance. Unprotected landscapes on disturbed land are less resilient to the introduction of invasive species compared to protected natural areas.

According to the UMBC CERA Guide, which provides a guided tour full of information about the forest ecology and land use history that corresponds to multiple markers along the CERA trail:

> Before UMBC was founded in 1966, the young forest to the north was likely an abandoned agricultural field, dominated by grasses and wildflowers. Gradually, shrubs and young trees began to grow and shade the site, replacing the herbaceous plants. This sequential change in plant species over time is known as succession. The forest to the south is a much older successionary stage. It has been a wood lot since the early 1900's, although the scattered nature of large trees indicates the forest may have been open to grazing in the first half of the twentieth century…
>
> English ivy coats many of the trees near [marker #5]. A non-native evergreen climbing vine, English ivy, is indicative of past nearby human habitation.
>
> Note the several erosion gullies here [at marker #7]. Water running off Sulphur Spring Road has eroded deep ditches (up to six feet) where the soil is sandy or gravely. On the other hand, in some places there is very little erosion. Invariably, these places have clay soils and rock just under the surface of the ground. Several remarkably different soil types underlie CERA, reflecting the complex geological history of this area near the junction of the Piedmont and Coastal Plain physiographic provinces.
>
> At marker #10, The lack of tree diversity indicates that when the land was allowed to revert back to nature after human use, red maple seeds happened to arrive here in great numbers, germinated quickly, and got a head start in growth to dominate the site. Red maple is a common, widely distributed tree tolerant of a substantial range of soil conditions, growing in habitats as diverse as sand dunes and swamps.

[2] https://health.maryland.gov/springgrove/phototours/Pages/history.aspx

At marker #11, there is a concrete boundary marker here. The remains of an old fence corner are visible as well. Observe that strands of barbed wire appear to run straight through one of the trees along the old fence line. In fact, the tree has merely grown larger in girth over the years, surrounding the immovable wire. Old photographs indicate that this area was once pastured.

From an excerpt from UMBC News (9/19/1966), a description of the past land use of UMBC states:

"126-Year History of UMBC Site Recalled," by Martin Schlesinger.
"In 1840 the State of Maryland acquired a large tract of land from the Stabler Estate. An Orphans' Home, "The Baltimore Trade School", was established that same year. A few years later a large building was constructed near the southern end of Walker Avenue. This building provided both dormitories and kitchen facilities for the 50 members of the school. The remaining area was farmed by these institutions, thereby making the farm more independent and providing more activities for the orphans. This trade school was used until World War II. By 1845 about 300 acres in the Catonsville area belonged to the State of Maryland... The property was later added to the Spring Grove State Hospital. This institution continued operation of the farm on the land until the later 1960s."

Below is a brief timeline with associated photos and maps of the land use history where UMBC resides:

From 1839-1922, the land was occupied by the Site of Manual Labor School for Indigent Boys.

Transcription:
"Baltimore Farm Where They Raise — Good, Honest Citizens",
"Just outside the pretty little village of Arbutus, about seven miles from Baltimore, there is a farm whose principle product for 60 years has been men. It is a beautiful farm, too, with 200 rolling acres of meadow land, orchards and fertile fields; with sleek cattle grazing over broad pastures and with attractive buildings embowered handsome trees and the crest of a hill overlooking the country for miles around. It is a farm that disposes of more than $3500 worth of produce annually, and yet with all the productiveness in the agricultural line its biggest and best and chiefest product is and has been honest men and useful citizens." (1903 news article I Albin O. Kuhn Library, UMBC) Johns Hopkins, founder of his namesake university and hospital in

Baltimore, served as a member of the Farm School's Board of Directors for nearly 25 years until his death in 1873. Gustav W. Lurman, Jr., esteemed 19th century Catonsville resident and owner of his well-known nearby estates of "Farmlands" and "Bloomsbury", served on the Farm School Board of Directors beginning in 1881 as a member, and later as Board President for a period of more than 20 years. (Maryland Historical Society Library)
Dedicated May 1996 by Coalition for the Preservation of Southwestern Baltimore County, Catonsville Historical Society, Baltimore County Historical Trust, University of Maryland Baltimore County.

A portion of the property on which UMBC was built previously was owned by the Baltimore Manual Labor School. Also known as the Farm School, it operated from 1839 to 1922 with the purpose of instructing and supporting poor or orphaned boys from Baltimore City. Support for the school came from wealthy Baltimoreans including Johns Hopkins and Gustav W. Lurman, Jr. Shown in the photograph is a Stabler family member in a carriage on the farm road from Maiden Choice Lane, now called Shelbourne Road. In addition to moral and religious teachings, the Baltimore Manual Labor School resident boys were taught how to read and were instructed in agriculture or other useful occupations in preparation to earn a living. Under staff supervision they tended the orchards and vegetables grown on the farm.

Baltimore Manual Labor School Seen from Shelbourne Road, ca. 1900. Baltimore Manual Labor School Collection, MSS 1988-02-012.

Baltimore Manual Labor School Orchards, ca. 1900. Baltimore Manual Labor School Collection, MSS 1988-02-008.

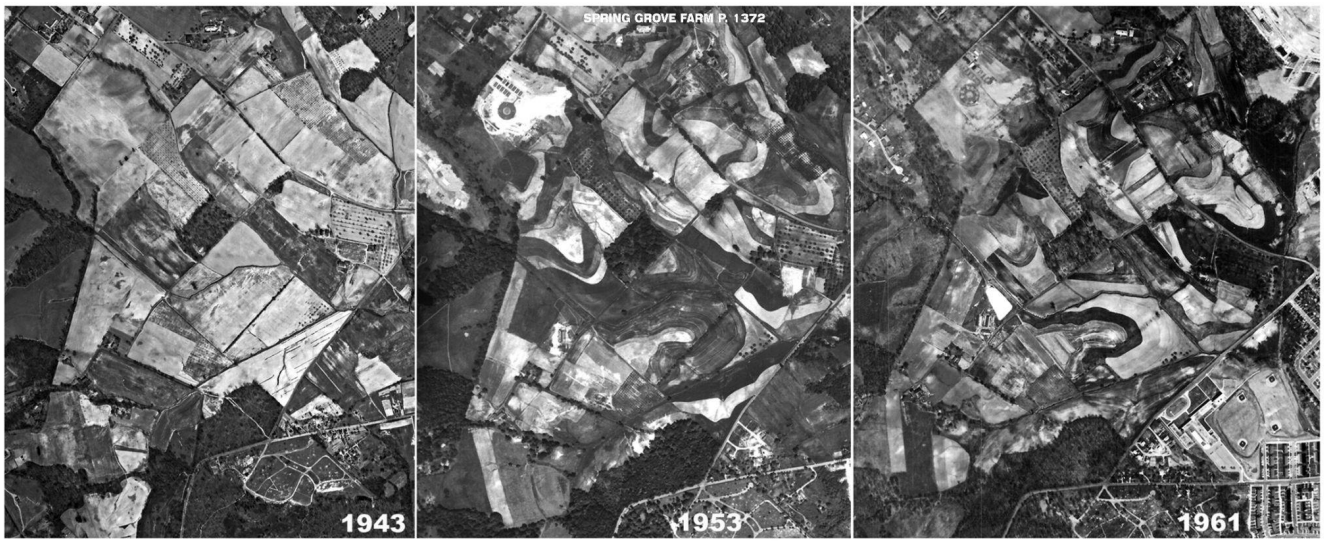
Baltimore Manual Labor School Residents, ca. 1900. Baltimore Manual Labor School Collection, MSS 1988-02-010.

In 1916, the Baltimore Manual Labor School was destroyed by a fire. The University of Maryland Baltimore County now occupies the site where the Baltimore Manual Training School once stood. The Albin O. Kuhn Library rests on the property of the Stabler Family.

In 1922, Spring Grove Hospital purchased the land following a devastating fire in 1916. The Stabler family owned the property and helped to run the school. Family patriarch Edmund Stabler held the position of superintendent from 1884 to 1904. Interestingly, the hospital used the farmland for a patient agricultural rehabilitation program. The state incorporated this and adjacent tracts of land in the early 1960's in order to create UMBC. The Stabler home was used by Dr. Albin O. Kuhn, UMBC's first Chancellor, during the construction of the campus and the Albin O. Kuhn Library now occupies the site where the home stood.

Spring Grove Hospital land in the 1930s:

Spring Grove Hospital Land in the 1940s:



Spring Grove Farm 1963:

“Spring Grove Site for U of MD Campus”, The Sunpapers, October 14, 1963. Baltimore Sun Photographs, P2014-01-0090.

Acquisition of Stabler Family Land in 1965:

Not all of the land on which the new campus was going to be built was already owned by the state. One parcel was owned by the Stabler Family, 13 acres along Walker Avenue approximately where the Library & Gallery is now situated. The State acquired the land in 1965 through an Option Contract. The letter from Albert P. Backhaus, Director of the Department of Public Improvements for the State Department of Public Works, sent the signed Option to Edmund Stabler. Edmund Stabler (1847-1905) became superintendent of the Baltimore Manual Labor School in 1884, and upon his retirement in 1904 the board of the school gave Stabler 13 acres of land along Walker Avenue, including the home in which he, his wife, and their six children had been living. Albin Kuhn and his family later moved into the house while Kuhn supervised the building of the new campus.

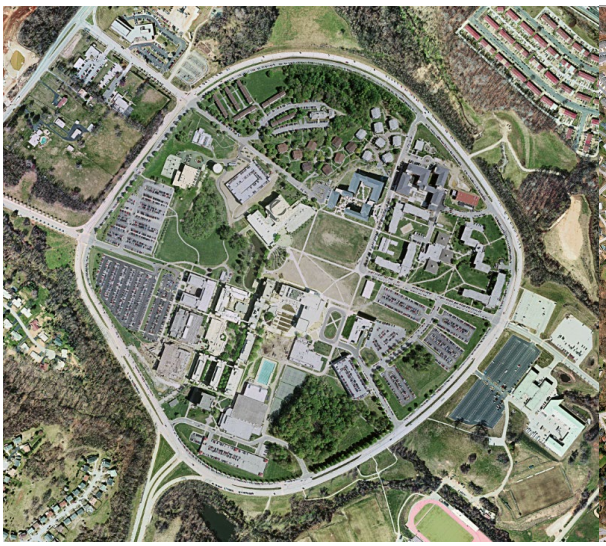
UMBC 1972:

UMBC 1980:

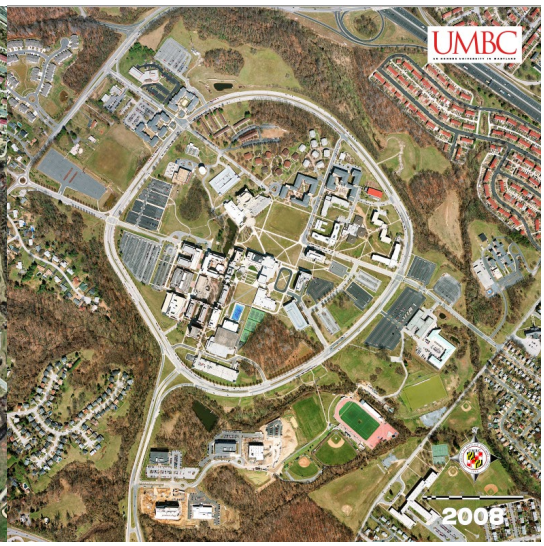
UMBC 1986:

UMBC 1996:

UMBC 2002:



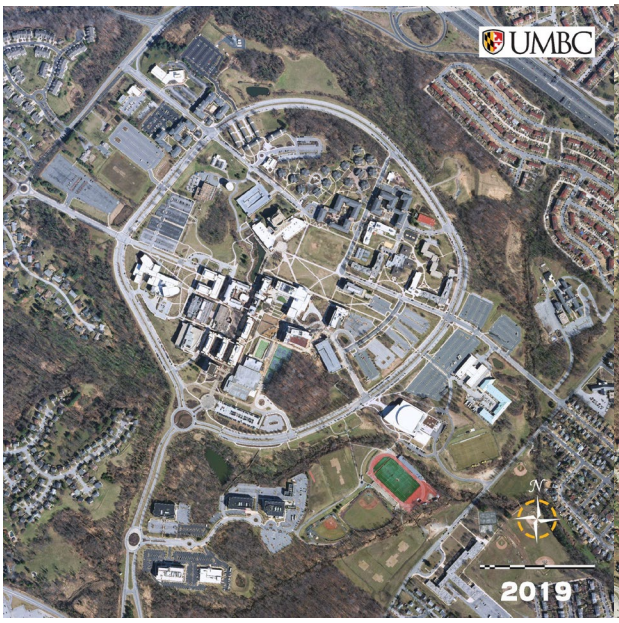
UMBC 2008:



UMBC 2016:

UMBC 2018:

UMBC 2019:



UMBC 2020:

UMBC 2021:

UMBC 2022:

*Note that this is not an exhaustive list of land use history information, but what was found to provide a brief overview of the land use history and urbanization.

EXISTING SITE CONDITIONS

The soil on UMBC campus continues to be disturbed by land development and invasive species infestations. The forested areas especially by the Herbert Run Dam were known to be urban land fill excavated from previous construction projects. It is likely there are invasive plant infestations in this area due to the viability of the seed bank present in soil. It is also important to note that one of the benefits and potential issues of campus is its close proximity to major interstate highways including I-95, I-195, and I-695. Rights of way including these interstate highways are one of the main pathways for the introduction of invasive species.

Following the topography of the campus are perennial streams that typically flow in a southeastern direction. The campus drains to two main tributary streams that run adjacent to Hilltop Circle around the outer perimeter of the main campus. Most drainage areas inside of Hilltop Circle drain to existing streams via culverts and storm drain systems. These tributaries then drain to Herbert Run Western Branch, which is classified as a Use Class I stream. The Performing Arts and Humanities Building and the UMBC Event Center projects have recently provided the university with the opportunity to restore two important stream corridors by clearing invasive species and restoring deteriorated stream banks. Much of the woodland on campus is successional forest growing on areas that were farmed or grazed for many prior years. On the perimeter of campus are dense forest zones that have been identified as areas of forest conservation. These areas total approximately 24 acres and satisfy the regulatory requirements of the Maryland Forest Conservation Act.

The Knoll, a mixed-aged canopy woodland on a hilly area adjacent to the Retriever Activities Center, is a prominent land resource on campus being used in long-term environmental research. The Knoll can continue to be managed to promote the health of the existing native tree canopy and to control invasive non-native plant species.

The CERA was established in 1997 to support environmental education and conservation. There are two CERA parcels. The larger tract, covering approximately 45 acres of the south end of the main campus, is composed of a wide variety of ecological conditions: mature upland forest, early- and mid-successional forests, and riparian and wetland environments. The smaller tract is about 3 acres and surrounds the historic farm pond, now commonly referred to as the CERA Pond.

From the end of summer of 2021 to the end of summer of 2022, Facilities Management completed construction activities related to the stream restoration and UMBC Stadium Complex access improvement projects. The project consisted of improvements to portions of a tributary of the West Branch of Herbert Run, general landscape improvements and a new accessible walkway and pedestrian bridge between Hilltop Circle and the UMBC Stadium Complex. This resulted in disturbed land, and even with the restorative efforts put in place, there are still invasive species present in this area.

Specific opportunities for stormwater management improvements include:

- Installing green roofs on existing and new buildings to treat rainfall that falls on these buildings
- Creating a new wetland area to the west of the UMBC stadium in a depression created by the confluence of several streams
- Creating working landscapes within existing and planned campus open spaces in ways that lend beauty, provide water management, and create environments for pollinators

As good environmental stewards, UMBC proposes to renew the university's oldest buildings. Optimizing use of existing resources is one of the master plan's guiding principles. However, additional space is essential to support and expand computing programs. With each proposed project, pedestrian paths will be upgraded, building utility services improved, new plazas developed, and stormwater management features integrated as working landscapes.

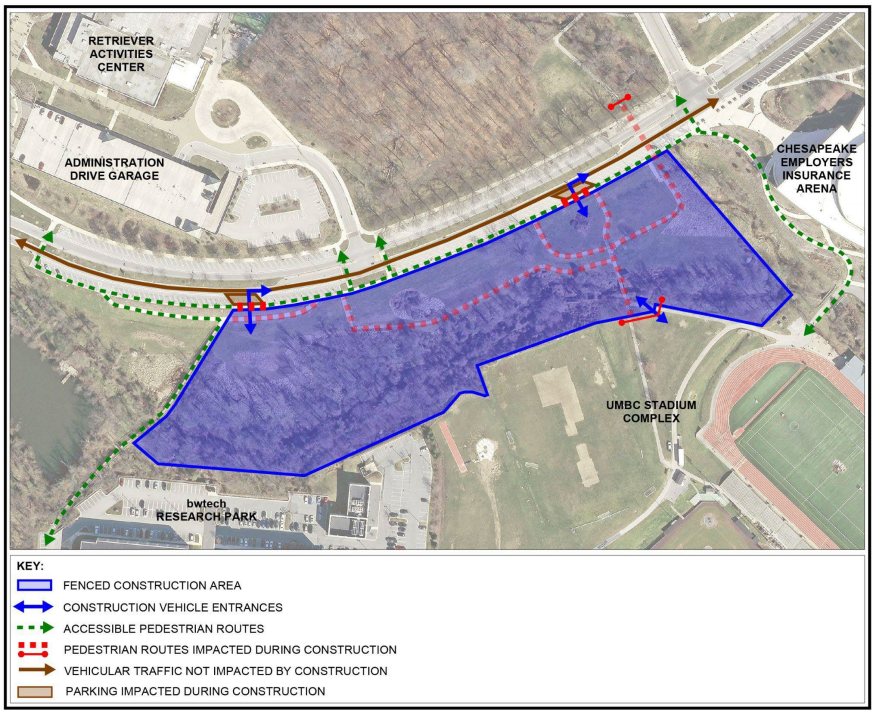


Figure 1.

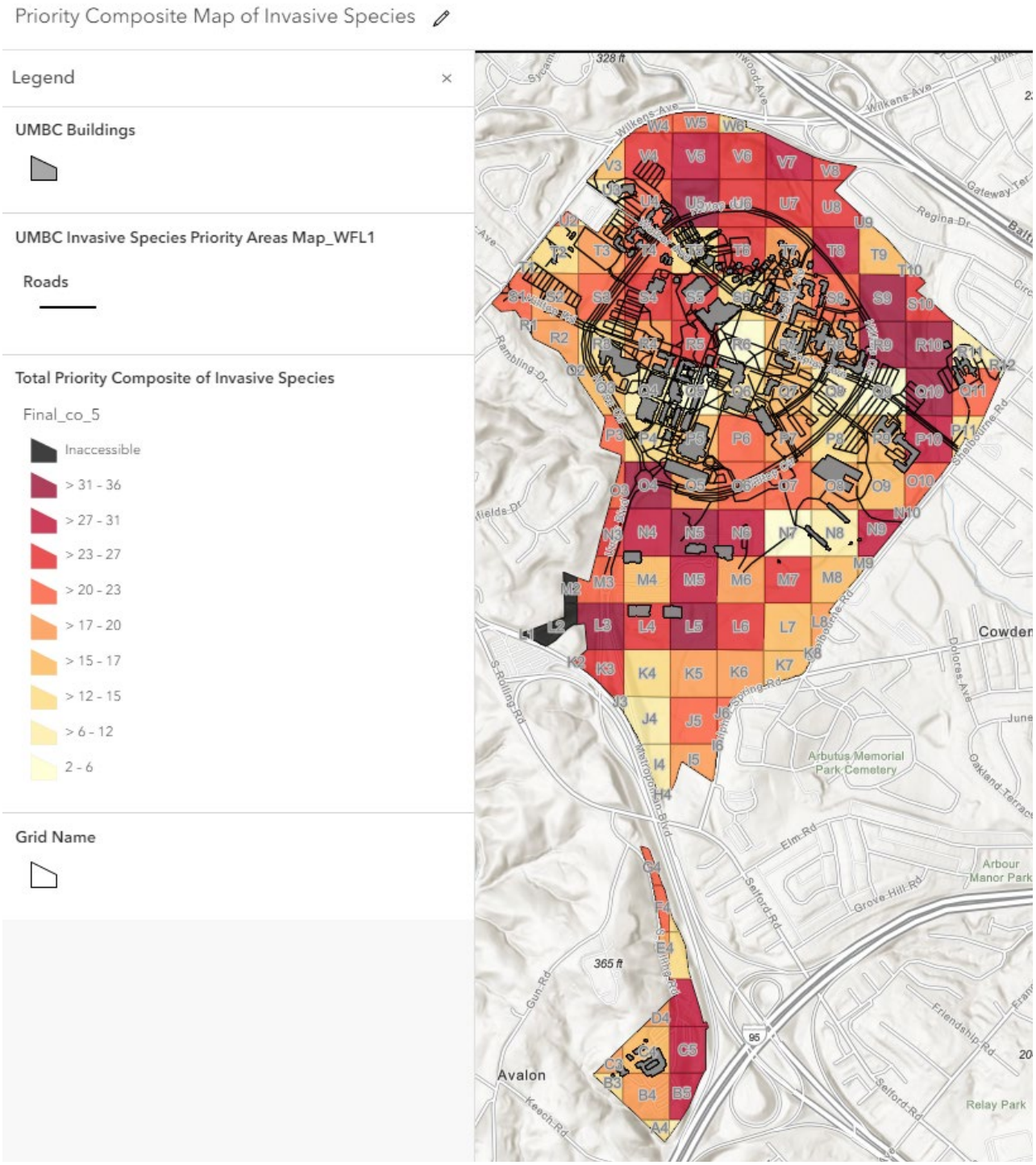


Figure 1. A composite map was created to display the top invasive plant species that are ranked as a priority to manage and remove from campus. See map notes for more information. https://arcg.is/fayXK

Figure 2.

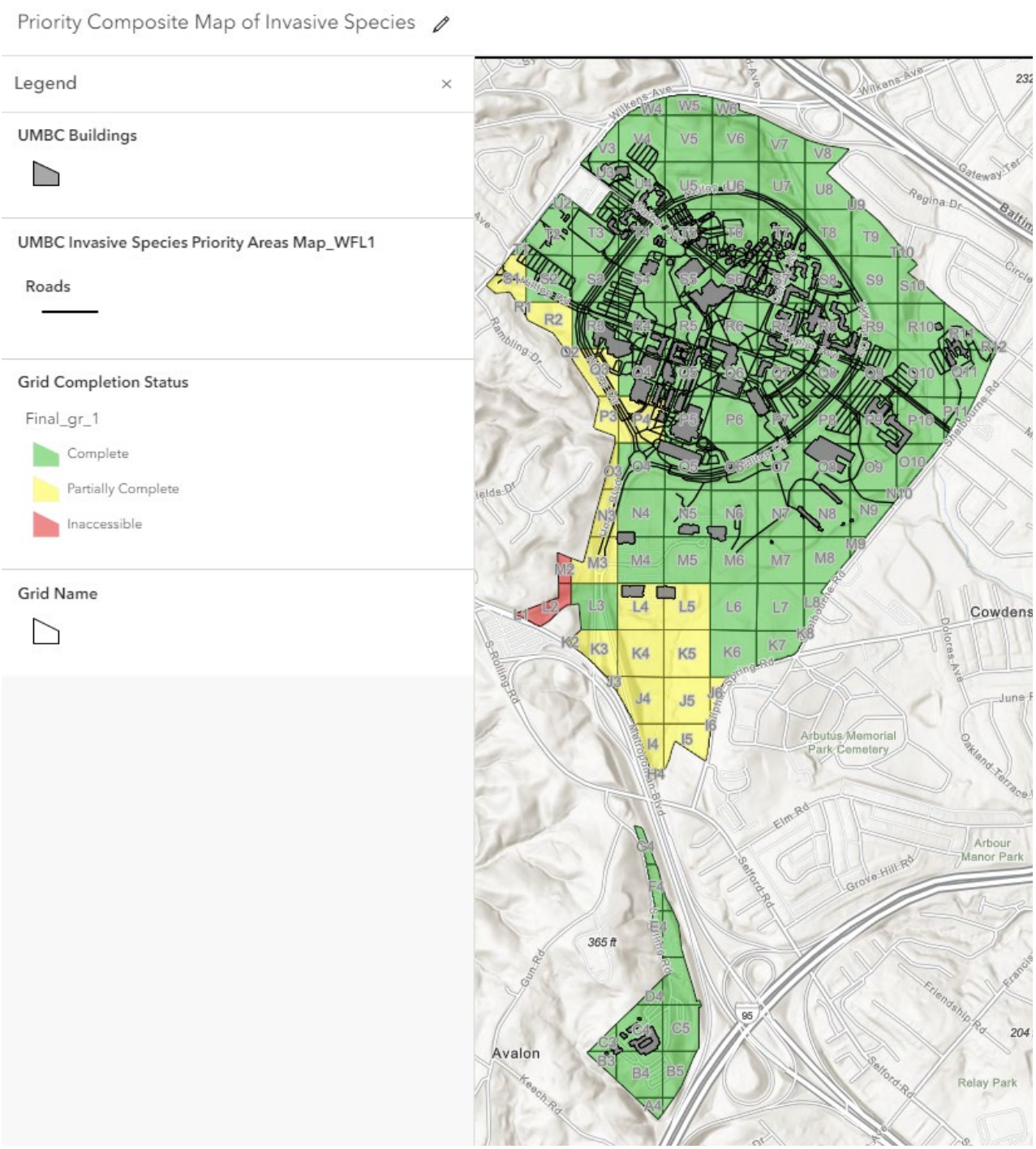


Figure 2. This is a map displaying the grid completion status from the final survey. Areas in red were inaccessible, areas in yellow were partially complete, and areas in green were complete.

Figure 3.

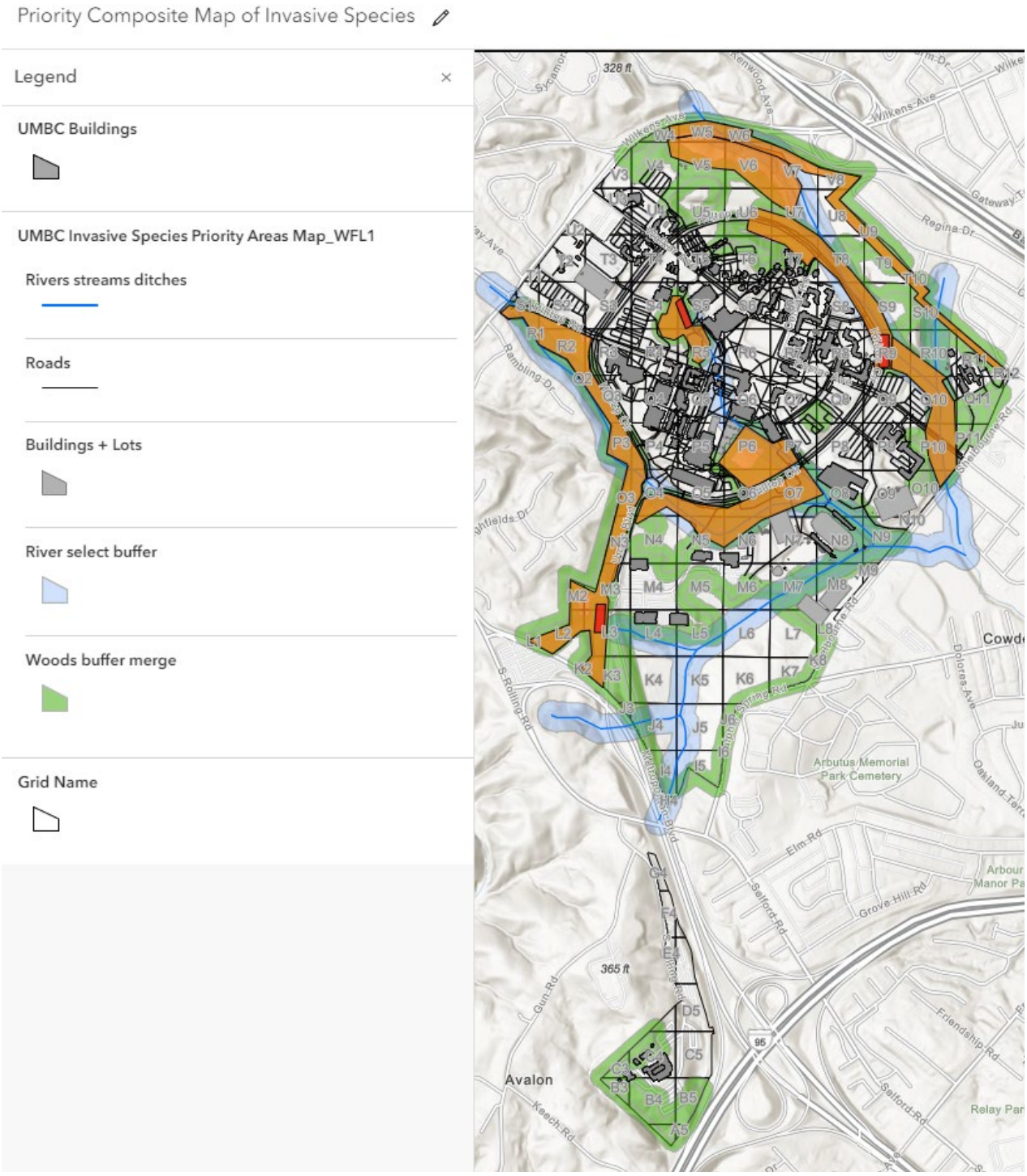


Figure 3. Overlaid on this map are buffer areas to consider for prioritizing management. Areas in orange are proposed priority areas for invasive species management. Areas in red are proposed areas to begin invasive species management efforts which will eventually expand into the orange areas. See map notes for more information.

Figure 4.

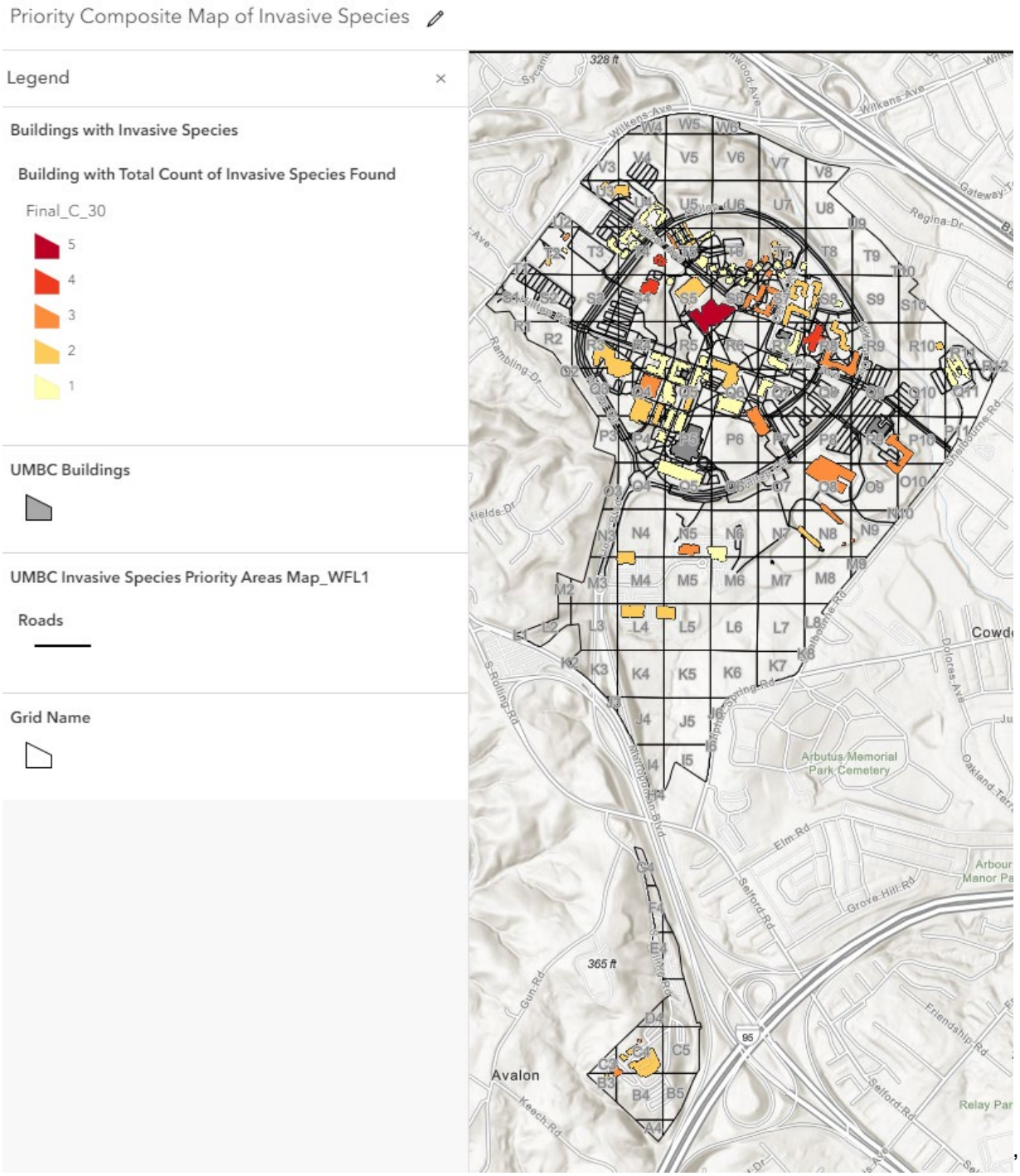


Figure 4. This map displays UMBC buildings and the total number of invasive plant species found on each building. Visit this link to look at each layer of individual species: https://arcg.is/fayXK

Figure 5.

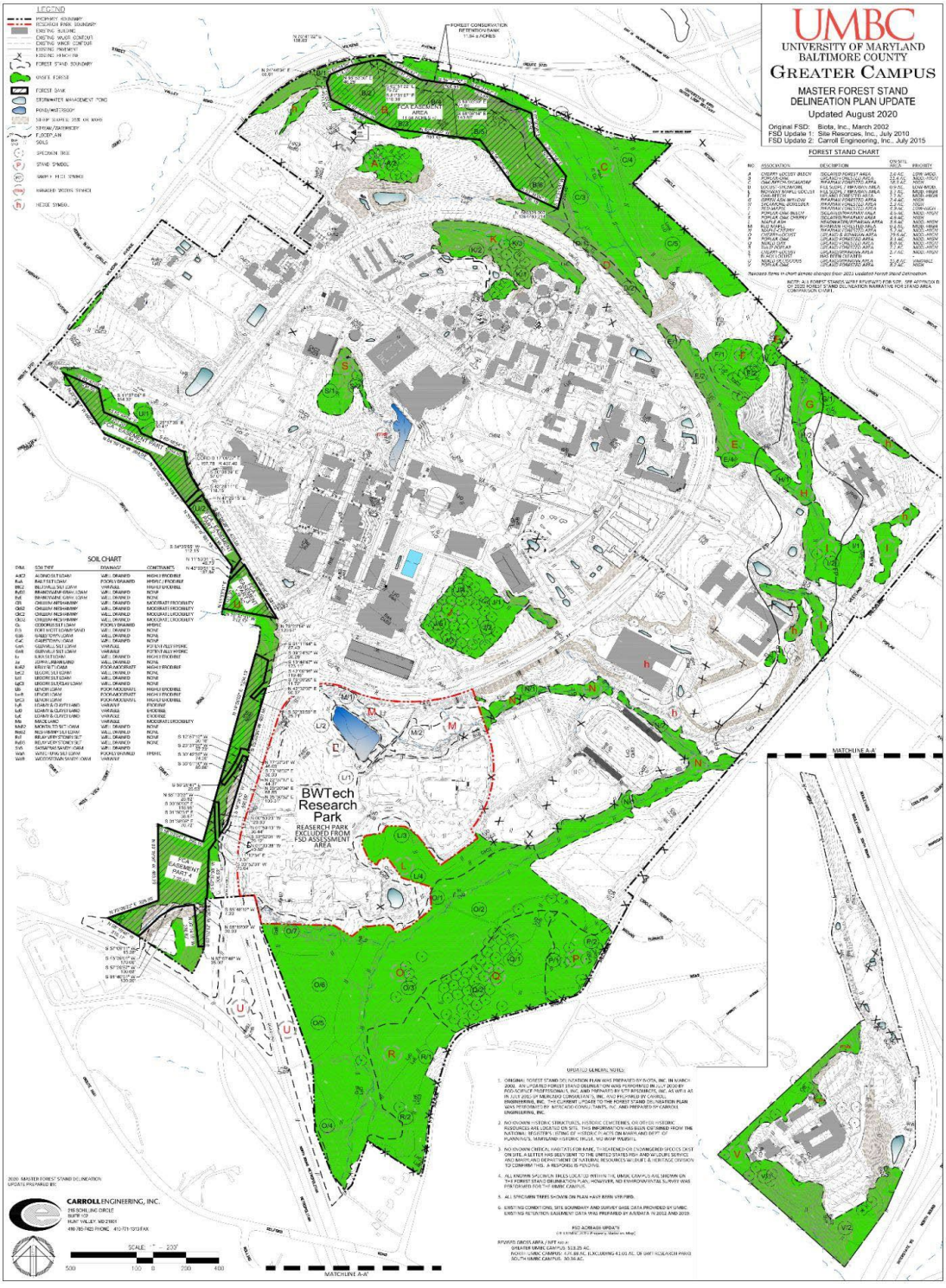


Figure 5. UMBC Campus contains Maryland Forest Conservation Act Easement areas which are of utmost importance to prioritize for invasive species management. See the designated Forest Bank areas (in the diagonal lines within the bold black outlined polygons) in the Maryland Forest Stand Delineation Plan for reference.

Map Notes:

1. The grid names are from UMBC's grid system used by UMBC Facilities Management Planning Department. Each grid is 500 feet by 500 feet. The grid system is used to ensure consistency, and to organize and manage the campus in smaller areas.
2. The Composite Species Count represents the total number of priority invasive species found in each grid area. If an invasive species is present, it is ranked from 1-3.
   1 meaning a low (1-25%) presence of invasive species found
   2 meaning a medium (26-50%) presence of invasive species found
   3 meaning a high (>50%) presence of invasive species found.
   Note that this is a survey estimate, not an inventory.
   The Composite Species Count represents the sum of all of the ranking numbers (0-3) of each species found in that grid. The highest composite number found was a ranking of 36.
3. The darker and redder the color of the grid, the higher the Composite Species Count. This means that there are more invasive species found in that grid and/or those invasive species were found in medium to high infestations. The lighter and yellower the color of the grid, the lower the Composite Species Count. This means that there are less invasive species found in that grid and/or those invasive species were found in low to medium infestations.
4. Black grids (L1, L2, M2) are labeled as inaccessible from the Fall 2022 survey. These were grids that were difficult to get access due to: steep slopes that were not safe to walk on, dense vegetation that made walking difficult, and/or high infestations of easily spreadable invasive species (Wavyleaf basketgrass).

Map Summary:

1. In the Maryland Forest Stand Delineation map, it is of utmost importance to prioritize the forest conservation easement areas (see Forest Bank areas on the map for reference) first and foremost. Both of these forest conservation easement areas overlap with the forest and river buffers in the composite maps, so these areas should definitely be prioritized first for the implementation of invasive species management efforts.
2. The next important area to prioritize the implementation of invasive species management are the forest edges on the outer circle on campus. This is mainly the north, northeast, west, and southwest portions of the outer circle. These areas need to be prioritized second for safety reasons - we do not want trees infested with invasive species potentially falling onto people, roadways, cars and other types of property on campus.
3. The third area to prioritize the implementation of invasive species management is the 100 ft buffer area placed on and around the rivers and streams that run through campus. This is the Herbert Run Greenway and its surrounding riparian forest buffer.
4. The fourth area to prioritize the implementation of invasive species management is the 50 ft buffer area placed on and around the forested edges of campus. This is a buffer with 50 feet on either side of the forest edge line. We want to first remove 'satellite' or small populations of invasive species found outside the edges, and then work our way inwards to the forest.

The invasive plant species were also broken down by forest story layers. These layers were divided up as:

1. Groundcover: any low-growing plant that covers the ground. Included are both groundcover and herbaceous plants.
2. Understory: Shrubs and bushes.
3. Canopy: These included trees regardless of its growth stage.
4. Vines: Vines needed a separate layer as they can grow on any story level, and they are first priority.

Below are links to each forest story layer for more details. The ArcGIS online application is interactive, so you can look at each invasive species within each story layer individually.

Invasive Groundcover Plants Map: https://arcg.is/19vWCD
Invasive Understory Plants Map: https://arcg.is/ujOW8
Invasive Canopy Plants Map: https://arcg.is/0HbCri0
Invasive Vines Plants Map: https://arcg.is/HLvSr
Priority Composite Map of Invasive Species (this includes layers for each composite story level, buildings, grid completion status, and buffer areas for priority of management practices): https://arcg.is/fayXK

3 GOALS & OBJECTIVES

In the next 5 years, the goals of this management plan will be to:

1. Collaborate across the UMBC campus community to optimize operations through leveraging partnerships, joint educational efforts, and funding for invasive species management efforts.
2. Cost-effectively prevent the introduction and spread of invasive species into and within UMBC campus.
3. Implement early detection and rapid response efforts to reduce potential damage and costs from new infestations becoming established.
4. Cost-effectively control and/or eradicate established invasive species populations to reduce impacts and help restore ecosystems.
5. Improve invasive species data management for decision-making within the Office of Sustainability and Facilities Management.[3]
6. Manage invasive species removal in areas close to roads, walkways, and buildings to prevent safety hazards from occurring.
7. Conserve UMBC's natural resources including the Herbert Run stream and surrounding riparian forest buffer, CERA, and the Knoll.
8. Establish monitoring practices for established, new, and potential invasive species that could infest the area.
9. Prioritize the implementation of Best Management Practices to ensure appropriate environmental restoration efforts with the least amount of disturbance and contamination to the campus environment.

[3] Adapted from Invasive Species Strategic Plan 2021-2025 by the Department of the Interior https://www.doi.gov/sites/doi.gov/files/doi-invasive-species-strategic-plan-2021-2025-508.pdf

4 Management Priorities

Not every invasive species will be completely managed and/or eradicated from campus. That is why it is important to prioritize the invasive species that are relatively new to the area (Early Detection Rapid Response), and those that pose a greater threat to the campus environment by way of seed and vegetative dispersal.

In reference to the maps included in this management plan, it is priority to:

1. Implement invasive species management strategies in areas within the 50 feet forest buffer area on the outer edges of Hilltop Circle (mainly the NE and SW portions of Hilltop Circle) to prevent safety hazards from trees that could potentially fall onto people, roadways, walkways, and property.
2. Implement invasive species management strategies in areas within the 100 feet stream buffer area to protect and conserve riparian forest buffers.
3. Implement invasive species management strategies in forest conservation easement areas.
4. Prioritize invasive species management efforts in older forests including CERA, Herbert Run Greenway, and the Knoll. Given that CERA and the Knoll have ongoing research projects and different rules than other spaces on campus, **permission will need to be requested before doing any invasive species removal work in these spaces.**
    - Contact for the chair of the CERA Committee, Suzanne Braunschweig: sbraun@umbc.edu, cera@umbc.edu
    - Contact for GES professors: Matt Baker: mbaker@umbc.edu, Erle Ellis: ece@umbc.edu, and Charlie Kaylor: ckaylor@umbc.edu
5. Remove any invasive vines growing on campus buildings to protect the infrastructure.
6. Apply an Integrated Pest Management approach to use manual, mechanical, chemical, and biological strategies in a cost effective manner.
7. Eradicate invasive species populations that are small, and gradually work our way to managing and controlling larger invasive species populations to reduce its spread.
8. Educate and engage the campus community with these management efforts so that the community is aware and involved via volunteering opportunities with the Environmental Task Force, signage, and social media postings.

In FY 2023-2024:

Invasive species management efforts should be focused on the top 3 priority areas in red (highlighted in Figure 3).

1. Priority Area #1: Kudzu patch by the UMBC silo. This is of utmost importance as an EDRR plant that can spread rapidly and harm our forests and infrastructure. This can be managed with goat grazing, mechanical brush hogging, and herbicide application.

    Estimated area: 10 ft-50 ft by 300 ft = 3,000-15,000 sq ft

2. Priority Area #2: The forest line facing the AOK Library. This area could potentially damage the library infrastructure, and this is a proposed area for goat grazing (and an ideal opportunity for public engagement and publicity).
    Estimated area: 80ft x 350 ft = 28,000 sq ft
3. Priority Area #3: The forest line facing Patapsco Hall on Hilltop Circle near the Herbert Run Dam. This forest line is severely covered in invasive plant species which can become a safety hazard if these trees are to fall onto people, Hilltop Circle traffic, and nearby residence halls and buildings (Patapsco Hall, Potomac Hall, Harbor Hall, and the Satellite Plant).
    Estimated area: 50 ft x 300 ft (for starting) = 15,000 sq ft

These are good areas to start in given their characteristics. Once these areas have been addressed and maintained, we can expand into the orange zones that are of priority for long term maintenance.

5 MONITORING PRACTICES

In the fall of 2022 and spring of 2023, the Sustainability Fellow conducted a survey to provide a qualitative assessment of the invasive plant species populations on campus. Here are the steps to conducting the survey:

1. Get familiar with common invasives in the mid-atlantic region. Use the Plant Invaders of Mid-Atlantic Natural Areas by the National Park Service and US Fish & Wildlife Service for reference. It's likely you will come across plants you are unfamiliar with. The PictureThis mobile application was useful in confirming plant identification. It isn't entirely accurate, but it is a good starting point. You can later confirm the identification after researching online, or bring a plant sample to an internal expert within Facilities Management, typically those working in Landscape & Grounds or Design & Construction.
2. Get familiar with identifying the invasive insect species listed in this document. When conducting invasive species surveys observe and take note of any invasive insects, signs of tree stress, entry/exit holes, etc.
3. Use the Invasives Survey map https://arcg.is/ziDXK and pull it up on the ArcGIS Field Maps application on your mobile device. Turn your location on to keep track of where you are on the map.
4. Walk around each grid to wherever you are physically able to walk to, and take pictures of invasive plants observed. Take note of each invasive plant species you find (on a notepad or notes app on your phone). After surveying the grid, estimate the coverage of each invasive species on a scale from 1-3
    a. 1 ranks as low presence (1-25% coverage of the grid)
    b. 2 ranks as medium presence (26-50% coverage of the grid)
    c. 3 ranks as high presence (>50% coverage of the grid)

*You may not be able to completely walk around the entirety of each grid area due to steep slopes, restricted areas, or high infestations of invasive species that spread easily (i.e., Wavyleaf Basketgrass). Make sure to take note of grids you were unable to fully walk around in, and follow the guidelines in the next step.

5. Take note of the completion status of each grid surveyed
    a. 0 being inaccessible, this can be due to steep slopes, unsafe conditions to walk through, restricted areas, high infestation of Wavyleaf Basketgrass or other easily spreadable invasive plant species
    b. 1 being partially surveyed
    c. 2 being completely surveyed
6. Upload your survey notes into a copy of this spreadsheet: https://docs.google.com/spreadsheets/d/152VvmI_vDuP1MUDFyV3AUuc9Varr-rdWwtwVOCwkKJM/edit?usp=sharing

- The top invasive species will be on the top column
- The grid numbers will be on the left hand column
- Plug in the rank numbers for the invasive species found

- Put [0] for the invasive species that weren't found
- Put [99] for any grids that were inaccessible
- You will be doing this for each layer: groundcover, understory, canopy, vines
- The status survey notes are on a separate table tab in the spreadsheet
- This spreadsheet will make it easy for you to upload your table into ArcGIS Pro to make maps of the invasive species presence on campus

7. Upload your survey pictures into Google Drive. These can be used for reference and evidence.
8. Take note of the time it took to complete your surveys for each grid. When the survey is finished, add up the time it took so that you have a better idea of how much time to dedicate to surveys in the future.

In both short and long term scope, it will be best to monitor priority areas on campus every spring.

6 TARGET INVASIVE SPECIES

Early Detection Rapid Response Invasive Plant Species

Early Detection and Rapid Response (EDRR) can stop the spread of new and emerging invasive species before they become established and widespread. It is one of the most cost-effective and ecologically viable methods for controlling invasive species and is well worth the effort to protect natural and agricultural resources.

COMMON NAME	SCIENTIFIC NAME
Common Reed or Phragmites	*(Phragmites australis)*
Chinese Silvergrass	*(Miscanthus sinensis)*
Japanese Knotweed	*(Reynoutria japonica)*
Chinese Lespedeza	*(Lespedeza cuneata)*
Lilyturf	*(Liriope muscari)*
Blue Buffel Grass	*(Cenchrus ciliaris)*
Japanese Bristlegrass	*(Setaria faberi)*
Johnsongrass	*(Sorghum halepense)*
Italian Arum	*(Arum italicum)*
Yellow Nutsedge	*(Cyperus esculentus)*
Beefsteak	*(Perilla frutescens)*
Wavyleaf Basketgrass	*(Oplismenus undulatifolius)*
Sweet Autumn Clematis, Sweet Autumn Virginsbower, Japanese Clematis	*(Clematis terniflora)*
Japanese Hop	*(Humulus japonicus)*
Yellow Flag Iris	*(Iris pseudacorus)*
Bull Thistle	*(Cirsium vulgare)*
Creeping Thistle	*(Cirsium arvense)*
Common Mugwort	*(Artemisia vulgaris)*

Kudzu	*(Pueraria montana)*
Autumn Olive	*(Elaeagnus umbellata)*
Watercress	*(Nasturtium officinale)*
Jetbead	*(Rhodotypos scandens)*
Field Bindweed	*(Convolvulus arvensis)*
Poison Hemlock	*(Conium maculatum)*
Burning Bush	*(Euonymus alatus)*

First Priority Invasive Plant Species

COMMON NAME	SCIENTIFIC NAME
English Ivy	*(Hedera helix)*
Porcelainberry	*(Ampelopsis brevipedunculata)*
Japanese Honeysuckle	*(Lonicera japonica)*
Amur Honeysuckle or Bush Honeysuckle	*(Lonicera maackii)*
Multiflora Rose	*(Rosa multiflora)*
Mile-a-Minute	*(Persicaria perfoliata)*
Oriental Bittersweet	*(Celastrus orbiculata)*
Privet Border privet California privet Chinese privet European privet	*(Ligustrsum spp.)* *(Ligustrum obtusifolium Sieb. & Zucc.)* *(L. ovalifolium Hassk.)* *(L. sinense Lour.)* *(L. vulgare L.)*
Garlic Mustard	*(Alliaria petiolata)*
Wintercreeper	*(Euonymus fortunei)*
Common Periwinkle	*(Vinca minor)*
Bigleaf Periwinkle	*(Vinca major)*
Hybrid Cattail	*(Typha x glauca)*
Japanese Barberry	*(Berberis thunbergii)*

Second Priority Invasive Plant Species

COMMON NAME	SCIENTIFIC NAME
Japanese Stiltgrass	*(Microstegium vimineum)*
Lesser Celandine or Fig Buttercup	*(Ranunculus ficaria L.)*
Reed Canarygrass	*(Phalaris arundinacea L.)*
Himalayan Blackberry, European Blackberry	*(Rubus armeniacus)*
Poverty Brome	*(Bromus sterilis)*

Third Priority Invasive Plant Species

COMMON NAME	SCIENTIFIC NAME
Wineberry	*(Rubus phoenicolasius)*
Callery Pear	*(Pyrus calleryana)*
Tree of Heaven	*(Ailanthus altissima)*
Princess Tree	*(Paulownia tomentosa)*
Wild Teasel or Fuller's Teasel	*(Dipsacus fullonum)*
Japanese Meadowsweet	*(Spiraea japonica)*
Common Velvetgrass	*(Holcus lanatus L.)*
Kentucky Bluegrass	*(Poa pratensis)*

Invasive Insect Species[4]
*species of concern in Maryland

COMMON NAME	SCIENTIFIC NAME
Spotted Lanternfly	*(Lycorma delicatula)*
Emerald Ash Borer	*(Agrilus planipennis)*
Spongy Moth	*(Lymantria dispar)*
Pine Shoot Beetle	*(Tomicus pniperda)*

[4] https://msa.maryland.gov/msa/mdmanual/01glance/wildlife/insects/html/invasive.html

Asian Longhorned Beetle*	*(Anoplophora glabripennis)*

Invasive Species Description & Biology

Early Detection Rapid Response Invasive Plant Species

Common Reed or Phragmites *(Phragmites australis)*

Description & Biology

- Plant: perennial grass, stems to 15 ft., somewhat rough to the touch, lack fungal spots but some mildew may be present.
- Leaves: blue green and darker than the native form; elongate, typically 1-1½ in. wide at their widest point; leaf sheaths adhere tightly to stem and persist through the winter; ligule is less than 1 mm long.
- Flowers, fruits and seeds: flowers in bushy panicles, usually purple or golden in color; upper glumes 4.5-7.5 mm, lower glumes 2.5-5.0 mm (most <4.0).
- Spreads: by seed which is dispersed by wind and water; vegetatively through rhizomes and transport of rhizome fragments.
- Look-alikes: native form of Phragmites; other large grasses with plume-like inflorescences.

Distribution & Habitat

- Common reed occurs in disturbed to pristine wet areas including tidal and non-tidal wetlands, brackish and fresh-water marshes, river edges, shores of lakes and ponds, roadsides and ditches. It prefers full sun and can tolerate fresh to mesohaline salinities.

Ecological Threat

- Common reed is a vigorous growing plant that forms dense monotypic stands that consume available growing space and push out other plants including the native subspecies. It also alters wetland hydrology, increases the potential for fire and reduces and degrades wetland wildlife habitat due in part to its very dense growth habit. There is currently no evidence of hybridization between native and introduced forms occurring in the field.

Chinese Silvergrass (*Miscanthus sinensis*)

Second picture taken in grid M6 on UMBC campus

Description & Biology

- A perennial grass with slender, upright or somewhat arching leaves up to 18 in. long, with silvery midribs, sharp tips and rough margins and feathery, fan-shaped, terminal flower panicles that are silvery to pink in color and up to 2 ft. long.
- Flowering occurs September through October.
- The species or wild type of *Miscanthus* likely originated from ornamental plantings. Due to the large number of forms planted, the wild type now produces a significant amount of viable seed that is wind-dispersed.
- Spread vegetatively by rhizomes and by seed.

Distribution & Habitat

- It is popular and frequently planted in commercial and residential landscapes. Chinese silvergrass is found in scattered locations in most of the eastern U.S. and as far west as Missouri and Louisiana, and in California and Colorado.
- It is a clump-forming grass with short, inconspicuous rhizomes and is adaptable to a variety of soil types including light, well-drained, nutrient-poor soils not suitable for agriculture such as roadsides, powerline rights-of-way, railroads, and steep embankments. It prefers full sun.

Ecological Threat

Chinese silvergrass can escape from ornamental plantings and can form large clumps along disturbed areas, displacing native vegetation. The grass is also extremely flammable and increases fire risks of invaded areas.

Japanese Knotweed (*Reynoutria japonica*)

Pictures taken in grid T8 and S10 on UMBC campus

Description & Biology

- Plant: upright, shrubby, herbaceous perennial 4-10 ft. tall with stems that are smooth, stout and hollow; stem leaf junctures are swollen and surrounded by a membranous sheath called an “ocrea” which is typical of the family.
- Leaves: variable; about 6 in. long by 3-4 in. wide, broadly oval to somewhat triangular with a truncated base and a tapered tip.
- Flowers, fruits and seeds: tiny greenish to white colored flowers occur in attractive sprays in summer; fruits are winged on three sides; seeds are triangular, dark brown, shiny and about 1/10 in. long.
- Spreads: by seed and by vegetative means through growth of long, stout rhizomes; can be transported long distances by water as a contaminant in fill-dirt, or on the soles of shoes; escapes from gardens and landscaped areas through discarded cuttings.
- Look-alikes: the lovely native Virginia knotweed (*Tovara virginiana*), and two exotic invasive relatives - Prince’s feather (*Polygonum orientale*) and Giant knotweed (*Polygonum sachalinense*).

Distribution & Habitat

- Japanese knotweed occurs across the U.S. and has been reported to be invasive in natural areas throughout the northeast into Georgia and west to Missouri, with additional infestations in Oregon and Washington. It can tolerate a wide variety of challenging conditions, including deep shade, high salinity, high heat, and drought. Knotweed is commonly found near water sources, such as along streams and rivers, and in a variety of low-lying areas like ditches, waste places, utility rights-of-way and around old home sites.

Ecological Threat

- It spreads quickly to form dense thickets and pushes out native plant species. Knotweed poses a significant threat to riparian areas where it can survive flooding events and rapidly colonize scoured shores and islands. Once established, populations are extremely persistent.

Chinese Lespedeza (*Lespedeza cuneata*)

Second picture taken in grid R10 on UMBC campus

Description & Biology

- Plant: warm season, perennial herbaceous plant with an erect growth form, 3-5 1⁄2 feet in height; mature stems are somewhat woody and fibrous with sharp, stiff, flattened bristles.
- Leaves: each leaf is divided into three smaller leaflets which are narrowly oblong and pointed, with awl-shaped spines and wedge-shaped bases; leaflets are covered with densely flattened hairs, giving a grayish-green or silvery appearance.
- Flowers, fruits and seeds: flowers small (about 1⁄4 in.) creamy white to pale yellow with central purple spots, single or in clusters of 2-4 in axils of upper and median leaves, summer; fruits form in fall; seeds tiny, bean-shaped, yellow to light brown.
- Spreads: by seed that is consumed by animals such as bobwhite quail and passed through digestive tract and deposited in new locations.
- Look-alikes: other species of Lespedeza including native and non-native species.

Distribution & Habitat

- Chinese lespedeza occurs throughout much of the eastern U.S. from Minnesota to Texas east to New York and Florida.
- It is found in a variety of habitats including fields, prairies, floodplains, pond borders, stream banks, swamps, meadows, open woodlands, roadsides and other disturbed grounds.
- Prefers full sun and is not tolerant of much shade.

Ecological Threat

- Chinese lespedeza poses the greatest threat to open areas such as meadows, prairies, open woodlands, wetland borders and fields. Once established, it out-competes and displaces native plants, forms extensive monocultures and develops an extensive seed bank in the soil, ensuring its long residence at a site. Its high tannin content makes it unpalatable to livestock and most native wildlife.

Lilyturf (*Liriope muscari*)

Description & Biology

- Plant: Lilyturf is a broadleaf evergreen, herbaceous perennial that forms dense basal clumps of narrow, arching dark green leaves and is commonly seen in the home landscape as a groundcover or edging. Though it may resemble ornamental grass it is not a true grass. The roots are fleshy and tuberous.
- Leaves: The clumps of leaves measure 1 to 1.5 feet tall and equally as wide.
- Flowers, fruits, and seeds: In the late summer and early fall, it has erect small spike-like purple flowers that are 6 to 8 inches tall. The flowers are followed by round, shiny black berries that remain through the winter months.

Distribution & Habitat

- Lilyturf is native to China, Taiwan, and Japan. The plant is usually found in forests, shady and moist areas, near ravines, and on slopes.
- Lilyturf requires acidic to neutral, well-drained soils in full sun to partial shade. It will tolerate almost full shade but growth is slower and leaves are elongated. It is drought and deer tolerant, moderately salt-tolerant

Ecological Threat

- Can easily spread vegetatively by radiating rhizomes and its short stolons. Taproots of young plants eventually become fibrous, filling the upper 6 to 12 inches of soil.
- Lilyturf can escape into natural areas. Spread is most rapid on moist, highly organic soils. The most extensive infestations of Liriope are typically found at old abandoned home sites and in woods adjacent to neighborhoods. Solid infestations of Liriope displace native plants to form monocultures. In many southern forests, the native ground-layer community is highly diverse; supporting countless beneficial insects, songbirds, game birds, small and large mammals. Exotic plant monocultures can severely degrade natural habitats and contribute to population declines of native flora and fauna.

Blue Buffel Grass (*Cenchrus ciliaris*)

Picture was taken in grid S2 on UMBC Campus

Description & Biology

- Plant and leaves: A perennial shrub-like grass from the family Poaceae. On average adult plants reach a height of 1.5 feet and a width of 3 feet. Immature forms of buffel grass look similar to bunchgrass because of the condensed appearance. Larger adult plants split at the nodes as they grow, developing a messy unorganized appearance with leaves extending multiple directions. New leaves and flowers are formed at the nodes of each grass blade allowing for extensive seed production following rain.
- Flowers, fruits, and seeds: Flowers are usually reddish brown, but occasionally stramineous. Each flower is covered with small spikes or burrs packed in a dense formation to facilitate seed dispersal by attaching to animal fur or human clothing. Blooming begins in the summer with seed production at its highest mid-summer and the end of seed production occurs in the fall. Seeds are produced in a high abundance with flowers occurring at nearly every node of the plant. Approximately 260,000 seeds are produced per pound of buffel grass with a moderate dispersal rate, but high seed viability once it reaches the ground. Vegetative reproduction occurs slowly and is rarely seen in buffelgrass.

Distribution & Habitat

- Native to Africa, Indonesia, Asia and the Middle East. As a desert plant adapted for drought, buffel grass is currently found growing in disturbed areas such as roadsides in ditches or along medians. Within the Sonoran desert, buffelgrass can be found along hillsides on southern facing slopes, in open fields, and steep rocky hillsides. Although it is characteristic of warm weather grass, it has been able to survive in northern states.

Ecological Threat

- Blue buffel grass is known for its high drought tolerance and tendency to grow in dense clumps. These characteristics allow the invasive plant to crowd native plants and compete for available resources. Smaller vegetation suffers from a lack of sunlight and prevents seed dispersal when buffelgrass becomes established because of crowding.
- In addition to being drought tolerant, buffel grass is adapted for regular burning and supports extremely hot fires, causing further death to native plant species

that haven't adapted for regular fires of high temperatures. Once buffel grass invades an area, it quickly becomes a monoculture and plant diversity is lost.

Japanese Bristlegrass (*Setaria faberi*)

Description & Biology

- Plant: An annual monocot in the grass family (Poaceae) growing 2 to 4 feet tall. Stems are weak and drop onto other vegetation for support.
- Leaves: Flat, linear, 5 to 20 inches long and .2 to .8 inch wide, and covered with short hairs on the upper surface.
- Flowers, fruit, and seeds: The elongated, compound flower cluster (panicle) is dense, cylindrical, 3 to 8 inches long, and bending near base with a drooping head. Three to six bristles extend from the base of each spikelet. It reproduces by seeds that are greenish and about 1/16 inch long. The seeds are produced from late summer to fall. Roots are fibrous and shallow.

Distribution & Habitat

- It is native to Asia and was accidentally introduced in the United States in the 1920s as a contaminant of other grain. Plants invade disturbed sites such as roadsides, landfills, fence rows, and right of ways.
- It is found in cultivated crops, waste areas, roadsides, fields, pastures, and wood edges. It grows best in fertile sandy soils.

Ecological Threat

- It is one of the most troublesome weeds in the Midwestern Corn Belt region. It competes with other vegetation and reduces yields in many crops. In burned prairie areas, it can become a serious pest, frequently forming monoculture pockets.
- *Setaria faberi* is native to Asia and was accidentally introduced in the United States in the 1920s as a contaminant of other grain. Plants invade disturbed sites such as roadsides, landfills, fence rows and right of ways.

Johnsongrass (*Sorghum halepense*)

Description & Biology

- Plant: A warm-season perennial grass and one of the most persistent and troublesome weeds in the southern United States. Johnsongrass grows in spreading patches due to its creeping rhizome system. It grows upright with a mature height that can range from 3 to 8 ft. Stout, unbranched stems up to 3 to 8 ft. in height with leaf blades up to 1.5 in. wide. The emerging sheath (coleoptile) of johnsongrass is maroon in color and grows to ½ inch long. Johnsongrass ligules are membranous, measure 3/16 inch long, and have ragged, hairy upper edges. Johnsongrass has a thick and aggressively growing/creeping rhizome system. When it is mature, fleshy white rhizomes can be seen if plants are hand-pulled
- Leaves: Leaves are typically 8 to 24 inches long but can be as long as 35 inches. Leaves have a prominent white midrib and rough underside. The leaves are rolled in the bud, do not have auricles, and have a membranous ligule with shallow teeth across the top
- Flowers, fruit, and seeds: The johnsongrass seed head has an open angular panicle, is reddish-brown or red/black, and ranges from 4 to 20 inches long. Seeds are produced annually, typically in the fall, and can remain dormant for long periods of time.
- Biology: thrives in moist environments, but it can also persist in drier areas due to its extensive rhizome system. The seeds of johnsongrass can emerge from the top 3 inches of soil. Johnsongrass can grow from both seeds and overwintering rhizomes, both growing rapidly as temperatures rise. However, seedlings from rhizomes grow faster than those from seeds. Seeds germinate at a temperature range of 70°F to 75°F within a year and remain viable for up to 6 years. Rhizome sprouting occurs in the early spring at an average temperature above 60°F. A single johnsongrass plant can produce 200 to 300 feet of new rhizome growth per year. Aboveground structures and older rhizomes die off in winter, but new rhizome growth persists and forms new sprouts the following spring.

Distribution & Habitat

- Johnsongrass grows in spreading patches due to its creeping rhizome system. It grows upright with a mature height that can range from 3 to 8 ft.
- *Sorghum halepense* is native to wet subtropical habitats from the Mediterranean region and has been introduced and naturalized throughout much of the United States and the world.
- Johnsongrass is often found growing in nutrient-rich soil but can survive in any type of soil, though it is not tolerant to flooding. It is often found in arable lands, meadows, waste places, roadsides, and field borders, and along irrigated canals and edges of irrigated fields. It is an occasional weed in nursery containers but primarily problematic in noncrop areas such as walkways, aisles, and other disturbed sites. In landscapes, it can be found in planting beds in and around ornamental plants.

Ecological Threat

- Johnsongrass is very invasive and can reduce corn and soybean yields over 30% and 40% respectively, even with normal control efforts. It is able to easily out-compete native grasses and can be found along roadsides all over Texas. Thick stands of *Sorghum halepense* can create a monoculture and alter the diversity of an area and affect the ecosystem and animals dependent on diverse grass cultures. Healthy plants can provide good forage for livestock. However, foliage of johnsongrass can produce toxic amounts of cyanide if growing under stressful conditions, such as cold (i.e. frost), extreme heat or drought or physical stresses and may be poisonous to livestock when ingested. High nitrate levels in the plant can complicate the problem and produce nitrate poisoning in sheep and cattle. All of these factors make *Sorghum halepense* one of the 10 most noxious weeds in the world.

Italian Arum (*Arum italicum*)

First picture taken of Italian Arum found in grid R5 near the UMBC Library pond

Description & Biology

- Plant: An evergreen herbaceous ornamental plant native to Africa, Asia and Europe that is showing signs of being invasive in natural areas. It has showy arrow-shaped fleshy leaves with white veins and can be seen in the dead of winter in the mid-Atlantic states. A tuberous perennial with erect stalked leaves and flowering stalks that terminate in a calla-lily-like inflorescence. The plant can grow to 12 inches in height.
- Leaves: The glossy leaves are arrow- to spear-shaped and are marbled with yellow or white, growing to 14 inches long.
- Flowers, fruit, and seeds: The flower is an erect, finger-like spadix of tiny white to yellow flowers that is partially enveloped by a large sheath-like pale green spathe (bract). The plant flowers in spring to early summer, and after bloom (in summer), the spathe and leaves wither away, leaving only the spadix. Spikes of bright orange-red berries then develop, which last until new leaves emerge in autumn.

Distribution & Habitat

- It has been reported to be invasive in Rock Creek Park and the U.S. National Arboretum in Washington, D.C. and in the state of Oregon. Italian arum occurs as individual plants in low level infestations of scattered individuals over a particular area. It reproduces and spreads by seed.
- Prefers partially shaded areas or full sun, and moist humus soils.

Ecological Threat

- Arum forms a dense groundcover that shades out other native plants. Riparian habitats are particularly susceptible to invasion. Arum also has the ability to survive harsh winters, giving it another advantage over some native vegetation.

Yellow Nutsedge (*Cyperus esculentus*)

Second image taken in grid O6 in the stream restoration area next to the UMBC Event Center; third picture taken in grid O4 on UMBC campus

Description & Biology

- Plant: A perennial weed in the sedge family with triangular shoots, borne individually from a tuber or basal bulb. Leaves arise from a central triangular stem and are three-ranked, or arranged in sets of three from the base, as well as V-shaped in the cross-section.
- Leaves: The leaves are thicker and stiffer than most grasses. Yellow nutsedge leaves are 0.5 inches wide and 12 to 35 inches long. They are yellow-green, smooth, and shiny or waxy on the upper surface with long attenuated tips.
- Roots, rhizomes, tubers, and bulbs: Yellow nutsedge produce deep fibrous roots, rhizomes, and distinct tubers. Tubers are produced on rhizomes, or underground stems. Buds on the tubers sprout and grow to form new plants and eventually form patches up to 10 feet or more in diameter. Yellow nutsedge tubers grow at the ends of rhizomes, are mostly round, hard, smooth, have scales when immature, are 0.1 to 0.6 inches diameter, and brown to black in color.
- Flowers, fruit, seed: the flowers of yellow nutsedge consists of an umbel (a cluster of flowers originating from a central point) of spikes distributed throughout stalks of unequal length (1–3 inches), are yellow-brown, golden, or straw colored, and are supported by leaf-like bracts as long or longer than the spikes. Yellow nutsedge has tiny, single-seeded fruit (achenes) that are triangular in cross-section, blunt-headed, and yellowish-brown in color. Reproduction by seed is typically not a concern for either species as seed production and viability is low.
- Yellow Nutsedge is perennial and grows most prolifically during the summer months but can emerge and grow in all seasons in Florida. Nutsedges reproduce mostly by tubers. Tuber formation begins from 4 to 6 weeks after seedling emergence; however, the shoot can continue to grow while tubers are forming. A rhizome emerges from the tuber, which forms a basal bulb after growing towards the soil surface. From the basal bulbs, the shoot and fibrous roots emerge. Basal bulbs usually form within 3 inches of the soil surface, although purple nutsedge bulbs can occur at 4–8 inches deep in the soil. During one growing season, especially if irrigation or rainfall is abundant and competition from other plants is minimal, yellow and purge nutsedge can produce 4 to 12 million tubers per acre

Distribution & Habitat

- Yellow Nutsedge is prevalent in lawns, cultivated areas, turf areas, landscape beds, gardens, fields, pastures, roadside, edges of forests, grasslands, riverbanks, irrigation canal banks, and disturbed areas. They are very persistent once established.
- Yellow Nutsedge is found worldwide in warm and temperate zones. In the western hemisphere, it grows from southern Canada to northern Argentina. This plant is common throughout most of the United States and is native to North America.

Ecological Threat

- Cyperus esculentus is widespread and varies morphologically. Four varieties are recognized. It can be aggressive, with the tubers persisting even when the plant is pulled up by the roots. Cyperus esculentus can form dense stands especially in disturbed wetlands.

Beefsteak (*Perilla frutescens*)

Second picture taken in grid S10 on UMBC campus

Description & Biology

- Plant: small, freely-branching annual herb that grows to 18-30 in. high; stems four-sided and covered with short hairs.
- Leaves: opposite, ovate, green to purple with toothed margins; distinctive musky mint-like odor.
- Flowers, fruits and seeds: flowers are small, bell-shaped, white and purple with a distinctive ring of fine hairs along the bottom in terminal spikes or emerging from leaf axils; July and October.
- Spreads: by seed that either drops close to parent plant or may be transported by wind or water.
- Look-alikes: beefsteak plant superficially resembles basil and coleus and can be confused with other members of the mint family.

Distribution & Habitat

- Beefsteak plant is reported to be invasive in Washington, D.C., Illinois, Maryland Missouri Pennsylvania, Tennessee, Virginia, and West Virginia. It is well established along riparian areas of streams and rivers, gravel bars, forest edges, roadsides, railroad right-of-ways, pastures, fields and other disturbed areas in soils that are rich, alluvial or dry.

Ecological Threat

- Beefsteak plant has spread to natural areas, especially those experiencing some form of disturbance. Once established, it disrupts native ecosystems by pushing out native plants. It has toxic characteristics which may explain why very few herbivores feed on it. It is ordinarily avoided by cattle and has been implicated in cattle poisoning. Beefsteak plants are most toxic if cut and dried for hay late in the summer, during seed production.

Wavyleaf Basketgrass (*Oplismenus undulatifolius*)

Description & Biology

- Plant: low-growing, shallow-rooted perennial grass; produces long stolons; branches and roots at the lower stem nodes.
- Leaves: flat, about 1⁄2 in. wide by 1 1⁄2-4 in. long; deep green with undulating ripples across the leaf surface; leaf sheath and stem are noticeably hairy, with short hairs.
- Flowers, fruits and seeds: flowers are in spikelets that alternate along the flowering stalk; spikelets have glumes (lower bracts) with very long awns (extended pointed tips) that are sticky; late September into October.
- Spreads: by seed; sticky substance produced by the awns facilitates adherence to animal fur, human clothing and shoes, tires and other objects.
- Look-alikes: two native subspecies of basketgrass (Oplismenus hirtellus ssp. fasciculatus and O. h. ssp. setarius) occur in southern and southeastern U.S. but are not known to occur in the mid-Atlantic region. O. h. ssp. setarius, its closest relative, setarius, has only a few hairs, if any. Native deer-tongue panicgrass (Dicanthelium clandestinum) and small carpetgrass (Arthraxon hispidus) resemble wavyleaf but grow in upright clumps and their leaves are not rippled.

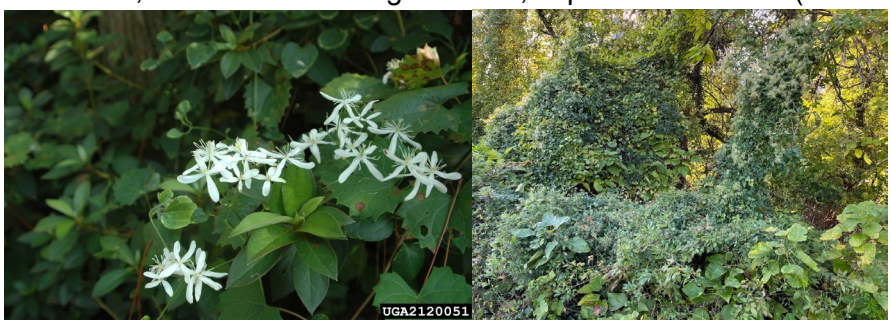
Distribution & Habitat

- Wavyleaf basketgrass has been found in six counties in Maryland (Anne Arundel, Baltimore, Carroll, Howard, Montgomery and Prince Georges) and in counties in Virginia (Fairfax, Fauquier, Loudon, Madison, and Rockingham). It is highly shade-adapted and is found in forested areas from the margins to interior.

Ecological Threat

- Wavyleaf Basketgrass grows low to the ground and spreads across the forest floor displacing native plant species completely or nearly so. It often occurs with Japanese stiltgrass. An urgent effort is underway to eradicate this fast-spreading invasive that has the potential to become much more widespread.

Sweet Autumn Clematis, Sweet Autumn Virginsbower, Japanese Clematis (*Clematis terniflora*)



Second picture taken in grid P10 on UMBC campus

Description & Biology

- Plant: climbing, deciduous to semi-evergreen, perennial vine.
- Leaves: opposite, compound 3 leaflets; leaflets are 2-3 in. long and have entire (non-toothed) margins.
- Flowers, fruits and seeds: flowers are produced late summer through fall; flowers are white with four petals; seeds are produced in profusion and are showy due to long, silvery-gray, feather-like hairs attached.
- Spreads: by wind-dispersed seed.
- Look-alikes: There are dozens of native species of Clematis in the U.S. including several that are quite rare. Devil's darning needles (C. virginiana), the species most likely to be confused with sweet autumn virginsbower due to its similar looking white flowers, has leaves that are compound and toothed. The much cultivated and highly popular ornamental Clematis vines with large, showy flowers in a wide variety of colors from white to rose to purple, typically with eight or more petals, have not been reported to be invasive.

Distribution & Habitat

- Sweet autumn virginsbower is documented to occur in much of the eastern U.S. from Minnesota to Vermont, south to Texas and Florida. It has been reported to be invasive in Alabama, Delaware, Florida, Georgia, Illinois, Maryland, New Jersey, North Carolina, South Carolina, Tennessee and Virginia, although it is probably invasive in additional states where it occurs. It prefers full sun but can tolerate partial shade.

Ecological Threat

- This species is found invading forest edges, right-of-ways and urban areas along streams and roads. It grows vigorously over other vegetation, forming dense blankets that block sunlight to the plants underneath. In late summer infestations are conspicuous as a result of its abundant showy white flowers.

Japanese Hop (*Humulus japonicus)*

The second picture was taken in grid T8 on UMBC Campus near the Herbert Run stream

Description & Biology

- Plant: herbaceous annual, twining, shallow-rooted vine that can climb to heights of ten or more feet with the help of rough-textured stems covered with short, sharp, downward pointing prickles that can be very irritating to the skin.
- Leaves: leaves are rough-textured, paired, simple, palmate (like a hand) with typically 5-7 lobes; leaf margins are toothed.
- Flowers, fruits and seeds: flowering occurs in July and August; male and female flowers are borne on separate plants; male flowers are very small, greenish yellow and occur in branched panicles; female flowers are in pale green, plump, drooping, cone-like structures with overlapping scales that become ‘hops’; hop scales and the seeds are covered with yellow glands; seeds are about 1/8 in. in diameter, roundish with a blunt tip, and light brown with darker specks; seeds mature through September.
- Spreads: by seed which begins to germinate in early spring, but new plants may continue to emerge as the season progresses if sunlight and moisture are available; seeds are dispersed by animals (including people), machinery and floodwaters.
- Look-alikes: native common hop (Humulus lupulus) looks very much like Japanese hop but it is usually 3-lobed or unlobed; native bur cucumber (Sicyos angulatus) lacks prickles, has tendrils, and the leaves have much less pronounced lobes.

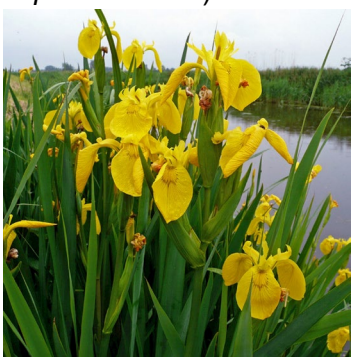
Distribution & Habitat

- Japanese hop occurs in scattered locations from Nebraska to Maine to Georgia and is most common in the Northeastern U.S. and eastern Canada. It has been reported to be invasive in natural areas in Connecticut, Delaware, Indiana, Maryland, Pennsylvania, Virginia and the District of Columbia. Japanese hop prefers plentiful sunlight and moisture, rich exposed soil, and is most commonly found along stream banks and floodplains. Growth is less vigorous in shade and on drier soils, but it can grow in disturbed areas with fairly moist soils, including roadsides, old fields, and forest edges. In milder climates, it can survive the winter.

Ecological Threat

- Japanese hop can spread to cover large areas of open ground or low vegetation including understory shrubs and small trees. Many thousands of hop plants per acre may be produced, eventually blanketing the land and vegetation. The vines grow rapidly during the summer, climbing up and over everything in their path and can form dense mats several feet deep, blocking light to plants underneath. Hop vines also twine around shrubs and trees causing them to break or fall over. It is invasive in riparian and floodplain habitats where it displaces native vegetation, prevents the emergence of new plants, and kills newly planted trees installed for streamside habitat restoration. Hop can quickly cover small trees hiding them from view, preventing mowing and obstructing herbicide applications.

Yellow Flag Iris, Pale Yellow Iris (*Iris pseudacorus*)



Description & Biology

- *Iris pseudacorus* is a perennial, emergent aquatic plant ranging from 0.5–1.5 m in height.
- Its inflorescence units consist of 4–12 flowers per stem; 6–9 cm spathes are green with brown margins. The outer spathe is strongly keeled, while the inner is without keel; they are subequal and the margins are not dry or membranous. Bright yellow flowers are approximately 7–9 cm wide and occasionally have brown/purple veins at the base of lanceolate to spatulate petals. Each flower has three downward sepals (5–7.5 cm by 3–4 cm) and three upward petals (2–3 cm) and a floral tube 0.6–0.8 cm. Flowers typically bloom from April-June.
- Fruit are prismatic, 6-angled, glossy green capsules (3.5–8.5 cm); individual plants may produce up to 6 pods. Each capsule may release up to 120 lustrous brown, flattened, D-shaped seeds (6–7 mm), but a small fraction of these are actually viable. The corky seeds are buoyant, with 95% of them able to float for up to 2 months.
- The basal deciduous leaves are smooth, stiff, broad, dark green with a gray/blue cast and have a central ridge (40–100 cm by 2–3 cm). Stems are usually solid, unbranched, and 70–150 cm in length. The plant remains green during mild winters.
- The fleshy roots are about 10–30 cm long. This species also has numerous, thick, pink tuberous rhizomes (2–3 cm in diameter) that are freely branching and may form extensive clumps. If broken, rhizomes release black sap
- *Iris pseudacorus* is a hearty, perennial monocot found in nutrient rich (especially nitrogen) environments such as wetlands, swamps, floodplain forests, and wet shores of rivers and lakes. Plants are highly tolerant to anoxic conditions and are able to grow vigorously in water/wet soil with a wide range of pH values. *Iris pseudacorus* also tolerates salt, but grows taller as soil salinity decreases. While initial colonization may be favored in silty areas, colonies can also root in pebbly/rocky substrate associated with stream riffles.
- Plants require three years of growth before they reach maturity and are able to flower. *Iris pseudacorus* is pollinated by long-tongue flies and bumblebees, including *Bombus pagans*, *B. ferpidus*, and *B. pennsyhankus*. Buoyant seeds spread in flowing water and will germinate along shore edges; they typically do not germinate while immersed in water. *Iris pseudacorus* also forms thick,

tuberous rhizomes that spread radially to produce large clonal populations of up to several hundred flowering “individuals”. These populations form dense, underwater mats of vegetation. Rhizomes can split to produce up to 10 plants per year. These rhizomes are drought tolerant, but during floods, both rhizomes and seeds may be transplanted downstream

Distribution & Habitat

- Pale yellow iris is native to Europe, northern Africa, and temperate Asia. A valued horticultural plant, pale yellow iris was brought to North America and escaped cultivation, often spreading down watercourses or washing downstream in floods. A review of early floras documented pale yellow iris in Virginia as early as 1771. Pale yellow iris is widely distributed across most of the United States and Canada. It occurs in almost every state
- In the eastern United States, pale yellow iris is found in forested wetlands, open wetlands, and in riparian and floodplain communities.

Ecological Threat

- It forms large clonal colonies displacing native species. The rhizomes are able to survive heavy droughts. Rhizomes and seeds can be transported downstream, further spreading the plant. Seeds can germinate even after a wetland area burns. It contains glycosides, making it toxic to grazing animals. No birds are known to disperse the seeds of this plant. Caution should be used when hand-pulling, as it can cause skin irritation.

Bull Thistle (*Cirsium vulgare*)

Description & Biology

- Bull thistle is biennial, growing up to 6.5 feet tall. A basal rosette of leaves is formed in the first year. After overwintering as a green rosette, the plant sends up tall flowering stems. These erect stems usually have spreading branches and are covered by white wooly hairs. Prominent ridges run down the stem from the leaf bases, and the entire plant is covered with prominent spines. It has a fleshy taproot, as opposed to the rhizomatous root system of Canada thistle. Solitary 1 to 2 inch purple flowers bloom at the end of each branch. The dead stems remain standing into the following winter. Bull thistle is identified by its more robust form and the non rhizomatous root system. Bull thistle grows in a variety of soil types, especially after disturbance, but does not grow in deep shade.
- Appearance: Cirsium vulgare is an annual or biennial, herbaceous plant that invades disturbed areas throughout the United States. The spiny, spreading, winged stems are up to 7 ft. (2.1 m) tall.
- Foliage: Leaves are 3-12 in. (7.6-30.5 cm) long, lance-shaped and very hairy.
- Flowers: Flowers develop, at the apex of the plant, from June to September. The purple flower heads are 1.5-2 in. (3.8-5.1 cm) in diameter and 1-2 in. (2.5-5.1 cm) long with narrow, spine-tipped bracts.
- Fruit: Fruits have several bristles on the tip and are up to 0.2 in. (5 mm) long.

Distribution & Habitat

- Bull thistle prefers sunny, open areas and can tolerate a wide range of conditions, from moist to dry soils, and is typically found in disturbed areas such as roadsides, trails, logged areas, vacant land, pastures and cultivated land. Overgrazed pastures are susceptible to bull thistle encroachment, and it can sometimes form dense stands that reduce productivity and stocking levels. Bull thistle may also dominate forest clear cuts and reduce growth of tree seedlings.
- Bull thistle is most troublesome in recently or repeatedly disturbed areas such as pastures, overgrazed rangelands, forest clearcuts, and waste places; and along roads, ditches, and fences.
- Cirsium vulgare is native to Europe, western Asia, and northern Africa. It is thought to have been introduced to the eastern United States during colonial

times and the western United States in the late 1800s. It is currently found in all 50 states.

Ecological Threat

- Cirsium vulgare can invade almost any type of disturbed area, such as forest clearcuts, riparian areas and pastures. Plants can form dense thickets, displacing other vegetation. The spiny nature of the plant renders it unpalatable to wildlife and livestock and reduces the forage potential of pastures.

Creeping Thistle, Canada Thistle (*Cirsium arvense*)


Description & Biology

- An aggressive perennial with a vigorous root system that continually produces new shoots, invading new areas and outcompeting other vegetation types. Grows 2 - 5 feet tall.
- Leaves are alternate, lance shaped, irregularly lobed, and have wavy spiny/toothed margins.
- Stems are usually smooth, but sometimes have short hairs and are slightly grooved.
- Flowers are purple and pink, occasionally white, and are borne at the end of the stems in clusters. Buds are 1/2 inch wide by 3/4 -1 inch long, have a tear-dropped shape, and lack spines.
- This plant is a prolific seed producer and also spreads by roots. Seedlings emerge as small rosettes in the fall or early spring, eventually bolting into erect branched flowering stems. Flowers begin to develop in late June, blooming between July and August.
- This plant is most recognizable in mid-July when flowers change to seedheads with obvious white fluffy tops. Seeds are attached to the "fluff" and can become airborne and spread to new areas.

Distribution & Habitat

- Found growing in a wide range of habitats. Typically infests a variety of disturbed landscapes and is commonly found along roadsides, trails, natural areas, pastures, forest and field margins, mining locations, waste areas and unmaintained gravel pits. This plant establishes quickly after new road

construction, housing and development projects, overgrazing of pastures, forestry clear-cuts, and destructive flooding events.

- Canada thistle is an extremely widespread weed of agricultural and ecological areas in the U.S, occurring throughout the northern states and Southwest but is largely absent in the South from Texas to Georgia. It invades a variety of dry to moist open habitats including barrens, fields, glades, grasslands, pastures, stream banks, wet meadows, wet prairies, and open forests. It is not very tolerant of shade.

Ecological Threat

- This plant is highly invasive, severely reduces pasture capacity and desirable forages, degrades wildlife habitat, and can hinder reforestation and landscape restoration efforts. Once a population gets established, it begins to quickly displace native vegetation, including desirable pollinator habitat, creating large stands with little biological diversity and low habitat value.

Common Mugwort *(Artemisia vulgaris)*

Description & Biology

- An invasive perennial forb with an extensive rhizome system. Shoots emerge during the spring, and flowering occurs from July to late September. A single plant can, depending on its environment, produce up to 200,000 seeds. The small seeds (~1mm in diameter) are largely wind dispersed. Seed production does not seem to be a major factor in the spread of mugwort populations, however, and some biotypes do not produce viable seed. Instead, mugwort spreads largely through vegetative expansion and the anthropogenic dispersal of root propagules.
- The root system is extensive though shallow (to 20 cm in depth), with numerous branching rhizomes up to 1 cm in diameter. Plants can regenerate from rhizome fragments as small as 2 cm
- The rarely-seen seedlings have oblong cotyledons without petioles.
- Adult stems are smooth and longitudinally ridged, with numerous axillary branches towards the upper portions of the plant. The stems become somewhat woody as they age.
- The leaves are alternate, densely covered with wooly, silver-white hairs on the underside, and slightly hairy on the upper surface. Leaf morphology is variable throughout the plant. The lower leaves are petiolate, with stipules at the base, and generally coarsely toothed and pinnately lobed. The upper leaves are sessile and lanceolate with smooth or toothed margins.
- The numerous ray and disk flowers are small (5 mm), green, and grow in racemes and clusters at the end of stems and branches. The foliage is aromatic and slightly pungent.

Distribution & Habitat

- Widespread throughout North America, though it is most common in the eastern United States and Canada. It is a weed of nurseries, turfgrass, vineyards, waste areas, forest edges, and roadsides. Mugwort spreads aggressively through an extensive rhizome system and will readily form large, mono-specific stands.

Ecological Threat

- A major weed in turf grass, field-grown ornamental crops, and orchards. Stands of mugwort displace native species, and can delay or disrupt succession in

natural ecosystems. Mugwort produces several terpenoid potential allellochemicals, and decaying mugwort foliage has been shown to inhibit the growth of red clover in laboratory experiments. Mugwort pollen is a common cause of hay fever.

Kudzu (*Pueraria montana*)

Picture taken in grid L3 on UMBC campus

Description & Biology

- Plant: climbing perennial vine in the pea family (Fabaceae); vines may extend 32-100 ft. in length, with stems up to 4 in. in diameter; roots are fleshy, with massive tap roots that can get to 7 in. or more in diameter, 6 ft. or more in length, and weigh as much as 400 lbs.; up to 30 vines may grow from a single plant.
- Leaves: alternate, deciduous, and compound, with three broad leaflets up to 4 in. across, leaflets may be entire or lobed with hairy margins.
- Flowers, fruits and seeds: individual flowers, about 1⁄2 in. long, are purple, fragrant and borne in upright clusters during late summer; fruits are brown, hairy, flattened seed pods, each of which may contain as many as ten hard seeds.
- Spreads: expands locally by vegetative means through runners & rhizomes and by vines that root at the nodes to form new plants; may spread by seed in areas where a pollinator, the giant resin bee, occurs.
- Look-alikes: Thick tangles of various vines including grape, porcelainberry and bittersweet may be mistaken for kudzu as well as some native three-leaved vines in the pea family.

Distribution & Habitat

- Kudzu occurs primarily in the eastern U.S. and has been reported to be invasive in natural areas from Connecticut to Florida and west to Texas. Infestations have also been reported in North Dakota and Oregon. Kudzu grows well under a wide range of conditions and in many soil types. Preferred habitats are open, sunny areas like forest edges, abandoned fields, roadsides and disturbed areas. Kudzu grows best where winters are mild, summer temperatures are above 80°F and annual rainfall is 40 inches or more.

Ecological Threat

- Its vigorous growth and large leaves smother and shade out native plants. It can kill trees through girdling and the extra weight of vines can lead to toppling during storms. Once established, kudzu plants grow rapidly, extending as much as 60 feet per season, about 1 foot per day.

Autumn Olive (*Elaeagnus umbellata*)

Second picture taken in grid L5 on UMBC campus

Description & Biology

- Plant: deciduous perennial shrub that can grow to 20 ft. in height; stems, buds and leaves have a dense covering of silvery to rusty scales.
- Leaves: alternate; deciduous; egg or lance-shaped, smooth margined, dull green above and often with brown scales beneath.
- Flowers, fruits and seeds: flowers occur in June and July; aromatic, pale yellow, fused at the base with 4 petals pointed at the tips; fruits are produced August through October; small, red-brown to pink and dotted with brown or silvery scales; abundant.
- Spreads: by seed that is dispersed by birds and mammals; some vegetative propagation also occurs.
- Look-alikes: Russian olive (Elaeagnus angustifolia) leaves are narrow-elongate with silvery scales on both sides and fruit is mealy, yellow or silvery; thorny olive (E. pungens) has leaves that are persistent, egg-shaped with wavy margins, upper surfaces shiny green, lacking scales, and lower surfaces covered with dull white scales and dotted with light brown scales.

Distribution & Habitat

- Autumn olive is found from Maine to Virginia and west to Wisconsin in grasslands, fields, open woodlands and other disturbed areas. It is drought tolerant and thrives in a variety of soil and moisture conditions. Because autumn olive is capable of fixing nitrogen in its roots, it can grow on bare mineral substrates.

Ecological Threat

- It threatens native ecosystems by out-competing and displacing native plant species, creating dense shade and interfering with natural plant succession and nutrient cycling.

Watercress *(Nasturtium officinale)*

Picture taken in grid V7 on UMBC campus

Description & Biology

- Plant: a fast-growing, aquatic or semi-aquatic, perennial herb that appears floating or prostrate in mud. Stems are succulent, hollow, and branched, rooting at nodes.This species can grow to a height of 50-200 cm, with a stem up to 20 mm in diameter and with leaves up to 27 cm in length.
- Leaves: pinnately divided; leaflets 3–7, oval to egg-shaped, entire to wavy-edged.
- Flowers, fruits, and seeds: flowers are small (6 mm, diameter) and white, in terminal clusters. Sepals are erect, green, about 3 mm long; petals are white, about 4 mm long with 4 long stamens attached near their bases to the filaments. Ovary about 3 mm long, style short, stigma with two lobes. Fruits borne on spreading pedicels and slightly curved upward. The double row of seeds in each half of the siliqua is a well marked character. The valves of the ripe siliqua are beaded; seeds suborbicular and compressed, with 25 alveoli on each side of the testa.
- Spreads: Watercress spreads by high flows uprooting some plants that then settle downstream to start a new colony. They also spread from seed production.

Distribution & Habitat

- Watercress grows at the water’s surface along the edges of cold lakes and reservoirs, and along slow-moving streams and rivers. Watercress prefers to take roots in limey, gravelly sediment. Watercress appears to be intolerant of heavy shade. A relatively high humidity is required for optimum growth.

Ecological Threat

- Watercress may be a noxious weed or invasive. In arid regions of western states, it can alter function and block streams.

Jetbead *(Rhodotypos scandens)*

Picture taken in grid U6 on UMBC campus

Description & Biology

- Plant: a small, multi-stemmed, up to 6 ft. (1.8 m) tall shrub that invades natural areas in the eastern United States.
- Leaves: opposite, simple, 2.5-4 in. (6.2-10 cm) long and doubly serrate. Leaves also have ribbed veins and a long, pointed tip.
- Flowers, fruits and seeds: white, four-petaled, 2 in. (5.1 cm) wide flowers occur in the spring. The flowers give way to small, red (turning black), bead-like fruit.
- Spreads: by seed, possibly bird-dispersed.
- Look-alikes: Linden viburnum *(Viburnum dilatatum)*

Distribution & Habitat

- Can grow in full sun to full shade but prefers full sun with moist, well-drained soils. It is adaptable to poor soils, various soil pH, soil compaction, shady spots, drought, shearing, heavy pruning, and urban tolerances such as pollution and salt tolerance.
- It is commonly found along roadsides, forest edges and forest understories

Ecological Threat

- Rhodotypos scandens invades forested areas creating a thick shrub layer which could displace native shrubs, shade out understory species and restrict tree seedling establishment. Rhodotypos scandens is native to eastern Asia and was first introduced into the United States in 1866 as an ornamental.

Field Bindweed *(Convolvulus arvensis)*

Description & Biology

- Plant: a perennial vine (0.4 – 2 inches in height) arising from deep, persistent, spreading roots. It has slender, trailing to somewhat twining, branched stems, 8 to 79 inches long, sometimes forming tangled mats. Taproots with a large numbers of annual lateral roots (2 to 10 feet long) develop throughout its length, and penetrate the soil in all directions.
- Leaves: Glabrous to pubescent, variable, 0.4-4 inches long and 0.1-2.4 inches wide with petioles 5-40 mm long.
- Flowers, fruits and seeds: peduncles arise from leaf axils and bear 1 to 3 white or pink flowers from June to August. Fruits that appear June to September contain 1 to 4 dark brown or black sub ovate seeds.
- Spreads: spreads by rhizomes and seeds
- Look-alikes: Hedge bindweed *(Calystegia sepium),* Common morningglory *(Ipomoea purpurea)*, Wild buckwheat *(Polygonum convolvulus)*

Distribution & Habitat

- It is a serious weed problem throughout the continental United States. It likes rich soil and the sunny locations of landscaped gardens, but more often can be found in disturbed areas, turf, and cropland.

Ecological Threat

- Field bindweed intertwines and topples native species. It competes with other species for sunlight, moisture and nutrients. It poses threats to restoration efforts and riparian corridors by choking out grasses and forbs. It can decrease habitat biodiversity. It is one of the most serious weeds of agricultural fields in temperate regions of the world.

Poison Hemlock *(Conium maculatum)*

Picture taken in grid L3 on UMBC campus

Description & Biology

- Plant: a biennial herb in the carrot family (Apiaceae) that grows 3 to 8 feet tall. Stems are stout, hollow, ridged, and purple-spotted. It has a thick, white taproot that may easily be mistaken for wild parsnips.
- Leaves: shiny green, 3 to 4 times pinnately compound, and clasp the stem at the obvious nodes. Crushed foliage and roots have a disagreeable, parsnip-like odor.
- Flowers, fruits and seeds: Flowers are small, white, and borne in umbrella-shaped clusters about 3 inches across (appearing in early summer). It reproduces from seeds that are ridged and flattened, with 2 seeds borne together.
- Spreads: reproduces by seeds that fall near the plant and disperse via fur, birds, water, and, to a limited extent, wind.
- Look-alikes: wild carrot or Queen Anne's Lace *(Daucus carota)*, wild parsnip *(Pastinaca sativa)*, water hemlock *(Cicuta maculata)*,

Distribution & Habitat

- The plant grows on dry to moist soils and is often found near roadsides, field borders, hiking trails, railroad tracks, stream banks, irrigation ditches, waste areas, riparian woodlands and open floodplains of rivers and streams.

Ecological Threat

- All plant parts are poisonous; however, the seeds contain the highest concentration of poison. It contains highly poisonous alkaloids toxic to all classes of livestock and humans. Human deaths have occurred from harvesting and consuming the roots as wild carrots or parsnips. It may act as a pioneer species quickly colonizing disturbed sites and displacing natives during early successional areas.

Burning Bush *(Euonymus alatus)*

Second picture taken in grid R7 on UMBC campus

Description & Biology

- Plant: multiple stemmed, angular branching shrub with conspicuously winged stems, normally 5-10 ft. high but mature plants can grow to 20 ft.
- Leaves: deciduous, dark green, in pairs along stem, turn brilliant red-purple in autumn.
- Flowers, fruits and seeds: inconspicuous, greenish flowers occur in late spring and red-purple fruits mature during summer.
- Spreads: expands locally through vegetative reproduction and to new areas through bird dispersal of seeds.
- Look-alikes: may be confused with other species of euonymus including our native strawberry bush (Euonymus americana), also called ‘hearts-a-bustin,’ which has green non-winged stems. Saplings of native sweetgum (Liquidambar styraciflua) with winged stems may be mistaken for winged burning bush.

Distribution & Habitat

- In the United States, winged burning bush is found from New England to northern Florida and the Gulf Coast and also in Illinois.

Ecological Threat

- It threatens a variety of habitats including forests, coastal scrublands and prairies where it forms dense thickets, displacing many native woody and herbaceous plant species. Hundreds of seedlings are often found below the parent plant in what is termed a “seed shadow.”

First Priority Invasive Plant Species

English Ivy *(Hedera helix)*

Picture taken in grid S9 on UMBC campus

Description & Biology

- Plant: evergreen perennial climbing vine that attaches to bark of trees, brickwork and other surfaces by root-like structures that exude a glue-like substance to aid in adherence.
- Leaves: alternate, dark green, waxy, somewhat leathery; extremely variable leaf forms, from unlobed to 3-5 lobed; typically green with whitish veins.
- Flowers, fruits and seeds: flowering occurs in late summer to early fall, typically under full sun conditions; flowers are small, greenish-yellow and occur in globular starburst type inflorescences at tips of flowering stems; fruits are black with a fleshy outer layer and stone-like seeds.
- Spreads: vegetatively by vigorous growth at tip of stems; and by seed which is consumed by birds and dispersed to new areas; fruits contain glycosides that may be mildly toxic and cause some birds to regurgitate them; new plants grow easily from cuttings or stem fragments that make contact with the soil.
- Look-alikes: Irish ivy (Hedera hibernica), Persian ivy (Hedera colchica), Boston ivy (Parthenocissus japonicus) and Virginia creeper (Parthenocissus quinquefolia). Poison ivy (Toxicodendron radicans) may sometimes be confused with English ivy because of its hairy stems but because it is deciduous, it will lack leaves in the winter. In summer, poison ivy can be distinguished easily by its compound leaves of three leaflets and its clusters of creamy white fruits.

Distribution & Habitat

- English ivy is found throughout the eastern U.S. and in the West where it occurs from Arizona to Washington State. It flourishes under shady to full sun conditions in soils that are moderately fertile and moist but it is intolerant of drought and salinity. Habitats invaded include forest openings and edges, fields, cliffs, steep slopes, and disturbed areas.

Ecological Threat

- English ivy is an aggressive invader that threatens all vegetation levels of forested and open areas, growing along the ground as well as into the forest canopy. Vines climbing up tree trunks spread out and envelop branches and twigs, blocking sunlight from reaching the host tree's foliage, thereby impeding photosynthesis. An infested tree will exhibit decline for several to many years before it dies. The added weight of vines also makes trees susceptible to blowing over during storms. English ivy has been confirmed as a reservoir for bacterial leaf scorch (Xylella fastidiosa), a harmful plant pathogen that affects a wide variety of native and ornamental trees such as elms, oaks and maples.

Porcelainberry *(Ampelopsis brevipedunculata)*

Pictures taken in grid R3 and O3 on UMBC campus

Description & Biology

- Plant: deciduous, woody, perennial vine that resembles grape and climbs by non-adhesive tendrils at the base of each leaf; grows to 15-20 ft.; young twigs are usually pubescent; stem pith is white (grape is tan or brown) and is continuous across the nodes (except for V. rotundifolia, grape is interrupted by a diaphragm across the node); bark is dotted with lenticels and does not peel (grape bark lacks lenticels and peels or shreds).
- Leaves: alternate, simple, 3-5 lobed to highly dissected with heart-shaped base and coarsely toothed margins, shiny underneath with hairs on veins.
- Flowers, fruits and seeds: tiny, greenish-white flowers with petals separate at their tips occur in flat-topped clusters opposite the leaves; appear in summer (June through August); fruit is a speckled berry in colors ranging from aqua to pink to purple; each berry carries 2-4 seeds.
- Spreads: by seed that is eaten by birds and other small animals and dispersed in their droppings.
- Look-alikes: native species of grape (Vitis) and peppervine (Ampelopsis) including heartleaf peppervine (Ampelopsis cordata) which is native to the Southeast and has unlobed leaves and smooth (hairless) stems; other native Ampelopsis have compound leaves.

Distribution & Habitat

- Porcelainberry occurs from Wisconsin & Iowa to New Hampshire & south to Georgia and has been reported to be invasive in natural areas in at least ten states from Massachusetts to Virginia. It grows well in most soils, especially forest edges, pond margins, stream banks, thickets, and waste places, where there is full sunlight to partial shade, and where it is not permanently wet. It appears to be less tolerant of heavily shaded areas, such as that found in mature forest interiors. The seeds germinate readily in the soil after natural or human disturbance.

Ecological Impact

- Porcelainberry is a vigorous invader of open and wooded habitats where it shades out native shrubs and young trees. As it spreads, it climbs over and blankets existing plants and weakens and kills them by blocking sunlight.

Japanese Honeysuckle *(Lonicera japonica)*


Second picture taken in grid P6 on UMBC campus

Description & Biology

- Plant: perennial, deciduous to semi-evergreen twining vine; stems are pubescent and reddish brown to light brown.
- Leaves: paired (opposite), ovate to oblong-ovate, about 1-3 in. long by 1⁄2-1 1⁄2 in. wide, entire-margined except for young leaves which are often deeply toothed.
- Flowers, fruits and seeds: flowers are bi-lobed, white turning yellow, highly fragrant and with nectar, produced in June; fruits are black, about 1⁄4 in. diameter, paired, produced in the fall.
- Spreads: by seed that is dispersed by birds.
- Look-alikes: native trumpet honeysuckle which has red or yellow, long tubular flowers.

Distribution & Habitat

- Japanese honeysuckle is one of the most recognizable and well established ornamental vines in the U.S. It is documented to occur and reported to be invasive throughout the eastern U.S. from Maine to Florida and west to Wisconsin and Texas, with scattered occurrences in the Southwest. It is adapted to a wide variety of habitats from full sun to shade.

Ecological Threat

- It is a fast-growing vine that twines around stems of shrubs, herbaceous plants and other vertical supports. In full sun it forms large tangles that smother and kill vegetation. It can kill shrubs and saplings by girdling.

Amur Honeysuckle or Bush Honeysuckle *(Lonicera maackii)*

Description & Biology

- Plant: upright, deciduous shrub up to 15-20 ft. high; pith of mature stems is hollow and white or tan (in contrast to solid white pith of native shrub honeysuckle species).
- Leaves: opposite, ovate with a tapered tip, lightly pubescent, and up to 3 1⁄2 in. long.
- Flowers, fruits and seeds: flowers paired, tubular, white to pinkish, fading to yellow, less than 1 in. long, borne from leaf axils, five petals, upper 4 fused; fruits are red to orange-red berries produced in late summer and persist through the winter.
- Spreads: by fruits which are abundant and highly attractive to birds that consume them and defecate the seeds in new locations. Vegetative sprouting aids in the local spread and persistence.
- Look-alikes: other exotic bush honeysuckles including Tartarian (L. tatarica) and Standish's honeysuckle (L. standishii); native species of Lonicera like American fly honeysuckle (L. canadensis), swamp fly-honeysuckle (L. oblongifolia) and mountain fly honeysuckle (L. villosa); northern bush-honeysuckle (Diervilla lonicera) which has leaves with toothed margins.

Distribution & Habitat

- Amur honeysuckle is one of the most common and invasive bush honeysuckles found in the mid-Atlantic region. It occurs in most states in the eastern U.S. except for Minnesota, Maine and Florida and has been reported to be invasive in many. It is adaptable to a range of conditions from sun to deep shade and wet to dry. It occurs in disturbed habitats including forest edges, forest interiors, floodplains, old fields, pastures, and roadsides. Disturbance increases the likelihood of invasion. Amur honeysuckle grows especially well on calcareous soils.

Ecological Threat

- Amur honeysuckle impedes reforestation of cut or disturbed areas and prevents reestablishment of native plants. It leafs out earlier than most natives and forms dense thickets too shady for most native species. Additionally, researchers in the Midwest found increased nest predation of robins using Amur honeysuckle as a result of plant structure which facilitates access to nests by predators such as

snakes. While the carbohydrate-rich fruits of exotic honeysuckles provide some nutrition for birds and rodents in winter, they do not compare to the lipid-rich fruits of native species that provide greater energy to sustain migrating birds.

Multiflora Rose *(Rosa multiflora)*

Description & Biology

- Plant: multi-stemmed shrub, sometimes climbing vine, with arching stems and recurved thorns.
- Leaves: divided into five to eleven sharply toothed leaflets; leaf stalks with fringed stipules (paired wing-like structures).
- Flowers, fruits and seeds: clusters of showy, fragrant, white to pinkish, 1 in. wide flowers appear during May; small bright red fruits, or rose hips, develop during the summer and remain on the plant through the winter.
- Spreads: reproduces by seed and by forming new plants from the tips of arching canes that can root where they contact the ground. An average plant produces an estimated one million seeds per year, which remain viable in the soil for up to 20 years.
- Look-alikes: pasture rose (Rosa carolina); swamp rose (Rosa palustris); Allegheny blackberry (Rubus allegheniensis); flowering raspberry (Rubus odoratus). Only multiflora rose has the combination of upright arching stems and fringed stipules.

Distribution & Habitat

- Multiflora rose occurs throughout the eastern half of the United States and in Washington and Oregon. It tolerates a wide range of soil, moisture and light conditions and is able to invade fields, forests, prairies, some wetlands and many other habitats.

Ecological Threat

- Multiflora rose grows aggressively and produces large numbers of fruits (hips) that are eaten and dispersed by a variety of birds. Dense thickets of multiflora rose exclude most native shrubs and herbs from establishing and may be detrimental to nesting of native birds.

Mile-a-Minute *(Persicaria perfoliata)*

Description & Biology

- Plant: herbaceous, annual, trailing vine; stems are delicate and armed with recurved barbs which are also present on the underside of the leaf blades; distinctive circular, cup-shaped leafy structures called ocrea surround the stem at nodes.
- Leaves: alternate, pale green and shaped like an equilateral (equal-sided) triangle.
- Flowers, fruits and seeds: flower buds, and later flowers and fruits, emerge from within the ocrea; flowers are small, white and generally inconspicuous; fruits are berry-like, attractive, deep blue and arranged in clusters at terminals; each fruit contains a single glossy, black or reddish-black hard seed called an achene with a small elaiosome.
- Spreads: by seed that is transported long distances by birds; short-distance seed dispersal by ants attracted to the elaiosome has been observed but needs further investigation; water is an important mode of dispersal as fruits can remain buoyant for seven to nine days.

Distribution & Habitat

- Mile-a-minute is found in the northeast from Virginia to New York to Ohio and Oregon. It invades open and disturbed areas, such as fields, forest edges, stream banks, wetlands, roadsides and wetlands.

Ecological Threat

- Mile-a-minute grows rapidly, producing a thick tangle of vines over herbaceous and woody plants and even scrambling up into trees. Thick tangles block sunlight and limit photosynthesis which eventually kills covered plants.

Oriental Bittersweet *(Celastrus orbiculata)*

Description & Biology

- Plant: deciduous, woody, twining vine, sometimes occurring as a trailing shrub; stems of older plants can reach 4 in. in diameter.
- Leaves: alternate, glossy and rounded with finely toothed margins.
- Flowers, fruits and seeds: abundant clusters of small greenish flowers emerge from most leaf axils; globular, green to yellow fruits split open at maturity to reveal fleshy red-orange arils that cover the seeds; seeds germinate in late spring.
- Spreads: by seed, which is dispersed to new areas by many species of birds and by people who are not responsible when disposing of faded bittersweet wreaths and other floral decorations; it expands locally by stolons and rhizomes and through root suckering (the ability to send shoots up from the roots).
- Look-alikes: is easily confused with the native American bittersweet (Celastrus scandens), which produces flowers just at the terminal ends (stem tips) rather than from multiple leaf axils as in the exotic invasive. For this reason, it is important to correctly identify the vine before controls are attempted.

Distribution & Habitat

- Oriental bittersweet has been reported to be invasive from Maine to North Carolina west to Wisconsin and Missouri. It occurs in forest edges, open woodlands, fields, hedgerows, coastal areas, salt marshes and disturbed lands. While often found in more open, sunny sites, its tolerance of shade allows it to invade forested areas.

Ecological Threat

- Oriental bittersweet is a vigorous growing plant that threatens native vegetation from the ground to the canopy level. Thick masses of vines sprawl over shrubs, small trees and other plants, producing dense shade that weakens and kills them. Shrubs and trees can be killed by girdling and by uprooting as a result of excessive weight of the vines. In the Northeast, Oriental bittersweet appears to be displacing the native American bittersweet (Celastrus scandens) through competition and hybridization.

Privet *(Ligustrsum spp.)*

Border privet - *Ligustrum obtusifolium Sieb. & Zucc.*

California privet - *L. ovalifolium Hassk.*

Chinese privet - *L. sinense Lour.*

European privet - *L. vulgare L.*

Description & Biology

- Plant: deciduous or semi-evergreen shrubs that grow from 8-20 ft. tall; trunks with multiple stems with long leafy branches; the presence or absence of hairs and type of hairs on stems is helpful in distinguishing species.
- Leaves: opposite, simple, entire, short-stalked, ranging in length from 1-3 in. and varying in shape from oval, elliptic to oblong.
- Flowers, fruits and seeds: flowers small, white and tubular with four petals and occur in clusters at branch tips; fragrant; late spring to early summer (May to July); length of corolla tube length ranges from 1/10 in. (Chinese) to ¼ in. (border); anthers exceed the corolla lobes (Chinese and California); fruit is small black to blue-black oval to spherical drupe (i.e., a fleshy fruit with 1-several stony seeds inside), mature late summer to fall.
- Spreads: by birds that consume fruits and excrete seeds undamaged in new locations; can spread locally through root sprouting.

Distribution & Habitat

- All four privet species featured here have been reported to be invasive in the mid-Atlantic region; some are recognized as invasive elsewhere in the eastern U.S. and nationwide. They thrive in floodplains, fields, disturbed forests and forest edges.

Ecological Threat

- Privets form dense thickets that shade out and take the place of native shrubs and herbaceous plants. The shady thickets make conditions unsuitable for native seedlings. Phenolic compounds in the leaves protect plants from leaf-feeding insects which include native herbivorous species.

Garlic Mustard *(Alliaria petiolata)*

Description & Biology

- Plant: biennial herb in the mustard family (Brassicaceae); first-year plants are low rosettes of kidney shaped leaves; second-year plants produce single or multiple flowering stalks 1-4 ft. high and then die back by late spring; dried fruiting stalks may persist for many months.
- Leaves: crushed leaves and stems smell like garlic; first-year leaves are kidney-shaped with scalloped margins; leaves of mature, second year plants are heart-shaped with toothed margins and pointed tips.
- Flowers, fruits and seeds: flowers occur in small button-shaped clusters, flowers have four petals in the shape of a cross; fruits are slender, erect capsules (siliques); seeds are 2 1⁄2-3 mm long, slender and tan to dark.
- Spreads: a single plant can produce hundreds of seeds, most of which fall nearby but may be carried further by wind, water, wildlife and people.
- Look-alikes: toothworts (Cardamine or Dentaria), sweet cicely (Osmorhiza claytonii), wild anise (Osmorhiza longistylis) and early saxifrage (Saxifraga virginiensis).

Distribution & Habitat

- Garlic mustard has been reported to be invasive in natural areas throughout the northeastern U.S. and in scattered localities in the Midwest, Southeast, western states, and Alaska. It occurs in moist to dry forest habitats, forest edges, floodplains, and along roadsides and disturbed lands and is not tolerant of highly acidic soils. White-tailed deer assist in its spread by eating native plant species that they prefer and are adapted to eat, leaving the garlic mustard behind.

Ecological Threat

- Garlic mustard has displaced vast areas occupied by native spring wildflowers like spring beauty (Claytonia virginica), wild ginger (Asarum canadense), bloodroot (Sanguinaria canadensis), trilliums (Trillium species) and toothworts (Cardamine). Three native butterfly species, the West Virginia white (Pieris virginiensis), mustard white butterfly (Pieris oleracea), and the falcate orange-tip (Anthocharis midea annicka), are especially impacted when garlic mustard displaces toothworts, its host plants. Chemicals in garlic mustard are toxic to the larvae of the native butterflies. Other chemicals have been found to affect mychorrhizal fungi associated with native trees, resulting in suppression of native tree seedling growth.

Wintercreeper *(Euonymus fortunei)*

Description & Biology

- Plant: evergreen woody vine or sprawling shrub with stems that are green when young, becoming light gray and corky with age.
- Leaves: opposite, glossy, dark green, oval, slightly toothed, with light-colored veins, about 1-2 1⁄2 in. long.
- Flowers, fruits and seeds: flowers are small and greenish with five petals on long branched stalks; fruits are small round pink-red capsules that split open to expose seeds with red-orange arils.
- Spreads: by seed that is dispersed by birds and other wildlife and by water; local spread is by vigorous vegetative growth.
- Look-alikes: Japanese honeysuckle (Lonicera japonica) and common periwinkle (Vinca minor).

Distribution & Habitat

- Wintercreeper has been reported to be invasive in natural areas in most of the states in the eastern half of the U.S. It can tolerate a broad range of environmental conditions ranging from full sun to deep shade, and acidic to basic and low nutrient soils, but it does not grow well in heavy wet soils.

Ecological Threat

- Winter creeper is a vigorous vine that invades forest openings and margins. It grows across the ground, displacing herbaceous plants and seedlings and climbs trees high into the tree canopy by clinging to the bark. Forest openings, caused by wind, insects or fire are especially vulnerable to invasion.

Common Periwinkle (*Vinca minor*)

Description & Biology

- Plant: vine-like erect or trailing groundcover; mostly evergreen; stems slender.
- Leaves: opposite, dark green, glossy, oval to lance-shaped, thick-textured; may be variegated.
- Flowers, fruits and seeds: flower blue, lavender or white, about 1 in. across, five petals blunt at tip, arranged in spiral; springtime; no fruits or seeds typically.
- Spreads: vegetatively through rhizomes.
- Look-alikes: may be confused with several close relatives of this plant, including bigleaf periwinkle (Vinca major), imported from Europe, and Madagascar periwinkle (Catharanthus roseus), native only to Madagascar, both also invasive in natural areas in the mid-Atlantic and other parts of the United States; and wintercreeper (Euonymus fortunei).

Distribution & Habitat

- Periwinkle has escaped cultivation and is invading natural areas throughout the eastern U.S. It inhabits open to shady sites including forests and often escapes from old homesites.

Ecological Threat

- Periwinkle has escaped cultivation and is invading natural areas throughout the eastern U.S. It inhabits open to shady sites including forests and often escapes from old homesites.

Bigleaf Periwinkle (*Vinca major*)

Description & Biology

- A spreading perennial vine or ground cover (family Apocynaceae) with dark green stems that contain milky latex.
- Evergreen to semi evergreen vines, some-what woody, trailing or scrambling to 3 ft. (1 m) long and upright to 1 ft. (30 cm).
- Foliage: Foliage is opposite, glossy and hairless, some-what thick, with margins slightly rolled under. Leaves are heart-shaped to somewhat triangular to elliptic, 1.5-2.5 in. (4-6 cm) long and 1-1.5 in. (2.5-4 cm) wide, with petioles 0.2-0.4 in. (5-10 mm) long.
- Flowers: Violet to blue lavender (to white), with five petals radiating pinwheel-like at right angles from the floral tube. Flowers from 1.5-2 in. (4-5 cm) wide with a 0.6-0.8 in. (1.5-2 cm) long tube. Five sepals long lanceo-late, about 0.4 in. (1 cm), hairy margined. Blooms April to May, then sporadically to September.
- Fruit: Slender, cylindrical fruit up to 2 in. (5 cm) long. Splitting when dry to release three to five seeds.

Distribution & Habitat

- Big periwinkle has escaped from garden plantings, and lowers species diversity and disrupts native plant communities. Riparian zones are particularly sensitive. Fragments of periwinkle vines can break, wash downstream, and start new invasions.

Ecological Threat

- Found around old homesites and scattered in open to dense canopied forests. Forms mats and extensive infestations even under forest canopies by vines rooting at nodes. Introduced from Europe in the 1700s. Ornamental ground cover, commonly sold and planted by gardeners.

Hybrid Cattail *(Typha x glauca)*

First picture taken in grid S5 on UMBC Campus

Description & Biology

- Plant: a perennial, erect wetland plant reaching 5-10’ tall, often with a submersed base. Hybrid cattail is a hybrid of common (broad-leaved) and narrow-leaved cattails and its structure is intermediate between that of its parental species.
- Leaves: erect, linear and flat-leaf blades are 0.3-0.8” wide, and generally longer than the parents. About 15 leaves emerge per shoot. The top of the leaf sheath has thin, ear-shaped lobes at the junction with the blade that usually disintegrates in the summer.
- Flowers, fruits, and seeds: numerous tiny flowers densely packed into a cylindrical spike at end of the stem, divided into the upper section of yellow male flowers and lower brown (in hybrid cattail green in flower), sausage-shaped section of female flowers. The gap between male and female sections is about 0-2” in hybrid cattail. They flower in late spring. Seeds are tiny (about 1 mm), dispersed by the wind with the aid of numerous hairs. Each hybrid cattail is highly sterile and produces no or very few seeds.
- Spreads: plants reproduce vegetatively by means of starchy underground rhizomes which form large colonies.
- Look-alikes: Narrow-leaved cattail *(Typha angustifolia),* Broadleaf cattail *(Typha latifolia)*

Distribution & Habitat

- Found in freshwater marshes, wet meadows, fens, roadsides, ditches, shallow ponds, stream and lakeshores.

Ecological Threat

- It plays an important role as a source of food and shelter for some marsh-dwelling animals, but large mono-specific stands of invasive cattails spread vegetatively, displacing other plants providing food and cover and excluding some less common species.

Japanese Barberry *(Berberis thunbergii)*

Description & Biology

- Plant: spiny deciduous shrub typically to 3, but sometimes to 6 ft. in height; branches are deeply grooved, brown and usually have simple spines as opposed to 3-pronged spines in exotic invasive European barberry (B. vulgaris) and the native Allegheny barberry (B. canadensis).
- Leaves: small 1⁄2-1 1⁄2 inches long and shaped like small spatulas or narrow ovals, with a color ranging from green to bluish-green to dark reddish purple.
- Flowers, fruits and seeds: flowering occurs in spring; abundant pale yellow flowers occur along the entire length of the stem in clusters of two to four; fruits are bright red berries about 1/3 in. long that mature July to October and persist through the winter.
- Spreads: seed produced in abundance and eaten by birds like turkey and grouse and other wildlife that spread it far and wide; local vegetative spread is through root creepers and tip rooting branches.

Distribution & Habitat

- Japanese barberry occurs and is reported to be invasive throughout the northeastern U.S. from Maine to North Carolina and west to Wisconsin and Missouri. It grows well in full sun to deep shade and forms dense stands in closed canopy forests, open woodlands, wetlands, fields and other areas.

Ecological Threat

- Where it is well established, barberry displaces many native herbaceous and woody plants. In large infestations, its leaf litter causes changes in the chemistry of the soil, making it more basic.

Second Priority Invasive Plants

Japanese Stiltgrass *(Microstegium vimineum)*

Description & Biology

- Plant: annual grass resembling a small, delicate bamboo; mature plants grow to 2-3 ft. in height.
- Leaves: pale green, lance-shaped, asymmetrical, about 3 in. in length, with a shiny midrib.
- Flowers, fruits and seeds: hidden (cleistogamous), self-fertilizing flowers in axils and/or exposed (chasmogamous) flowers in terminal racemes of paired, hairy spikelets that open and are wind-pollinated; fruits awned and bristly; late summer to fall.
- Spreads: by seed and vegetative spread by rooting at joints along the stem—a new plant can emerge from each node; a single plant can produce 100-1,000 seeds that remain viable in the soil for at least three years, ensuring its persistence; seed germinates readily following soil disturbance. Although dispersal is not fully understood, seeds can be transported by water (e.g., surface runoff, streams, and floodwaters), in soil and gravel, in nursery grown plants, and on the feet of animals including humans.
- Look-alikes: Virginia cutgrass (Leersia virginica), hairy jointgrass or small carpetgrass (Arthraxon hispidus), and possibly other delicate grasses and wildflowers like Pennsylvania knotweed (Polygonum persicaria).

Distribution & Habitat

- Stiltgrass is currently established in 16 eastern states, from New York to Florida. It occurs on stream banks, river bluffs, floodplains, emergent and forested wetlands, moist woodlands, early successional fields, uplands, thickets, roadside ditches, and gas and power-line corridors. It can be found in full sun to deep shaded forest conditions and is associated with moist, rich soils that are acidic, neutral or basic and high in nitrogen.

Ecological Threat

- Stiltgrass threatens native understory vegetation in full sun to deep shade. It readily invades disturbed shaded areas, like floodplains that are prone to natural scouring, and areas subject to mowing, tilling and other soil-disturbing activities including white-tailed deer traffic. It spreads opportunistically following

disturbance to form dense patches, displacing native wetland and forest vegetation as the patch expands.

Lesser Celandine or Fig Buttercup *(Ranunculus ficaria L.)*

Description & Biology

- Plant: perennial herbaceous spring ephemeral plant with thick tuberous roots and bulblets.
- Leaves: shiny, dark green, kidney-shaped, and stalked.
- Flowers, fruits and seeds: glossy, butter-yellow flowers appear in March and April supported on delicate stalks above the leaves. Aboveground portions of lesser celandine die back by early June.
- Spreads: primarily by bulblets and underground tubers. native to Europe and parts of northern Africa and Asia. It was introduced to the U.S. in the late 1860s as an ornamental plant. The tiny cream-colored bulblets are attached to leafstalks and are easily dislodged from the plant. A mass of small, gray, fingerlike tuberous roots underlies each plant. Bulblets and tubers are easily carried downstream during flood events and may be unearthed and scattered by the digging activities of some animals.
- Look-alikes: marsh marigold *(Caltha palustris)*, a native relative in the buttercup family, wood or celandine poppy *(Stylophorum diphyllum)* and greater celandine *(Chelidonium majus)*, native and non-native members of the poppy family, respectively.

Distribution & Habitat

- Lesser celandine is currently found in nineteen states in the Northeast and Pacific Northwest. It is reported to be invasive in nine states (Connecticut, Delaware, Maryland, New Jersey, Oregon, Pennsylvania, Virginia, Wisconsin, West Virginia), and the District of Columbia.
- It occurs most commonly on moist, forested floodplains and other wet areas. It can occur in some drier upland areas, and seems to prefer sandy soils.

Ecological Threat

- Fig buttercup's greatest threat is to native spring-flowering or "ephemeral" plants. It emerges in the winter in advance of most native species, giving it a great competitive advantage. Spring ephemerals complete the reproductive part of their life cycle and most of their above-ground development before woody plants

leaf out and shade the forest floor. Native spring ephemerals include bloodroot, common and cut-leaved toothwort, Dutchman's breeches, harbinger-of-spring, squirrel-corn, trout lily, Virginia bluebells, and many others. Once established, it spreads rapidly, forming a solid green blanket across the ground through which native plants are unable to penetrate.

Reed Canarygrass *(Phalaris arundinacea L.)*

Description & Biology

- Plant: Reed canarygrass is a rhizomatous perennial grass that grows from 2 to 7 feet (0.6-2 m) tall. Leaves: broad, flat leaves that are 5 to 25 mm wide and a hollow stem. Leaves are typically green but may be variegated.
- Flowers, fruits and seeds: spikelets are 3-flowered and occur on a narrow panicle 2 to 12 inches (5-30 cm) long. The fruit is 1.5 to 4 mm long and from 0.7 to 1.5 mm wide.
- Spreads: spreads by creeping rhizomes and by seeds.
- Look-alikes: Canary Grass *(Phalaris canariensis)*

Distribution & Habitat

- In North America, reed canarygrass occurs in many wetland plant communities including wet meadows, prairie potholes, marshes, riparian areas, and peatlands (i.e., fens, bogs). It may occur as an occasional species, a codominant species, or a dominant species, sometimes forming monotypic stands.

Ecological Threat

- Reed canarygrass is widely considered a threat to native wetland plant communities, and several studies document a loss of diversity in invaded communities.

Himalayan Blackberry, European Blackberry *(Rubus armeniacus)*

Picture taken in grid R9 on UMBC campus

Description & Biology

- Plant: a trailing shrub. Vegetative stems (primocanes) arch, then droop and trail along the ground. They are generally from 1 to 7 m long, averaging about 3 m long. Flowering stems (floricanes) branch out from primocanes. In western Oregon, primocane stems ranged from 0.5 to 1.4 m long (mean = 0.9 m), and stands ranged from 0.8 to 3.4 m tall (mean = 1.5 m). The stems are armed with large, recurved to straight prickles. The thick, arching stems and large prickles help distinguish Himalayan blackberry from other blackberry species of North America.
- Leaves: The leaves of Himalayan blackberry are deciduous to evergreen. Himalayan blackberry is sometimes described as "semi-evergreen" because its leaves stay green well into fall, and some leaves are retained through winter. The compound leaves have mostly three leaflets on primocanes and mostly five leaflets on floricanes. They are armed with short prickles
- Flowers, fruits and seeds: Himalayan blackberry's inflorescence is a panicle with perfect flowers. The fruit is a fleshy drupe consisting of an aggregate of 15 to 40 tiny, one-seeded drupelets or individual fruits that adhere to the fruit-bearing part (torus). Each drupelet contains a single, hard-coated nutlet.
- Spreads: Spreads by canes, stems, roots and seeds. Birds and small mammals will eat the berries and disperse the seeds.

Distribution & Habitat

- In North America, Himalayan blackberry has escaped cultivation and established in many wildlands of North America. In western North America, it occurs from southwestern British Columbia and western Montana south to northwestern Mexico. In eastern North America, it occurs sporadically from southern Ontario, Delaware, and New Jersey south to southern Alabama.
- Himalayan blackberry occurs in areas with mediterranean and temperate climates. Himalayan blackberry is a facultative wetland species, growing in both wetlands and uplands. It is most common on warm, wet to moist, disturbed sites such as ditches and streambanks. It is flood tolerant, withstanding periodic inundation by fresh or brackish water. It can survive approximately 40 days of flooding, and it may initiate shoot growth after 2 weeks of submergence. However, it cannot withstand months-long inundation. Himalayan blackberry may occur on the edges of perennial wetlands but does not spread into them.

Ecological Threat

- Himalayan blackberry stands may form large mounds and/or dense thickets of trailing stems that envelop banks or other areas, displaces native plants, hinders wildlife movement, and causes economic losses.

Poverty Brome *(Bromus sterilis)*

Second picture taken in grid R10 on UMBC campus

Description & Biology

- Plant: an annual grass, 12-32″ (30-80 cm) high. The stem (culms) are erect and smooth. Sometimes the culm can be rough at the very top.
- Leaves: leaves are from 0.08-0.16″ (2-4 mm) wide and they can be densely hairy. The leaf sheath is closed and hairy.
- Flowers, fruits and seeds: inflorescence is an open and branching panicle. The purplish to green panicle can be elongated and drooping. It flowers from March to June. Fruits are grains that are about 0.4″ (10 mm) long.
- Spreads: spreads by seed.

Distribution & Habitat

- This species is primarily listed as an agricultural weed in parts of Europe, the US, and Canada. However, it is also found in disturbed sites, like roadsides and abandoned areas, and more pristine sites, such as meadows and rock outcrops.

Ecological Threat

- *B. sterilis* tends to inhabit disturbed areas such as wastelands and roadsides, but can also be a weed in agriculture fields. It can tolerate a wide range of soil types and moisture conditions.

Third Priority Invasive Plant Species

Wineberry *(Rubus phoenicolasius)*

Description & Biology

- Plant: multi-stemmed shrub with spiny stems densely covered with reddish, glandular hairs, also on flowering stems and buds.
- Leaves: alternate, divided into three leaflets with toothed margins, terminal leaflet largest; undersides conspicuously white.
- Flowers, fruits and seeds: flowers with five white petals occur in springtime; bright red edible berries produced in early summer.
- Spreads: by seed that is consumed and dispersed by birds and mammals (including humans) and by vegetative means when new plants grow from the tips of canes that touch the ground and new plants sprout from root buds.

Distribution & Habitat

- Wineberry is found from New England and eastern Canada to North Carolina and west to Michigan and Tennessee. It occurs along forest, field, stream and wetland edges and in open woods, preferring moist habitats.

Ecological Threat

- Wineberry forms dense shady thickets that displace native plants and significantly alter habitat structure.

Callery Pear *(Pyrus calleryana)*

Street view of Callery Pear trees along Hilltop Road on UMBC campus (grid S2)

Description & Biology

- Plant: 30-50 ft. tall, 20-30 ft. wide; young trees may be thorny.
- Leaves: deciduous, alternate, simple, broad-ovate to ovate, 1 1⁄2-3 in. long; shiny dark green and leathery, small round-toothed margins; scarlet, mahogany, purple hues in fall.
- Flowers, fruits and seeds: flowers in early spring before the leaves, white with five petals, about 1 in. across; fruits mature in fall and are small, hard, brown, and almost woody.
- Spreads: by seeds that are dispersed to new locations by starlings and other birds that eat the fruits.
- Look-alikes: apple and crabapple (Malus); basswood (Tilia).

Distribution & Habitat

- Callery pear occurs throughout the eastern U.S. from New Jersey to Illinois and south to Texas. It grows best in full sun but will tolerate some shading and drought.

Ecological Threat

- Once established, Callery pear forms dense thickets that push out other plants including native species that can’t tolerate the deep shade or compete with pear for water, soil and space. A single tree can spread rapidly by seed and vegetative means forming a sizeable patch within several years. Its success as an invader results from its capacity to produce copious amounts of seed that is dispersed by birds and possibly small mammals, seedlings that germinate and grow rapidly in disturbed areas and a general lack of natural controls like insects and diseases, with the exception of fire blight.

Tree of Heaven *(Ailanthus altissima)*

Description & Biology

- Plant: deciduous tree that can reach 70 ft. in height; twigs with smooth, pale gray bark, and twigs that are light chestnut brown, especially in the dormant season; dioecious meaning plants are either male or female; wood soft, weak, coarse-grained and creamy white to light brown in color; leaves, stems and some flowers have a strong, unpleasant to offensive odor likened to cat urine or rotting peanuts or cashews.
- Leaves: alternate, large (1-4 ft. long), compound, with 11-25 smaller leaflets, each with one to several glandular teeth near the base.
- Flowers, fruits and seeds: large showy clusters of small yellowish-green flowers produced during June; in summer, flat, twisted, single-seeded winged fruits or samaras are produced on female trees and may remain on trees for long periods of time; individual trees may produce an estimated 325,000 seeds per year.
- Spreads: reproduces by seed and by vigorous re-sprouting, especially in response to injury such as breakage or cutting.
- Look-alikes: compound-leaved shrubs and trees like staghorn sumac (Rhus typhina), ash (Fraxinus sp.), black walnut (Juglans nigra), and hickory (Carya sp.). Sumac has fuzzy, reddish-brown stems and leaves; ash species have opposite leaves; ash, black walnut, hickory and sumac leaf margins are completely to mostly toothed; black walnuts have large green fruits.

Distribution & Habitat

- Tree of heaven is reported to be invasive in natural areas in 30 states across continental U.S. and Hawaii. It is highly adaptable to disturbance and a huge range of soil types and conditions, grows best in full sun and is tolerant of drought.

Ecological Threat

- A common tree in urban areas where it causes damage to sewers and structures, ailanthus poses a greater threat to agriculture and natural ecosystems. It is a vigorous growing tree and prolific seeder that establishes dense stands that push out natives. Tree of heaven contains chemicals, including ailanthone, that have been found to have strong allelopathic (herbicidal) effects on the growth of other plants which help it establish and spread.
- A preferred host tree for the invasive Spotted Lanternfly

Princess Tree *(Paulownia tomentosa)*

Pictures taken in grids O3 and O6 on UMBC Campus

Description & Biology

- Plant: medium-sized deciduous tree that grows to 30-60 ft. in height; twigs are stout, green to brown, and have many lenticels; bark is thin, gray-brown with shallow features.
- Leaves: paired, large, hairy on upper surfaces, broadly oval to heart-shaped and sometimes shallowly three-lobed.
- Flowers, fruits and seeds: flowers are showy, pale violet and fragrant and produced in conspicuous upright clusters in spring before the leaves appear; fruit is a four-compartmented oval capsule containing thousands of small winged seeds; capsules green, becoming brown and dry as they mature and persist through the winter.
- Spreads: by seed which is abundant and easily transported long distances by wind and water; a single tree is estimated to produce twenty million seeds; seeds germinate easily in suitable soil; seedlings grow and mature quickly, producing flowers within 8-10 years.

Distribution & Habitat

- Princess tree occurs throughout much of the eastern United States from Texas to New England where it can be found growing along roadsides, stream banks and forest edges. It tolerates infertile and acid soils and drought conditions and adapts to a wide variety of habitats.

Ecological Threat

- Princess tree invades forests, stream banks and some rocky habitats, displacing native plant species.

Common Teasel or Fuller’s Teasel *(Dipsacus fullonum)*

Description & Biology

- Fuller's teasel and cutleaf teasel are robust, prickly, monocarpic perennials that can reach 7 to 10 feet (2-3 m) tall.
- Stems are erect, hollow, and support erect branches. Degree of branching may relate to soil fertility. On "poor", rocky soils, branching may be limited.
- Teasel plants typically flower after 2 or more years of growth and die after flowering. The only Fuller's teasel plants to flower in their first year of growth were sown very early in the spring and grew in "well manured soil.” Plants grow as a rosette before bolting and flowering. Basal leaves generally die by the middle of the flowering season. Teasel flowers occur in terminal, stiff, egg-shaped heads that are up to 4 inches (10 cm) long. Inflorescences contain 250 to 1,500 flowers, which bloom for only 1 day. Flowering begins in the middle of the inflorescence and then progress up and down. Often there are few flowers blooming at the same time. Flower heads are subtended by linear bracts that are about 4 times as long as they are wide. Teasel fruits are hairy achenes that measure up to 8 mm long.
- Fuller's teasel taproots may be more than 2 feet (0.6 m) long and 1 inch (2.5 cm) in diameter at the crown
- Teasel flowers bloom for only 1 day, and plants die after flowering. Teasel first develops a rosette and after 2 or more years, bolts and flowers. Rosette leaves generally die by the middle of the flowering season.
- Teasel plants flower from April to October throughout their nonnative ranges. Generally teasel flowering dates were later, July to October, in the midwestern and eastern United States and adjacent Canada. In eastern North America, Fuller's teasel seeds mature and disperse from September to late November.
- In the field, Fuller's teasel germinates in the spring or the fall. In a review of Fuller's teasel in the northeastern United States, researchers indicated that most Fuller's teasel seeds germinated in late summer or fall and overwintered as rosettes.
- Teasel reproduces by seed, and plants die after flowering. Plants may sprout following damage during the rosette or flowering stage.
- The teasel seed bank is short lived. While Fuller's teasel seeds stored indoors remained viable for 6 years or more, less than 1% of Fuller's teasel emerged after 5 years of storage in the soil

Distribution & Habitat

- Teasel is common on disturbed sites and in early-seral habitats. While large, dense teasel populations are possible, without periodic disturbances they are likely to be replaced by slow-growing, late-seral species. Both teasel species grow best in full sun to partial shade and are common in canopy openings.

Ecological Threat

- Although few studies indicate the methods by which teasel impacts its nonnative habitats, several studies report that teasel may develop large monocultures, negatively impact riparian area integrity, and occupy habitats important to sensitive or threatened plant species. However in Michigan old fields, diversity and species richness were higher in early-seral old-fields with Fuller's teasel than in those without.
- Several sources provide anecdotal information about teasel impacts. In northwestern North America, Taylor describes Fuller's teasel as "truly noxious" in moist areas and capable of displacing native vegetation. Weber notes that monotypic teasel stands can exclude other vegetation and may restrict wildlife movements.
- Although several researchers and land managers consider teasel a potentially invasive nonnative species, Fuller's teasel was not a high-priority species in a list ranking those species thought to seriously reduce biodiversity. Fuller's teasel was listed number 80 in a prioritized list of 81 nonnative invasive species in natural Canadian habitats. However, several morphological and reproductive characteristics suggest teasel has the potential to be a problematic invasive species. A review reports that teasel's thick, well-developed taproot allows for substantial nutrient and water storage, which increases the potential for regrowth after damage and/or survival of inclement conditions. Barbs and spines defend teasel against herbivory and may focus grazing or browsing on unprotected associated vegetation. High levels of seed production, high seed germinability, and little dormancy in fresh seed allows for rapid establishment in open areas, and death of the parent provides habitat for future seedling recruitment[5]
- Dipsacus fullonum favors disturbed sites such as roadsides, ditches, waste places, riparian sites, fields and pastures in most of the continental United States.

[5] https://www.fs.usda.gov/database/feis/plants/forb/dipspp/all.html

Japanese Meadowsweet *(Spirea japonica)*

Description & Biology

- Plant: small, deciduous perennial shrub, 4-6 ft. tall, brown to red-brown stems.
- Leaves: alternate, oval to lance-shaped, 3-6 in. long, dark green above, pubescent on veins beneath, coarsely toothed margins.
- Flowers, fruits and seeds: flowers small pink (rarely white) in dense branched umbel-like clusters at the tips of branches, July to August; fruits mature in the fall.
- Spreads: by seed which is produced in abundance.
- Look-alikes: native white meadowsweet (Spiraea alba) which has white flowers in narrow branched clusters; exotic invasive Thunberg's meadowsweet (S. thunbergii) and bridalwreath spiraea (S. prunifolia).

Distribution & Habitat

- Japanese meadowsweet is found throughout the mid-Atlantic and in the Southeast, most commonly in the Appalachian Mountains. Great Smoky Mountains National Park identifies it as a targeted invasive plant.
- It tolerates a wide range of soil and light conditions and inhabits forest edges and interiors, riparian areas, roadsides, power-line rights-of-way and other disturbed areas. It is often associated with old home sites.

Ecological Threat

- Japanese meadowsweet grows rapidly and can form dense stands, filling in open areas and creating dense shade. It displaces native plants and impedes native seedlings.

Common Velvetgrass *(Holcus lanatus L.)*

Picture taken in grid R10 on UMBC Campus

Description & Biology

- Plant: a perennial, tufted grass that grows between 12 to 39″ (30-100 cm) in height.
- Leaves: stems of common velvetgrass are hollow. Leaves are grayish in color, flat, and have open sheaths that are (0.4″) 1 cm wide and (9.8″) 25 cm in length.
- Flowers, fruits and seeds: Common velvetgrass produces a dense, compact panicle that can reach 6 inches (15 cm) long. Spikelets are generally 2-flowered. Upper florets are staminate with fairly robust awns that become hooked when dry. Lower florets are perfect. Common velvetgrass seeds measure 1.5 to 2.5 mm long.
- Spreads: flowers bloom anywhere from May to October depending on location. Flowering starts at the tip of the panicle downwards. After blooming, nutrients are stored below the soil with reproduction primarily taking place by seed or a basal shoot.
- Look-alikes: creeping velvetgrass *(Holcus mollis)*

Distribution & Habitat

- a widespread invasive in the United States. Occupying a range of habitats, common velvetgrass is often found in pastures, wet disturbed areas, and roadsides.

Ecological Threat

- Dense populations of common velvetgrass have been shown to reduce the establishment of native species and the growth of tree seedlings. The accumulation of litter from common velvetgrass can prevent the germination of native grasses. Litter accumulation from common velvetgrass can increase risk of fires. This species rapidly colonizes disturbed areas, where it outcompetes native species for soil moisture and nutrients. Its long, fast-growing roots, long root hairs, and rapid rate of establishment enable it to aggressively compete for nutrients, especially in nutrient-limited substrates.

Kentucky Bluegrass *(Poa pratensis)*

Description & Biology

- Plant: perennial, cool season mat-forming grass. The stems are from 15cm to 1m in height, and eventually develop into flower-bearing stems. Kentucky bluegrass can be distinguished from other grasses by its narrow leaf blade which is V-shaped in cross section and boat-shaped tip. The wide, creeping rootstock produces underground runners and leafy shoots. Runners creep under the surface of the ground and produce upright leafy stems from their ends.
- Leaves: Leaves are smooth, soft and measure 1/8 to ¼ inch wide and 6 to 12 inches long with keeled tips.
- Flowers, fruits and seeds: Seedhead panicles have an open-pyramid shape and produce numerous small seeds. Each branch of the panicle carries several spikelets which are bluish green to purple. Each spikelet has four to five flowers enclosed within two glumes of equal size
- Spreads: reproduces both vegetatively and via seed. Once established plants expand mainly through the formation and growth of rhizomes and tillers, which are responsible for the sod-forming capability of the plant.
- Look-alikes: Perennial ryegrass *(Lolium perenne)*, Muttongrass *(Poa fendleriana)*

Distribution & Habitat

- Kentucky bluegrass can grow in many habitat types including meadows, roadsides, forest edges, dry hills, marshes and along seashores

Ecological Threat

- Sod forming grasses such as *Poa pratensis* are known to have negative effects on native prairie species in the northern Great Plains of the U.S. It outcompetes native plant species and reduces biodiversity in invaded areas.
- Litter from Kentucky bluegrass is known to inhibit seedling establishment of other plant species.
- Kentucky bluegrass has been found to disrupt ecosystem function by altering nitrogen cycling and carbon storage, lowering plant diversity and shifting seasonal forage production. These impacts affect livestock production, wildlife habitat and ecosystem services

Invasive Insect Species

Spotted Lanternfly *(Lycorma delicatula)*

Description & Life Cycle Stages

- An invasive sap-feeding insect native to eastern Asia.
- Eggs: Spotted lanternfly females prefer to lay their egg masses on a host tree, however; they have also been seen depositing eggs on a variety of flat surfaces such as buildings, trailers, fence posts and vehicles. The eggs are laid in groups of approximately 30-50 and then coated with gray wax. When the wax has dried it can look similarly to a splash of mud which can make them difficult to notice. The eggs typically hatch in the spring, usually in the first week of May.

- There are three instars (phases) of these early-stage nymphs and they are usually found from April-July.
    - Early Instar: Spotted lanternfly nymphs (immature form) resemble large black aphids with white spots. They hatch in the first week of May

    - Fourth instar: Later-stage nymphs (fourth instar) are red with white spots. These are typically found from June-September.

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- Adults: Adult Spotted Lanternflies are about 2.5 cm (1 inch) in length. The forewings are light brown with black spots. The hind wings are mainly red with black spots. The red color is especially noticeable when the insect flies. Adults can be found as early as July, and they will remain active until the first hard frost

of the year, usually in November. The females begin laying eggs in October and conclude their egg laying by the first frost in November.

Distribution & Habitat

- Spotted lanternfly was first discovered in Berks County, Pennsylvania in 2014. A shipment of stone imported from Asia was contaminated with spotted lanternfly egg masses. Despite quarantine efforts, spotted lanternfly became established and continued to spread throughout southeastern Pennsylvania.
- Spotted Lanterfly has since been confirmed in Connecticut, Delaware, Indiana, Massachusetts, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. It was discovered in Maryland in 2018, in Cecil County. It has spread to Harford County, and smaller populations have also been found in Baltimore City, and Allegany, Baltimore, Caroline, Carroll, Frederick, Howard, Kent, Montgomery, Prince George's, Queen Anne's, Wicomico, and Washington counties.
- Based on climate data, most of the eastern half of the United States as well as California, Washington, and Oregon have suitable conditions for spotted lanternflies to expand their range.
- The Tree of Heaven is a preferred host plant. Early research suggests that spotted lanternfly prefer to feed and reproduce on tree-of-heaven (but research has shown it also can complete its life cycle on other species such as maple and willow). From tree-of-heaven in particular, the insects may obtain toxic chemicals from the tree which make them poisonous to potential predators.
- Here is a list of some of the host plants on which Spotted Lanternfly has commonly been found to feed. Please keep in mind that this is not a complete list because they feed on over 70 plant species. Some plants that are at risk: grape, black walnut, red maple, silver maple, eastern white pine, weeping willow, black willow, black cherry, sycamore.

Ecological Threat

- This pest does not bite or sting. It feeds on grapes, apples, stone fruits, and other plant species. It is primarily a threat to Maryland's agricultural crops.
- Both adults and nymphs (immatures) feed by sucking sap from plant stems, trunks, and leaves. During feeding, they produce a sugary waste substance called honeydew. Honeydew is attractive to ants, wasps, and bees. Honeydew can develop an intense, rotten odor as it ferments. The honeydew sticks to leaves and fruits where it attracts other pests and supports the growth of sooty mold, which contaminates and reduces the value of fruits, reduces plant

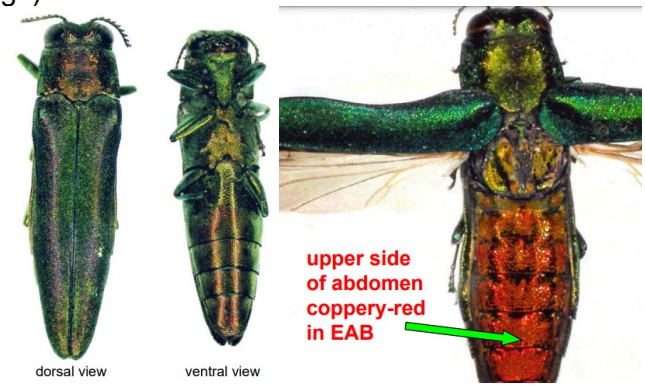
photosynthesis, and weakens overall plant health. Sooty mold can also cover manmade structures and can be difficult to remove.

- Nymphs and adults feed on plants, using their piercing mouthparts to suck sap from trunks and stems. This has been shown to cause stunted growth, localized damage, and reduced yields.
- Although Spotted Lanternfly can be present in large numbers on host plants, Spotted Lanternfly are not typically associated with host mortality. Spotted Lanternfly is considered a stressor that may contribute to the decline of its host. The exception to this is grapes, which can suffer greatly reduced winter hardiness as a result of Spotted Lanternfly feeding. It remains to be seen what effect lanternfly feeding will have on Maryland's vineyards.

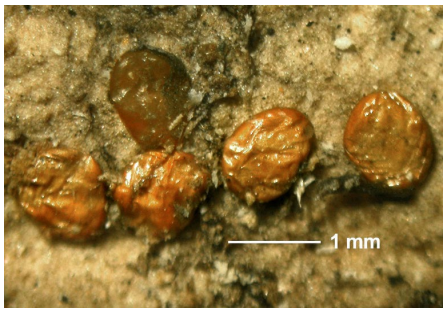
Emerald Ash Borer *(Agrilus planipennis)*

Description

- The emerald ash borer has a metallic, bright green body, a flat back and a rounded belly. It grows up to one-half inch in length.
- The Emerald Ash Borer was introduced to the Chesapeake Bay watershed in 2003 when a Michigan nursery shipped ash trees to Maryland.
- The Emerald Ash Borer (EAB) is a member of a family of insects called metallic wood-boring beetles (Buprestidae). Adult EAB are a brilliant metallic green color. The dorsal side of the abdomen, which can be seen when the wings are spread, is a metallic purplish-red. Adult EAB average 3/8 inch to 3/4 inch (10 mm to 20 mm) long and 1/6 inch (4 mm) wide (males are slightly smaller than females).
- Typical specimens are a bright, metallic, emerald green color overall, with the elytra usually appearing somewhat duller and slightly darker green. The overall greenish coloration may also have variable amounts of brassy, coppery or reddish reflections, especially on the pronotum and ventral surfaces.
- EAB in general is somewhat larger in size and more brightly metallic green than most other U.S. Agrilus species.
- EAB is the only Agrilus species found in North America that has the dorsal surface of the abdomen bright metallic red. This may be the simplest diagnostic character for separating EAB from all other Agrilus in North America.
- EAB generally have a one-year life cycle, emerging from beneath the bark of ash trees beginning in late-May or early-June with peak activity between mid-June and early-July. They emerge between 450 and 500 growing degree days which coincides with the flowering of black locust, Robina pseudoacacia.
- EAB adult flight season is finished by early August. Adult EAB are most active during the day and favor sunny, warm weather; sheltering in bark crevices or under foliage when it is rainy, windy or cooler. The life span of adult EAB is about 3 weeks.
- Adult EAB feed along the margins of leaves, leaving small, irregular shaped edges. Newly emerged adults must feed for at least several days before mating; mated females feed for an additional 1 to 2 weeks before laying eggs (females can mate multiple times; males do not). An “average” female may lay from 60 to 100 eggs during her lifespan, placing the eggs singly in bark crevices or under bark flaps on the trunk or branches (some long-lived females may lay more than 200 eggs).



Adult EAB



EAB eggs

- Eggs hatch in 7 to 10 days. The slightly flattened, white to cream-colored larvae have 10 abdominal segments with the last 3 or four segments resembling bells that are nested one upon the other. This is a good characteristic to use when comparing EAB to other insect larvae that may be found under the bark of ash trees. EAB larvae go through five life stages (instars) with mature larvae reaching an average length of 1 1/2 inches (38 mm). After hatching, the first instar larvae chew through the outer bark and feed in the phloem (the inner bark, the pipeline through which food is passed from the leaves to the rest of the tree) and the cambium (the growing part of the trunk, located between the phloem and the sapwood).

- As they feed the larvae wind back and forth, either up or down the stem, creating serpentine (S-shaped) “galleries”, characteristic of this wood-boring beetle. The galleries are filled with “frass”, a fine sawdust-like material. When EAB have finished feeding, the final galleries can extend from 4 inches to 20 inches (10 to 50 cm) in length.

- Larval feeding ends in autumn, at which time the fifth instar larvae excavate pupal chambers 1/2 inch beneath the surface of the sapwood and overwinter as pre-pupae. Pupal chambers can also be found in the outer bark when it is thick enough. Pupation generally takes place the following spring (late-April to May), with adults staying in the pupal chambers for 1 to 2 weeks, at which time they emerge headfirst through a distinctive 1/8 inch to 1/6 inch (3 mm to 4 mm) D-shaped exit hole, beginning the cycle of life over again. The presence of the exit holes typically goes undetected until trees show other, more visible symptoms of being infested.

- It should be noted that when EAB is developing in healthy, newly infested ash tree larvae may need an additional year (a 2-year life cycle) before pupating and emerging as adults. As infestations develop and EAB populations increase, the 1-year life cycle becomes the norm.[6]
- Signs of Infestation:
    - Woodpecker damage: The first sign you might see is woodpecker activity on your ash trees. Woodpeckers will strip off pieces of bark, leaving lighter exposed layers.

    - Crown thinning: You will begin to see thinning of the leaves in the canopy, usually starting at the tops and sides.

    - “D” shaped exit holes: “D” shaped exit holes on a tree definitively indicate Emerald Ash Borer.

[6] https://nyis.info/eabbiology/

- “S” shaped galleries: Underneath the bark, EAB will make “S” shaped galleries as it tunnels through the tree.

- Bark splitting: Vertical cracks in the bark might appear along the trunk or branches

- Epicormic sprouts: Sprouts may form around the tree base or branches, indicating that your tree is stressed.

Distribution & Habitat

- EAB has spread to every county west of the Chesapeake Bay, and to Queen

Anne's, Talbot, and Dorchester Counties on the Eastern Shore.

- EAB was accidentally introduced into southeastern Michigan sometime in the 1990's in wood packing material imported from eastern Asia. It wasn't until 2002 that EAB was first recognized as being the source of ash tree deaths and its identity confirmed, by which time it had apparently become well established. Since then, EAB has been found in many parts of Michigan and most nearby states and Canada. The beetles are easily transported in dead ash logs and firewood, and despite quarantines on wood movement, this method of dispersal seems partly or mostly responsible for their rapid spread

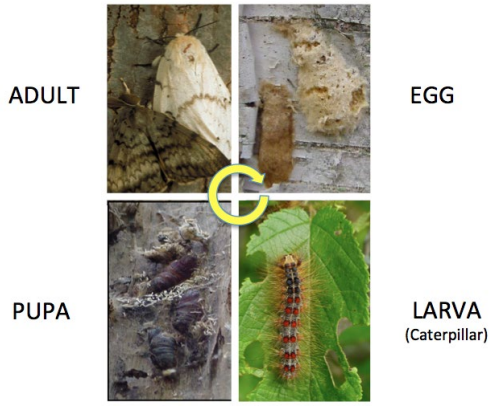
Ecological Threat

- EAB is an invasive beetle that kills up to 99% of US ash trees. It has moved across the US killing millions of trees. When we lose ash trees from our cities and forests, we lose community value, heating and cooling cost savings, stormwater and water quality management, and carbon storage.
    - Ash trees are one of the most common landscaping trees used in the U.S. and are common in western Maryland forests. Ash wood is used for all traditional applications of hardwood from flooring and cabinets to baseball bats and tool handles. Ash is the most common tree in Baltimore - 293,000 trees, 10.4% of the total population. Ash accounts for 5,982,000 - 6,591,000 trees in the Baltimore metro area. USDA has estimated losses could exceed $227,568,000 in the Baltimore area alone.
- Adult emerald ash borers eat ash tree leaves. Larvae feed on the nutrient-rich tissue just under the ash tree's bark, forming S-shaped lines in the tree. This feeding process disrupts the trees' ability to move food and water from its roots to its leaves, eventually killing the tree.

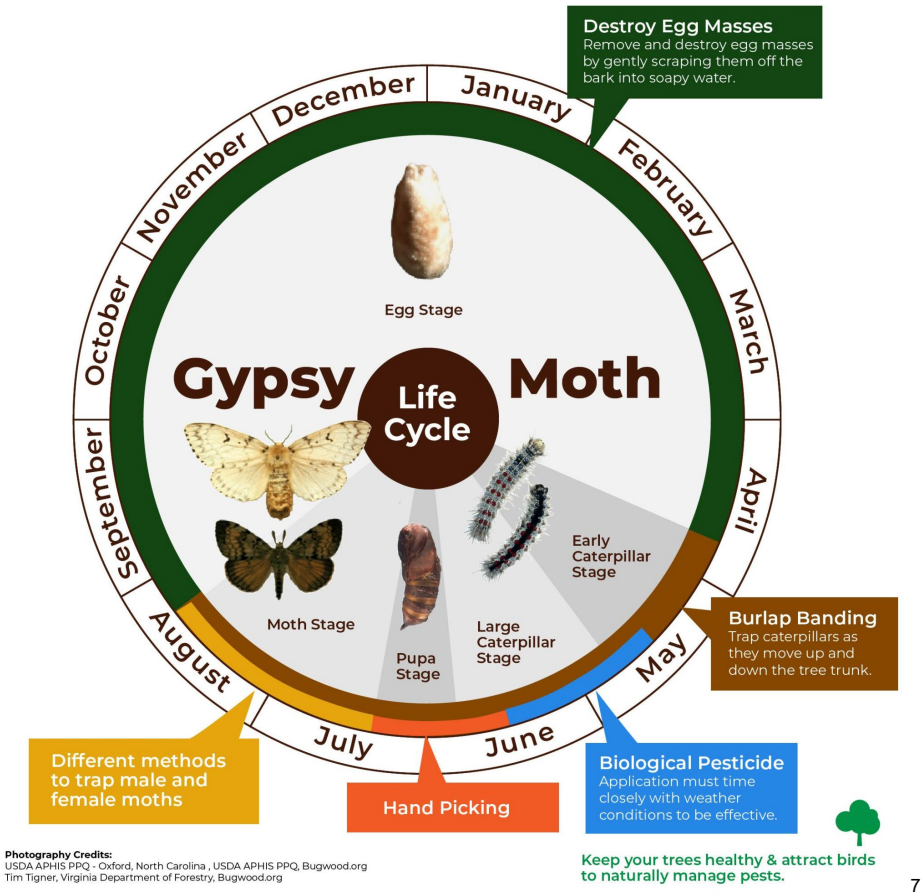
Spongy Moth *(Lymantria dispar)*

Description

- The spongy moth goes through four life stages: egg, larva (caterpillar), pupa, and adult.



- Egg masses: In early summer, females lay eggs on trees as well as a variety of outdoor items. Each egg mass can have several hundred eggs. Spongy moths overwinter in the egg stage, and hatch in April or May. The egg masses are fuzzy, tan in color, and about the size of a nickel or quarter. The eggs masses are laid individually or in large clumps in protected places.
- Larva (caterpillar): Eggs hatch around the time of oak bud break. Early stage larvae will tend to stay in the lower forest canopy, but under high populations, larvae will move higher in the crown to disperse through ballooning. Larvae or caterpillars go through 5 stages or instars for males and 6 for females. Each caterpillar is capable of eating a square meter of foliage, before spinning a resting area and pupating.
- Pupa: The pupae are dark brown, shell-like cases approximately two inches long and covered with hairs. They are primarily located in sheltered areas such as tree bark crevices or leaf litter. Adult Spongy moths emerge from the pupae in 10 to 14 days. They are present from July into August.
- Adult: Moths emerge in early summer. Adults differ in appearance, males being brown with a fine, darker brown pattern on the wings. Females are nearly white, with a few dark markings on the wings. European females do not fly.



[7]

Distribution & Habitat

- The European spongy moth was brought to North America in 1869 by an entrepreneur who hoped to cross breed it with the silk worm, to create a hardy silk-producer that would be easy to raise and inexpensive to feed. He was unsuccessful, and unfortunately, several spongy moths escaped and established a wild population. By 1890, they had begun defoliating trees in his Massachusetts neighborhood. More than a century later, the spongy moth has expanded its range throughout Northeastern United States and Canada, west to Minnesota and south to North Carolina to be one of the most significant pest of shade trees and forests.
- It is the caterpillar stage of the insect that is infamous for its appetite. Oaks are its first choice, but it readily consumes beech, birch, elm, maples, and most other hardwoods, apple, linden, willow, sweetgum, and hawthorn trees. During heavy infestations, it will also consume pine, spruce, and hemlock needles. It tends not to feed on ash and tulip poplar.
- Only the caterpillar stage feeds, during a larval stage that lasts about seven to eight weeks. Caterpillars feed at the tops of branches; they begin by chewing small holes in the leaves then eat from the outside inward until the tree is stripped of its foliage.

Ecological Threat

- Although there are a few native predators of the colorful caterpillars that hatch

[7] https://extension.umd.edu/resource/forest-pests-gypsy-moth

(including mice, shrews, and some birds), these insects can ravage a tree, feeding on unripe tissues of annual shoots, flowers and buds, and killing about 15% of the trees. In the long term, this mortality and defoliation can cause changes in tree species composition of the forest. Regenerating tree species may be less valuable to wildlife and less valuable as timber. This then causes a ripple effect throughout the ecosystem.

- Like those of other defoliators, spongy moth outbreaks usually last two years. In oak-dominated stands, spongy moth outbreaks usually persist two or three years, before collapsing. Populations can remain low for up to ten years before rebounding again.
- Effects of spongy moth defoliation are usually most severe during the initial outbreak in a newly infested area. If more than 60 percent of the tree's canopy is consumed by spongy moth caterpillars, trees typically refoliate, producing a second set of leaves later in summer. Low rates of diameter growth are common during years of heavy defoliation and often for one or more years after defoliation ceases.
- The amount of tree mortality and topkill sustained during a spongy moth outbreak depends on the severity and frequency of defoliation, as well as tree health. Defoliated trees often become more susceptible to attack by other insects and disease.
- Outbreak populations naturally decline due viral disease, fungi, natural enemies, and starvation. Low spongy moth populations may be held in check by birds, insect predators, and small mammals for several years, before the next outbreak occurs.
- Trees that lose more than 60 percent of their leaves often re-foliate depleting their energy reserves and leaving them under severe stress and vulnerable to attack by diseases and damaging insects. The combination of defoliation, refoliation, and disease or insect activity, complicated by other factors such as drought or soil compaction, may kill the tree in one to three years

Pine Shoot Beetle *(Tomicus pniperda)*

Description & Biology

- Eggs: Pine shoot beetle eggs are approximately 1⁄25 inch (1 mm) long, oval, smooth, and shiny white.
- Larvae: Larvae are legless, white grubs, up to 1⁄5 inch (5 mm) long, with brown heads. Both eggs and larvae are found inside galleries under the bark of weakened trees or stumps. Reddish sawdust may be apparent as the larvae bore in the inner bark. Larvae feed for 6–8 weeks as they bore horizontally into cambial tissues before pupating.
- Pupae: Larvae pupate at the end of the feeding galleries under the bark, and emerge as young adults in the summer months.
- Adults: Adult beetles are cylindrical, dark brown or black, and generally shiny. They can be up to 1⁄5 inch (5 mm) in length. Newly emerged adults are easiest to find in summer as they go through their maturation feeding stage. Although they can survive as mature larvae or pupae, pine shoot beetles most often overwinter as adults in the bark or lower stems at the base of trees (Figure 3). In early spring, adults become active and fly to recently cut trees and stumps, attracted to chemicals released by the trees. Both sexes create a club-shaped chamber called a gallery between the bark and sapwood (Figure 4). The female beetle carves out the gallery, which runs parallel with the grain of the wood, while the male ejects the debris from the tunnel and blocks the opening so other males cannot enter. Eggs are deposited in niches created along the wall of the gallery and hatch 2–3 weeks later.
    - In early summer, new adults emerge from the breeding site and begin feeding on current or one-year-old growth of living trees. This “maturation feeding" can occur from May through October. Beetles may feed on as many as six shoots before overwintering. One generation occurs per year

Distribution & Habitat

- The PSB is found in Canada (parts of Quebec, Ontario and New Brunswick), north central and northeastern United States (Connecticut, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Virginia, Vermont, West Virginia, and Wisconsin).

Ecological Threat

- These new adults will feed inside current-year shoots until fall when they seek overwintering sites. They generally feed within 6 inches (15 cm) or less of the shoot tip, completely hollowing out the shoot. This gallery is completely free of sawdust and frass, in contrast to the gallery of moth larvae. The entrance/exit hole used by the adults is round and frequently ringed with sap and sawdust. Shoots bored by pine shoot beetles turn yellow and may droop or break from the tree
- In North America, all pine tree species are susceptible to the PSB, including jack pine (Pinus banksiana), red pine (Pinus resinosa), eastern white pine (Pinus strobus), and the Scots pine (Pinus sylvesris), commonly found in eastern

Canada. When the PSB is abundant, it can also threaten the balsam fir (Abies balsamea), the Norway spruce (Picea abies) and larch (Larix laricina).

- 
- Figure 1. Exit hole from summer maturation feeding site.
- 
- Figure 2. Symptom of pine shoot beetle infestation.

Asian Longhorned Beetle*

*species of concern

Description & Biology

- Adult beetles have bullet-shaped bodies from 3/4 inch to 1-1/2 inches long, shiny black with white spots and long striped antennae, 1-1/2 to 2-1/2 times the size of its body.

- The Asian longhorned beetle (ALB) is a very serious exotic pest that was introduced in solid wood packing material from China. It has the potential to cause more damage than Dutch elm disease, chestnut blight, and spongy moths combined. The beetle was first detected in Brooklyn, NY in 1996. It has since been discovered in Chicago (1998), Jersey City, NJ (2002), Borough of Carteret, NJ (2004), Prall's Island (near Staten Island), NY (2007), and in Worcester, Massachusetts (2008). In June of 2020, the invasive beetle was discovered for the first time in South Carolina.
- Eggs: In northern areas, eggs laid in the late season may overwinter as eggs. Once mating has occurred, the female will start the chewing process into the tree to lay the egg. The male is present until this process occurs.
- Females can lay up to 160 eggs. She chews oval to round pits in the bark in

which she lays eggs. Eggs hatch in 10-15 days.

- Larvae: Larvae tunnel under the bark and feed on living tissue through the fall and winter. They eventually pupate in the wood and emerge through round exit holes the following spring.
- Adult: Adult is 1 to ½ inches long, shiny black with white spots, and long antennae with black and white bands. Once in adult form, their feeding habits decrease in that they do not feed as much as when in the stages of development. Adults will continue to reproduce and develop from the tree until the weather turns cooler or the first hard frost of the fall occurs.
    - One generation per year. Adults are present from July to October, later if temperatures are warm. They usually stay on trees they emerged from or will migrate short distances to find a new host to feed and reproduce.

- The Asian longhorned beetle's life cycle mostly occurs under the host tree's bark, so homeowners will not see the egg, larva, or pupal stage. However, once they have matured into adults, their presence becomes known since adult beetles exit infested host trees by chewing holes in the tree and emerging.
- Adult beetles are generally most active from late spring into the late fall, depending upon the conditions.

Distribution & Habitat

- Massachusetts, New York, Ohio and South Carolina. Though not yet found in western states, all states are considered at risk.

Ecological Threat

- In the U.S., ALB is known to attack 29 species of deciduous hardwood trees. ALB prefers species of maple (Acer spp.) including boxelder, Norway, red, silver, and sugar maples. Other known hosts include alders (Alnus spp.), birches (Betula spp.), elms (Ulmus spp.), horsechestnut (Aesculus spp.), poplars (Populus spp.), sycamore (Platanus spp.), and willows (Salix spp.)
- These trees are at risk from the Asian Longhorned Beetle:
    - Ash
    - Birch
    - Elm
    - Horse chestnut/buckeye
    - Golden raintree
    - London planetree/sycamore
    - Katsura
    - Maples, including boxelder, red, silver and sugar maple

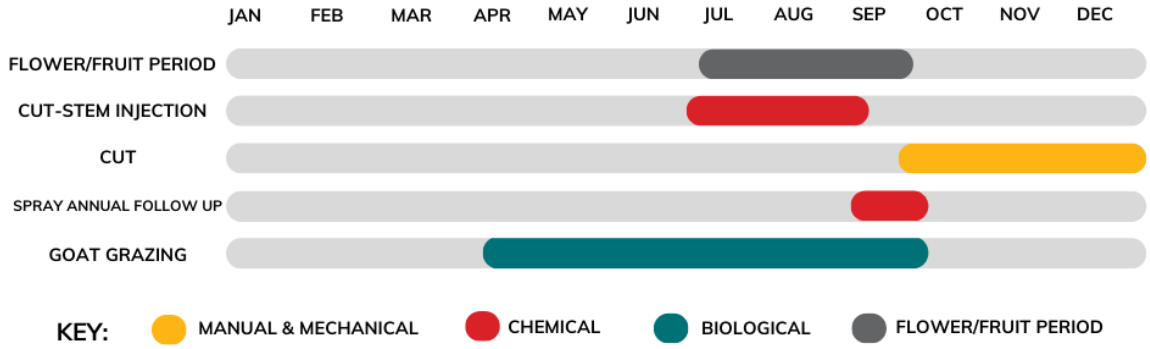
    - Mountain Ash
    - Poplar
    - Willow
- Source of threat: These materials can spread the infestation even if no beetles are visible
    - Firewood
    - Solid wood packing material
    - Wood debris and trimmings
    - Branches
    - Logs
    - Stumps
    - Lumber
- Signs and symptoms of impact:
    - Chewed round depressions in the bark of a tree
    - Pencil-sized, perfectly round tree exit holes; 3/8 inch or larger on trunk and branches larger than 1 ½ inches in diameter.
    - Excessive sawdust (frass) buildup near tree bases and in branch crotches
    - Unseasonable yellowed or drooping leaves
    - Oval to round pits in bark and possibly oozing sap, especially on maples.
- Signs of ALB start to show about 3 to 4 years after infestation, with tree death occurring in 10 to 15 years depending on the tree's overall health and site conditions. Infested trees do not recover, nor do they regenerate. Foresters have observed ALB-related tree deaths in every affected state.

7 BEST MANAGEMENT PRACTICES

Disclaimer: Any biological control method involving goats should be implemented BEFORE any chemical application to avoid any harm to the goats.

Early Detection Rapid Response Invasive Plant Species

COMMON REED, PHRAGMITES *(PHRAGMITES AUSTRALIS)*[8]



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Cut off and remove seed heads and weed whack • Mowing	• Foliar herbicide application • Cut-stem injection of herbicide application	• Cut seed heads first • Cut-stem injection of herbicide application that is aquatically approved • Mechanically cut treated plants and remove from site • Goat grazing[9]

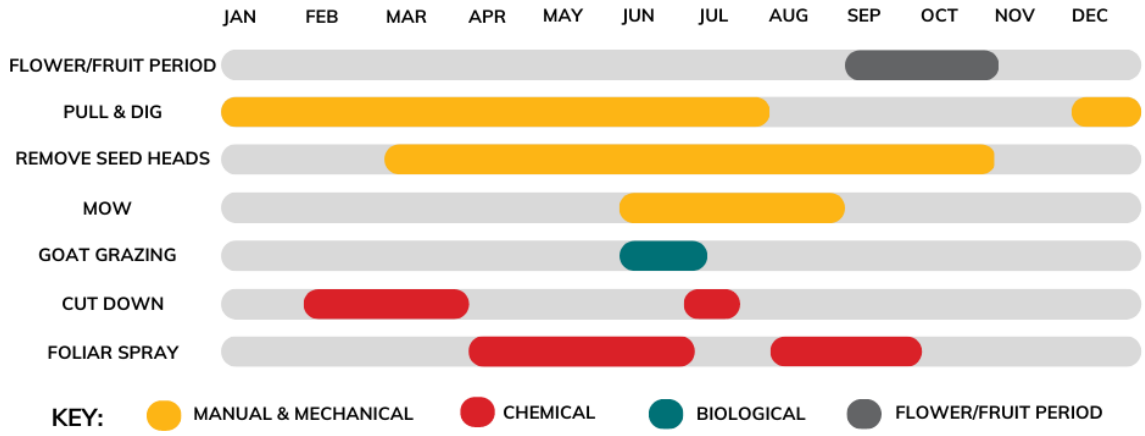
Native Plant Alternatives:

- Native phragmites (*P. australis ssp. australis*)?
- Softstem bulrush *(Schoenoplectus tabernaemontani)*
- Broadleaf arrowhead *(Sagittaria latifolia)*
- Giant burreed *(Sparganium eurycarpum)*
- Sweet flag *(Acorus americanus)*
- Native broadleaf cattail *(Typha latifolia)*
- Blue flag iris *(Iris versicolor)*
- White water lily *(Nymphaea odorata)*
- Pickerelweed *(Pontederia cordata)*

[8] For reference https://cipwg.uconn.edu/wp-content/uploads/sites/244/2018/10/Invasive-Plant-Management-Calendar.pdf

[9] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4178463/#:~:text=Experimental%20field%20tests%20demonstrate%20that,also%20readily%20consume%20this%20plant.

CHINESE SILVERGRASS *(MISCANTHUS SINENSIS)*

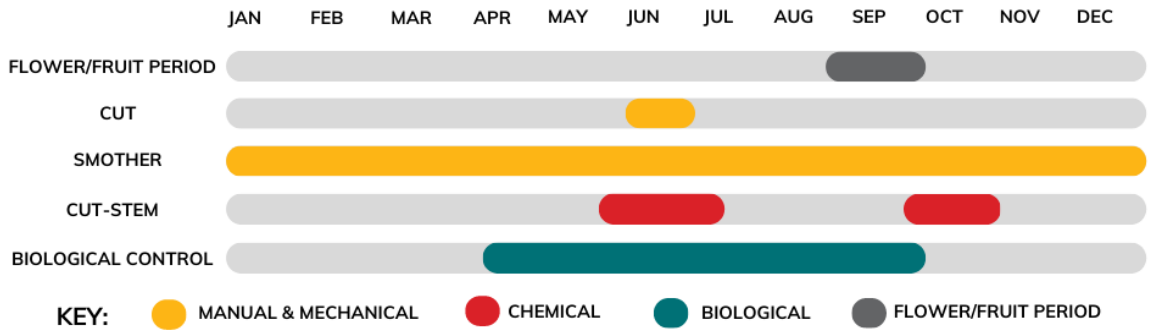


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand pulling & digging up new plants and entire root system • Removing seedheads • Repeated mowing	• Foliar application of herbicide for large populations (glyphosate)	• Mowing in the summer before seedheads develop if possible • Removing and disposing seedheads • Hand pulling and digging up new plants • Goat grazing in early summer

Native Plant Alternatives:

- Eastern gamagrass (*Tripsacum dactyloides*)
- Little bluestem (*Schyzachirium scopyrium*)

JAPANESE KNOTWEED *(REYNOUTRIA JAPONICA)*



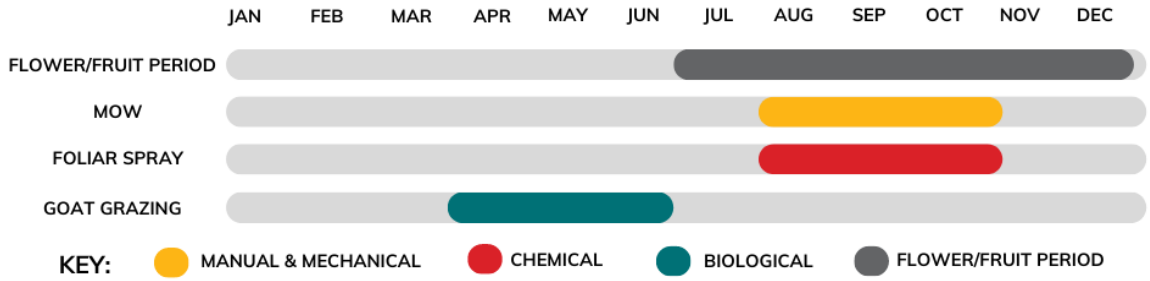
MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Cut to a stump and then smother with black 7-mil tarp, cardboard, mulch, or wood chips	• Cut-stem herbicide application	• Biological control: *Apahlara itadori*, a psyllid from Maryland Department of Agriculture • Cut & smother • Cut-stem herbicide application • Goat grazing[10]

Native Plant Alternatives:

- Virginia sweetspire (*Itea virginica*)
- Maleberry (*Lyonia ligustrina*)
- Silky dogwood (*Cornus amomum*)
- Fragrant sumac (*Rhus aromatica*)
- Flameleaf sumac (*R. copallinum*)

[10] https://www.taylor-weed-control.co.uk/news/post/what-eats-japanese-knotweed

CHINESE LESPEDEZA *(LESPEDEZA CUNEATA)*

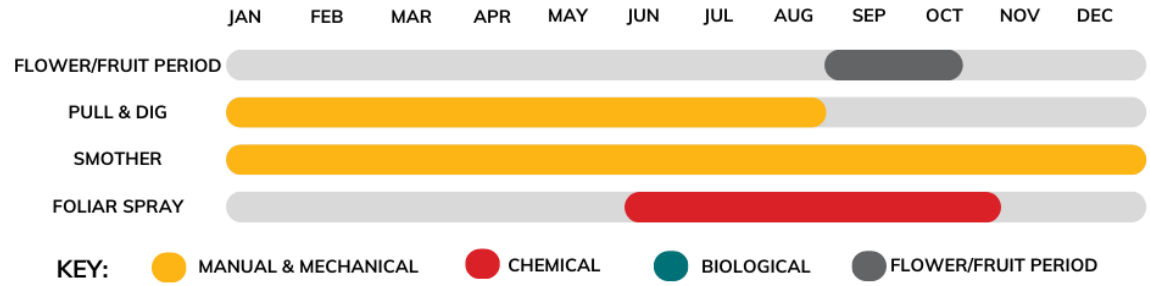


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Mowing in the flowering stage (late July-October) for 2-3 years for control	• Foliar herbicide application (glyphosate) • Spot spraying herbicide application	• Goat grazing in spring • Mowing followed by spot spraying herbicide application

Native Plant Alternatives:

- Blue indigo (*Baptisia australis*)
- Yellow wild indigo (*Baptisia tinctoria*)
- Partridge pea (*Cassia fasciculata*)
- Virginia wild rye (*Elymus virginicus*)
- Little bluestem (*Schizachyrium scoparium*)
- Wild senna (*Senna hebecarpa or marilandica*)

LILYTURF *(LIRIOPE MUSCARI)*



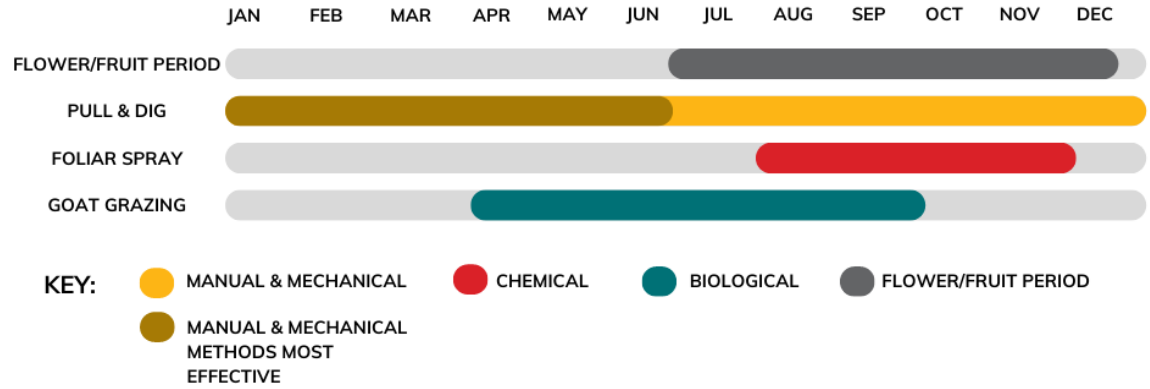
MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Pulling and digging up plant and roots • Placing black 8-mil tarp over area to kill off remaining roots	• Foliar herbicide application	• Pulling and digging, then placing black tarp over area to kill off remaining roots

Native Plant Alternatives:

- Eastern woodland sedge (*Carex blanda*)
- Pennsylvania sedge (*Carex pensylvanica*)
- Lyreleaf sage (*Salvia lyrata*)

- Crested wood fern (*Dryopteris cristata*)
- Native pachysandra (*Pachysandra procumbens*)

BLUE BUFFEL GRASS *(CENCHRUS CILIARIS)*



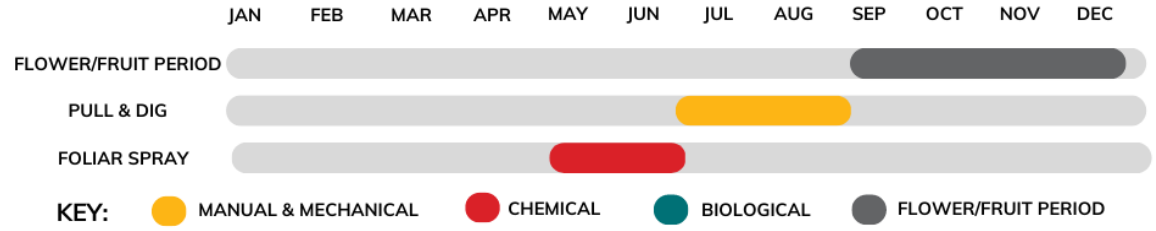
MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Pulling and digging entire plant and roots when soil is moist	• Foliar herbicide application	• Pulling & digging entire plant and roots • Goat grazing[11]

Native Plant Alternatives:

- Big bluestem (*Andropogon gerardii)*
- Prairie dropseed (*Sporobolus heterolopsis)*
- Little bluestem (*Schizachyrium scoparium);*Common cultivars: ‘Standing Ovation’, ‘Cimmaron’, ‘Smoke Signal’
- Purple love grass (*Eragrostis spectabilis)*

[11] https://gdna.weebly.com/goats-to-weed.html#:~:text=The%20goats%20LOVE%20Buffelgrass%2C%20which,lot%20of%20in%20the%20easements

JAPANESE BRISTLEGRASS *(SETARIA FABERI)*

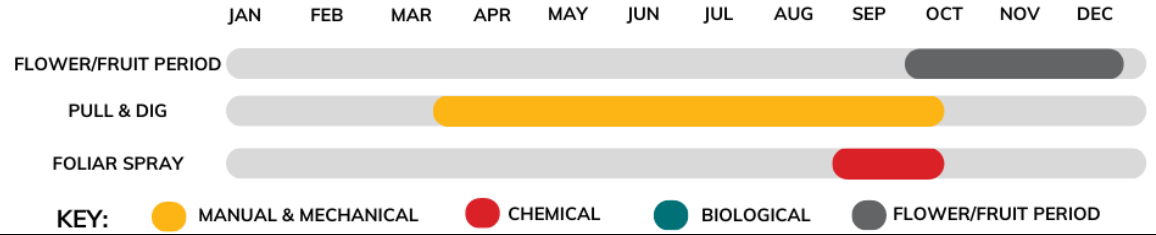


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Pulling and digging entire plant and roots	• Foliar herbicide application (metolachlor, nicosulfuron, glyphosate, sethoxydim)	• Digging and pulling entire plant and roots

Native Plant Alternatives:

- Broomsedge (*Andropogon virginicus*)
- Canada wild rye (*Elymus canadensis*)
- Virginia wild rye (*Elymus virginicus*)
- Switchgrass (*Panicum virgatum*)

JOHNSONGRASS *(SORGHUM HALEPENSE)*

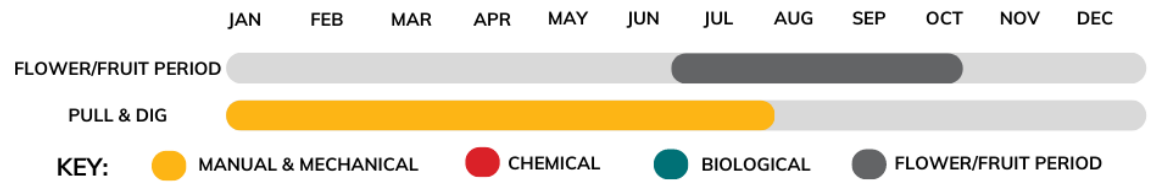


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Pulling and digging up entire plant and roots • Repeated mowing for larger areas for several growing seasons	• Foliar herbicide application • Selective: fluazifop, sethoxydim, and clethodim • Broad-spectrum: glyphosate	• Pulling and digging entire plant and roots

Native Plant Alternatives:

- Broomsedge (*Andropogon virginicus*)
- Canada wild rye (*Elymus canadensis*)
- Virginia wild rye (*Elymus virginicus*)
- Switchgrass (*Panicum virgatum*)

ITALIAN ARUM *(ARUM ITALICUM)*

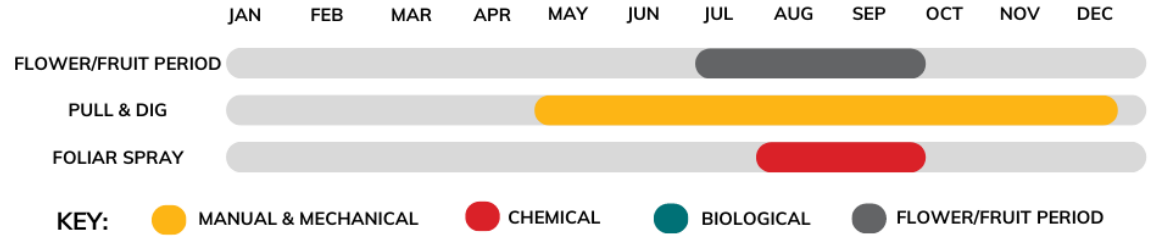


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Cut off berry clusters • Dig and pull the entire plant and tubers	• Herbicides are only effective on aboveground plant mass	• Manual removal methods only

Native Plant Alternatives:

- Toothwort (*Cardamine diphylla*)
- Jack-in-the-pulpit (*Arisaema triphyllum* (L.)
- Allegheny spurge or Allegheny pachysandra (*Pachysandra procumbens*)
- Mayapple (*Podophyllum peltatum*)

YELLOW NUTSEDGE *(CYPERUS ESCULENTUS)*

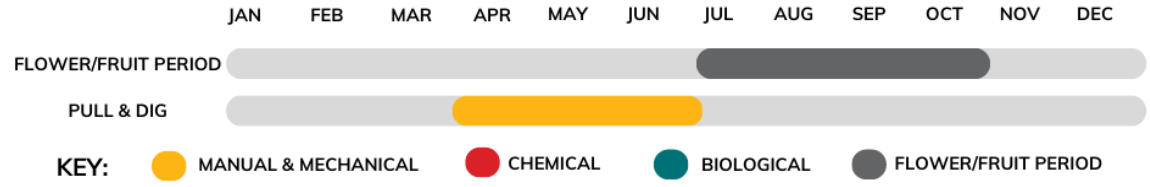


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Pulling and digging entire plant and underground 'nutlets' • Hand pulling before going to seed	• Spot treatment with herbicide (Sedgehammer, Prosedge, and Sedgemaster)	• Manual removal methods are recommended due to low infestation and occurrences in environmentally sensitive areas

Native Plant Alternatives:

- Tussock sedge (*Carex stricta*)
- Pennsylvania sedge (*Carex pensylvanica*)
- Blue wood sedge (*Carex glaucodea*)
- Broomsedge (*Andropogon virginicus*)

BEEFSTEAK *(PERILLA FRUTESCENS)*

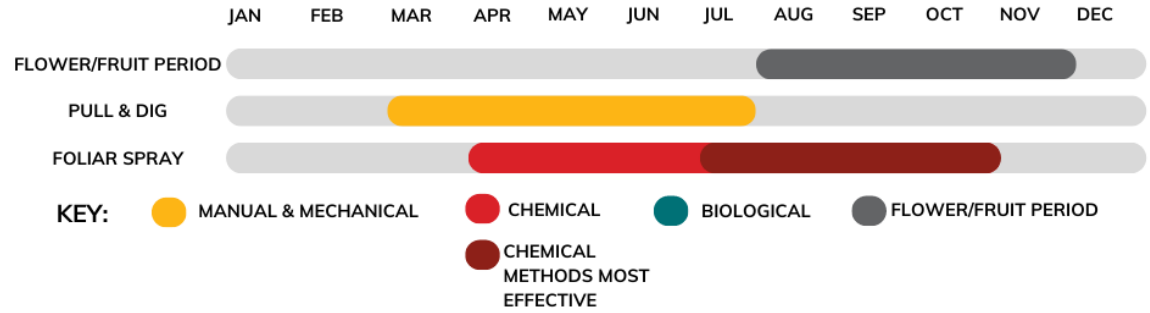


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Cut and remove flowers and seeds first • Pulling and digging entire plant and roots • Mowing	• Foliar herbicide application	• Low infestation, manual removal methods are recommended

Native Plant Alternatives:

- Bee balm (*Monarda didyma*)
- Mountain mint (*Pycnanthemum muticum*)

WAVYLEAF BASKETGRASS (OPLISMENUS UNDULATIFOLIUS)

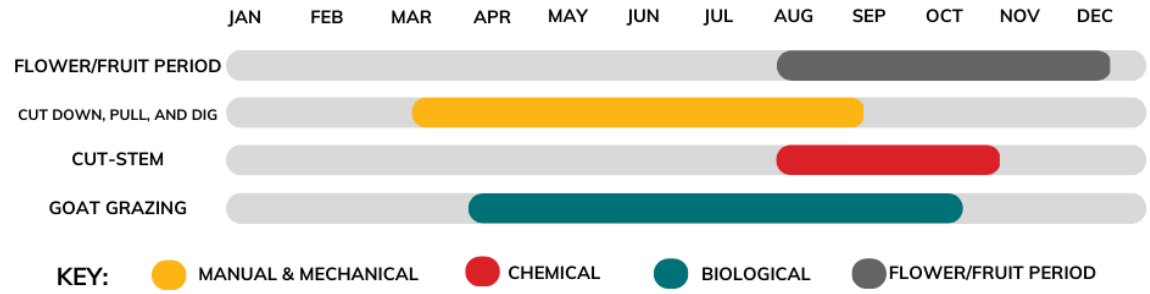


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand pull and dig up plants and roots before flowers and seeds emerge	• Foliar herbicide application (Clethodim, glyphosate)	• Manual removal of patches early spring to mid-summer • Focus removal in high traffic areas first

Native Plant Alternatives:

- Deer-tongue grass (*Dichanthelium clandestinum*)
- Bottlebrush grass (*Elymus hystrix*)
- Christmas fern (*Polystichum acrostichoides*)
- Sensitive fern (*Onoclea sensibilis)*

SWEET AUTUMN CLEMATIS, SWEET AUTUMN VIRGINSBOWER, JAPANESE CLEMATIS *(CLEMATIS TERNIFLORA)*



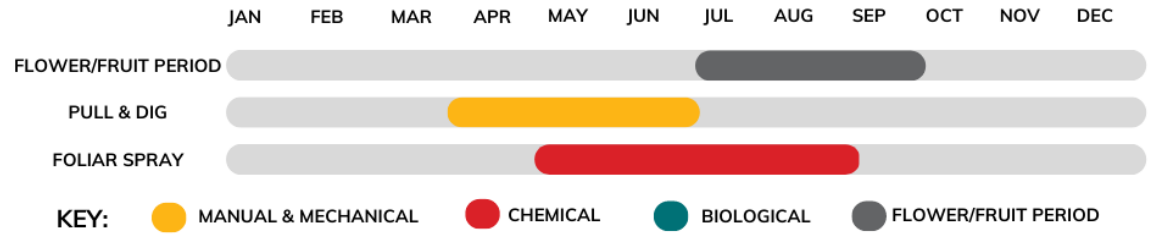
MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Cut back, then hand pull or mow seedlings and root masses • Grubbing	• Foliar herbicide application: triclopyr amine (e.g. 2-3% Garlon 3A) • Basal bark herbicide application: triclopyr amine (e.g. 2-3% Garlon 3A) or triclopyr ester (e.g. 15% Garlon 4 oil). • Cut-stem/window cutting herbicide application: triclopyr ester (e.g. 15% Garlon 4 oil)	• Manual removal methods are recommended due to the close proximity of these plants to streams and environmentally sensitive areas • Goat grazing • Cut-stem/window cutting herbicide application is low-impact • Goat grazing[12]

Native Plant Alternatives:

- For invasive vines, it is recommended to replace the trees with the same tree species, or refer to a list of native Maryland trees in the Appendix

12 http://www.iucngisd.org/gisd/species.php?sc=1224#:~:text=terniflora%20is%20widely%20used%20as,sun%20(Floridata%2C%202007).

JAPANESE HOP *(HUMULUS JAPONICUS)*

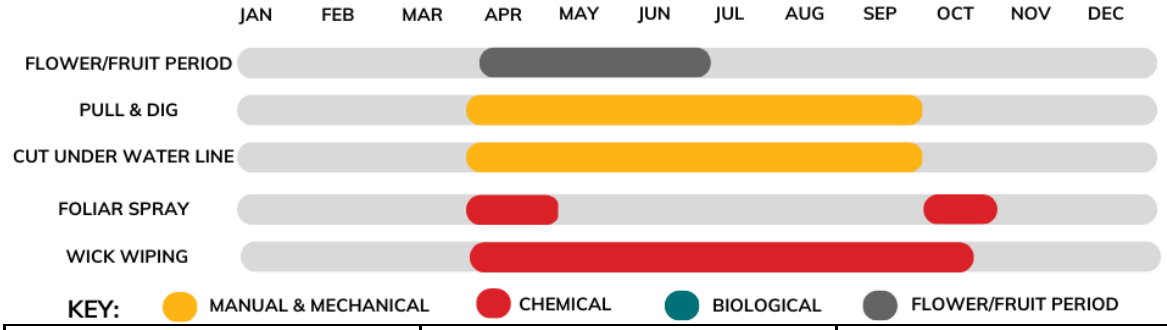


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Repeated hand pulling early in the season • Repeated, frequent cutting with tools including: weed whip, brush-cutter, or mower	• Repeated foliar herbicide application	• Manual removal methods are recommended due to the close proximity of these plants to streams

Native Plant Alternatives:

- For invasive vines, it is recommended to replace the trees with the same tree species, or refer to a list of native Maryland trees in the Appendix
- For invasive vines that are found in the groundcover, herbaceous layer, and/or understory, refer to the Native Plant Alternatives section in Appendix A

YELLOW FLAG IRIS *(IRIS PSEUDACORUS)*

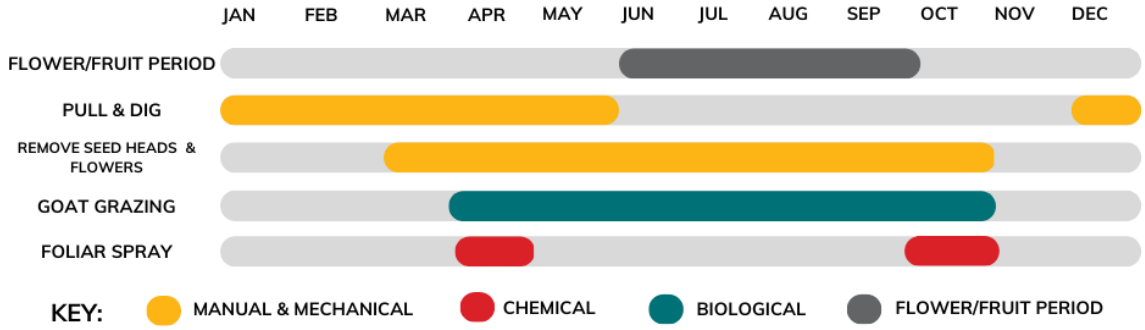


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Pull and dig entire plant and rhizomes for small populations • For plants in standing water, cut to below the waterline	• Aquatic approved herbicide application • Foliar herbicide application (Imazamox, Imazapyr, glyphosate, • Wick-wiping herbicide method (Imazapyr, glyphosate)	• Manual removal methods are recommended

Native Plant Alternatives:

- Southern blue flag iris (*Iris virginica*)
- Northern blue flag iris (*Iris versicolor*)
- Cardinal flower (Lobelia cardinalis)
- Marsh marigold (*Caltha palustris*)
- Canada anemone (*Anemone canadensis*)
- Canada lily (*Lilium canadense*)

BULL THISTLE *(CIRSIUM VULGARE)* + CREEPING THISTLE *(CIRSIUM ARVENSE)*

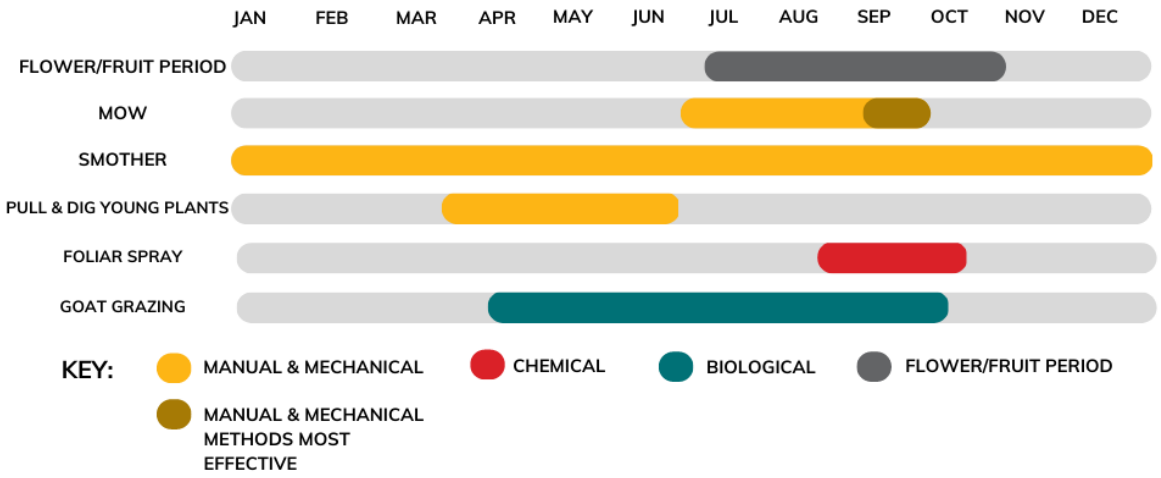


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Before flower heads emerge: repeated hand pulling, hoeing, grubbing, and cutting • Clipping seeds and flowers	• Foliar herbicide application • Selective: dicamba, clopyralid, or picloram either alone or in combination with 2,4-D. Aminopyralid and aminocylopyrachlor are labeled for thistle control and are also effective.) • Broad-spectrum: glyphosate	• Manual & mechanical methods are recommended due to small, isolated populations • Goat grazing • Interseeding with competitive grasses

Native Plant Alternatives:

- Common yarrow (*Achillea millefolium* var. *alpicola)*
- New england aster (*Symphyotrichum novae-angliae)*
- Goldenrod (*Solidago*)

COMMON MUGWORT *(ARTEMISIA VULGARIS)*



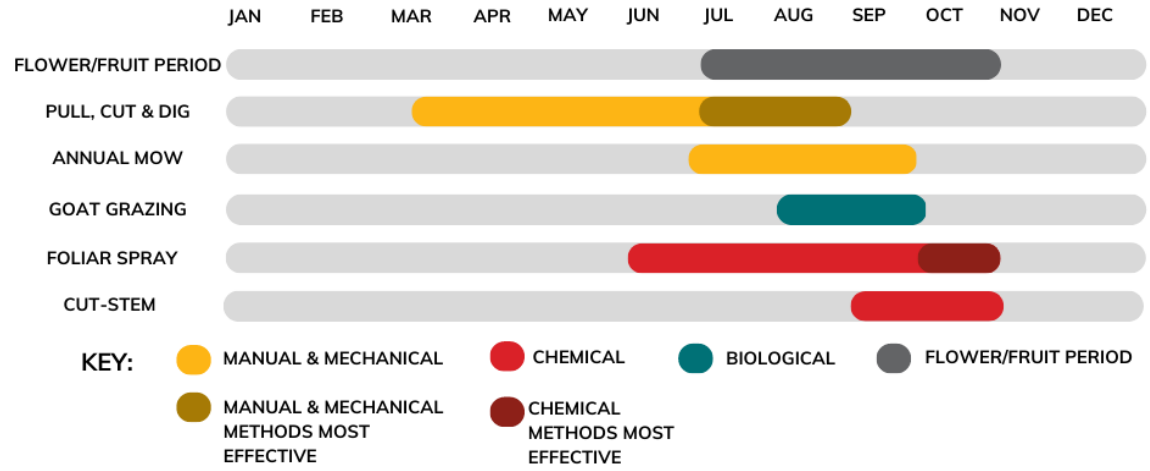
MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Repeated mowing all summer before seedhead production • Hand pulling young plants before the formation of rhizomes • Mow/cut and smother with black 8-mil tarp and mulch • Repeated digging of entire plant and rhizomes	• Foliar herbicide application (glyphosate, triclopyr, clopyralid)	• The first two weeks of September are the best time to mow to prevent seed formation • Hand pulling young plants before the formation of rhizomes • Mow/cut and smother with black 8-mil tarp and mulch • Goat grazing[13]

Native Plant Alternatives:

- Goldenrod (*Solidago*)
- Common yarrow (*Achillea millefolium* var. *alpicola)*
- Allegheny spurge or Allegheny pachysandra (*Pachysandra procumbens*)
- Spicebush (*Lindera benzoin*)

[13] https://eap.mcgill.ca/agrobio/ab370-04e.htm#:~:text=Many%20wormwood%20species%20have%20deworming,fowl%20readily%20consume%20it10.

KUDZU *(PUERARIA MONTANA)*

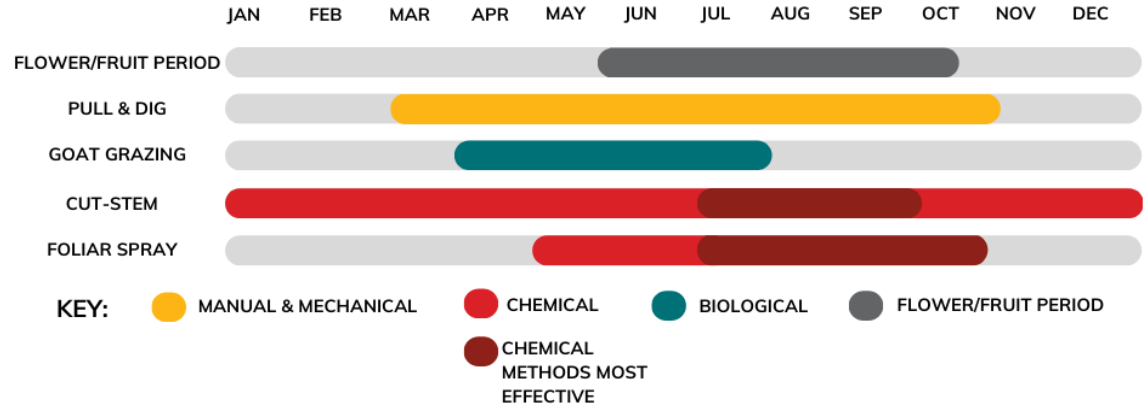


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand pulling and digging up entire plant and root crowns • Cut vines at the base of tree to kill the aboveground portion • Sever the root crown from the taproots • Repeated cutting or mowing every week during the summer for 2-3 years	• Foliar herbicide application (2,4-D + picloram, picloram liquid, metsulfuron methyl, clopyralid, glyphosate, triclopyr) • Basal bark herbicide application (triclopyr) • Cut stem herbicide application (triclopyr, picloram + 2,4-D, glyphosate)	• Combination of mowing with foliar/cut stem application of aquatic approved herbicides (since the kudzu infestation on campus is near a stream) • Goat grazing *before any herbicide application, but NOT after herbicide application • Cut vines at the base of tree to kill the aboveground portion, then repeatedly dig up and remove root crowns at the base

Native Plant Alternatives:

- For invasive vines, it is recommended to replace the trees with the same tree species, or refer to a list of native Maryland trees in the Appendix

AUTUMN OLIVE *(ELAEAGNUS UMBELLATA)*[14]



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand pulling entire individual small plants and roots	• Foliar herbicide application (glyphosate, triclopyr) • Basal bark herbicide application (triclopyr ester) • Cut-stump herbicide application (glyphosate, triclopyr)	• Cut-stump herbicide application • Mowing followed by herbicide application • Foliar applications are best used for sites with low infestations • Hand pulling • Goat grazing

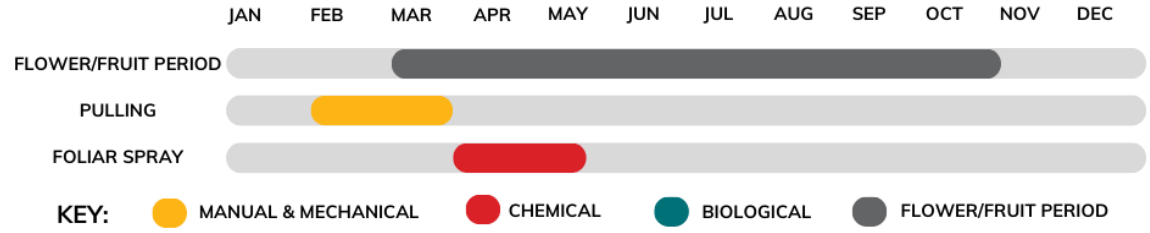
Native Plant Alternatives:

- Downy serviceberry (*Amelanchier arborea*)
- American beautyberry (*Callicarpa americana*)
- Eastern baccharis (*Baccharis halimiolia*)
- Buttonbush (*Cephalanthus occidentalis*)
- Fringe tree (*Chionanthus virginicus*)
- Summersweet (*Clethra alnifolia*)
- Winterberry (*Ilex verticillata*)
- Gray dogwood (*Cornus racemosa*)
- Virginia sweetspire (*Itea virginica*)
- Spicebush (*Lindera benzoin*)
- Southern wax myrtle (*Morella cerifera*)
- American elder (*Sambucus canadensis*)
- Highbush blueberry (*Vaccinium corymbosum*)
- Mapleleaf viburnum (*Viburnum acerifolium*)
- Southern arrowwood (*Viburnum dentatum*)
- Withe rod (*Viburnum nudum*)
- Blackhaw viburnum (*Viburnum prunifolium*)

[14] For reference: https://extension.psu.edu/autumn-olive#:~:text=Foliar%20herbicide%20treatments%20with%20a,foliar%20treatment%20for%20this%20species

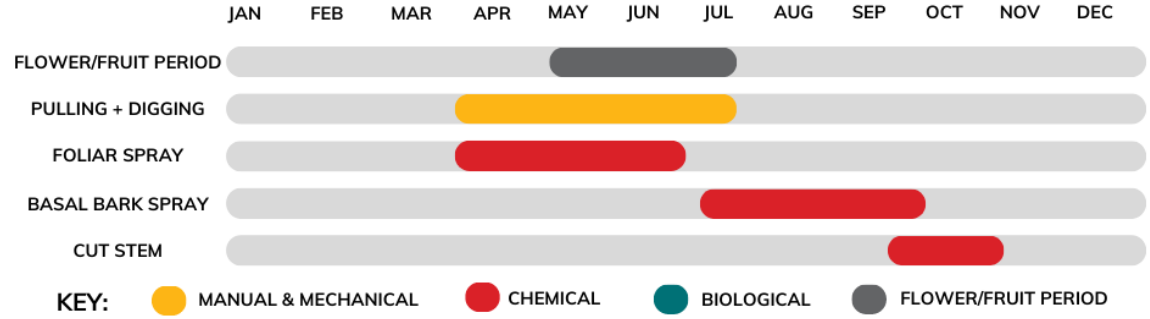
- Black chokeberry (*Aronia melanocarpa*)

WATERCRESS *(NASTURTIUM OFFICINALE)*



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand pulling	• Aquatically approved herbicide application	• Hand pulling is most appropriate since this is a low infestation

JETBEAD (*RHODOTYPOS SCANDENS)*

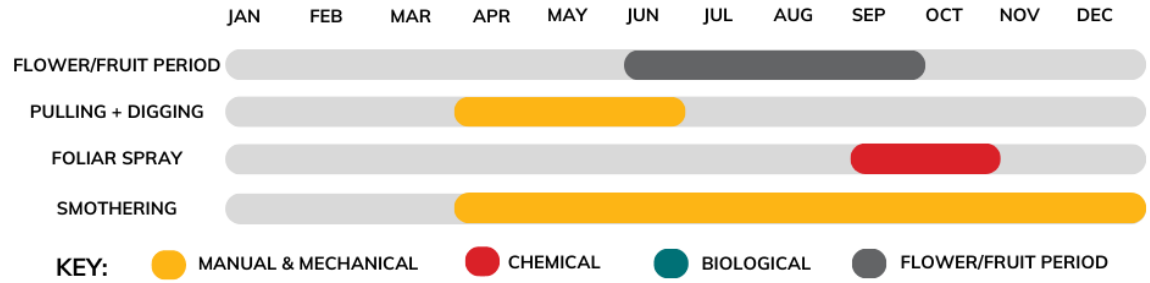


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand digging small plants • Cut shrubs to ground in fall-winter	• Foliar herbicide application in spring • Cut-stump herbicide application in the fall followed by a 20% solution of glyphosate to the stump • Basal bark herbicide application: 25% solution of triclopyr applied July-September	• There is a small infestation of jetbead, so manual and mechanical methods are most appropriate. • Cut-stem herbicide application in fall

Native Plant Alternatives:

- Winterberry *(Ilex verticillata)*
- Spicebush *(Lindera benzoin)*
- Black Chokeberry *(Aronia melancarpa)*
- Silky dogwood *(Cornus amomum)*
- New Jersey Tea *(Ceanothus americanus)*

FIELD BINDWEED *(CONVOLVULUS ARVENSIS)*



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Repeated hand pulling followed by smothering with tarp and/or mulch over at least 2 growing seasons	• Foliar herbicide application: glyphosate, dicamba, picloram, quinclorac, and paraquat	• There are small infestations, so manual & mechanical methods should be prioritized • Hand pulling in early spring • Foliar herbicide application in late summer to early fall • Smothering, mulching, and tarping for at least 2 growing seasons

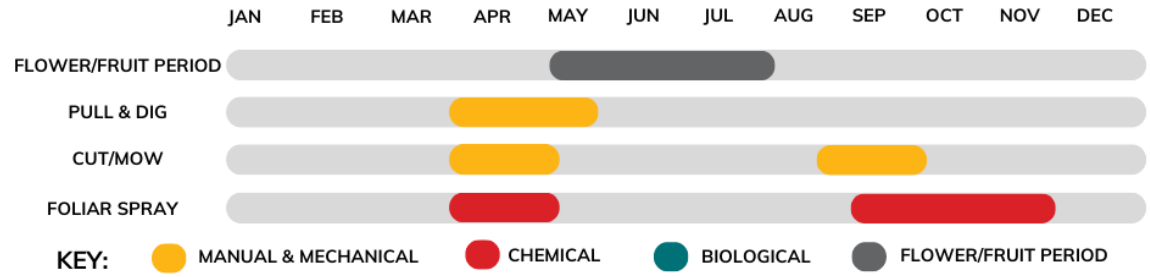
Native Plant Alternatives:

Groundcover/Herbaceous

- Creeping phlox (*Phlox stolonifera*)
- Green-and-gold (*Chrysogonum virginianum*)
- Allegheny spurge (*Pachysandra procumbens*)
- Virginia ginger (*Hexastylis virginica*)
- Golden ragwort (*Senecio aureus*)
- Partridgeberry (*Mitchella repens*)
- Foamflower (*Tiarella cordifolia*)
- Pussytoes (*Antennaria plantaginifolia*)
- Mouse-eared coreopsis (*Coreopsis auriculata*)
- Plantain-leaved sedge (*Carex plantaginea*)
- Colonial oak sedge (*Carex communis*)
- White bear sedge (*Carex albursina*)

- Wild ginger (*Asarum canadense*)
- Violet (*Viola canadensis*)
- Marginal woodfern (*Dryopteris marginalis)*
- Woodland aster (*Eurybia divaricatus)*
- Alumroot (*Heuchera villosa)*
- Creeping mint (*Meehania cordata)*
- Christmas fern (*Polystichum acrostichoides)*
- Black-eyed Susan *(Rudbeckia hirta)*

POISON HEMLOCK *(CONIUM MACULATUM)*



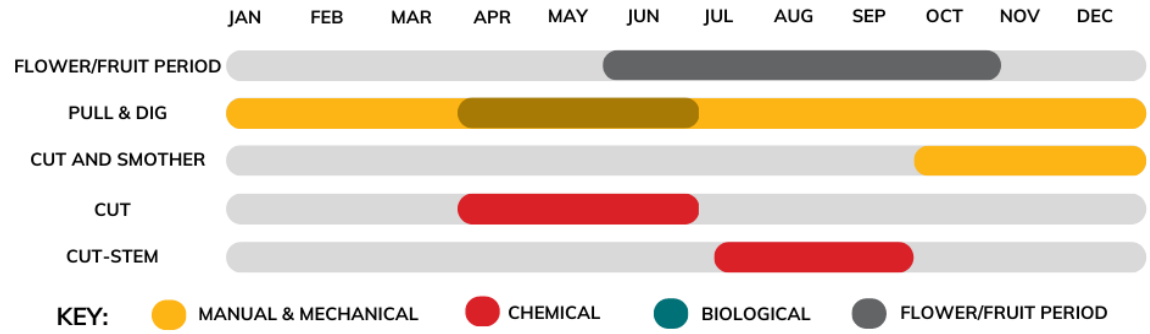
MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand pulling and digging • Mowing	• Foliar herbicide application • Broad-spectrum: Glyphosate, imazapyr • Selective: 2,4-D, aminopyralid	• Small infestation, manual methods are recommended before chemical methods

*** Poison hemlock causes some people to break out in a rash upon contact with skin; therefore, protective clothing (long pants, long-sleeved shirts, and gloves) should be worn when working in areas with this weed. Also, inhalation of plant particles should be minimized.

Native Plant Alternatives:
- Wild carrot or Queen Anne's Lace *(Daucus carota)*
- Cinnamon fern *(Osmunda cinnamomea)*
- Interrupted fern *(Osmunda claytoniana)*
- Royal fern *(Osmunda regalis)*
- Bracken fern *(Pteridium)*
- New York fern *(Thelypteris noveboracensis)*
- Marsh fern *(Thelypteris palustris)*
- Sensitive fern *(Onoclea sensibilis)*
- Netted chain fern *(Woodwardia areolata*)
- Virginia chain fern *(Woodwardia virginica)*
- Broomsedge *(Andropogon virginicus)*
- Blue wood sedge *(Carex glaucodea)*
- Tussock sedge *(Carex stricta)*

- Northern sea oats *(Chasmanthium latifolium)*
- Canada wild rye *(Elymus canadensis)*
- Virginia wild rye *(Elymus virginicus)*
- Switchgrass *(Panicum virgatum)*
- Little bluestem (*Schyzachirium scopyrium*)
- Gama grass *(Tripsacum dactyloides)*
- False blue indigo *(Baptisia australis)*
- Marsh marigold *(Caltha palustris)*

BURNING BUSH *(EUONYMUS ALATUS)*[15]



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Pulling with a weed wrench and digging • Cutting • Mowing repeatedly • Hand pulling seedlings	• Foliar herbicide application (glyphosate, triclopyr) • Basal bark herbicide application (triclopyr) • Cut stump herbicide application (glyphosate, triclopyr, triclopyr ester)	• Cut stump herbicide application • Cut and smother • Pulling and digging

Native Plant Alternatives:

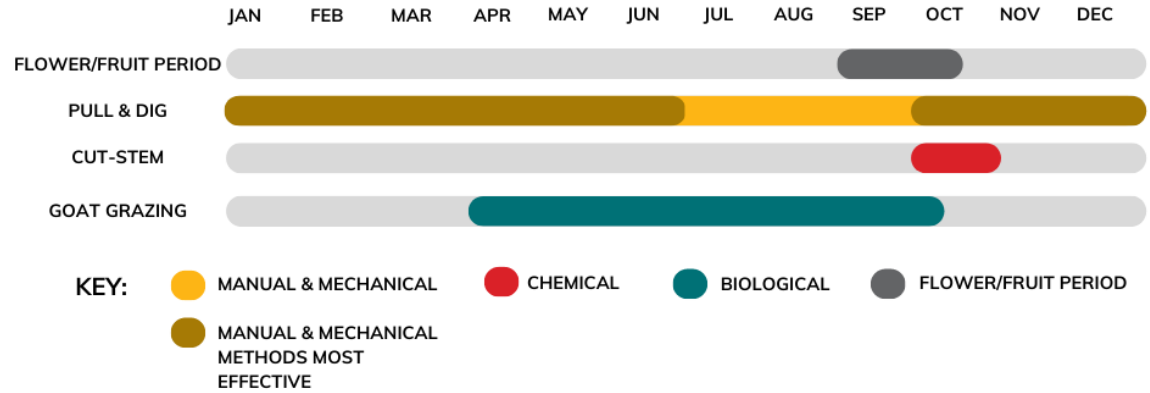
- Fragrant sumac (*Rhus aromatica*)
- Virginia sweetspire (*Itea virginica*)
- Dwarf fothergilla (*Fothergilla gardenii*)
- Black chokeberry (*Aronia melanocarpa*)
- Red chokeberry (*Aronia arbutifolia*)
- Highbush blueberry (*Vaccinium corymbosum*)
- Silky dogwood (*Cornus amomum*)
- Gray dogwood (*Cornus racemosa*)
- Eastern wahoo (*Euonymus atropurpureus*) is an American Euonymus plant
- Mountain witch alder (*Fothergilla major*)
- Winterberry (*Ilex verticillata*)

[15] Taken from https://extension.psu.edu/burning-bush

- Winged sumac (*Rhus copallinum*)
- Smooth sumac (*Rhus glabra*)
- Blackhaw viburnum (*Viburnum prunifolium*)
- Ninebark (Physocarpus opulifolius)
- Possumhaw viburnum (*Viburnum nudum*)
- Mapleleaf viburnum (*Viburnum acerifolium*)
- American strawberry bush (*Euonymus americanus*)

First Priority Invasive Plant Species

ENGLISH IVY *(HEDERA HELIX)*



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Window cutting • Pulling and digging vines and roots on the ground	• Cut stem herbicide application (glyphosate) • Foliar herbicide application for areas of 100% ivy groundcover (triclopyr, triclopyr ester, glyphosate)	• Cut stem window cutting herbicide application • Pulling and digging vines from the ground • Goat grazing[16]

Native Plant Alternatives:

Groundcover/Herbaceous

- Creeping phlox (*Phlox stolonifera*)
- Green-and-gold (*Chrysogonum virginianum*)
- Allegheny spurge (*Pachysandra procumbens*)
- Virginia ginger (*Hexastylis virginica*)
- Golden ragwort (*Senecio aureus*)
- Partridgeberry (*Mitchella repens*)
- Foamflower (*Tiarella cordifolia*)

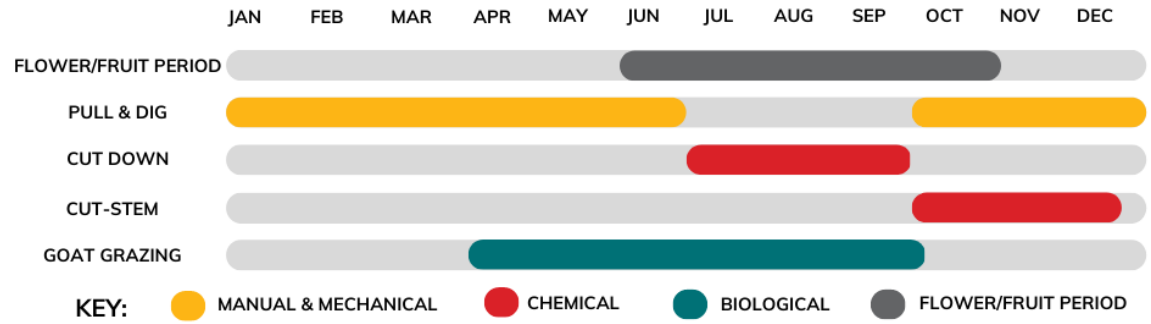
16 https://www.oregon.gov/ODA/programs/Weeds/Meetings/Documents/English%20Ivy%20Forum%202016/EnglishIvyResponseGoatBrowsing.pdf

- Pussytoes (*Antennaria plantaginifolia*)
- Mouse-eared coreopsis (*Coreopsis auriculata*)
- Plantain-leaved sedge (*Carex plantaginea*)
- Colonial oak sedge (*Carex communis*)
- White bear sedge (*Carex albursina*)
- Wild ginger (*Asarum canadense*)
- Violet (*Viola canadensis*)
- Marginal woodfern (*Dryopteris marginalis)*
- Woodland aster (*Eurybia divaricatus)*
- Alumroot (*Heuchera villosa)*
- Creeping mint (*Meehania cordata)*
- Christmas fern (*Polystichum acrostichoides)*

Vines

- For invasive vines, it is recommended to replace the trees with the same tree species, or refer to a list of native Maryland trees in the Appendix

PORCELAINBERRY *(AMPELOPSIS BREVIPEDUNCULATA)*



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand pulling small vines • Cutting vines close to ground	• Cut and paint (triclopyr, triclopyr amine, glyphosate) • Foliar herbicide application (triclopyr, triclopyr amine, glyphosate) • Basal bark herbicide application (triclopyr ester)	• Cut and paint • Hand pulling small vines • Goat grazing[17]

Native Plant Alternatives:

Groundcover/Herbaceous

- Creeping phlox (*Phlox stolonifera*)
- Green-and-gold (*Chrysogonum virginianum*)

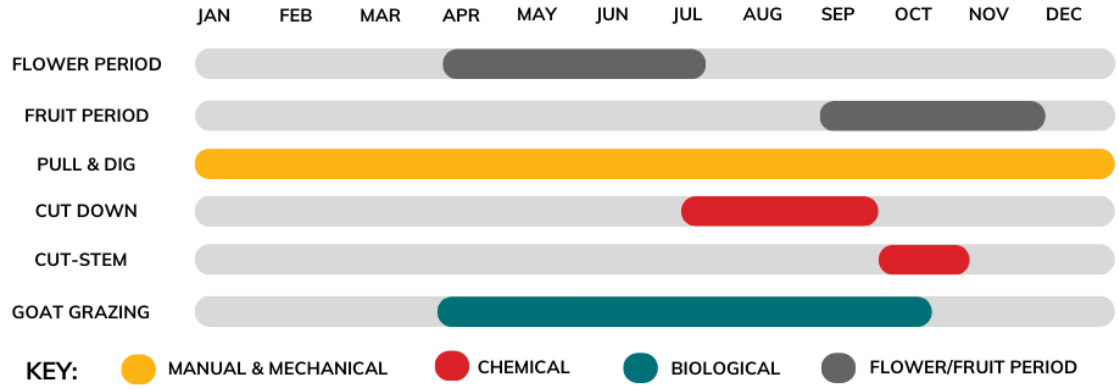
[17] https://www.chesapeakebay.net/news/blog/invasive-plants-got-your-goat

- Allegheny spurge (*Pachysandra procumbens*)
- Virginia ginger (*Hexastylis virginica*)
- Golden ragwort (*Senecio aureus*)
- Partridgeberry (*Mitchella repens*)
- Foamflower (*Tiarella cordifolia*)
- Pussytoes (*Antennaria plantaginifolia*)
- Mouse-eared coreopsis (*Coreopsis auriculata*)
- Plantain-leaved sedge (*Carex plantaginea*)
- Colonial oak sedge (*Carex communis*)
- White bear sedge (*Carex albursina*)
- Wild ginger (*Asarum canadense*)
- Violet (*Viola canadensis*)
- Marginal woodfern (*Dryopteris marginalis)*
- Woodland aster (*Eurybia divaricatus)*
- Alumroot (*Heuchera villosa)*
- Creeping mint (*Meehania cordata)*
- Christmas fern (*Polystichum acrostichoides)*
- Black-eyed Susan *(Rudbeckia hirta)*

Vines

- For invasive vines, it is recommended to replace the trees with the same tree species, or refer to a list of native Maryland trees in the Appendix

JAPANESE HONEYSUCKLE *(LONICERA JAPONICA)*



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Mowing at least 2x a year • Mechanical cutting of aerial vines • Hand removal of small vines	• Cut and paint (glyphosate, triclopyr) • Foliar herbicide application (glyphosate, triclopyr)	• Cut plants in mid-late summer, allow regrowth, spray new foliage with herbicide • Hand removal of seedlings • Cut and paint • Goat grazing[18]

Native Plant Alternatives:

Groundcover/Herbaceous

- Creeping phlox (*Phlox stolonifera*)
- Green-and-gold (*Chrysogonum virginianum*)
- Allegheny spurge (*Pachysandra procumbens*)
- Virginia ginger (*Hexastylis virginica*)
- Golden ragwort (*Senecio aureus*)
- Partridgeberry (*Mitchella repens*)
- Foamflower (*Tiarella cordifolia*)
- Pussytoes (*Antennaria plantaginifolia*)
- Mouse-eared coreopsis (*Coreopsis auriculata*)
- Plantain-leaved sedge (*Carex plantaginea*)
- Colonial oak sedge (*Carex communis*)
- White bear sedge (*Carex albursina*)
- Wild ginger (*Asarum canadense*)
- Violet (*Viola canadensis*)
- Marginal woodfern (*Dryopteris marginalis)*
- Woodland aster (*Eurybia divaricatus)*
- Alumroot (*Heuchera villosa)*

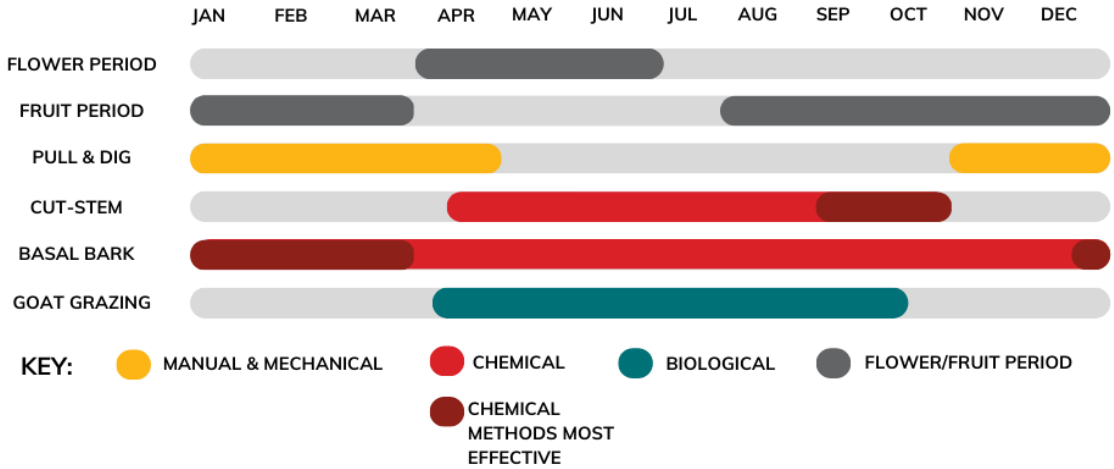
[18] https://wordpressua.uark.edu/sustain/goats-on-campus-ofs-hires-the-herd-to-fight-invasive-plants/#:~:text=As%20their%20website%20explains%2C%20%E2%80%9CGoats,%2C%20Blackberry%2C%20and%20Black%20Locust.

- Creeping mint (*Meehania cordata)*
- Christmas fern (*Polystichum acrostichoides)*

Vines

- For invasive vines, it is recommended to replace the trees with the same tree species, or refer to a list of native Maryland trees in the Appendix

AMUR HONEYSUCKLE, BUSH HONEYSUCKLE *(LONICERA MAACKII)*[19]



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand removal of seedlings • Weed wrench to remove larger plants • Mowing repeatedly throughout growing season	• Foliar herbicide application (glyphosate, triclopyr) • Basal bark herbicide application (glyphosate, triclopyr) • Cut stem herbicide application (glyphosate, triclopyr)	• Cut stem herbicide application • Hand removal of seedlings • Weed wrench to remove larger plants • Basal bark herbicide applications in dormant season • Goat grazing[20]

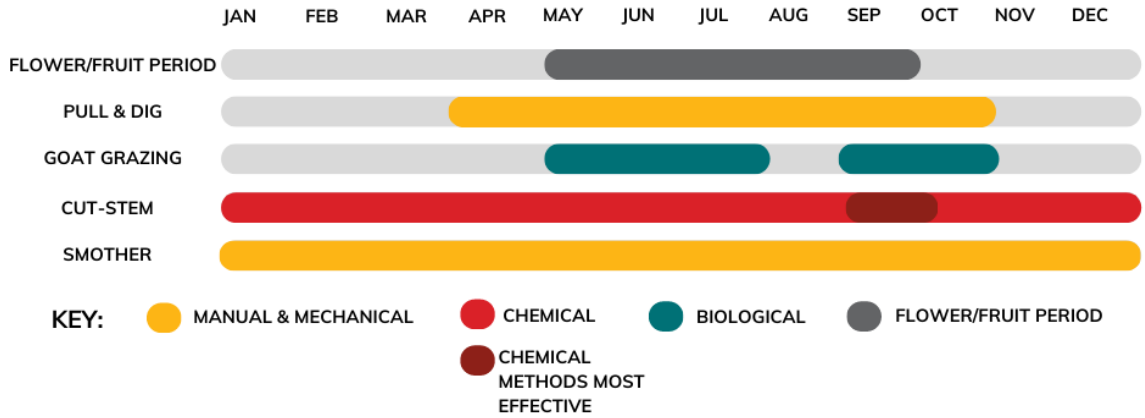
Native Plant Alternatives:

- American fly honeysuckle (*L. canadensis*),
- Swamp fly-honeysuckle (*L. oblongifolia*)
- Mountain fly honeysuckle (*L. villosa*)
- Northern bush-honeysuckle (*Diervilla lonicera*)

[19] For reference: https://extension.psu.edu/shrub-honeysuckles

[20] https://wordpressua.uark.edu/sustain/goats-on-campus-ofs-hires-the-herd-to-fight-invasive-plants/#:~:text=As%20their%20website%20explains%2C%20%E2%80%9CGoats,%2C%20Blackberry%2C%20and%20Black%20Locust.

MULTIFLORA ROSE *(ROSA MULTIFLORA)*[21]



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Repeated cutting/mowing 3-6x per growing season for 2-4 years • Pulling entire seedlings, small plants, and roots • Use a weed wrench on hard to pull plants • Cut stump to ground level, then place 4-mil plastic tarp over for 1 year to control the spread. Root crown can be dug up after 1 year.	• Cut stump herbicide application: (glyphosate, triclopyr, • Foliar herbicide application: (glyphosate, fosamine) • Basal bark herbicide application: (glyphosate)	• In high-quality natural communities, repeated cutting 2-6x per growing season for 2-4 years is recommended to minimize disturbance • Cut stump herbicide application • Goat grazing • Pulling entire seedlings, small plants, and roots • Cut stump to ground level, then place 4-mil plastic tarp over for 1 year to control the spread. Root crown can be dug up after 1 year.

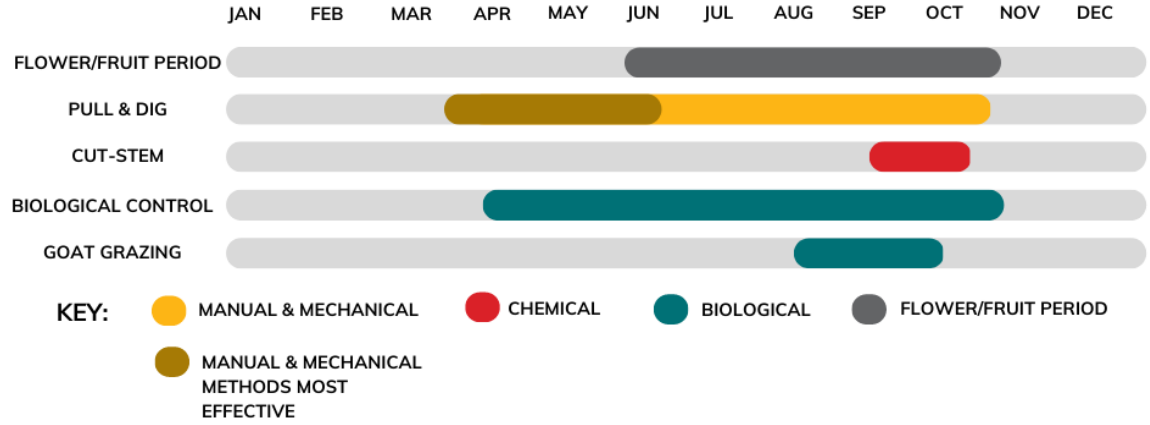
Native Plant Alternatives:

- Meadow rose (*Rosa blanda*)
- Carolina rose (*Rosa caroliniana*)
- Swamp rose (*Rosa Palustris*)
- White meadowsweet (*Spiraea alba*)
- Witch hazel (*Hamamelis virginiana*)
- Winterberry holly (*Ilex verticillata*)
- Arrowwood viburnum (*Viburnum dentatum*)
- American hazelnut (*Corylus americana*)
- Virginia rose (*Rosa virginiana*)

[21] For reference: https://extension.psu.edu/multiflora-rose

- Native black raspberry (*Rubus occidentalis*)
- Allegheny blackberry (*Rubus allegheniensis*)
- Downy serviceberry (*Amelanchier arborea*)
- Highbush blueberry (*Vaccinium corymbosum*)
- Fragrant sumac (*Rhus aromatica*)
- Coralberry (*Symphoricarpos orbiculatus*)
- Mapleleaf viburnum (*Viburnum acerifolium*)
- Purple-flowering raspberry (*Rubus odoratus*)

MILE-A-MINUTE *(PERSICARIA PERFOLIATA)*[22]



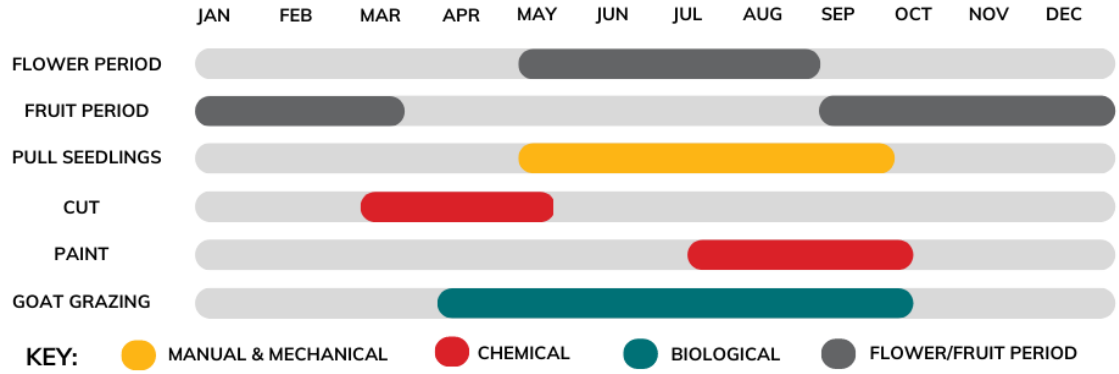
MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand removal of seedlings • Manual removal before fruiting • Removing large patches with a garden rake	• Cut stem herbicide application (glyphosate, triclopyr) • Foliar herbicide application (glyphosate, triclopyr)	• Biological control: *Rhinocominus latipes* Korotyaev, AKA the Mile-a-Minute weevil • Hand removal for small populations • Cut and paint for large populations • Goat grazing

Native Plant Alternatives:

- For invasive vines, it is recommended to replace the trees with the same tree species, or refer to a list of native Maryland trees in the Appendix

[22] For reference: https://extension.psu.edu/mile-a-minute

ORIENTAL BITTERSWEET *(CELASTRUS ORBICULATA)*[23]



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Manual removal of small vines • Cut vines at the ground level	• Cut stem herbicide application: window-cut method (glyphosate, triclopyr, triclopyr ester) • Basal bark herbicide application (triclopyr ester)	• Cut stems, allow regrowth, paint with herbicide • Window-cut method • Manual removal of small vines • Goat grazing[24]

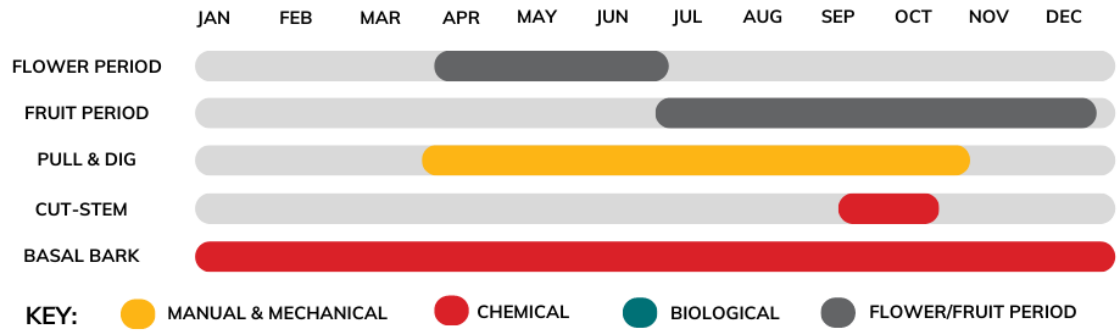
Native Plant Alternatives:

- For invasive vines, it is recommended to replace the trees with the same tree species, or refer to a list of native Maryland trees in the Appendix

[23] For reference: https://extension.psu.edu/oriental-bittersweet

[24] https://www.ecolandscaping.org/09/landscape-challenges/invasive-plants/goats-as-an-ecological-management-option-for-invasive-plants/

PRIVET *(LIGUSTRUM SPP.)*[25]



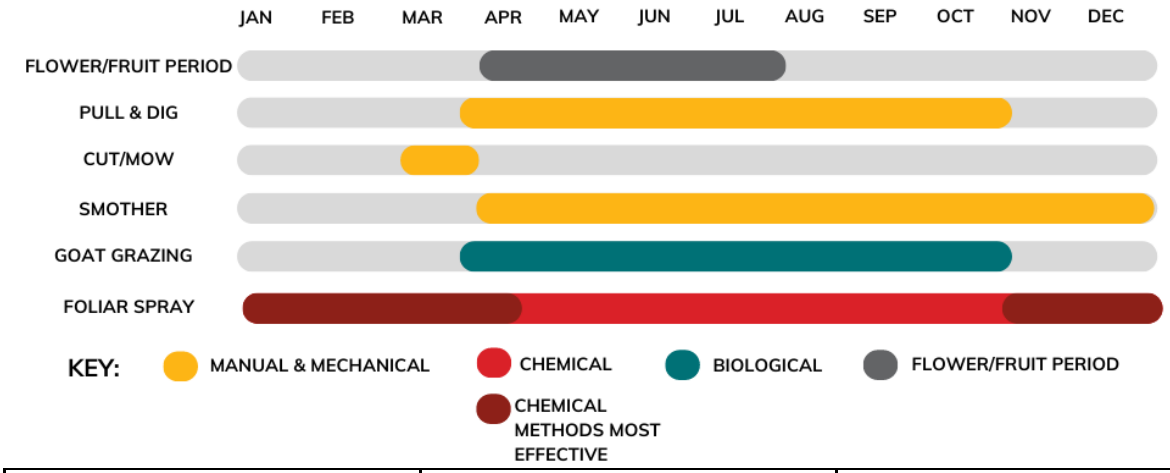
MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand pulling, digging, or use of a weed wrench for small plants • Repeatedly cutting larger plants • Repeatedly mowing	• Foliar herbicide application • Basal bark herbicide application • Cut stem herbicide application	• Cut stem herbicide application • Manual removal methods for small plants

Native Plant Alternatives:

- Limelock arrowwood (*Viburnum bracteatum*)
- Red chokeberry (*Aronia arbutifolia*)
- Black chokeberry (*Aronia melanocarpa*)
- Silky dogwood (*Cornus amomum*)
- Gray dogwood (*Cornus racemosa*)
- Red osier dogwood (*Cornus sericea*)
- Winterberry (*Ilex verticillata*)
- Spicebush (*Lindera Benzoin*)
- Carolina cherry laurel (*Prunus caroliniana*)
- Southern arrowwood (*Viburnum dentatum*)
- Blackhaw (*Viburnum prunifolium*)

[25] For reference: https://extension.psu.edu/privet

GARLIC MUSTARD *(ALLIARIA PETIOLATA)*[26]



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand removal of small populations • Cut large populations with flowering stems to ground level • Cut and remove seedpods • Cut and mow • Smother with cardboard or 8-mil black plastic tarp with mulch on top for one growing season following manual removal methods	• Foliar herbicide applications for heavy infestations (glyphosate)	• Hand removal of small populations • Cut large populations with flowering stems to ground level • Cut and remove seedpods • Smother with cardboard or 8-mil black plastic tarp with mulch on top for one growing season following manual removal methods • Goat grazing

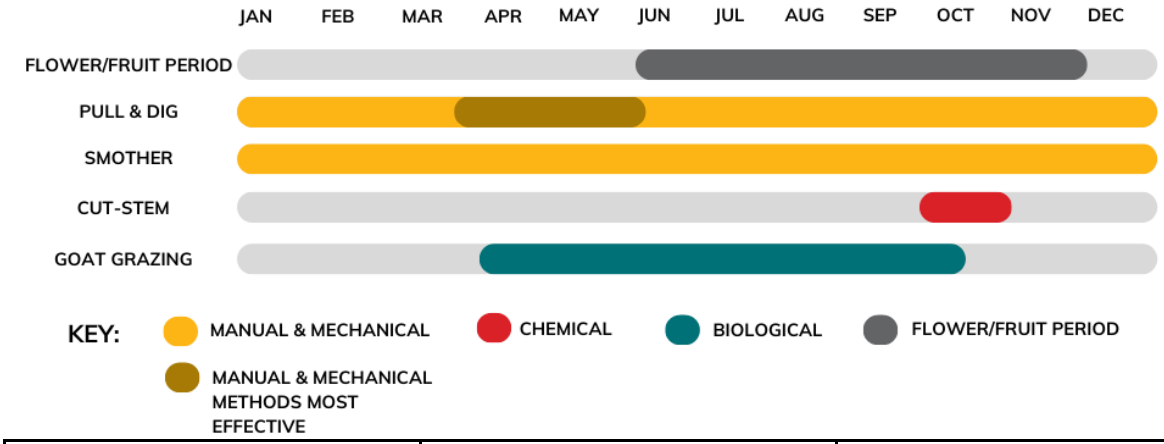
Native Plant Alternatives:

- Wild ginger (*Asarum canadense*)
- Canada mayflower (*Maianthemum canadense*)
- Wild strawberry (*Fragaria virginiana*)
- Foamflower (*Tiarella cordiformis*)
- Bishop's cap (*Mitella diphylla*)
- American alumroot (*Heuchera americana*)
- Jacob's ladder (*Polemonium reptans*)
- Bloodroot (*Sanguinaria canadensis*)
- Pennsylvania sedge (*Carex pennsylvanica*)
- Silver sedge (*Carex platyphylla*)
- Male fern (*Dryopteris filix-mas*)

[26] For reference: https://extension.psu.edu/garlic-mustard#:~:text=mature%20forest%20understories.-,Control,shoot%20tissue%20will%20prevent%20regrowth

- Christmas fern (*Polystichum acrosticoides*)
- Northern sea oats (*Chasmanthium latifolium*)
- Big leaf aster (*Aster macrophyllus*)
- Mayapple (*Podophyllum peltatum*)
- Long beaked sedge (*Carex sprengelii*)
- Ivory sedge (*Carex eburnea*)
- Golden star sedge (*Carex rosea*)

WINTERCREEPER *(EUONYMUS FORTUNEI)*



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand pulling and digging up entire plant and roots for small populations • In large populations, cover the area with 6-8-mil black plastic tarp for 1-2 growing seasons	• Cut stem herbicide application (glyphosate, triclopyr) • Foliar herbicide application for large populations (2,4-D, triclopyr)	• Hand pulling and digging up entire plant and roots for small populations • In large populations, cover the area with 6-8-mil black plastic tarp for 1-2 growing seasons • Cut stem herbicide application • Goat grazing[27]

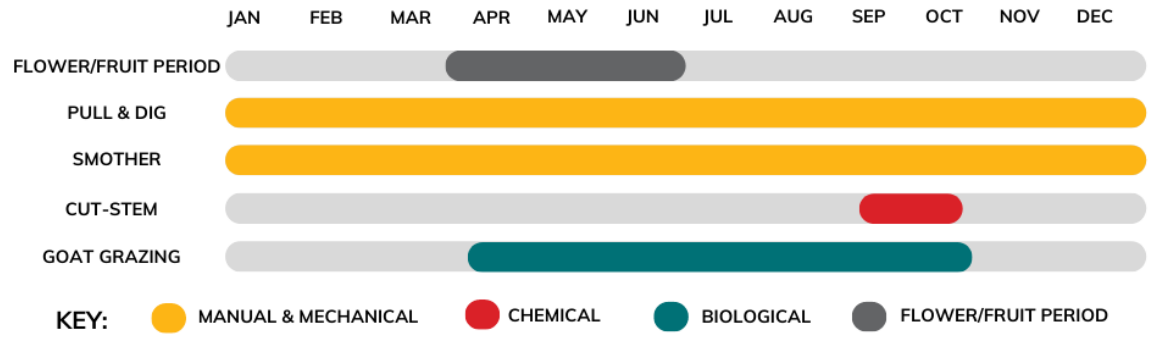
Native Plant Alternatives:

- Bearberry *(Arctostaphylos uva-ursi)*
- Field pussytoes (*Antennaria neglecta*)
- Parlin's pussytoes (*Antennaria parlinii*)
- Plantain-leaf pussytoes (*Antennaria plantaginifolia*)
- Pennsylvania sedge (*Carex pensylvanica*)
- Wild ginger (*Asarum canadense*)

[27] https://wordpressua.uark.edu/sustain/goats-on-campus-ofs-hires-the-herd-to-fight-invasive-plants/#:~:text=As%20their%20website%20explains%2C%20%E2%80%9CGoats,%2C%20Blackberry%2C%20and%20Black%20Locust.

- Calamint (*Clinopodium arkansamum*)
- Bristle-leaved sedge (*Carex eburnea*)
- Golden ragwort (*Packera aurea*)
- Robin's plantain (*Erigeron pulchellus*)
- Verbena (*Glandularia canadensis*)
- Dwarf crested iris (*Iris cristata*)
- Bluebells (*Mertensia virginica*)
- Round-leaved ragwort (*Packera abovata*)
- Wild sweet william (*Phlox divaricata*)
- Aromatic aster (*Symphyotrichum oblongifolium*)
- Woodland phlox (*Phlox divaricata*)

COMMON PERIWINKLE *(VINCA MINOR)* + BIGLEAF PERIWINKLE *(VINCA MAJOR)*



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand pulling and digging of entire plants and roots • Repeated mowing • Patches can be cut down and then covered with 8-mil black plastic tarp for at least 1-2 growing seasons, and then dug out	• Foliar herbicide application • Cut stem herbicide application	• Hand pulling + digging of entire plants and roots • Patches can be cut down + then covered with 8-mil black plastic tarp for at least 1-2 growing seasons, and then dug out • Cut stem herbicide application • Cut plants down, allow regrowth, then apply herbicide • Goat grazing[28]

Native Plant Alternatives:

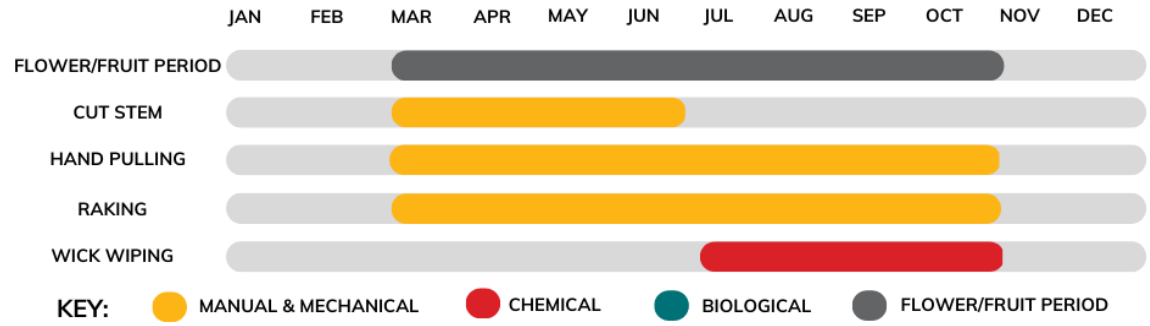
- To replace invasive groundcover:

[28] https://wjla.com/news/local/goats-eat-invasive-species-at-towson-university#:~:text=The%20goats%20eat%20Asian%20bittersweet,eat%20everything%2C%22%20said%20Hull.&text=The%20goats'%20indiscriminate%20appetite%20is%20the%20first%20step%20in%20the%20process.

- Native pachysandra (*Pachysandra procumbens*)
- Christmas fern (*Polystichum acrostichoides*)
- Partridgeberry (*Mitchella repens*)
- Creeping phlox (*Phlox stolonifera)*
- Star jasmine (*Trachelospermum jasminoides*)
- Creeping juniper (*Juniperus horizontalis*)
- Partridgeberry (Mitchella repens)

- For invasive vines, it is recommended to replace the trees with the same tree species, or refer to a list of native Maryland trees in the Appendix

HYBRID CATTAIL *(TYPHA X GLAUCA)*

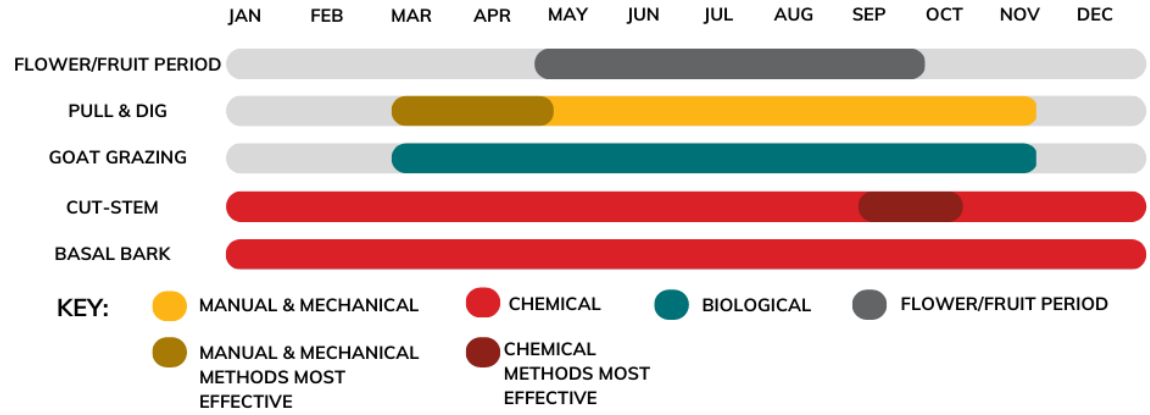


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Cut stems below water line • Raking & removing • Hand pulling young cattails	• Herbicidal wick wiping (aquatically approved glyphosate, imazapyr) • Foliar herbicide application (aquatically approved glyphosate, imazapyr)	• Cut stems below water line • Raking & removing • Hand pulling young cattails

Native Plant Alternatives:

- Softstem bulrush *(Schoenoplectus tabernaemontani)*
- Broadleaf arrowhead *(Sagittaria latifolia)*
- Giant burreed *(Sparganium eurycarpum)*
- Sweet flag *(Acorus americanus)*
- Native broadleaf cattail *(Typha latifolia)*
- Blue flag iris *(Iris versicolor)*

JAPANESE BARBERRY *(BERBERIS THUNBERGII)*[29]



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Pull and dig with a weed wrench • Cut down to ground level • Hand removal of young plants • Mowing 3-6 times a year	• Foliar herbicide application • Cut stump herbicide application • Basal bark herbicide application	• Pull and dig plants with a weed wrench • Goat grazing • Cut stump herbicide application • Basal bark herbicide application

Native Plant Alternatives:

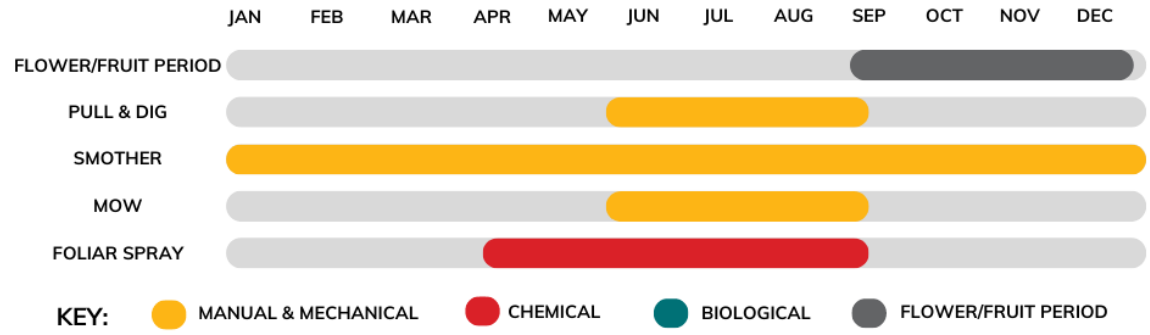
- Allegheny barberry (*Berberis canadensis*)
- Winterberry holly (*Ilex verticillata*)
- Inkberry holly (*Ilex glabra*)
- New jersey tea (*Ceanothus americanus*)
- Bayberry (*Myrica pensylvanica*)
- Wild hydrangea (*Hydrangea arborescens*); Oakleaf hydrangea (*Hydrangea quercifolia*)
- Common ninebark (*Physocarpus opulifolius*); Ginger wine; Summer wine black ninebark; Tiny wine gold ninebark (*Physocarpus opulifolius*);
- Silky dogwood (*Cornus racemosa*); Red osier dogwood (*Cornus sericea*)
- Red chokeberry (*Aronia arbutifolia*)
- Black chokeberry (Aronia melanocarpa)
- Kodiak black diervilla (*Diervilla rivularis*); Kodiak orange diervilla (*Diervilla x*)
- Fragrant sumac (*Rhus aromatica*)
- Butterflyweed (*Asclepias tuberosa*)
- Red baneberry (*Actaea rubra*)
- Joe-pye weed (*Eutrochium maculatum*)
- Little bluestem (*Schizachyrium scoparium*)
- Switchgrass (*Panicum virgatum*)
- Virginia sweetspire (*Itea virginica*)

[29] For reference: https://extension.psu.edu/japanese-barberry

- Dwarf fothergilla (*Fothergilla gardenii*) *not native to Maryland, native to North Carolina and south, in regards to shifting growth zones due to climate change, this could be a suitable plant
- Mountain witch alder (*Fothergilla major*)
- Bottlebrush buckeye (*Aesculus parviflora*) *native to South Carolina to Florida, in regards to shifting growth zones due to climate change, this could be a suitable plant
- Coralberry (*Symphoricarpos orbiculatus*)
- Highbush blueberry (*Vaccinium corymbosum*)
- Mountain laurel (*Kalmia latifolia*)

Second Priority Invasive Plant Species

JAPANESE STILTGRASS *(MICROSTEGIUM VIMINEUM)*[30]



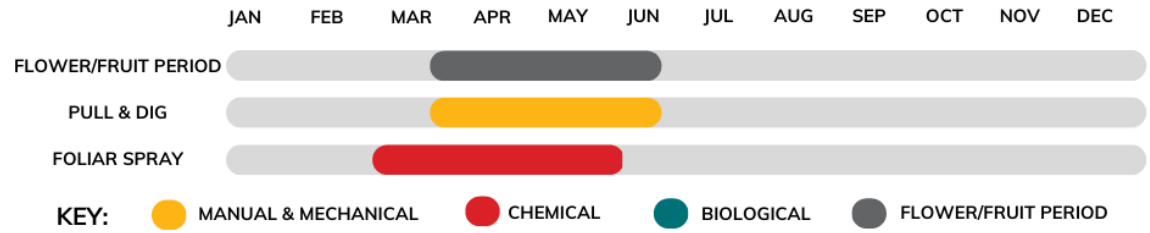
MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand pulling entire plant and roots • Weed whacking or mowing • Smothering with cardboard and/or black plastic tarp for 1-2+ growing seasons	• Foliar grass-selective herbicide application (Imazapic, sulfometuron, clethodim, fluazifop, sethoxydim, fenoxaprop) • Foliar broad-spectrum herbicides (glyphosate, glufosinate)	• Hand pulling entire plant and roots • Smothering with cardboard and/or black plastic tarp for 1-2+ growing seasons

Native Plant Alternatives:
- Virginia cutgrass (*Leersia virginica*)
- Hairy jointgrass/Small carpetgrass (*Arthraxon hispidus*)
- Pennsylvania knotweed (*Polygonum persicaria*)
- Nimblewill (*Muhlenbergia schreberi*)
- Pennsylvania sedge (*Carex pensylvanica*)
- Little bluestem (*Schizachyrium scoparium*)
- Narrowleaf blue-eyed grass (*Sisyrinchium angustifolium*)

[30] For reference: https://extension.psu.edu/japanese-stiltgrass

- Ostrich fern (*Matteuccia struthiopteris*)
- Sensitive fern (*Onoclea* sensibilis)
- Carolina allspice (*Calycanthus floridus*)
- Mountain mint (*Parthenium muticum*)
- Beebalm (*Monarda* spp.)
- Jewelweed (*Impatiens capensis*)
- Annual ryegrass (*Lolium multiflorum*)
- Golden ragwort (*Packera aurea*)
- Native violet (Viola banksii)
- White avens (Geum canadense)
- Green-and-gold (Chrysogonum virginianum)
- Enchanter's nightshade (Circaea lutetiana)
- Christmas ferns (*Polystichum acrostichoides*)
- Sensitive fern (*Onoclea sensibilis*)
- Northern sea oats (*Chasmanthium latifolium*)
- Robin's plantain (*Erigeron pulchellus*)
- Clearweed (*Pilea pumila*)
- Common milkweed (*Asclepias syriaca*)
- Horseweed (*Conyza canadensis*)
- New York ironweed (*Vernonia noveboracensis*)

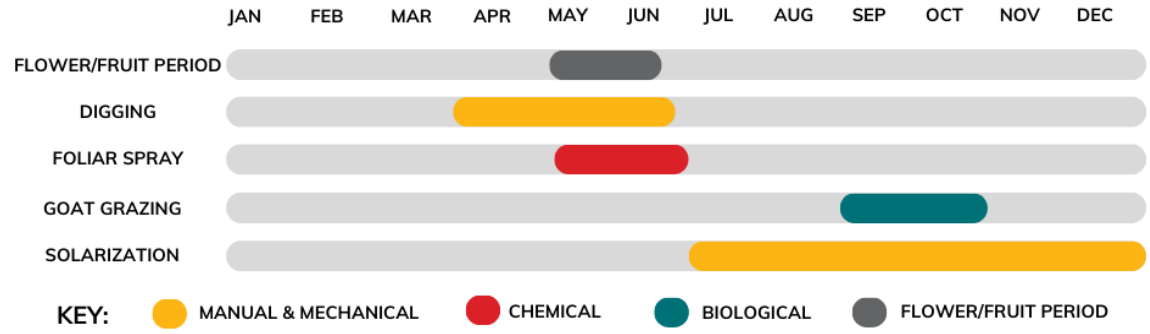
LESSER CELANDINE OR FIG BUTTERCUP *(RANUNCULUS FICARIA L.)*



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand removal • Digging with shovel or hand trowel	• Wetland approved foliar herbicide application (glyphosate)	• Small infestations: manual & mechanical methods • Large infestations: chemical methods

- Wood poppy *(Stylophorum canadense)*
- Marsh marigold *(Caltha palustris)*
- Wild ginger (Asarum canadense)
- Dutchman's breeches (Dicentra cucullaria)
- Squirrel-corn (Dicentra canadensis)
- Cutleaf toothwort (Cardamine concatenata)
- Twinleaf (Jeffersonia diphylla)
- Bloodroot (Sanguinaria canadensis)

REED CANARYGRASS *(PHALARIS ARUNDINACEA L.)*

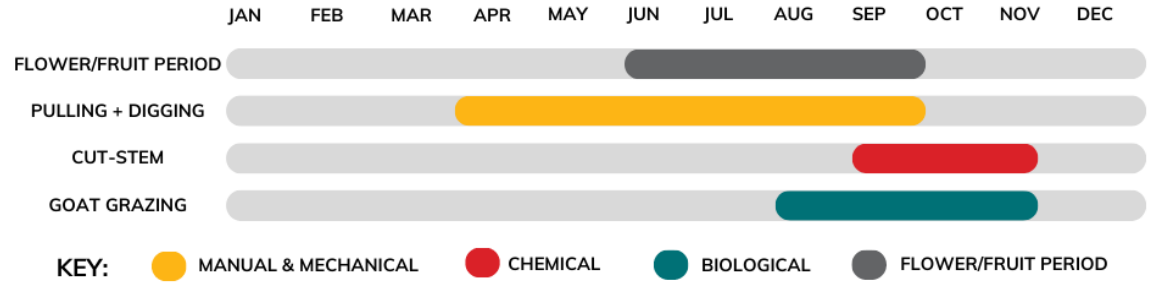


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Digging and excavating • Solarization • Mowing	• Broad spectrum herbicide application (glyphosate, imazapyr) • Grass-specific herbicide (sethoxydim, fluazifop)	• Digging • Mowing • Solarization • Goat grazing • Grass-specific herbicide application

Native Plant Alternatives:

- Cinnamon fern *(Osmunda cinnamomea)*
- Interrupted fern *(Osmunda claytoniana)*
- Royal fern *(Osmunda regalis)*
- Bracken fern *(Pteridium)*
- New York fern *(Thelypteris noveboracensis)*
- Marsh fern *(Thelypteris palustris)*
- Sensitive fern *(Onoclea sensibilis)*
- Netted chain fern *(Woodwardia areolata*)
- Virginia chain fern *(Woodwardia virginica)*
- Broomsedge *(Andropogon virginicus)*
- Blue wood sedge *(Carex glaucodea)*
- Tussock sedge *(Carex stricta)*
- Northern sea oats *(Chasmanthium latifolium)*
- Canada wild rye *(Elymus canadensis)*
- Virginia wild rye *(Elymus virginicus)*
- Switchgrass *(Panicum virgatum)*
- Little bluestem (*Schyzachirium scopyrium*)
- Gama grass *(Tripsacum dactyloides)*
- False blue indigo *(Baptisia australis)*
- Marsh marigold *(Caltha palustris)*

HIMALAYAN BLACKBERRY *(RUBUS ARMENIACUS)*

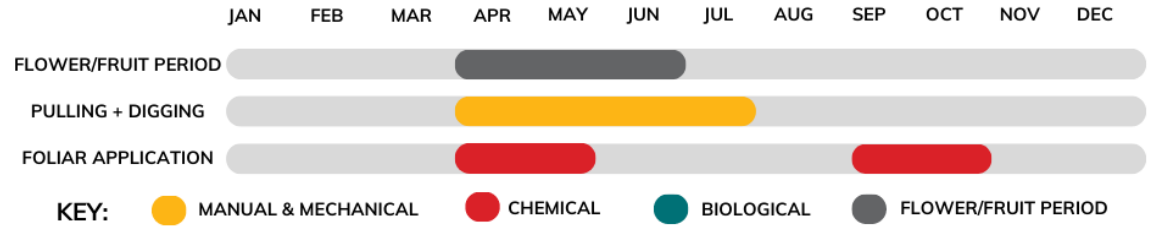


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Repeated cutting • Grubbing • Pulling and digging for small infestations	• Repeated foliar herbicide application • Cut stem herbicide application • Stem injection herbicide application • Basal herbicide application • Glyphosate or triclopyr	• Goat grazing • Cut stem herbicide application • Pulling and digging for small infestations

Native Plant Alternatives:

- Snowberry *(Symphoricarpos albus)*
- Northern sea oats *(Chasmanthium latifolium)*
- Goldenrod *(Solidago odora)*
- Black-eyed Susan *(Rudbeckia hirta)*
- Red Maple *(Acer rubrum)*
- Eastern redbud *(Cercis canadensis)*
- Golden ragwort *(Packera Aurea)*
- Zizia *(Zizia Aurea)*
- Downy serviceberry *(Amelanchier arborea)*
- Northern Red Oak *(Quercus rubra)*
- Pin Oak *(Quercus palustris)*
- Persimmon *(Diospyros virginiana)*
- Eastern White Pine *(Pinus strobus)*
- Tulip poplar *(Liriodendron tulipifera*

POVERTY BROME *(BROMUS STERILIS)*



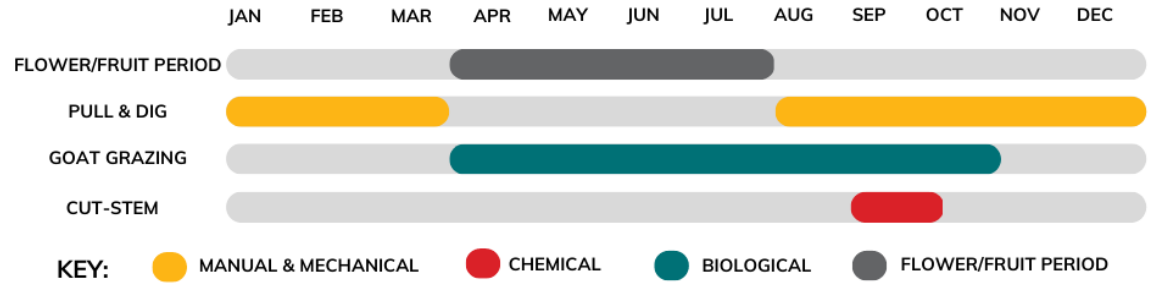
MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand pulling • Hoeing	• Foliar herbicide application • Selective: Metoxuron, metoxuron+simazine, isoproturon • Broad-spectrum: glyphosate, simazine	• Hand pulling and hoeing from spring to early summer • Early spring foliar herbicide application of glyphosate • Late summer to fall foliar herbicide application of Metoxuron, metoxuron+simazine and isoproturon

Native Plant Alternatives:

- Northern sea oats *(Chasmanthium latifolium)*
- Tufted hair grass *(Deschampsia cespitosa)*
- Switchgrass *(Panicum virgatum)*
- Broomsedge bluestem *(Andropogon virginicus)*
- Canada wildrye *(Elymus canadensis)*
- Christmas fern *(Polystichum acrostichoides)*
- Foamflower *(Tiarella cordifolia)*
- Golden groundsel *(Packera aurea)*
- Green and Gold *(Chrysogonum virginianum)*
- Lady fern *(Athyrium filix-femina)*
- Sensitive Fern *(Onoclea sensibilis)*
- Wild ginger *(Asarum canadense)*
- Blue Sedge *(Carex flacca)*
- Alumroot *(Heuchera richardsonii)*
- Blue Wood Aster *(Aster cordifolius)*
- Butterfly Weed *(Asclepias tuberosa)*
- New York Ironweed *(Vernonia noveboracensis)*
- Rosemallow *(Hibiscus moscheutos)*
- Wild Bergamot *(Monarda fistulosa)*

Third Priority Invasive Plant Species

WINEBERRY *(RUBUS PHOENICOLASIUS)*

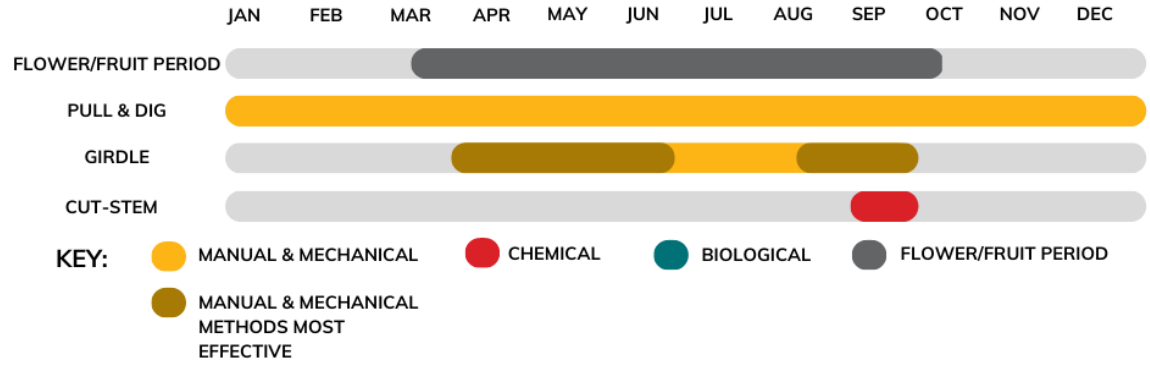


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand removal and digging of plants • Mowing or brush hogging	• Foliar herbicide application (triclopyr, metsulfuron-methyl) • Cut stem herbicide application (glyphosate, triclopyr)	• Hand removal and digging of plants • Cut stem herbicide application • Goat grazing

Native Plant Alternatives:

- Maple-leaf viburnum (*Viburnum acerifolium*)
- Coralberry (*Symphoricarpos orbiculatus*)
- Deer berry (*Vaccinium stamineum*)
- Allegheny blackberry (*Rubus allegheniensis*)
- Flowering raspberry (*Rubus odoratus*)

CALLERY PEAR *(PYRUS CALLERYANA)*[31]



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Pull and dig seedlings • Girdling	• Cut stump herbicide application (glyphosate, triclopyr) • Foliar herbicide application (glyphosate, triclopyr) • Basal bark herbicide application (triclopyr ester)	• Pull and dig seedlings • Cut stump herbicide application • Girdling

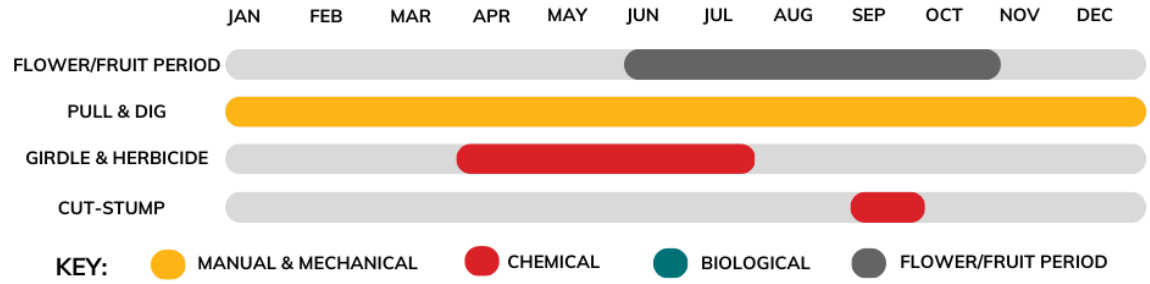
Native Plant Alternatives:

- Eastern redbud (*Cercis canadensis*)
- Serviceberry (*Amalanchier canadensis*)
- Fringetree (*Chionanthus virginicus*)
- Flowering dogwood (*Cornus florida*)
- Black gum (*Nyssia sylvatica*)
- Green hawthorn (*Crataegus viridis*)
- Eastern hophornbeam (*Ostrya virginiana*)
- Carolina buckthorn (*Rhamnus caroliniana*)
- Sassafras (*Sassafras albidum*)
- Blackhaw viburnum (*Viburnum prunifolium*)
- Rusty blackhaw Viburnum (*Viburnum rufidulum*)
- Trident maple (*Acer buergerianum*)
- Natchez crape myrtle (*Lagerstroemia indica x fauriei*)
- American witch hazel tree (*Hamamelis virginiana L.*)
- American hornbeam (*Carpinus caroliniana*)
- Pawpaw (*Asiminia triloba*)
- River birch tree (*Betula nigra*)
- White oak (*Quercus alba*)
- Northern red oak (*Quercus rubra*)

[31] For reference: https://extension.psu.edu/callery-pear

- Black oak (*Quercus velutina*)
- American sweetgum (*Liquidambar styraciflua*)

TREE OF HEAVEN *(AILANTHUS ALTISSIMA)*[32]



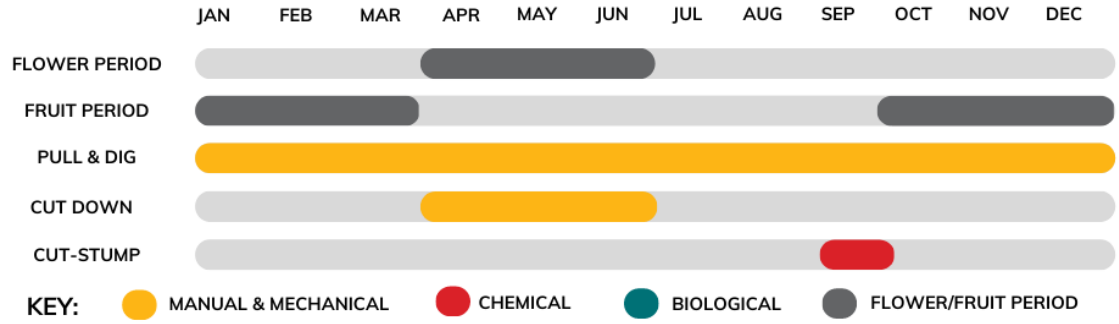
MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Pulling and digging saplings • Grubbing • Chopping & cutting • Girdling	• Foliar herbicide application (glyphosate, triclopyr) • Cut stump application (triclopyr ester, imazapyr • Trunk injections (triclopyr, imazapyr, dicamba, picloram, 2,4-D) • Girdling (glyphosate, imazapyr, triclopyr, or picloram with 2,4-D) • Basal bark herbicide application (triclopyr, picloram, imazapyr)	• Pulling and digging saplings • Girdling • Cut stump herbicide application

Native Plant Alternatives:

- Shagbark Hickory (*Carya ovata*)
- Butternut (*Juglans cinerea*)
- Smooth Sumac (*Rhus glabra*)
- Staghorn Sumac (*Rhus typhina*)
- Eastern American Black Walnut (*Juglans nigra*)
- Winged Sumac (*Rhus copallinum*)
- Box Elder (*Acer negundo*)

[32] Taken from https://extension.psu.edu/tree-of-heaven

PRINCESS TREE *(PAULOWNIA TOMENTOSA)*

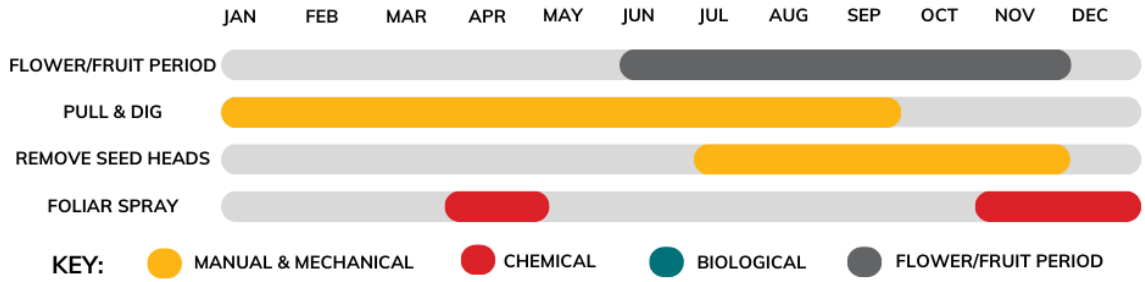


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Pulling and digging saplings • Cut at ground level • Girdling	• Cut stump herbicide application • Basal bark herbicide application • Foliar herbicide application • Hack-and-squirt injection	• Pulling and digging saplings • Cut stump herbicide application

Native Plant Alternatives:

- Serviceberry (*Amelanchier canadensis* and *A. arborea*)
- Redbud (*Cercis canadensis*)
- Flowering dogwood (*Cornus florida*)
- American holly (*Ilex opaca*)
- Red mulberry (*Morus rubra*)
- Spicebush (*Lindera benzoin*)
- Sassafras (*Sassafras albidum*)

COMMON TEASEL, FULLER'S TEASEL *(DIPSACUS FULLONUM)*

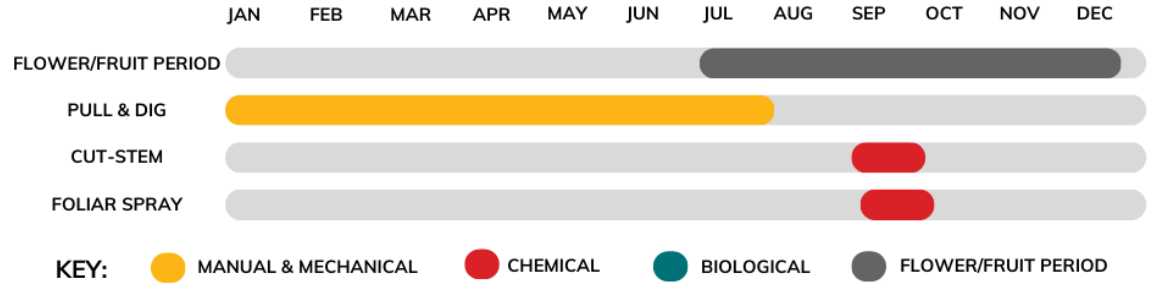


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Pulling and digging entire plant and roots • Cutting • Cutting flowers and seedheads • Mowing before seeds enlarge	• Foliar herbicide application • Selective: triclopyr • Broad-spectrum: glyphosate • Wipe method	• Cutting off flowers and seedheads, then • Pulling and digging entire plant and roots

Native Plant Alternatives:

- Rattlesnake master (*Eryngium yuccifolium*)
- Cup plant (*Silphium perfoliatum var. perfoliatum*)
- Culver's root (*Veronicastrum virginicum*)
- Giant blue hyssop (*Agastache foeniculum*)
- Compass plant (*Silphium lacinatum*)
- Prairie cinquefoil (*Potentilla arguta*)

JAPANESE MEADOWSWEET *(SPIRAEA JAPONICA)*

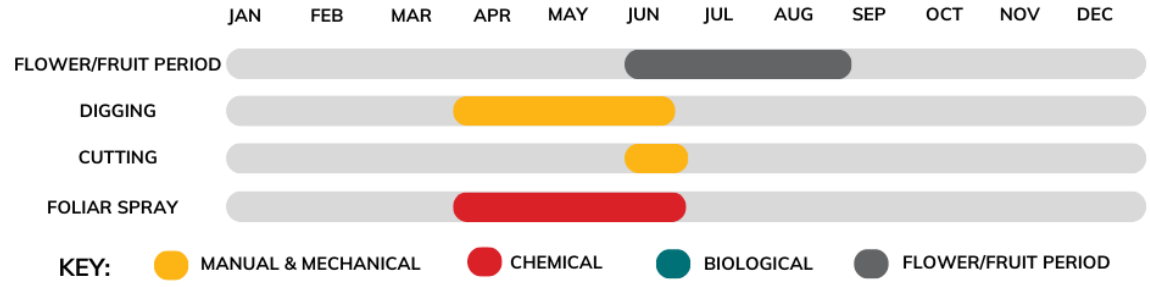


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Cutting prior to seed production for small populations or in environmentally sensitive areas • Repeated mowing/cutting • Pulling and digging seedlings when soil is moist	• Cut & paint herbicide application (glyphosate, triclopyr) • Foliar herbicide application (glyphosate, triclopyr) • Basal herbicide application (glyphosate, triclopyr)	• Manually remove seedlings • Cut & paint herbicide application

Native Plant Alternatives:

- White meadowsweet (*Spiraea alba*)
- Ninebark (*Physocarpus opulifolius*)
- Silky dogwood (*Cornus amomum*)
- Virginia sweetspire (*Itea virginica*)
- Leatherleaf (*Dirca palustris*)

COMMON VELVETGRASS *(HOLCUS LANATUS L.)*

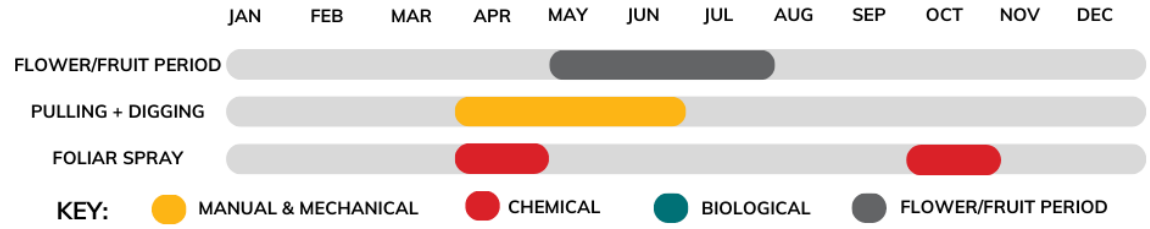


MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Hand pulling • Digging • Cutting plants in early June	• Foliar herbicide application (glyphosate, fluazifop, sethoxydim)	• Hand pulling and digging of the entire plant since there are small infestations

Native Plant Alternatives:

- Switchgrass *(Panicum virgatum)*
- Little bluestem *(Schizachyrium scoparium)*
- Indiangrass *(Sorghastrum nutans)*
- Bottlebrush grass *(Elymus hystrix)*
- Pennsylvania sedge *(Carex pensylvanica)*
- Prairie dropseed *(Sporobolus heterolopsis)*
- Northern sea oats *(Chasmanthium latifolium)*
- Indiangrass *(Sorghastrum nutans)*
- Black-eyed Susan *(Rudbeckia hirta)*

KENTUCKY BLUEGRASS *(POA PRATENSIS)*



MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Frequent hand pulling and/or hoeing	• Foliar herbicide application (glyphosate, Glyphosate, imazapyr, sulfometuron methyl)	• Manual & mechanical methods for small infestations and areas intermixed with desirable species • Herbicide application for monocultures

Native Plant Alternatives:

- Switchgrass *(Panicum virgatum)*
- Little bluestem *(Schizachyrium scoparium)*
- Indiangrass *(Sorghastrum nutans)*
- Bottlebrush grass *(Elymus hystrix)*
- Pennsylvania sedge *(Carex pensylvanica)*
- Prairie dropseed *(Sporobolus heterolopsis)*
- Northern sea oats *(Chasmanthium latifolium)*
- Indiangrass *(Sorghastrum nutans)*
- Black-eyed Susan *(Rudbeckia hirta)*

Invasive Insect Species

Spotted Lanternfly *(Lycorma delicatula)*

MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
● Scraping egg masses into a bottle of rubbing alcohol solution or soapy water[33] ● Smashing insect at any life stage ● Sticky traps ● Sticky bands ● Circle traps ● Using Tree of Heaven as a trap tree	● Contact insecticides ● Systemic insecticides ● Insecticidal soap ● Neem oil ● Treating Tree of Heaven trap trees with a systemic insecticide	● Any manual & mechanical methods are recommended ● Because there is a low infestation in our area, insecticides are not recommended ● Establishing and maintaining native plant communities that support generalist natural enemies such as praying mantids, assassin bugs, spiders ● Removal of most Tree of Heaven while leaving a few trees as 'trap trees' for SLF using manual methods and/or chemical methods[34]

[33] https://extension.umd.edu/resource/spotted-lanternfly-management-residents

[34] https://www.agriculture.pa.gov/Plants_Land_Water/PlantIndustry/Entomology/spotted_lanternfly/Documents/Spotted%20Lanternfly%20%20Property%20Management.pdf

Emerald Ash Borer *(Agrilus planipennis)*[35]

MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Removing ash trees that are dead or in poor condition	Prevention: • Trunk injections, trunk sprays, or basal soil drenches of systemic insecticides (imidacloprid, dinotefuran or emamectin) to prevent our specimen ash tree from being impacted by EAB[36] Control of EAB[37]: • soil drenches (Imidacloprid and dinotefuran) • soil injections (Imidacloprid and dinotefuran) • trunk injections (Imidacloprid, emamectin benzoate, azidirachtin, dinotefuran) • lower trunk sprays (Dinotefuran) • cover sprays to the trunk, main branches, and (depending on the label), foliage.	• Chemical methods have been proven the most effective for preventing ash trees from being impacted by EAB • Recommended methods include: ○ Trunk injections ○ Trunk sprays ○ Soil drenches • Removing ash trees that are dead or in poor condition

[35] https://www.aphis.usda.gov/import_export/plants/manuals/domestic/downloads/eab-manual.pdf
[36] https://www.canr.msu.edu/news/best-management-practices
[37] http://www.emeraldashborer.info/documents/multistate_eab_insecticide_fact_sheet.pdf

Spongy Moth *(Lymantria dispar)*

MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Scraping off egg masses • Sticky barriers can be placed on trees to trap caterpillars • Burlap collection bands can be placed after sticky bands are used • "Crush & brush" species in the pupal stage into a container with soapy water[38] • Leaving diseased larvae so that other larvae get infected[39] • Mass trapping with pheromone baited traps.	• Spraying egg masses with horticultural oil Biological methods: • (commonly called Btk) to kill caterpillars • Nucleopolyhedrosis virus (NPV), a natural disease agent in gypsy moth caterpillars. Gypchek® is a registered NPV product that is available for use.[40] • Release of sterile male gypsy moths. Chemical insecticides: • tebufenozide, which causes caterpillars to prematurely molt and stops them from feeding[41] • Mating disruption with a registered synthetic version of the pheromone disparlure in products such as Disrupt®II, Luretape Gypsy Moth®, and Luretape Plus®. • Other active ingredients labeled for use include acephate, acetamiprid, azadirachtin, Bacillus thuringiensis subsp. aizawai, carbaryl, emamectin benzoate,	• Manual methods are recommended • Biological methods are recommended as priority • Chemical methods are only recommended when there is a present threat

[38] https://fyi.extension.wisc.edu/spongymothinwisconsin/pest-management-2/management-guide-for-homeowners/#:~:text=Destroy%20egg%20masses%20by%20spraying,not%20labeled%20for%20spongy%20moth.
[39] https://cals.cornell.edu/new-york-state-integrated-pest-management/outreach-education/whats-bugging-you/spongy-moth
[40] https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5187452.pdf
[41] https://extension.psu.edu/preparing-for-high-spongy-moth-densities

	insecticidal soap, permethrin, and tebufenozide.[42]	

Pine Shoot Beetle *(Tomicus pniperda)*

MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
• Use trap logs to attract breeding parent beetles by systematically placing freshly cut pine trees or logs along the edges of the field in early spring. Chip or burn after breeding occurs but before new adults emerge.[43] • Potential egg-laying materials (such as stressed, dying, or dead pine trees) should be removed from a high-risk forest before the emergence of beetles in the spring[44]	• Insecticide applications to stumps • Insecticide applications to foliage	• Manual methods are recommended for preventative measures • Stump insecticide methods should only be used when this species is present • Foliage insecticide methods are not recommended to avoid chemical drift

[42] https://ag.umass.edu/landscape/fact-sheets/spongy-moth
[43] https://extension.psu.edu/pine-shoot-beetle
[44] https://www.invasivespeciescentre.ca/invasive-species/meet-the-species/invasive-insects/pine-shoot-beetle/

Asian Longhorned Beetle *(Anoplophora glabripennis)** species of concern

MANUAL & MECHANICAL	CHEMICAL	BEST MANAGEMENT PRACTICES
● Removing infested host trees via cutting or burning ● Chipping wood of infested trees[45] ● If ALB is found, trap and save it in a secure container and immediately call MDA at 410-841-5922[46]	● Imidacloprid can be applied to high-risk host trees via: ○ Tree trunk injections ○ soil drenches[47]	● This is a species of concern in Maryland, so manual, mechanical, and chemical methods are not recommended

[45] https://www.invasivespeciescentre.ca/invasive-species/meet-the-species/invasive-insects/asian-long-horned-beetle/
[46] https://extension.umd.edu/resource/forest-pests-asian-longhorned-beetle
[47] https://www.aphis.usda.gov/plant_health/plant_pest_info/asian_lhb/downloads/response-guidelines.pdf

8 DISPOSAL METHODS

For invasive plants:

- Place removed plant material in large black trash bags and dispose in landfill
- Place removed plant material in large black trash bags and leave it onsite to desiccate and dry out so material is not viable in order to:
    - Burn dried, unviable plant material; or
    - Compost dried, unviable plant material

For invasive insects:

- Smashing any adult insects and leaving them onsite
- Scraping egg masses into a secure container and let them die before disposing in landfill

9 PRECAUTIONS, EQUIPMENT, RESTRAINTS & CONSTRICTIONS

Precautions

Herbert Run is a part of UMBC's campus. It is a stream that runs through Baltimore County, and is a tributary of the Patapsco River that leads into the Chesapeake Bay. When designing a management plan for invasive species, it is crucial to prioritize different types of management options that are suitable for site-specific conditions. In regards to chemical control, it is important to avoid any risk of herbicidal contamination to nearby streams and groundwater sources[48]. Below are options of best management practices for invasive species management that should be considered for implementation.

1. Prioritize manual and mechanical removal in sensitive areas (100 feet buffer near streams and other water bodies). Hand pulling and the use of a weed wrench are preferable in order to avoid disturbing animals and other species and native plants.

2. It would be best practice to minimize the use and potential runoff of herbicides, so foliar applications should be of least priority for chemical control. Cut stump and basal bark methods should be prioritized when chemical control methods are needed. This is because there is a lower surface area and lower amount of chemicals used in these methods, so there is less runoff and the cost of chemical use is lowered.

3. Any implementation of biological control methods (i.e., goat grazing, introduction of insects, etc.) should be done before any chemical control methods to prevent harm and contamination.

4. Some invasive plant species can irritate or cut skin, so it is important to wear gloves, long sleeved shirts and pants when implementing control measures.

Equipment

1. Mechanical & manual control options:
    - Gloves
    - Rake
    - Pruners
    - Hand saw
    - Brush hog
    - 4-8mil pvc black tarp for smothering
    - Landscape stakes and staple for securing tarp

2. Chemical control options:
    - Backpack sprayers of glyphosate, Garlon (these are commonly used by

[48] https://www.scientificamerican.com/article/weed-whacking-herbicide-p/#:~:text=Used%20in%20yards%2C%20farms%20and,placental%20and%20umbilical%20cord%20cells

Landscape & Grounds?)
- Brushes for painting herbicide
- Blue dye typically used for marking treated areas
- Personal Protective Equipment (PPE): nitrile chemical gloves, safety glasses, face protection (respirator)

3. Biological control options:
    - Goat grazing
        - Eco Goats contact information
        - Browsing Green Goats
    - Cathy Stragar, Maryland Department of Agriculture, has permitting and federal funding from USDA-APHIS to raise and release psyllids for Japanese Knotweed

Constraints & Restrictions

For the forest conservation easement areas on campus: No materials may be dumped, placed or stored in the Easement Area, including, but not limited to, ashes, sawdust, bark, trash, garbage, rubbish, dredge spoil, chemicals, pesticides, fertilizers, abandoned vehicles, appliances, or machinery.

For more information on pesticide regulations in Maryland visit:
https://mda.maryland.gov/plants-pests/Pages/pesticide_regulation.aspx

10 COST ESTIMATES

UMBC campus is a 512 acre campus, and about 125 acres of campus are forested/natural areas. With these calculations, it's clear that a combination of mechanical and chemical treatment is the most cost effective and efficient; however, it is highly recommended that we invest in goat grazing in at least the two areas highlighted on campus (Priority Areas #1 and #2).

125 acres of mechanical and chemical treatment would be $6,370,650, and this is just the cost for initial mechanical and chemical treatment. We won't be able to treat all of campus given this high cost considering follow up treatment costs in addition. A breakdown of the highlighted priority areas will help determine what will fit in UMBC's budget for invasive species management.

The initial estimates for mechanically and chemically treating the proposed kudzu patch site (Priority Area #1: 10 ft x 300 ft, or 3,000 sq ft) is $3,500

The two sites that are proposed for goat grazing are also the kudzu patch site by the UMBC silo (Priority Area #1), and the forest edge by the AOK Library behind the Central Plant (Priority Area #2: 80 ft x 350 ft). The total cost for both sites is $7,500. The total area of these two sites (31,000 sq ft) is the minimum size needed in order to have goat grazing done on campus.

Using tarp for solarization and occultation is an alternative that may save time and costs for manual and mechanical labor. The average price per square foot is included for black tarp (occultation) and clear tarp (solarization) purposes.

Method	Rates
Mechanical + Chemical	$1.17/sq ft or $50,965.20/acre
Goat Grazing	$4.13/sq ft or $179,902.80/acre
8 mil Black Tarp	$3-9/ sq ft
6 mil Clear Tarp	$9/ sq ft

Home Depot black tarp: $2.34/ sq ft
Tractor Supply Co black tarp: $2.88/ sq ft

Site Description	Size	Cost Estimate

Priority Area #1: Kudzu patch by UMBC Silo	10-50 ft x 300 ft 3,000-15,000 sq ft 0.068- 0.344 acres	Mechanical + chemical: $3,500-$17,500 Goat Grazing: $7,500 (including Priority Area #2)
Priority Area #2: Forest edge by AOK Library	80 ft x 350 ft 28,000 sq ft 0.643 acres	Mechanical + chemical: $32,760 Goat Grazing: $7,500 (including Priority Area #1)
Priority Area #3: Forest edge NE section of Hilltop Circle	10 ft x 300 ft 3,000 sq ft 0.068 acres	Mechanical + chemical: $3,500
Forest Conservation Easements on W and NE sides of campus	24 acres	Mechanical + chemical: $1,223,164.80
NE perimeter of UMBC campus	12 acres	Mechanical + chemical: $611,582.40
AOK Library forest patch	2 acres	Mechanical + chemical: $101,930.40
Forest edge behind Lots 23 + 24 and Facilities Management	~10 acres	Mechanical + chemical: $509,652
Entire forest edge in the NE section of Hilltop Circle	~9 acres	Mechanical + chemical: $458,686.80
South edge of Hilltop Circle including restoration area + CERA Pigpen Pond	~12 acres	Mechanical + chemical: $611,582.40
CERA	50 acres	Mechanical + chemical: $2,548,260
The Knoll	~6 acres	Mechanical + chemical: $305,791.20
Entire area of natural spaces on campus	~125 acres	Mechanical + chemical: $6,370,650

11 APPENDICES

APPENDIX A. ACKNOWLEDGEMENTS

UMBC Land Acknowledgement: UMBC was established upon the land of the Piscataway Conoy and Susquehannock peoples. Over time, citizens of many more Indigenous nations have come to reside in this region. We humbly offer our respects to all past, present, and future Indigenous people connected to this place.

I am grateful to all of those with whom I have had the pleasure to work during this fellowship and related projects. This acknowledgement is not limited to this list, as these were the people I have worked and connected with closely.

Strategic Energy Innovations (SEI) Climate Corps Program:
- Cyan Dandridge, Founder and Executive Director of SEI
- Ondrea Austin, Program Manager and East Coast Regional Supervisor

UMBC Office of Sustainability:
- Ryan Kmetz, Director of Sustainability
- Claire Runquist, Environmental Sustainability Coordinator
- Celine Brundridge, Eco-Ambassador Team Lead
- Alex Bauserman, Eco-Ambassador

UMBC Facilities Management:
- Charlie Hogan, Landscape & Grounds Manager
- Molly Power, Campus Planner I
- Will Wiley, GIS Mapping Specialist
- John Zahor, Assistant Vice President Facilities Management
- Valerie RiChard, Director of Operations and Maintenance
- Linda Zepp, Administrative Assistant
- Tom Argasinski, Assistant Director of Design & Construction Services
- Larry Hennessey, former Associate Director of Design & Construction Services, and advisor for the Environmental Task Force club
- John Savage, IT Specialist
- Phill Cho, Landscape Architect

UMBC Department of Geography & Environmental Systems:
- Matt Baker, Associate Dean & Professor
- Anita Kraemer, Graduate student, ForestGEO Inventory
- Suzanne Braunschweig, Principal Lecturer, Chair of the Conservation and Environmental Research Area (CERA) Committee
- Andy Miller, Professor and in charge of the GES Department Seminar Series
- Maggie Holland, Acting GES Department Chair, Associate Professor
-

UMBC SGA:
- Thirandie Bambaradeniya, SGA Director of Sustainability

UMBC GESCoM:
- Amal Hussain, Executive Board

UMBC Environmental Task Force:
- James Harris, former president (2022-2023)
- Sam Christenson, former vice president (2022-2023)

- Josh Ohler, former treasurer (2022-2023)
- Camryn Blair, current president (2023-2024)
- Alex Bauserman, current vice president (2023-2024)
- Rohan Kyasa, current treasurer (2023-2024)

Chartwells, UMBC Dining Services:
- Adam Sachs, Resident Campus Dietician
- Megan Gibbs, Marketing Manager

Towson University:
- Jim Hull, Professor Emeritus, Director of Glen Arboretum
- Donna Anderson, Manager of Landscape Services
- Paddy Watson, Director of Sustainability
- Vanessa Beauchamp, Associate Professor, Biological Sciences
- Meghan Bennett, Sustainability Specialist
- Roni Cassilly, goat herder from Harmony Church Farm, Goats in the Glen

Sierra Club Maryland Chapter:
- Marc Imlay, Member of the Natural Places Committee

Baltimore Green Space:
- Katie Lautar, Executive Director
- Eric Fishel, Forest Program Manager

Maryland Department of Agriculture:
- Craig Kuhn, Program Manager of Forest Pest Management
- Heather Harmon Disque, Forest Health Entomologist
- Cathy Stragar, Administrator II, Greenhouse & Plant Pathology Lab, Biocontrol Program, Plant Protection and Weed Management

Howard Eco Works
- Lori Lilly, Executive Director
- Genevieve Simard, Field Operations Manager

Maryland-National Capital Park and Planning Commission
- Ning Xu, Senior Park Ranger

Chesapeake Climate Action Network
- Jesse Buff, Invasive Vines Volunteer Program Coordinator

A&A Tree Experts
- Rich Anaker
- Kaity Handley, Plant Healthcare Department Manager

OCA Mocha
- Michael Berardi, Manager

Jessie Houff Art
- Jessie Houff, Community Artist

APPENDIX B. STATE FOREST CONSERVATION TECHNICAL MANUAL

This manual is provided by the Maryland Department of Natural Resources for reference: https://legislativereference.baltimorecity.gov/sites/default/files/Forest%20Conservation%20Technical%20Manual_State%20-%201997.pdf

APPENDIX C. NATIVE PLANT ALTERNATIVES

Please note that any list of native plant alternatives in this document is not an exhaustive list.

Groundcover Layer Plants:

- Alumroot (*Heuchera villosa)*
- Bearberry *(Arctostaphylos uva-ursi)*
- Bloodroot (*Sanguinaria canadensis*)
- Calamint (*Clinopodium arkansamum*)
- Canada mayflower (*Maianthemum canadense*)
- Creeping juniper (*Juniperus horizontalis*)
- Creeping mint (*Meehania cordata)*
- Creeping phlox (*Phlox stolonifera*)
- Green-and-gold (*Chrysogonum virginianum*)
- Native pachysandra, Allegheny spurge, or Allegheny pachysandra (*Pachysandra procumbens*)
- Partridgeberry (*Mitchella repens*)
- Twinleaf *(Jeffersonia diphylla)*
- Violet (*Viola canadensis*)
- Virginia ginger (*Hexastylis virginica*)
- Wild ginger (*Asarum canadense*)
- Wild strawberry (*Fragaria virginiana*)
- Wood poppy *(Stylophorum canadense)*

Herbaceous Layer Plants:

- Annual ryegrass (*Lolium multiflorum*)
- Aromatic aster (*Symphyotrichum oblongifolium*)
- Bee balm (*Monarda didyma*)
- Big bluestem (*Andropogon gerardii)*
- Big leaf aster (*Aster macrophyllus*)
- Bishop's cap (*Mitella diphylla*)
- Black-eyed Susan *(Rudbeckia hirta)*
- Bloodroot *(Sanguinaria canadensis)*
- Bluebells (*Mertensia virginica*)
- Blue flag iris *(Iris versicolor)*
- Blue indigo (*Baptisia australis*)
- Blue Wood Aster *(Aster cordifolius)*
- Blue wood sedge (*Carex glaucodea*)
- Bottlebrush grass (*Elymus hystrix*)
- Bracken fern *(Pteridium)*
- Bristle-leaved sedge (*Carex eburnea*)
- Broadleaf arrowhead *(Sagittaria latifolia)*
- Broomsedge (*Andropogon virginicus*)
- Butterflyweed (*Asclepias tuberosa*)

- Canada anemone (*Anemone canadensis*)
- Canada lily (*Lilium canadense*)
- Canada wild rye (*Elymus canadensis*)
- Cardinal flower (Lobelia cardinalis)
- Carolina allspice (*Calycanthus floridus*)
- Christmas fern (*Polystichum acrostichoides*)
- Cinnamon fern *(Osmunda cinnamomea)*
- Clearweed (*Pilea pumila*)
- Colonial oak sedge (*Carex communis*)
- Common milkweed (*Asclepias syriaca*)
- Common yarrow (*Achillea millefolium* var. *alpicola)*
- Compass plant (*Silphium lacinatum*)
- Crested wood fern (*Dryopteris cristata*)
- Culver's root (*Veronicastrum virginicum*)
- Cup plant (*Silphium perfoliatum var. perfoliatum*)
- Cutleaf toothwort *(Cardamine concatenata)*
- Deer-tongue grass (*Dichanthelium clandestinum*)
- Dutchman's breeches *(Dicentra cucullaria)*
- Dwarf crested iris (*Iris cristata*)
- Eastern gamagrass (*Tripsacum dactyloides*)
- Eastern woodland sedge (*Carex blanda*)
- Enchanter’s nightshade (Circaea lutetiana)
- Field pussytoes (*Antennaria neglecta*)
- Foamflower (*Tiarella cordifolia*)
- Gama grass *(Tripsacum dactyloides)*
- Giant blue hyssop (*Agastache foeniculum*)
- Giant burreed *(Sparganium eurycarpum)*
- Golden ragwort (*Packera aurea*)
- Goldenrod (*Solidago*)
- Golden star sedge (*Carex rosea*)
- Hairy jointgrass/Small carpetgrass (*Arthraxon hispidus*)
- Horseweed (*Conyza canadensis*)
- Indiangrass *(Sorghastrum nutans)*
- Interrupted fern (*Osmunda claytoniana)*
- Ivory sedge (*Carex eburnea*)
- Jack-in-the-pulpit (*Arisaema triphyllum* (L.)
- Jacob’s ladder (*Polemonium reptans*)
- Jewelweed (*Impatiens capensis*)
- Joe-pye weed (*Eutrochium maculatum*)
- Lady fern *(Athyrium filix-femina)*
- Little bluestem (*Schizachyrium scoparium);*Common cultivars: ‘Standing Ovation’, ‘Cimmaron’, ‘Smoke Signal’
- Long beaked sedge (*Carex sprengelii*)
- Lyreleaf sage (*Salvia lyrata*)
- Male fern (*Dryopteris filix-mas*)

- Marginal woodfern (*Dryopteris marginalis)*
- Marsh fern *(Thelypteris palustris)*
- Marsh marigold (*Caltha palustris*)
- Mayapple (*Podophyllum peltatum*)
- Mountain mint (*Pycnanthemum muticum*)
- Mouse-eared coreopsis (*Coreopsis auriculata*)
- Narrowleaf blue-eyed grass (*Sisyrinchium angustifolium*)
- Native broadleaf cattail *(Typha latifolia)*
- Native violet (Viola banksii)
- Netted chain fern *(Woodwardia areolata*)
- New england aster (*Symphyotrichum novae-angliae)*
- New York fern *(Thelypteris noveboracensis)*
- New York ironweed (*Vernonia noveboracensis*)
- Nimblewill (*Muhlenbergia schreberi*)
- Northern blue blag iris (*Iris versicolor*)
- Northern sea oats (*Chasmanthium latifolium*)
- Ostrich fern (*Matteuccia struthiopteris*)
- Parlin's pussytoes (*Antennaria parlinii*)
- Partridge pea (*Cassia fasciculata*)
- Pennsylvania knotweed (*Polygonum persicaria*)
- Pennsylvania sedge (*Carex pennsylvanica*)
- Pickerelweed *(Pontederia cordata)*
- Plantain-leaf pussytoes (*Antennaria plantaginifolia*)
- Plantain-leaved sedge (*Carex plantaginea*)
- Prairie cinquefoil (*Potentilla arguta*)
- Prairie dropseed (*Sporobolus heterolopsis)*
- Purple love grass (*Eragrostis spectabilis)*
- Rattlesnake master (*Eryngium yuccifolium*)
- Red baneberry (*Actaea rubra*)
- Robin's plantain (*Erigeron pulchellus*)
- Round-leaved ragwort (*Packera abovata*)
- Royal fern *(Osmunda regalis)*
- Sensitive fern (*Onoclea sensibilis)*
- Silver sedge (*Carex platyphylla*)
- Softstem bulrush *(Schoenoplectus tabernaemontani)*
- Southern blue flag iris (*Iris virginica*)
- Squirrel-corn *(Dicentra canadensis)*
- Sweet flag *(Acorus americanus)*
- Switchgrass (*Panicum virgatum*)
- Toothwort (*Cardamine diphylla*)
- Tufted hair grass *(Deschampsia cespitosa)*
- Tussock sedge (*Carex stricta*)
- Verbena (*Glandularia canadensis*)
- Virginia chain fern *(Woodwardia virginica)*

- Virginia cutgrass (*Leersia virginica*)
- Virginia wild rye (*Elymus virginicus*)
- White avens (Geum canadense)
- White bear sedge (*Carex albursina*)
- White water lily *(Nymphaea odorata)*
- Wild Bergamot *(Monarda fistulosa)*
- Wild carrot or Queen Anne's Lace *(Daucus carota)*
- Wild senna (*Senna hebecarpa or marilandica*)
- Wild sweet william (*Phlox divaricata*)
- Woodland aster (*Eurybia divaricatus)*
- Woodland phlox (*Phlox divaricata*)
- Yellow wild indigo (*Baptisia tinctoria*)
- Zizia *(Zizia Aurea)*

Understory Layer Plants:

- Allegheny barberry (*Berberis canadensis*)
- Allegheny blackberry (*Rubus allegheniensis*)
- American beautyberry (*Callicarpa americana*)
- American fly honeysuckle (*L. canadensis*),
- American hazelnut (*Corylus americana*)
- American hornbeam (*Carpinus caroliniana*)
- American strawberry bush (*Euonymus americanus*)
- American witch hazel tree (*Hamamelis virginiana L.*)
- Arrowwood viburnum (*Viburnum dentatum*)
- Bayberry (*Myrica pensylvanica*)
- Black chokeberry (*Aronia melanocarpa*)
- Blackhaw viburnum (*Viburnum prunifolium*)
- Bottlebrush buckeye (*Aesculus parviflora*) *native to South Carolina to Florida, in regards to shifting growth zones due to climate change, this could be a suitable plant
- Butternut (*Juglans cinerea*)
- Buttonbush (*Cephalanthus occidentalis*)
- Carolina buckthorn (*Rhamnus caroliniana*)
- Carolina cherry laurel (*Prunus caroliniana*)
- Carolina rose (*Rosa caroliniana*)
- Common ninebark (*Physocarpus opulifolius*); Ginger wine; Summer wine black ninebark; Tiny wine gold ninebark (*Physocarpus opulifolius*);
- Coralberry (*Symphoricarpos orbiculatus*)
- Deer berry (*Vaccinium stamineum*)
- Downy serviceberry (*Amelanchier arborea*)
- Dwarf fothergilla (*Fothergilla gardenii*) *not native to Maryland, native to North Carolina and south, in regards to shifting growth zones due to climate change, this could be a suitable plant
- Eastern baccharis (*Baccharis halimiolia*)
- Eastern hophornbeam (*Ostrya virginiana*)
- Eastern wahoo (*Euonymus atropurpureus*) is an American Euonymus plant

- Flameleaf sumac (*R. copallinum*)
- Fragrant sumac (*Rhus aromatica*)
- Gray dogwood (*Cornus racemosa*)
- Green hawthorn (*Crataegus viridis*)
- Highbush blueberry (*Vaccinium corymbosum*)
- Inkberry holly (*Ilex glabra*)
- Kodiak black diervilla (*Diervilla rivularis*)
- Kodiak orange diervilla (*Diervilla x*)
- Leatherleaf (*Dirca palustris*)
- Limelock arrowwood (*Viburnum bracteatum*)
- Maleberry (*Lyonia ligustrina*)
- Mapleleaf viburnum (*Viburnum acerifolium*)
- Meadow rose (*Rosa blanda*)
- Mountain fly honeysuckle (*L. villosa*)
- Mountain laurel (*Kalmia latifolia*)
- Mountain witch alder (*Fothergilla major*)
- Natchez crape myrtle (*Lagerstroemia indica x fauriei*)
- Native black raspberry (*Rubus occidentalis*)
- New jersey tea (*Ceanothus americanus*)
- Ninebark (Physocarpus opulifolius)
- Northern bush-honeysuckle (*Diervilla lonicera*)
- Pawpaw (*Asiminia triloba*)
- Possumhaw viburnum (*Viburnum nudum*)
- Purple-flowering raspberry (*Rubus odoratus*)
- Red chokeberry (*Aronia arbutifolia*)
- Red osier dogwood (*Cornus sericea*)
- Rosemallow *(Hibiscus moscheutos)*
- Rose meadowsweet (*Spiraea splendens*)
- Rusty blackhaw Viburnum (*Viburnum rufidulum*)
- Shagbark Hickory (*Carya ovata*)
- Silky dogwood (*Cornus racemosa*)
- Smooth sumac (*Rhus glabra*)
- Snowberry *(Symphoricarpos albus)*
- Southern arrowwood (*Viburnum dentatum*)
- Southern wax myrtle (*Morella cerifera*)
- Spicebush (*Lindera benzoin*)
- Star jasmine (*Trachelospermum jasminoides*)
- Summersweet (*Clethra alnifolia*)
- Swamp fly-honeysuckle (*L. oblongifolia*)
- Swamp rose (*Rosa Palustris*)
- Virginia rose (*Rosa virginiana*)
- Virginia sweetspire (*Itea virginia*)
- White meadowsweet (*Spiraea alba*)
- Wild hydrangea (*Hydrangea arborescens*)

- Oakleaf hydrangea (*Hydrangea quercifolia*)
- Winged sumac (*Rhus copallinum*)
- Winterberry holly (*Ilex verticillata*)
- Witch hazel (*Hamamelis virginiana*)
- Withe rod (*Viburnum nudum*)

For more information please visit: Alliance for the Chesapeake Bay Native Plant Center

APPENDIX D. LIST OF NATIVE TREES

*See:
https://drive.google.com/file/d/1Wkwtg5LPx3Km5Q1bXLJDf8wUo9ENkCrz/view?usp=sharing

APPENDIX E. NATIVE PLANTS FOR WILDLIFE HABITAT AND CONSERVATION LANDSCAPING

https://dnr.maryland.gov/criticalarea/Documents/chesapeakenatives.pdf

APPENDIX F. LIST OF SOUTHERN INVASIVE PLANT SPECIES

*See:
https://drive.google.com/file/d/1fnLrkeK3GnU7m_5aWM7a8H9vx97bwJXl/view?usp=sharing

APPENDIX G. BEST MANAGEMENT PRACTICES REFERENCE DOCUMENTS

*See:
https://drive.google.com/drive/folders/1xfLusTxlLRnySmNaqOirlQUEqivPYj3z?usp=sharing

APPENDIX H. ALTERNATIVE CONTROL OPTIONS

For dense patches and monocultures of invasive plant species, solarization and occultation are alternative control options to effectively control invasive species while minimizing soil disturbance.

Solarization

Solarization is the use of 2-6 mil clear plastic tarp to cover an area of invasive plants. “The plastic traps heat and moisture, which encourages seed germination and plant growth. By blocking access to water and heating up the soil, the process eventually kills the vegetation underneath. The heat from the sun can penetrate through the clear tarp, and the heat gets trapped, killing the plants underneath. By blocking access to water and heating up the soil, the process eventually kills the vegetation underneath.” - University of Minnesota
This also prevents additional moisture getting to the plants underneath which will also eventually kill them. This can effectively control weeds in a 2-3 week period during the hot summer months.

Occultation

For invasive plants located in the groundcover, understory, and canopy, one method is to cut the plant down as close to the ground as possible or try to remove as much of the aboveground plant and root structure (depending on the species), put 8 mil black tarp over the area with a few feet extra on the perimeter, and secure with landscape staples or large rocks around the edges. Mulch can be put on top of it for extra sunlight blockage and for aesthetic purposes. This can be left for 1-2 growing seasons. The University of Minnesota claims that occultation takes longer than solarization, that is comparing 4-6 weeks of treatment versus 2-3 weeks of treatment.

- Pros: less labor depending on species, lower cost with less chemical usage, effectively kills aboveground plant and belowground root structure
- Cons: longer time period, depending on how much sheeting needs to be used it could be expensive, could be more laborious in areas with high infestations.

Goat Grazing

Towson University has been hosting the Goats at the Glen Arboretum where they hired Harmony Church Farm to bring in their goats to eat woody invasive plant species. This is a beneficial biological control option to reduce invasive plant coverage, and then have volunteers pull up the remaining invasive plants. This can be done when plants are fully leafed out through the late summer.[49] Goats are also great at getting to hard-to-reach places where mechanical equipment or even people can’t get to. Harmony Church Farm did their last Goats at the Glen event last year, but there are other local goat farms in the state the University could look into if they are interested in implementing this biological control option:

- Eco-Goats: From their website, “We offer a free visit to walk your property, evaluate your needs, answer your questions, and determine if goats would be a good choice. We assess the vegetation, make sure we know what your intentions for the property are

[49] https://woodyinvasives.org/management/grazing/#1593464256974-8b8c7c48-8959

(there is no one "right" plan for all property), and then provide you with an estimate given the acreage, vegetation, time and materials involved. When your scheduled date arrives, we move the goats by trailer from our farm in Centreville, MD to your property. We set up portable electric fencing that we provide, including information and warning notices so that curious passers-by can safely enjoy watching the goats graze. In most cases, grazing goats are visited on the job by an Eco-Goats staff member once a day. We check for any problems in fencing (even if a part were to be down, the goats respect that electric deterrent!), evaluate the grazing, and make sure everyone is healthy and happy. Once finished, we remove the goats and fence. Goat droppings become great fertilizer, so this parting gift is yours to keep! Having been trampled by the goats, it breaks down quickly and becomes rich soil. Depending on the time of year, it is most often absorbed into the land within a week or two. The goats are just the first step! We work with landowners to formulate a long-term plan for managing the re-growth and eradication of unwanted and invasive vegetation. Brian is a Licensed Professional Forester and has written many Forest Stewardship Plans for landowners.

- Browsing Green Goats from their website, “In many cases, you’ll find that renting a herd of goats for grazing to clear your land will cost less than other more traditional methods. This is especially the case in areas where people and machines cannot go safely. Rates are determined by the size of the area to be munched and the density of the vegetation/distance from the farm/how much clearing has to be done to put up the temporary electric fencing for the goats. Size x density + herd size = # of days to complete. No two jobs are the same. Prices range from $1,500 – $50,000 a project. “Save the environment, Save the pollinators, rent goats for grazing invasive species is our motto”. Goats favorite things to eat are Poison Ivy, Kudzu, Phragmites, Knotweed, Wisteria, Oriental Bittersweet, Multiflora Rose, Japanese Honeysuckle, Reed Grass.
- Invasive plants from the priority list that goats can eat:
    - Common Reed, Phragmites *(Phragmites australis)*
    - Chinese Silvergrass (*Miscanthus sinensis*)
    - Japanese Knotweed (*Reynoutria japonica*)
    - Chinese Lespedeza *(Lespedeza cuneata)*
    - Blue Buffel Grass *(Cenchrus ciliaris)*
    - Sweet Autumn Clematis, Sweet Autumn Virginsbower, Japanese Clematis *(Clematis terniflora)*
    - Bull Thistle *(Cirsium vulgare)*
    - Creeping Thistle *(Cirsium arvense)*
    - Common Mugwort *(Artemisia vulgaris)*
    - Kudzu *(Pueraria montana)*
    - Autumn Olive *(Elaeagnus umbellata)*
    - English Ivy *(Hedera helix)*
    - Porcelainberry *(Ampelopsis brevipedunculata)*
    - Japanese Honeysuckle *(Lonicera japonica)*
    - Amur Honeysuckle, Bush Honeysuckle *(Lonicera maackii)*
    - Mile-a-Minute *(Persicaria perfoliata)*
    - Oriental Bittersweet *(Celastrus orbiculata)*
    - Garlic Mustard *(Alliaria petiolata)*
    - Wintercreeper *(Euonymus fortunei)*
    - Common Periwinkle & Bigleaf Periwinkle *(Vinca minor) & (Vinca major)*
    - Multiflora Rose *(Rosa multiflora)*
    - Japanese Barberry *(Berberis thunbergii)*
    - Wineberry *(Rubus phoenicolasius)*

Foaming

“Foaming equipment, such as Foamstream, uses heated water to kill weeds. The foam is primarily a water solution mixed with biodegradable and organic foam. This foam blanket helps denature plant proteins by retaining and concentrating the water's heat on the crown of the weed for a more effective kill rate. The price for foaming equipment usually exceeds steaming equipment, but foaming equipment operates faster and quieter. The capital cost for foaming equipment usually exceeds steaming equipment, but the equipment speed and fewer treatment cycles normally offsets these upfront costs in the long-term.” - Lawn & Land

APPENDIX I. TREE CARE REPLACEMENT PLAN

For any trees that are dead from the infestation of invasive plant and/or insect species, it is recommended to remove those trees and replace them with native trees. Please reference the other appendix documents for a list of native plants and trees.

Please see the Maryland Green Purchasing Committee Approved Specification – Landscaping Plants for a list of prohibited invasive plant species and resources for finding native plant species.

APPENDIX J. FUNDING OPPORTUNITIES

Below is a list of funding resources that the University should consider for supporting the efforts of invasive species management on campus.

www.grants.gov for all US grant opportunities

BGE Green Grants: These grants are being offered to communities within the BGE's service area. These grants complement our environmental giving and are part of steps to link our employees to the communities they live and work in.

Grant Criteria:

- Organization must be a 501c3 non-profit with Board of Directors
- Organization must meet all grant guidelines description for eligibility
- Grant range - $500-$10,000
- Grant funds limited to 10% of operating budget.
- Grants will be considered for new and existing programs that fall within the Energy Empowerment in our Communities focus areas as well as requests for funding that clearly demonstrates improvement in environmental efforts of the community.
- All applications must include a project budget indicating how grant dollars will be spent.
- Applications will not be accepted for grants requested for basic operating expenses.
- The project must be located geographically within the BGE service area.
- BGE employee engagement is preferred but not required (Example: board or volunteer role).
- All awarded grantees must submit a brief report within 8 months of receiving funds detailing expenditures of the grant in order to be considered for any future funding.
- Applications are reviewed in April with notifications the end of April. Payments made in May.

Environmental Focus Areas

- Conservation
    - Green Space preservation
    - Wetlands restoration
    - Wildlife/habitat protection
- Education
    - Workshops, seminars, training and/or public relations to inform and influence the public regarding environmental stewardship
- Energy Efficiency
    - Projects and/or partnerships that support large and small-scale energy conservation measures
- Pollution Prevention
    - Recycling projects and drop-off collection events
    - Tree plantings and maintenance to reduce CO2 emissions
    - Litter reduction
- Community Engagement
    - Neighborhood, park clean-ups
    - Creation of public green spaces, community gardens, urban forests

Baltimore Community Foundation: We welcome applications from organizations across Baltimore City and Baltimore County that are strengthening schools and building neighborhoods

where children and families can thrive.

Maryland Native Plant Society: The 2023 grant applications are now being accepted. Anyone may apply whose project meets the following criteria:

- The project must concern Maryland native vascular plants, bryophytes, and/or their habitats.
- The project may concern the effects of invasive non-native plants on Maryland native plants.
- Following these criteria, projects in a number of different fields and disciplines may be appropriate, for example: botany, ecology, genetics, education, environmental restoration, horticulture, and silviculture.
- 2023 Application due March 27, 2023
  Background and Scope
    - MNPS allocates funds for empirical, hypothesis-driven research relevant to Maryland's native plants.
    - A committee comprising local educators and scientists will review applications and administer the awards.
    - The committee may choose to fund more than one grant; the maximum amount awarded to any applicant will be $3000.
    - Email the proposal as a single document to grants@mdflora.org
    - For additional information, questions may be addressed to grants@mdflora.org

Chesapeake Bay Trust Outreach and Restoration Grant Program

- Grant applications are closed, but this is a good resource to check back on later
- The Outreach and Restoration Grant Program is a partnership between the Chesapeake Bay Trust and Charles County, the City of Annapolis, the City of Baltimore Department of Public Works, the City of Gaithersburg, the City of Salisbury, Harford County, Howard County, the Maryland Department of Transportation Maryland Port Administration, Queen Anne's County, and Tradepoint Atlantic.
- This grant program encourages outreach, community engagement activities, and on-the-ground restoration projects that increase knowledge, change behavior, and accelerate stewardship of natural resources that involve residents in restoring local green spaces, waterways, and natural resources.
- What this funds: This grant program welcomes applications for projects in the state of Maryland. Applicants can request funds from one of the following tracks.
    Track 1: Outreach/Knowledge Building Projects (up to $30,000)
    Track 2: Behavior Change Projects (up to $50,000)
    Track 3: Restoration Projects (up to $50,000)
    Track 4: Outreach and Restoration Projects (up to $75,000)
- Who can apply: Non-profit organizations, community and homeowner associations, faith-based organizations, and more. See the RFP for full list of organizations.
- Match is encouraged but not required.

National Coastal Wetlands Conservation Grants: Today, the U.S. Fish and Wildlife Service is awarding nearly $19 million to support 21 projects in eight coastal states to protect, restore or enhance nearly 14,000 acres of coastal wetlands and adjacent upland habitats under the National Coastal Wetlands Conservation Grant Program.

- State, local and Tribal governments, private landowners, conservation groups and other partners will contribute more than $20 million in additional funds to these projects. These grants will have wide-reaching benefits for local economies, people and wildlife – boosting coastal resilience, reducing flood risk, stabilizing shorelines and protecting

natural ecosystems.
- Northeast Region 5 Contact information: Bill Perry, +1-413-253-8302
- Grant application packages must be submitted in GrantSolutions.gov or Grants.gov no later than Friday, June 23, 2023, at 11:59 p.m. EDT.
- https://www.grants.gov/search-grants.html?cfda=15.614

Invasive and Noxious Plant Management Assistance Listing: This program continues to advance the Department of the Interior's priorities to address the climate crisis, restore balance on public lands and waters, advance environmental justice, and invest in a clean energy future. One of the BLM's highest priorities is to promote ecosystem health and one of the greatest obstacles to achieving this goal is the rapid expansion of weeds across public lands. This program supports project funded through the Infrastructure Investment and Jobs Act, Section 40804 (b) Ecosystem Restoration. These invasive plants can dominate and often cause permanent damage to natural plant communities. If not eradicated or controlled, noxious weeds will continue to jeopardize the health of public lands and to constrain the myriad activities that occur on them. These reforms allow the Bureau to realign time and resources to completing important on–the-groundwork. To encourage interested State and local governments and Federal agencies to work together to inventory, manage, restore, educate, reduce the spread of, and prevent the further invasion and establishment of noxious, invasive weeds, and other invasive species. These entities will develop and implement Integrated Pest Management Plans (IMPs) to develop and implement projects that foster consultation and cooperation among stakeholders, interested parties, and the public and to organize, finalize, and develop projects to implement IPM plans for noxious weeds or invasive species within a specific geographic area.

NRCS Conservation Innovation Grants: A competitive program that supports the development of new tools, approaches, practices, and technologies to further natural resource conservation on private lands. Through creative problem solving and innovation, CIG partners work to address our nation's water quality, air quality, soil health and wildlife habitat challenges, all while improving agricultural operations.

Keep Maryland Beautiful Stewardship Environmental Grant: Maryland Environmental Trust, the Forever Maryland Foundation and the Maryland Department of Transportation annually award Keep Maryland Beautiful Stewardship Grants to encourage stewardship of the environment, and educate community members. The Keep Maryland Beautiful Citizen Stewardship grants honor the legacy of Bill James, who drafted the legislation that founded Maryland Environmental Trust, and Margaret Rosch Jones, former executive director of the Keep Maryland Beautiful program. These grants also support organizations that are demonstrating active engagement as defenders of the environment by developing innovative solutions to local environmental problems. Proposed projects should activate citizens and encourage stewardship through education and outreach while elevating awareness of local environmental problems and working to reduce them.
- Who can apply: Schools, nonprofits and other community organizations whose missions are centered upon directly engaging community members (especially children and young adults) in environmental education and stewardship.
- How much can be awarded: Up to $5,000
- The objectives of the grants are:
    - To inspire and empower young people to become caretakers of their local environment and community through hands-on, project-based learning
    - To support and encourage the ongoing work or organizations that have been active in educating fellow community members about environmental issues such as Urban Tree Planting, litter prevention, stormwater management, coastal

resiliency, local stewardship and beautification, or other local and statewide environmental issues.
- To help community organizations identify and eliminate the root causes of local environmental issues, rather than just their consequences
- To encourage thoughtful consideration of local land use and development that preserves natural capital
- To preserve natural areas and create a sense of place in communities
- Applications for Keep Maryland Beautiful grants are submitted online beginning October 1.
- Required Application Materials: W9, Budget, Photographs

Chesapeake Bay Stewardship Fund: The National Fish and Wildlife Foundation (NFWF), in partnership with the U.S. Environmental Protection Agency (EPA), the U.S. Fish and Wildlife Service (FWS), and the federal-state Chesapeake Bay Program (CBP) partnership, is soliciting proposals through the Chesapeake Bay Stewardship Fund to protect and restore water quality and habitats of the Chesapeake Bay and its tributary rivers and streams.

- NFWF is soliciting proposals under two distinct programs through this request. Through the Small Watershed Grants (SWG) Program, delivered in partnership with EPA and the CBP partnership, NFWF is soliciting proposals for projects within the Chesapeake Bay watershed that promote voluntary, community-based efforts to protect and restore the diverse and vital habitats of the Chesapeake Bay and its tributary rivers and streams. Through the Chesapeake Watershed Investments for Landscape Defense Grants (WILD) Program, delivered in partnership with FWS, NFWF is soliciting proposals for projects that conserve, steward, and enhance fish and wildlife habitats and related conservation values in the Chesapeake Bay watershed.
- For the WILD Program, NFWF will award funding through two distinct funding opportunities. All WILD Program proposals must directly align with one or more of the WILD PROGRAM PRIORITIES outlined further in this Request for Proposals.
    1. WILD Implementation grants of $75,000-$750,000 will be awarded for projects that result in direct on-the-ground conservation, stewardship, and enhancements of fish and wildlife habitats and related conservation values in the Bay watershed.
    2. WILD Planning and Technical Assistance (WILD-PTA) grants up to $75,000 will be awarded for projects that enhance the capacity of local and regional partners to implement future on-the-ground actions, consistent with WILD Program priorities, through community-based assessment, planning, design, and other technical assistance-oriented activities.
- As a higher education institution, UMBC would be eligible for SWG-PTA, WILD Implementation, and WILD-PTA programs

Chesapeake Bay Program Grants Page: This is a good resource for current open grants and Requests for Proposals (RFPs)

Community Engagement and Restoration Mini Grant: This grant program is designed to support activities that enhance communities, engage residents, and improve natural resources. This program runs annually; we typically begin accepting applications at the start of July every year.

- What this funds: Activities such as tree plantings, rain gardens, stream cleanups, and storm drain stenciling. To see a longer list of potential projects, read the full Request for Proposals (RFP). Please note the RFP is updated every year.
- Who can apply: Nonprofit organizations, community associations, faith-based organizations and more. The Trust seeks to engage groups that have traditionally been under-engaged with environmental issues but also new applicants and organizations

from a diverse array of communities. Only applicants who have received three grants or fewer from the Trust in the past are eligible to apply. See RFP for full list of organizations and details.
- How much can be awarded: Up to $5,000.
- Match is encouraged, but not required.
- Contact the program's grant manager, Hayley Rost, at hrost@cbtrust.org or 410-974-2941 ext. 119.

The National Fish and Wildlife Federation grant application information page

Chesapeake Bay Small Watershed Grants Program: The Chesapeake Bay Small Watershed Grants Program awards grants of $20,000 to $200,000 to organizations and local governments that work on community-based projects to improve the condition of their local watershed while building stewardship among residents. Small Watershed Grants support local restoration and protection actions that help restore healthy waters, habitats and wildlife in the Chesapeake Bay region.

- Since 2000, the Small Watershed Grants Program has provided more than $27 million to support 626 projects throughout the Bay watershed. These grants have been used by recipients to leverage close to $90 million in matching funds, for a total of more than $115 million supporting local community restoration projects.
- The Small Watershed Grants Program is administered by the National Fish and Wildlife Foundation (NFWF) and primarily funded by the U.S. EPA Chesapeake Bay Program. Additional funding partners vary annually, but have included the U.S. Forest Service, the National Oceanic and Atmospheric Administration and the USDA Natural Resources Conservation Service
- Website states that this grant program is currently closed and will reopen in 2023, no other updates on this page

Constellation Community Champions Grant: Through our Community Champions program, our customers can apply for small grants (up to $500) for causes that are important to their communities. Extra consideration will be given to those requests where the project, organization, or initiative focuses on education, environment, or youth.

Eligibility
- Projects are eligible for up to $500 for 501c3 organizations
- Limit of one grant award per customer, per year
- Limit of one grant award per organization, per year
- The selection team reserves the right to approve or deny any request Please note that for individual schools:

Constellation generally does not provide support to individual schools, as they typically are not listed in the IRS Exempt Organizations Business Master File. To support an individual school, the EIN provided in the application must be registered via the IRS Tax Exempt Organization Search: Results for Tax Exempt Organization Search (irs.gov)
Selection Criteria
- Consideration will be given to those requests where the project, organization, or initiative:

1. Focuses on education, environment, or youth
2. Identifies a specific project for which the grant will be a significant percentage of the funding needed to complete the project
3. Provides detailed budget information about how the grant will be spent
4. Has broad community impact

EPA Environmental Education Grants: Under the Environmental Education Grants Program, EPA seeks grant applications from eligible applicants to support environmental education projects that promote environmental awareness and stewardship and help provide people with the skills to take responsible actions to protect the environment. This grant program provides financial support for projects that design, demonstrate, and/or disseminate environmental education practices, methods, or techniques. Since 1992, EPA has distributed between $2 and $3.5 million in grant funding per year, supporting more than 3,800 grants.

Region 3 Contact Information:
Stephanie Branche, U.S. EPA, Region 3
1650 Arch Street, Mail Code: 3OCTEA, Philadelphia, PA 19103-2029
branche.stephanie@epa.gov

Maryland Urban and Community Forestry Committee (MUCFC) Grants program helps community groups fund tree planting and education projects statewide to enhance Maryland's urban forest*. Community tree projects may be organized via schools, service organizations, homeowner organizations or other volunteer-based groups. The tree planting/educational projects must be located on public lands in parks, metropolitan areas, cities or towns. The maximum grant awarded per project is $1,000. Grant proposals are due to Grants Chair, with forestry board member original signature, by 4:30 p.m. on February and July 15. and reviewed shortly thereafter.

Guidelines for Applying for MUCFC Grant
Projects with matching funds and/or in-kind support will be given priority.
All grants will be awarded to organizations rather than to individual citizens.
All funded projects must take place on public lands* and not on an individual's private property.
All funded projects (and applications) must be approved by MUCFC (and signed by your county Forestry Board by the application deadline) before the actual project is begun.
Projects supporting the urban tree canopy* will be given preference.
Any unused money must be returned, by check or money order, with final report.
Final Report is due one month after the proposed completion date.
Failure to turn in report and/or unused money will result in no future funding of projects by MUCFC.

For Tree Planting Projects:
Project can be completed on school grounds or other public land*.
Include a simple site plan, project design, and /or photo of the proposed planting site.
If permits are required, describe the status of permits, review process etc.
List plants (and their sizes) to be used in the planting project. Use of native, larger growing shade trees is preferred. MUCFC will not fund planting of invasive species.
Attach a plan that describes how the project will be maintained (i.e., watering, weeding, mulching, long term maintenance)
Price range for plant material should be appropriate for size. Smaller plants cost less, are easily handled and have a higher survival rate than larger B&B plants. Occasionally, larger plants are necessary, however. When possible, purchase plants from the state facilities. Purchase seedlings from the state tree nursery and container grown trees from Tree-Mendous MD Program. Prices are typically $18-$50 dollars for trees and shrubs.

For Educational / Printing Projects:
Project must raise public awareness of the benefits of trees in the urban environment.

Project should provide links to organizations that can provide additional information or assistance.
Attach a sample of the images and/or draft of text for printing and signage requests.
Explain how the project or material will fulfill an unmet need for information.
Describe your audience, and how you plan to distribute the publication to your audience.
Name partners who can assist you in furthering your project.
Will the completed project be printed in a newsletter or placed on a website? If so, include a copy of the newsletter or URL in report.
Include the statement: Maryland Urban & Community Forestry Committee (MUCFC) funded the printing of this publication on any printed material funded by MUCFC. Display this statement prominently on the publication.
Include the MUCFC logo on any signage funded by MUCFC. Contact wtm@umd.edu for a camera-ready digital file of logo.
Contact Information:

MD DNR Forest Service
Tawes State Office Building E-1
580 Taylor Avenue, Annapolis, MD 21401
410-260-8510

Wanda MacLachlan
MUCFC Grants Chair, University of Maryland Extension
11975 Homewood Road, Ellicott City, MD 21042
410-531-5973
wtm@umd.edu