Proceedings of the 2023 Ohio Invasive Plants Research Conference

Invasive Plants and Global Change – Addressing the Challenges of Tomorrow

October 27, 2023

Nationwide & Ohio Farm Bureau 4-H Center, Columbus, OH

Conference Chair: Dr. Emily S. J. Rauschert

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Speaker Biographies

Dr. Lew Ziska is currently an Associate Professor in the Environmental Health Sciences at the Mailman School of Public Health at Columbia University. Lew began his career as a Smithsonian fellow, then was the Project Leader for global climate change at the International Rice Research Institute in the Philippines prior to a 24-year career at the USDA's Agricultural Research Service. He has worked primarily on documenting the impact of climate change and rising carbon dioxide levels on plants, including how it affects crop selection, agronomic pests, and public health impacts. Lew was a contributor to five International Panel on Climate Change (IPCC) reports, as well as to the 2014 and 2018 National Climate Assessment (NCA), and helped lead the 2016 special NCA report on climate and health*, The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment.*

Dr. Evelyn Beaury received her PhD from the University of Massachusetts Amherst where she studied the spatial ecology and biogeography of plant invasions in the context of climate change. This work included research and outreach on the management and policy of invasive plants, working with stakeholders to proactively prevent invasive plant introductions. Evelyn is now a postdoctoral researcher at Princeton, where she has broadened her research to think spatially about how to increase carbon storage via changes in land use and land management.

Theresa Gruninger is a senior aquatic invasive species program specialist at the Great Lakes Commission. She splits her time on multiple invasive species projects including the Great Lakes *Phragmites* Collaborative, the Great Lakes Panel on Aquatic Nuisance Species, the Invasive Mussel Collaborative, the Great Lakes Aquatic Invasive Species Landing Blitz and more. She has been with the Great Lakes Commission since 2021.

Dr. Deah Lieurance is an Ohio native and an Assistant Professor of Invasive Species Biology and Management at Penn State. Previously, she worked at the University of Florida as an Extension Scientist and for USDA in Ft. Lauderdale working on biocontrol. Her research and extension work centers around invasive species prevention and prioritization using decision support tools and horizon scanning. She is the 2021 recipient of North American Invasive Species Management Association's Rita Beard Visionary Leadership Award. She was the chair of the Florida Invasive Species Council (FISC) from 2019-2023 and serves as the President of the Invasion Ecology Section of the Ecological Society of America.

Dr. Kali Mattingly is a statistician with the USEPA's Great Lakes research office in Duluth, Minnesota, where she collaborates on a variety of ecotoxicology and ecology projects. For her graduate research, Kali studied the ecology and evolution of invasive plants, working primarily with lesser celandine and purple loosestrife, for which she received an OIPC grant in 2016.

David Listerman is a Certified Arborist and the co-owner of Listerman and Associates. His forty years' experience in the industry has included managing a wholesale yard, being an outside sales representative of a 9 mid-western state territory, and co-owner of a horticultural brokerage company. Throughout his career, David has worked with over 200 nursery growers, multiple landscape architects, and contractors, giving him a unique opportunity to appreciate the many facets within the industry.

Conference Agenda

8:30 AM ***Registration and refreshments (Sponsor: Greenacres Foundation)***

9:00 AM ***Welcome*** - Emily Rauschert, Conference Chair, OIPC Board, and Cleveland State Univ

9:10 AM ***Keynote Speaker Introduction —*** Emily Rauschert, Conference Chair 9:15 AM ***KEYNOTE: Carbon Dioxide, Climate Change, and Invasive Plants —*** Lew Ziska, Columbia University

10:15 AM ***Coffee Break (Sponsor: Ohio Stream & Wetlands Foundation)***

10:30 AM ***Building Consistent and Proactive Invasive Species Policies and Management*** — Evelyn Beaury, Princeton University

11:00 AM ***The Phragmites Adaptive Management Framework: Managing Phragmites with Science on your Side*** — Theresa Gruninger, Great Lakes Commission

11:30 AM ***Poster Session (Sponsor: Ohio Green Industry Association)***

12:15 PM ***Lunch and Annual Meeting (Sponsor: Columbus & Franklin Co. Metro Parks)***

1:15 PM ***Cultivating Resilience: Invasive Species Prevention and Prioritization in a Changing Climate*** —Deah Lieurance, Pennsylvania State University

1:45 PM ***Purple Loosestrife – Horticultural Darling and Model Invader*** —Kali Mattingly, OIPC grant recipient and USEPA

2:00 PM ***Meeting the Challenges of Nursery Grown Invasives*** —David Listerman, OIPC Board and Listerman & Associates 2:30 PM

Coffee Break (Sponsor: The Conservationist LLC)

2:45 PM *Rapid Updates of Ohio Invasive Plant Management Projects:*

A Potential New Nemesis for Garlic Mustard? Identifying and Reporting a Newly Arrived Garlic Mustard Specialist Aphid *-- Rebecah Troutman, Holden Forests and Gardens*

Target Cattails & Phragmites with Precision & Accuracy: Mitigate Overspray with the Handwick Method *-- Maureen Bogdanski, DNAP*

Lessons from the Ground: Survival and Performance of Planted Seedlings Following Honeysuckle Removal Across Central Ohio Riparian Forests *-- Charlie Flower, USDA Forest Service Northern Station*

A Strategy for Invasive Plant Removal in High Quality Natural Areas -- Brian Yahn, Great Parks of Hamilton County

Habitat Management Efforts at Cranberry Bog State Nature Preserve -- Madison Brown, Cedar Bog Nature Preserve

Using Livestock and Non-timber Forest Products to Incentivize Woodland Invasive Plant Management -- Matt Davies, OSU Extension

3:15 PM ***Panel Discussion and Wrap-up —*** Emily Rauschert, Conference

Invasive Plants and Global Change – Addressing the Challenges of Tomorrow

Speaker Abstracts

KEYNOTE: Carbon dioxide, climate change and invasive plants

Dr. Lew Ziska, Columbia University

The rise of CO2 will affect not only climate but directly affect plant biology. Such effects, in turn, can exacerbate issues related to invasive plants, from warming winters that can promote the invasion of kudzu, to how rising CO2 can alter the efficacy of herbicides. There are, however, ways and means that we can begin to address these challenges. These include understanding the links between climate and invasive plant biology to promoting a more integrated management approach. Overall, a strategy to monitor invasives, to mitigate their introduction through improved identification, and a management approach that does not rely entirely on chemical control. There is a lot that can be done, but recognizing that climate change is science not politics, is the first step.

Building consistent and proactive invasive species policy and management

Dr. Evelyn Beaury, Princeton University

Many invasive species are on the move to new locations with climate change, and horticultural trade is one of the primary vectors that could unwittingly facilitate this movement. To assess the scope and scale at which horticulture could facilitate invasion, we compared the distribution of ornamental sales of invasive plants to where these species are currently invasive and could pose future risk with climate change. We found substantial evidence that invasive species are sold as ornamentals within species' predicted ranges under current climate conditions, and within species' predicted ranges under a scenario of +2C of climate change. Prohibited plant regulations are somewhat effective at reducing invasive plant spread through horticulture, but to reduce invasion risk, we need to expand the geographic scale at which we are managing plant introductions from trade.

The Phragmites *Adaptive Management Framework: Managing* Phragmites *with science on your side*

Theresa Gruninger, Great Lakes Commission

The Great Lakes *Phragmites* Collaborative (GLPC), formed in 2012, to facilitate communication among stakeholders across the region and serve as a resource center for information on invasive Phragmites biology, management, and research. The GLPC utilizes an approach called Collective Impact, a structured collaborative process to improve efficiency and effectiveness of inter-organizational partnerships which leads to collective progress on challenging issues like invasive *Phragmites*. In 2017, the GLPC launched the *Phragmites* Adaptive Management Framework (PAMF), a collective learning and participatory science program designed to find best management practices for *Phragmites*. Participants enrolled in PAMF submit *Phragmites* monitoring and management data for annual inclusion in a predictive model, which learns from data collected over time and predicts the optimal management techniques for use in the next season given a site's *Phragmites* establishment level, treatment costs, and any management restrictions. PAMF bridges the gap between research and management, allowing managers to contribute directly to, and benefit from, applied research. Compared to uncoordinated management, PAMF speeds the pace of progress toward identifying best management practices by relying on data submitted by managers across the Great Lakes basin. Through collaborative action, PAMF continues to serve and learn from *Phragmites* managers across the Great Lakes basin.

Cultivating resilience: Invasive species prevention and prioritization in a changing climate

Dr. Deah Lieurance, Penn State

Biological invasions are a global issue that threaten biodiversity, ecosystem function, the economy, and human health. The compounding effects of climate change and biological invasions will exacerbate negative impacts to natural areas creating new challenges for prevention and management. These impacts include changes to the fire cycles or introducing fire to areas that are not fire adapted (e.g., the fire in Lahaina), changes in the way existing organisms interact with their local environment (e.g., changing microclimate increasing survivorship of ticks that vector many tickborne diseases), and the emergence of new introduction pathways (e.g., alternative crops introduced for green energy). Prevention efforts including risk assessment and horizon scanning can help identify potential threats and invasion status assessments can support management prioritization. However, current methods rarely include climate change. As the field evolves, climate change should be incorporated in assessment methods through modifications to the tools used to assess or the addition of species distribution models developed using current conditions and future climate scenarios. Regional Invasive Species and Climate Change Management Networks help coordinate applied research to improve management of current and future invasions and disseminate information to lang management practitioners, policymakers, and the general public.

Purple loosestrife: horticultural darling and model invader

Dr. Kali Mattingly, USEPA and SpecPro Professional Services

Lythrum salicaria (purple loosestrife) is one of the best-studied invasive plants. It is the first invasive species where local adaptation has been documented within the introduced range. This rapid evolution seems to have been driven by high genetic and trait diversity. The horticultural plant *L. virgatum* might further introduce meaningful variation by escaping into established *L. salicaria* populations or by hybridizing with *L. salicaria*. Although many experiments have focused on *L. salicaria* genotypes, relatively little is known about *L. virgatum* ecology. We used a greenhouse common garden to compare traits and flood response of *L. salicaria* and *L. virgatum* collected from two sources each in their native range. We tested the hypotheses that these two wetland taxa have comparable responses to flooding. *Lythrum virgatum* responded more strongly to flooding. Compared to *L. salicaria, L. virgatum* decreased inflorescence biomass by 40% more and produced 7% more stem aerenchymatous phellum, a specialized tissue that maintains aeration. Despite these more pronounced responses to flooding stress, *L. virgatum* had higher fitness (inflorescence biomass) than *L. salicaria*. Overall, *L. virgatum* differed from *L. salicaria* in functionally important ways. *Lythrum virgatum* produced more reproductive biomass than *L. salicaria* under both flooded and non-flooded conditions. Though *L. virgatum* persisted under severe inundation, flooding stressed *L. virgatum* more than *L. salicaria. Lythrum virgatum* is more fit than *L. salicaria,* at least under some conditions, and is likely to establish into the same wetland habitats occupied by *L. salicaria* but may possess different habitat tolerances. Regulation of *L. virgatum* unfortunately has lagged. Most states regulate *L. salicaria* on noxious weed lists, aquatic invasive species lists, or weed seed lists.

Meeting the challenges of nursery grown invasives

David Listerman, OIPC Board and Listerman & Associates

The presentation detailed the many reasons nurseries continue to grow known invasive plants. The general public's familiarity of many of the invasives along with high profit margins make it a difficult task to discourage nurseries from producing and selling invasive species. Only through educating the public about the destructive aspects and encouraging them not to plant or grow invasive species will we be successful in reducing the number of nursery-produced invasives.

Rapid Update Speakers

A Potential New Nemesis for Garlic Mustard? Identifying and Reporting a Newly Arrived Garlic Mustard Specialist Aphid

Rebecah Troutman, Holden Forests and Gardens

In the 2021 field season during routine garlic mustard (*Alliaria petiolata*) management, the Holden Forests and Gardens Natural Areas Biologist noticed damaged garlic mustard plants that were infested with aphids. The aphid was identified as *Lipaphis alliariae*, a garlic mustard specialist aphid native to Europe and previously unrecorded in the United States. A pilot project has included two components 1) to determine the local distribution of the aphid and 2) quantify how this aphid is affecting growth and productivity of garlic mustard within northeast Ohio. Our initial results suggest that 1) the aphid is distributed at least throughout the Great Lakes region and 2) garlic mustard plants with the aphid present on average are shorter, weigh less, have fewer seed pods, and have more twisted seed pods than plants without the aphid present. It is still unclear whether these differences will cause changes in garlic mustard populations.

Target Cattails & Phragmites with Precision & Accuracy: Mitigate overspray with the handwick method

Maureen Bogdanski, Ohio Department of Natural Resources:

We tend to choose the handwick method for cattails and phragmites when there are few or sporadic individual stems in a high quality habitat that has high public visibility. The handwick method mitigates overspray when applying herbicide with a broadcast spray method via backpack sprayer or high velocity sprayer. This method results in lower amounts of herbicide applied per acre and allows for better precision and accuracy of target species.

A Strategy for Invasive Plant Removal in High Quality Natural Areas

Brian Yahn and Daniel Kovar, Great Parks of Hamilton County

Invasive plant management in natural areas requires thoughtful prioritization because threats are numerous and resources are limited. As natural areas land managers, we seek to prioritize high-quality natural areas (i.e., areas with remnant natural systems minimally degraded by human actions) for invasive plant control. However, we sometimes lack information on the specific location or extent of high-quality remnants, or recent data on the status of the important resources therein. To gather this information, we developed a rapid data collection protocol and used GIS on mobile devices to sample across areas known or suspected to contain high quality natural areas (the “monitoring grid”). The protocol was designed to be used by staff who were not necessarily specialists in monitoring natural resources, so training resources were provided. At each plot (“grid square”), we recorded information on native plant cover, invasive plant cover, presence of spring wildflowers, evidence of human disturbance, deer browse level, and other indicators of natural area health. By combining these data into a singular score, we were able to identify areas of relative high and low quality, and produce maps showing their distribution across the gridded areas. These maps are being used to plan management, including invasive plant treatment, and are shared with the park staff carrying out the work. By having staff with varying backgrounds collect data, this project has also increased familiarity with these important high-quality natural areas and the overall level of natural resource knowledge among our staff.

Habitat Management Efforts at Cranberry Bog State Nature Preserve

Madison Brown, Cedar Bog Nature Preserve

Cranberry Bog State Nature Preserve is a small, acidic bog that is completely surrounded by a shallow, alkaline lake and known to be the only floating bog in the world. Cranberry "Island" surfaced in 1830 and was roughly 50 acres. Water levels at the lake are consistently lowered, leaving the surface of the bog without water. Almost two hundred years later, the island is now only 11 acres due to pieces breaking off and floating away. When dedicated as a state nature preserve in in 1977, state staff managed woody species and other succession plants on a yearly basis, keeping the bog meadows fairly open for plants such as pitcher plant, round-leaf sundew, grasspink orchid, and rose pogonia. When the recession hit in 2012, management came to a halting stop and Cranberry Bog was without human interaction for almost a decade. Managing partners, such as Ohio Natural Areas and Preserves Association (ONAPA), offered to help open the meadows back up. After four years of consistent woody species removal, partners realized that the bog mat is slowly dying. Sphagnum peat moss is drying up and we are seeing more and more woodland species encroaching the meadows (woodland mosses, glossy buckthorn, chokeberry). A graduate student from Antioch College, Colin Stewart, wanted to study if the herbicide we were using was causing a reaction between the sphagnum, other bog species, and our restoration efforts. Four plots are currently being studied, with three different kinds of herbicide and one plot acting as our control. Colin also set up a transect between the east and west bog meadows to measure the difference in temperature, pH, and water levels. This study started in the summer of 2023 so we have yet to see results. We are excited to see the end results and hope to care for Cranberry Bog for many years to come.

Using livestock and non-timber forest products to incentivize woodland invasive plant management

Matt Davies, Ohio State University

Lessons from the ground: survival and performance of planted seedlings following honeysuckle removal across central Ohio riparian forests

Charlie Flower, USDA Forest Service Northern Station

Poster Presentations

Answering a burning question: Are invasive populations of Winged Burning Bush (*Euonymus alatus*) related to ornamental cultivars?

Theresa M. Culley, Megan O. Callahan, Aaliyah N. Mann

Winged burning bush is a popular ornamental shrub commonly planted in residential yards and commercial landscapes throughout the Midwest. Known for its bright red fall color, this Asian species is commonly sold today as the cultivar 'Compactus' or in the past, as 'Rudy Haag'. New cultivated varieties, such as 'Fireball', 'Unforgettable Fire', and 'Little Moses', are becoming increasingly available. In recent years, escaped populations of this non-native species have been observed in Ohio natural areas, and the species is now recognized as invasive by the OIPC. Despite the spread of *E. alatus*, nothing is known about the identity of escaped individuals. Are they the original imported species, an escaped cultivar, a hybrid among cultivars, or a hybrid with the native *E. atropurpureus* (Eastern wahoo)? The purpose of our study was to identify how *E. alatus* is spreading, using microsatellite markers developed for the related *E. fortunei* (wintercreeper). We sampled multiple individuals from different cultivars of *E. alatus* available for purchase locally or through mail order, as well as mature shrubs planted throughout a residential area in West Chester, Ohio, and a wild population located at Spring Grove Arboretum in Cincinnati, Ohio. We found that cultivars of. *E. alatus* are genetically different from one another and that some cultivars are sold mislabeled. All residential samples consisted of 'Compactus'. We also discovered that DNA was most readily obtained from green leaves as opposed to leaves with red fall coloration. Finally, the genetics of the wild population at Spring Grove Arboretum was consistent with our expectations. Overall, these results will help land managers and researchers understand why the species is spreading into natural areas. Information about the genetic identity of wild individuals will also be helpful for state agencies across the Midwest as they consider certain non-native species and their cultivars for commercial regulation.

A comparison of hack and squirt and cut stump methods for control of* Ailanthus altissima*, tree of heaven

Chad Gibson, Greenacres Foundation

Tree of heaven (*Ailanthus altissima*) is a highly invasive species that has spread throughout the United States. The objective of this study was to compare tree of heaven removal methods to develop best management practices to guide land managers in their decision making. There were two study sites each with a minimum 10 mature trees and 130 immature trees per 1000 square meters. Mature trees were treated with either hack and squirt (triclopyr mixed with water at 1:1 ratio) or cut stump (triclopyr mixed with diesel at a 1:3 ratio). All immature trees received foliar spray (2% glyphosate mixed with a surfactant at 0.5%). Both treatments decreased the population of tree of heaven by over 90% within 24 months. Despite successful control of tree of heaven, lessons were learned that can improve future management.

Co-occurring invaders differentially affect biomass allocation and reproduction in spring geophytes

Grace R. Gutiérrez and Steve Hovick, Ohio State

Native plants respond to ecosystem changes associated with invasion by altering morphology, phenology, biomass allocation, physiology, and reproduction. Impacts of individual invaders on natives can be difficult to distinguish when multiple invasives co-occur. Despite the frequency of multiple invaders within a single site, few studies quantify the net effects of co-occurring invaders on the same native species. We experimentally investigate how two widespread Ohio-native spring ephemerals (*Erythronium albidum* and *E. americanum*; trout lilies) interact with *Ficaria verna* (lesser celandine), a novel invader in Ohio forests. We examine impacts of simulated forest litter layer reduction associated with invasive shrubs and earthworms. 189 *Erythronium* corms were planted in a common garden with each individual assigned to one of three treatments: grown 1) with celandine collected from a Columbus population 2) under a leaf litter layer representative of local non-invaded sites, or 3) in bare soil. For each *Erythronium* we measured one year (2022-23) of corm growth, reproduction, biomass allocation, and phenology.

Litter presence caused *Erythronium* to emerge and flower 14 days later and produce heavier and 133 to 229% taller stems relative to both other treatments. However, these effects did not reduce survival nor corm growth. In contrast, leaf litter benefited corm growth. Celandine caused a net loss in *Erythronium* corm resources (-23 ± 17%), and growth was halved when litter was removed relative to present (75 ± 18% vs 147 ± 17%). Interestingly, these effects occurred even as celandine unintentionally emerged later than *Erythronium* and thus did not shade these natives as it would in natural populations. Despite major growth impacts, *Erythronium* reproduction was not altered. Neither offspring number nor reproductive strategy (vegetative vs sexual) varied significantly between treatments. Both *Erythronium* species responded similarly to treatments; no species effect or treatment*species interactions were found.

We conclude that invader impacts on *Erythronium* are not driven by light reduction but rather by below-ground competition, likely for root space. Celandine management should primarily target below-ground biomass and create celandine-free gaps where geophytes can produce asexual offspring. Species selection when planting natives after invasive shrub removal should include natives that produce abundance, recalcitrant litter.

Individual and interactive effects of white-tailed deer and woody invasive plants on native tree seedlings in an early-successional forest

Abby Hay, Miami University

Regeneration failure is a pressing issue in forests throughout eastern North America endangering the health of forests. Densities of white-tailed deer (*Odocoileus virginianus*) have drastically increased in many of these forests and impact tree establishment and growth via browsing. Densities of non-native invasive plant species have also increased, with direct and indirect negative impacts on native tree seedlings. While the individual negative impacts of overabundant deer and invasive plants are well known, the interactive effects are not as well understood. This study investigated the individual and interactive effects of deer and woody invasive plants on seedlings in an early successional forest. In a stand of *Juniperus virginiana*

forest near Oxford, OH (39°31'N, 84°42' W), we initiated a factorial experiment with each combination of deer access/exclosure and invasive woody plants removed/not removed. In June 2022, we applied treatments by placing deer exclosures, 2.13m tall fences made of galvanized poultry wire using four trees as corner posts, and by removing all woody invasive shrubs and vines. We planted native tree seedlings and monitored natural regeneration in each plot.

Survival of planted *Quercus rubra* seedlings was lowest in invasive removal plots, with no individuals surviving. *Quercus rubra* seedlings in deer exclosure plots grew taller and had the highest survival. However, there was no significant effect on height and survival of *Liriodendron tulipifera* seedlings. We found a marginally significant interaction of deer and invasives on natural regeneration survival: where deer were allowed access, invasive removal resulted in the lowest survival of seedlings while invasive species present resulted in marginally significant greater survival, suggesting a facilitative effect of invasive plants. However, when deer were excluded, the removal of invasives resulted in higher survival than when invasives were present. Recruitment of native seedlings was also greater in deer exclosure plots. Due to these findings, we recommend land managers in comparable early-successional forests with the primary goal of tree regeneration focus on alleviating deer pressure over removing invasive plants.

Maintaining a rare hemlock-hardwood-white pine forest on Little Mountain: treating a native a day keeps the invasives away

Albert Jackson, Chad Knisely, Mike Watson, and Rebecah Troutman, Holden Forests and Gardens

Historical deforestation and unsustainable agricultural practices have rendered much of Ohio's original forests sparse and vulnerable to many threats such as invasion, pests, and disease. As old growth and unique forests are becoming increasingly more uncommon it is vital action be taken to prevent further degradation before the ecosystems are lost entirely. Starting in 2017, the Holden Arboretum began efforts to help preserve a unique 191-acre hemlock-hardwood-white pine habitat located in NE Ohio called Little Mountain. The eastern hemlock trees growing there have been affected by two invasive insects, the hemlock woolly adelgid (HWA) and elongate hemlock scale (EHS). These insects damage the foliage of hemlock trees by draining their nutrients, inhibiting proper growth, and in severe infestations even causing death within a few years if left unmanaged. Conservation efforts on Little Mountain began with initial infestation severity surveys and tree tagging which was then followed with respective pesticide treatment to each of the assessed 2775 hemlock trees. To track progress reassessments began in 2021 and has continued annually.

Eastern hemlocks are the only native species that can fill the niche they fulfill in their ecosystems; they create microclimates that promote the growth of other native plants and act as a host species for a variety of wildlife. Maintaining healthy hemlock trees makes it harder for unhealthy ecological succession to occur and maintains this unique habitat. It is imperative that the trees on Little Mountain were managed before HWA and EHS were able to spread to nearby natural areas where management would be difficult. Treating this remaining unique habitat not only prevents further infestations but subsequently strengthens the ecosystem to fight invasive plant species more effectively. It is likely that, without management, native invasive plants like red maple and tulip poplar would become dominant and non-native invasives like barberry, honeysuckle, and privet would fill the understory. Continuing conservation efforts will hopefully allow the unique habitat on Little Mountain to prosper and keep invasive plants from succeeding the habitat.

How does sexual recruitment contribute to knotweed invasion?
Joey Jaros, Ohio State

The knotweed species complex (*Reynoutria spp.*) is a perennial invader that forms dense stands with extensive rhizomes. Although often producing an abundance of seeds, knotweed has traditionally been thought to reproduce exclusively through asexual means from fragments of the stem or rhizome. While asexual reproduction is a driver of invasion, new research shows higher genetic diversity than expected if cloning was the sole mode of reproduction, signaling a role of seed recruitment in population dynamics. My research objective was to determine the ecology of sexual reproduction for knotweed to understand how it contributes to invasion dynamics and uncover any recruitment limitation that may be used to improve management outcomes.

I conducted germination trials of seeds collected from 5 populations spread between New York, Connecticut, and Pennsylvania. For all populations and years, germination was high (>85%) showing no limitation in seed viability. As germination testing showed no germination cues (such as a dormancy period), I measured seed overwinter survival to test if winter climate limits seedling recruitment. While many seeds germinated early in winter and then died with colder temperatures, a large percentage of seeds remained dormant over winter and germinated once temperatures rose in the spring. I also assessed the effect of competition on seedling development. Competition from adult plants completely inhibited seedling growth, while seedlings grown only with other seedlings can put on considerable rhizome mass in their first year. Adult-offspring inhibition was not driven by nutrient or light limitation, suggesting that chemical signaling, or allelopathy may limit seedling growth.

These results show where and when seedling recruitment will be most important in invasion spread. Clonal reproduction will be the driver of stand development, while seedlings may contribute to new populations. Since seeds are wind dispersed, they can spread where rhizome fragments cannot, moving past traditional dispersal routes of flooding and soil movement. Management should consider the timing of control efforts to minimize seed production, and control of satellite populations outside of main stands should be prioritized as seedlings can easily be removed in their first year before rhizomes take hold.

Native and non-native thistles (*Cirsium spp.*) support many generalists, but fewer specialist bees

Matthew Semler, MaLisa Spring, Amber Fredenburg, and Karen Goodell, Ohio State

Ohio is home to more than 300 native bee species that pollinate wild plants and crops. Non-native plants provide abundant floral resources that may support some bee species, but the non-native flowers may not be preferred by diet specialist bees, even those that use native congeners as pollen sources. We investigated the use of native and non-native thistles by generalist bees and specialist bees. In Ohio, the genus *Cirsium* is represented by both native and non-native species. Two native bee species that specialize on *Cirsium* pollen occur in Ohio: *Melissodes desponsus* and *Osmia texana.* We observed bee visitation to native and non-native *Cirsium* to answer two questions 1) Does the abundance of bees differ between native and non-native thistles? and 2) Do specialists visit native species more than non-native species?

We quantified bee visitation to natural populations of one native (*C. discolor*) and two non-native (*C. arvense and C. vulgare*) thistle during 34 timed surveys at 19 sites across Ohio in June – August 2022. The peak bloom of *C. arvense* occurred much earlier than that of the *C. discolor* or *C. vulgare* and therefore the surveys of these species do not overlap. We documented 214 bees visiting flowers. *Cirsium arvense* had the most bees (mean = 17.5), *C. discolor* had the second highest (mean = 12.52), and *C. vulgare* the fewest (mean = 10.78). Specialist bees disproportionately used the native species with 43 specialist bees observed on *C. discolor,* two on *C. vulgare,* and none on *C. arvense*. Native plants appear to better support native specialist bee taxa. Eradication of *C. arvense* and *C. vulgare* will have a negligible impact on specialist bees. Conservation management of the native specialist bees should include a plan to maintain the native Field Thistle, *C. discolor*.

Other host plants of specialist bees have non-native congeners that could be surveyed to provide insights into the role of other non-native plants or cultivars on Ohio's specialist bees. By understanding the role of natives and non-natives within bee communities a plan for conservation and management of both plant and bee species can be found.

Making forests healthy is about more than invasive removal: Rapid Upland Forest Assessments (RUFA), a tool for holistic forest health prescriptions

Beck Swab, Chad Knisley, Mike Watson, and David Burke, Holden Forests and Gardens

Managing for forest health requires first understanding what characteristics a forest is lacking, and then deciding what steps would improve forest processes to create needed features. The Rapid Upland Forest Assessment (RUFA) tool, developed by conservation staff at Holden Arboretum, is designed to quickly evaluate a variety of important forest characteristics including woody debris, canopy diversity, invasive species threats and understory composition. After evaluation, scores can be compared between sites or the same site can be compared over time, and management actions prescribed based on results.

We used this tool at the Holden Arboretum to assess over 2,000 acres of forest, and have since managed hundreds of acres with invasive removal, thinning, and planting. Having a full understanding of what forests need beyond invasive species removal is an important step in adaptive management to create more resilient forests, and to get forest managers off the hamster wheel of perpetual invasive species removal.

How to manage invasive plants as a non-profit with limited staff

Daniel Volk and Zachary Justus, The Wilderness Center

The Wilderness Center (TWC) is headquartered in rural Stark County, OH, with 20 properties across six surrounding counties. TWC has protected over 3,000 acres of land, including through ownership (2,000 ac), conservation easements (1,000 ac), and a conservation loan program that assists other organizations in acquiring land for conservation. TWC has two full-time staff members dedicated to conservation. However, it is difficult to manage thousands of acres with limited staff availability. Invasive species are among the most severe threats to our ability to protect the land. The most common invasive species on TWC properties include garlic mustard

(*Alliaria petiolata*), autumn olive (*Elaeagnus umbellata*), multiflora rose (*Rosa multiflora*), Japanese stiltgrass (*Microstegium vimineum*), and reed canarygrass (*Phalaris arundinacea*). Using conventional control methods, TWC relies heavily on volunteers, contractors hired with grant funds, and mitigation bank programs. TWC plans to increase the implementation of prescribed fires to manage prairies and woodlands better moving forward, but difficulty with burn conditions and an inexperienced crew will be a challenge to overcome in the short term. In addition to conventional control methods, TWC is actively collecting and spreading locally adapted native seeds to increase competition with invasive species.

Tree regeneration 4 years after **Lonicera maackii** *removal in a Southwest Ohio woodland*

Luke Weyer and Jennifer Mansfield, Greenacres Foundation

In 2019, 4 different Amur honeysuckle (*Lonicera maackii*) removal methods were applied to a mixed hardwood woodland (80 x 30 m treatment areas) in Indian Hill, Ohio. The treatments were as follows: hand-cut followed by glyphosate spray (1%); hand-cut followed by glyphosate spray 6 months later; mechanical removal followed by glyphosate foliar spray in spring and mechanical removal followed by glyphosate foliar spray in fall. Small seedling (less than 30 cm) and large seedling (30-200 cm) data were collected across each treatment for 4 years.

Compared to pre-removal data, seedling density increased for both size classes; total tree species richness also increased. In one of the mechanical removal areas, large tree of heaven seedlings were present prior to removal and rebounded strongly, totaling 79% of large seedlings after 4 years. Different honeysuckle removal strategies can be applied and result in positive tree regeneration but recovery can be complicated by the presence of invasive species.