College of Food, Agricultural, and Environmental Sciences

Plant Community Response to Vegetation Treatments on a Columbia Gas Pipeline Right-of-Way

Ohio State University-Mansfield Ecolab and Ohio Woodlands Stewards Report

THE OHIO STATE UNIVERSITY

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Summary

In 2019, The Ohio State University (OSU)-Mansfield campus began collecting vegetation data on a Columbia Gas right-of-way (ROW) to evaluate the efficacy of various vegetation maintenance treatments to control woody incompatibles and to understand treatment effects on compatible vegetation and characteristics important to wildlife. Three distinct zones were monitored, each with their own maintenance plan. In Zones A and B, Columbia Gas reduced reliance on mechanical clearing and supported the utility's stewardship goals by selectively treating incompatible species with herbicide applications. Herbicide applications (cut-stubble and cut-stump) effectively controlled woody vegetation with the more selective treatment (cut-stump) yielding slightly better habitat outcomes. In Zone C, follow-up herbicide treatment was deferred, resulting in a need for repeated mechanical clearing. From this research we learned that: 1) mechanical controls without follow-up chemical controls are not functionally effective or economically efficient means of reclamation when re-sprouting woody vegetation is present, 2) deferred maintenance results in higher monetary costs, wasted treatment effort, and delayed ecological benefits, and 3) proactively treating ecologically incompatible species can reduce vegetation maintenance work for a utility/pipeline operator (even when the source population is off-ROW) and increase ecological integrity long term. Future vegetation monitoring efforts should dovetail with subsequent vegetation management cycles and continue to examine efficacy of reducing structurally and ecologically incompatible vegetation while promoting native biodiversity that advances goals beyond just regulatory compliance, safety, and reliability.

Introduction

The OSU-Mansfield campus, located in north-central Ohio, is a unique one-square mile property. A Columbia Gas pipeline ROW and a TC Energy pipeline ROW as well as a First Energy transmission corridor all intersect the campus; as a result, opportunities to develop partnerships that connect utility working landscapes with research, teaching, and education are abundant. The ability to connect students with research projects active on campus is impactful. It is one thing to learn about the delicate balance between natural resources and the environment, it is quite another to see what stewardship looks like on the ground.

The Ecolab at the OSU-Mansfield campus began studying vegetation on the Columbia Gas pipeline in 2019, focusing monitoring on vegetation conditions pre- and post- treatment. To date, the Ecolab has collected 11 months of data over four different years. Monitoring takes place on a 300-meter stretch, where three different treatments are compared (Figure 1). The west side of the ROW is surrounded by a contiguous deciduous forest minus a small stand of conifers at the end of Zone B, and to the east a thin strip of forest separates the ROW from a state route highway. Due to this close proximity, a small section of Zone A has regularly been included in the roadside mowing that the Ohio Department of Transportation conducts (Figure 1). Vegetation monitoring includes vegetation height, plant composition density, invasive plant species presence, and blooming species abundance and diversity. These metrics were selected to study data significant to the upkeep of utility regulatory standards as well as ecologically relevant measures to inform sustainable management practices on utility ROWs.

Figure 1. Map of Zones A, B, and C.

Methods

Starting on the west side of the ROW a handheld GPS was used to locate the starting coordinates, then a 50-m reel tape measure was fully extended, a Daubenmire frame (D-frame) was laid down to the west side of the reel tape, placed flush to the tape, starting with the middle of the D-frame in line with 6-m (Figure 2). This was repeated every 6-m for 300-m on the west side of the ROW, then another 300-m on the east side of the ROW heading back south towards the beginning of the ROW sampling section, totaling 100 replicates and 600-m sampled (Figure 2). Sampling within the D-frame began by identifying and recording any blooming species that were rooted inside the D-frame. The location of the blooming species was determined and recorded by visually splitting the D-frame in half vertically, each side was assigned a letter, left side A, right side B, we then visually took the D-frame and flipped it to the right, over the reel tape and assigned that entire visual frame the letter C per protocol specifications from the Integrated Monarch Monitoring Program (Figure 2; Cariveau et al. 2019). The A/B/C categorization using the D-frame was only implemented during blooming species sampling. All other vegetation parameters utilized the entire space inside the D-frame located to the left of the reel tape. Blooming species within the ROW that failed to appear in any of the D-frames, were identified and recorded in the Other Blooming Species section.

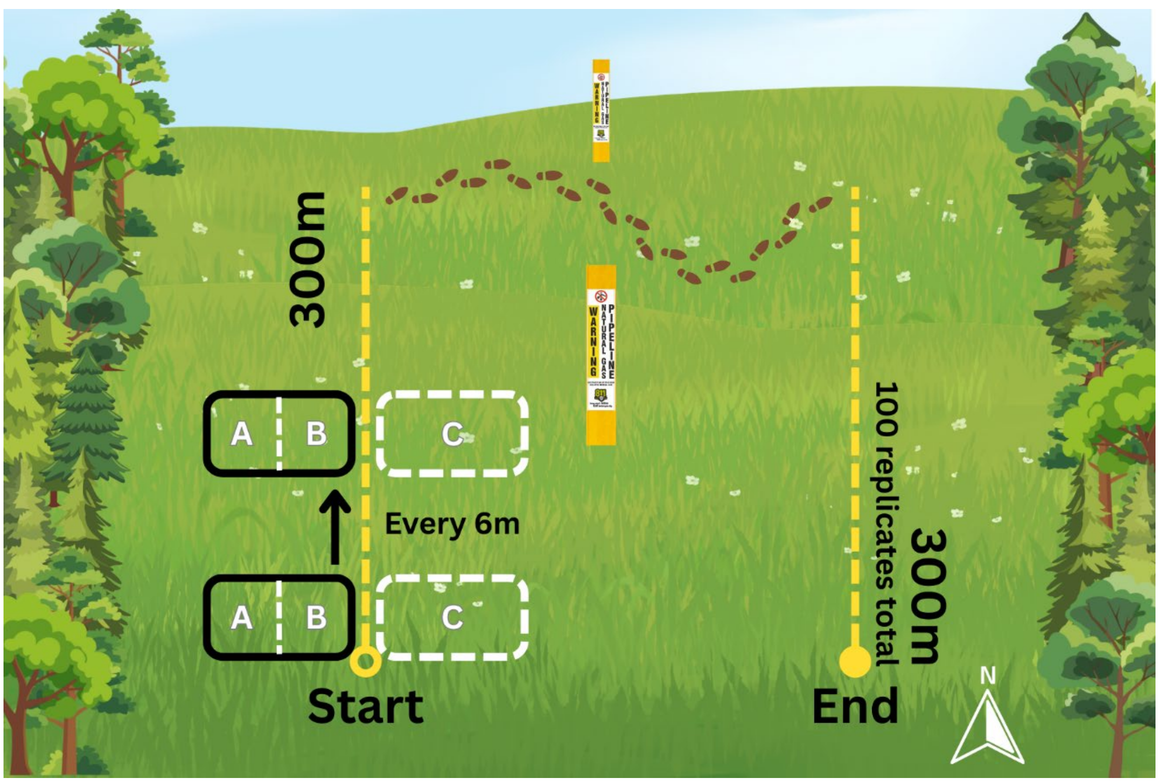


Figure 2. Methodology for vegetation sampling transects on study section of ROW, including arrangement of blooming species sampling D-Frame.

Percent cover was determined for vegetation rooted inside the D-frame, categories include Forbs, Grasses, Invasive Shrubs, Woody Natives, Briars (e.g., Rubus spp.), and Other (sedges, bare ground, rushes, etc.). In 2021 and 2025, Bare Ground was designated as a separate category from Other. The scale used to gauge percent cover was 1: 0-5%, 2: 5-25%, 3: 25-50%, 4: 50-75%, 5: 75-95%, and 6: 95-100%. Invasive species were identified and recorded if they were rooted within the D-frame (this began in 2025). Typically, vegetation height was recorded every 60-m which equated to ten times in the 600-m section, generally every tenth plot. The tallest plant within 2-m of the D-frame center was located, identified (this occurred regularly starting in 2025), and measured. This vegetation sampling method was generally conducted once a month during the growing season.

Discussion

Overview

Zone A is comprised of an even mix of forbs and grasses with limited woody encroachment. Forbs and grasses in Zone B are less dominant with a greater influence of briars (Rubus spp.), sedges, and native and non-native woody incompatibles. Zone C is dominantly comprised of autumn olive (*Elaeagnus umbellata*) and continues to revert into a dense thicket, causing navigation difficulties for leakage inspectors. Zones A and B received site-specific selective treatments, while Zone C's heavy invasive woody composition required non-selective mechanical clearing (Table 1).

Table 1. Zones A, B, and C: treatment table, PGI stands for plant growth inhibitor.

Zone	Woody Encroachment	Typical Max Vegetation Height	Treatment		
			2021	2025	2026 (Planned)
A	Low	≤5ft	Cut-stubble herbicide[1] + PGI over pipe zone	Cut-stubble herbicide[2] + PGI over pipe zone	N/A
B	Low	≤ 6ft	Cut-stump treat[1] + PGI over pipe zone	Cut-stump treat[2] + PGI over pipe zone	N/A
C	High	≥ 10ft	Mulch-and-grind, no herbicide	Mulch-and-grind, no herbicide	Spring follow-up foliar herbicide[2] on resprouts

[1] 2021 herbicide mixture including Aminocyclopyrachlor, Aminopyralid, Picloram, plus a surfactant

[2] 2025/2026 herbicide mixture including Triclopyr, Aminopyralid, Imazapyr, Metsulfuron-methyl, plus an Adjuvant, and water

State and federal safety regulations require leakage inspectors to conduct on-foot ROW patrols, which can be impeded by certain types of vegetation. Compliance denotes a site with easy and convenient access; non-compliance suggests the density, height, or other characteristic of the vegetation makes access difficult, or perhaps even, impossible. Both Zones A and B have generally remained in compliance, while Zone C has not, thus the reason it has undergone reclamation multiple times. Utility compliance standards are to ensure accessibility for personnel, but also to protect the integrity of the pipeline infrastructure, all while trying to be cost efficient. The root systems of woody species pose significant risks to underground utilities.

Utility gas pipeline ROWs in the U.S. cover more land than any single U.S. National Park, upwards of 15 million acres. That's over six times the size of Yellowstone National Park not including other utility ROWs such as energy transmission lines (Marcellus Shale Coalition, n.d.; Nudd, 2026; U.S. Department of Energy, n.d.). The potential ecological impact of sustainably managing utility ROWs can't be overstated. One of the ways ecological impact can be measured on a ROW is by examining blooming species. The blooming species sampling methodology allowed us to test whether flowering forbs were more abundant in the center of the ROW compared to the sides. No difference was observed. This result is to be expected for a predominately north-south oriented ROW, such as the Columbia Gas line, and suggests that the Plant Growth Inhibitor (PGI) application had only temporary and not lasting effects on the forb community. In an east-west running corridor, such as the TC Energy ROW, where solar exposure is significantly different from one side to the other, this pattern would not necessarily hold.

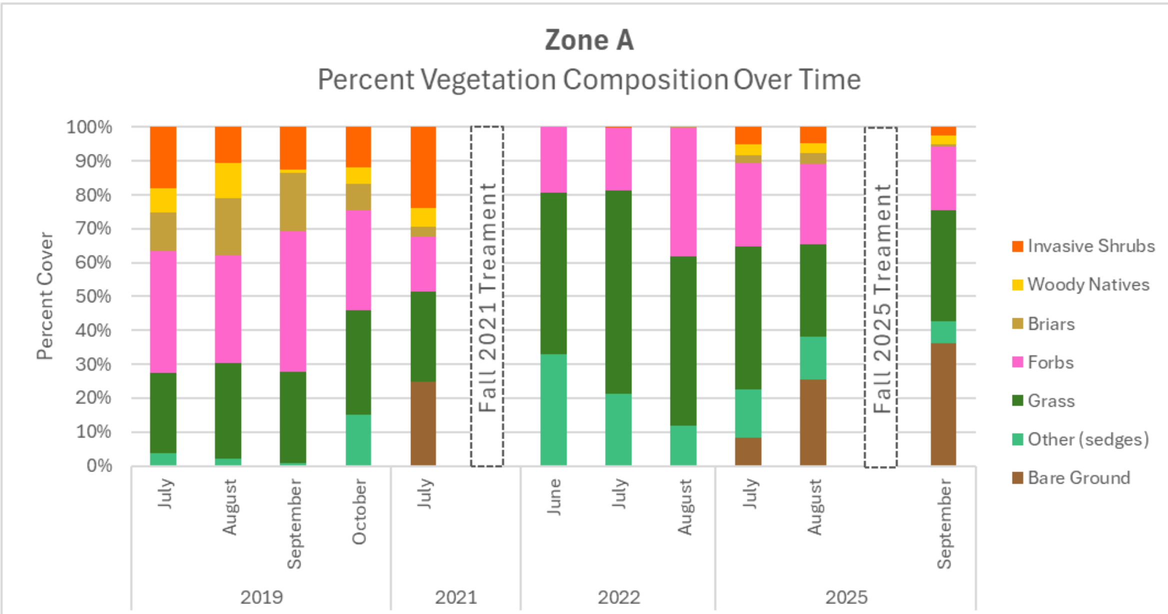
Comparison Between Typical IVM Treatment Methods (Zones A & B)

Zones A and B represent more typical Integrated Vegetation Management (IVM) cycles than Zone C and are well suited for comparison. In 2021, maintenance for Zone A and B differed, with Zone A receiving a cut-stubble herbicide treatment, which was mowing followed by a low volume broadleaf herbicide application over the remaining stubble. Zone B received a cut-stump treatment which targeted woodies through the cutting of individual trees and applying herbicide to the stump. Cut-stump (Zone B) is only feasible in areas with a low density of woody plants that tend to be larger in diameter, versus cut-stubble (Zone A) which is better suited for areas with denser, smaller diameter woody plants. Of the 2 treatments, cut-stump is the more selective method. Both Zones A and B had PGI applied to the pipe zone, the section of ROW directly over the underground pipe structure, which is done to prevent root interference and stifle vigor of plant growth (Figure 3).

Figure 3. Zone B in May 2022, one year after cut-stump treatment highlighting the impact of the Plant Growth Inhibitor application over the pipe zone (Photo taken by Dr. Gabriel Karns on May 31, 2022).

Following the 2021 treatment, woody plants in both zones mainly consisted of a single stem meaning that they germinated from the seed bank as opposed to stump sprouts that would have numerous stems, indicating that both the cut-stubble and cut-stump treatments successfully controlled the target incompatibles (2021 to 2025 decrease in Invasive Shrubs and Woody Native categories; Figure 4). As the name suggests, the category Invasive Shrubs only includes woody plants, which are often structurally incompatible on utility ROW due to safety and accessibility concerns, and does not capture other invasives such as forbs or grasses. While woody incompatible invasives (by the limited regulatory definition) were less prevalent, invasive species in general (most commonly Japanese stiltgrass) were present in over 50% of the Zone A sample plots and over 75% of the Zone B sample plots after the 2025 treatments. Follow-up monitoring in 2026 will reveal the true effectiveness of the 2025 treatments, but equating effective control of woody invasives (though important and well documented in both zones) is not the same as restoring the ecological integrity of a site.

In July 2021, both zones were composed of similar vegetation categories (Figure 4). Following the autumn 2021 treatment, compositions shifted in both zones – all woody plants drastically decreased and were replaced by forbs, grasses, and sedges. In Zones A and B, the initial shift in 2022 favored grasses over forbs. The degree to which grasses remained dominant influenced how much bare ground was present in more recent surveys. Zone A, which retained grass cover above 40%, did not possess much bare ground, whereas fewer grasses correlated with a corresponding increase in bare ground for Zone B.



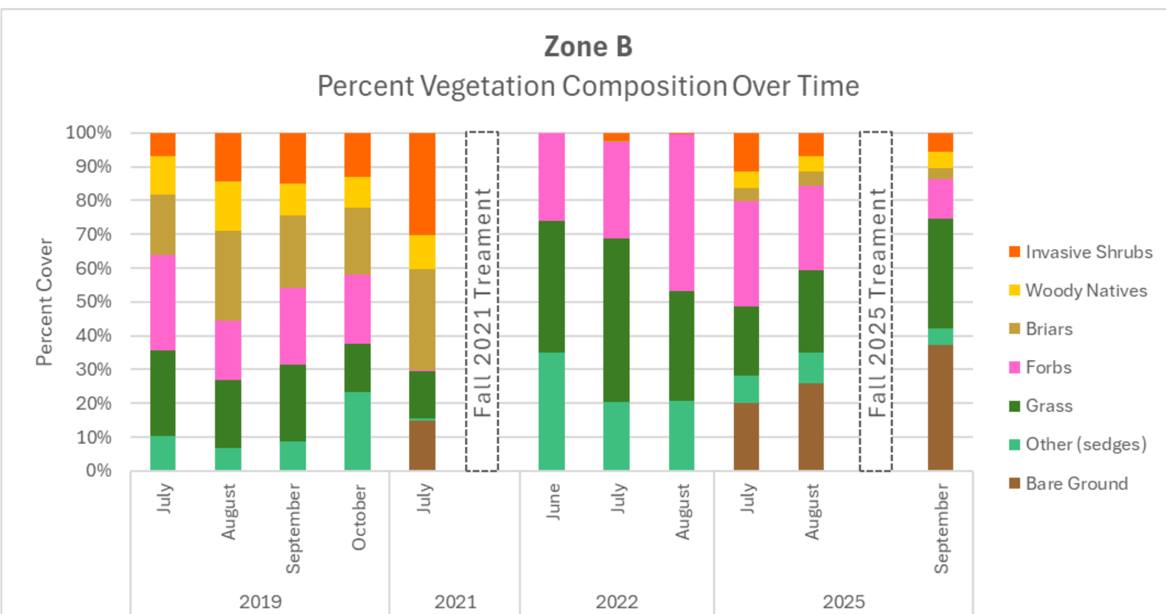


Figure 4. Percent vegetation cover composition of Zones A & B from 2019-2025.

While the coverage of forbs remained fairly stable over time, the distribution of pollinator resources did not. Between the 2021 and 2025 treatments, the abundance of flowering forbs and the diversity of flowering species increased in both zones. While neither treatment affected species richness more than the other (both Zones A and B had 13 species in July 2025, following counts of four and two in July 2021, respectively), Zone B possessed more pollinator resources than Zone A according to 2025 bloom surveys. The zones shared a similar baseline in 2021, therefore the more selective cut-stump treatment used in Zone B could explain this difference.

<u>Effects of Deferring Maintenance After Reclamation (Zone C)</u>

Figure 5. Zone C "entrance" in June of 2024, three years after mulch-and-grind treatment with no herbicide follow-up (Photo taken by Dr. Gabriel Karns on June 25, 2024).

Zone C has been continually overwhelmed by autumn olive, so much so that prior to management in 2025 (and even more so in 2021), to navigate through this zone a person had to crouch below branches arching over the narrow pathway in the center of the ROW as they ducked and weaved through a dense thicket (Figure 5). The few openings within Zone C were often inhabited by poison hemlock (Conium maculatum), creating significant access and navigation obstacles for leakage inspectors. In 2021, Zone C received a mulch-and-grind treatment, which consists of utilizing a skid steer with a forestry mulching head to eliminate most vegetation, essentially restarting secondary succession (Figure 6). A follow-up foliar herbicide treatment was planned to control incompatible woody resprouts, but budgetary constraints prohibited follow-up activities, and the planned herbicide treatment was deferred. By 2025, Zone C had returned to a dense thicket of autumn olive, requiring a similar reclamation approach (Figure 5). Reclamation is a term reserved for especially intensive vegetation treatments to get a site back into compliance from a state of serious non-compliance.

Figure 6. Zone C in May 2022, in the spring following the 2021 mulch-and-grind treatment, showing autumn olive stump sprouts that did not receive follow-up herbicide treatment (Photo taken by Dr. Gabriel Karns on May 31, 2022).

Figure 7 contrasts two different metrics in Zone C – percent Invasive Shrub cover and average maximum vegetation height. The solid orange line illustrates a decline in maximum vegetation height after a mulch-and-grind treatment in autumn 2021. Note the change from Invasive Shrubs measuring nearly 20 feet tall to waist height in the following growing season. While overall Invasive Shrub plant cover decreased, and vegetation height came into compliance, autumn olive was only temporarily controlled with the mechanical disturbance. By the summer of 2025, Invasive Shrubs had returned to pre-treatment levels (Figure 8). Zone C was treated again in late 2025 and follow-up chemical control with low volume foliar is planned for spring 2026. What we learn from Zone C is that deferring chemical controls in sites dominated by invasive woodies leads to cyclical reclamation which is more costly in the long-term than had the site been treated chemically following the initial mulch-and-grind as planned.

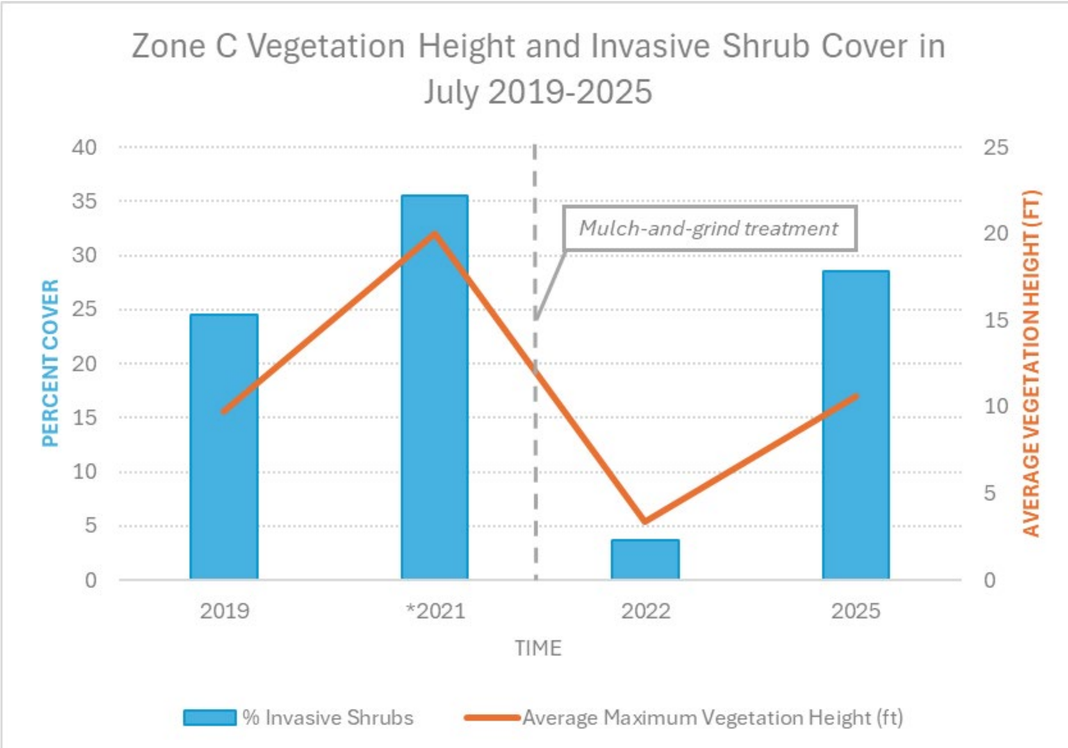


Figure 7. Comparison between average maximum vegetation height and percent cover of Invasive Shrubs in Zone C from July 2019 to 2025. The asterisk next to 2021 represents a single estimate (not an average between 2 heights like the other values) for maximum vegetation height of the dense autumn olive stand.

Understanding why maintenance was deferred is an equally important part of the story. Budget cuts in 2022 prevented a planned follow-up herbicide treatment that would have suppressed root resprouts and achieved better long-term control of incompatibles (Charlton & Goodfellow 2021). The savings achieved by deferring maintenance in 2022 will ultimately result in higher maintenance costs long-term for Zone C. This concept is well demonstrated in Goodfellow (2018), who found through least cost analysis that follow-up chemical control decreases operational costs by up to 48% over a 20-year cycle (commonly 4-5 maintenance cycles) as compared to repetitive mechanical treatments. Taking this into account, we recommend following-up mechanical reclamation with herbicide treatments to achieve better control of incompatibles, lower long-term operational costs, and to establish better quality wildlife habitat via management into the future. By following best practices of IVM and controlling invasive shrubs with a combination of mechanical and chemical controls, this would have replaced the dense monotype of autumn olive that unfortunately offered low quality wildlife habitat, continued to harbor non-native invasive plant species, and most importantly – failed to meet utility compliance standards.

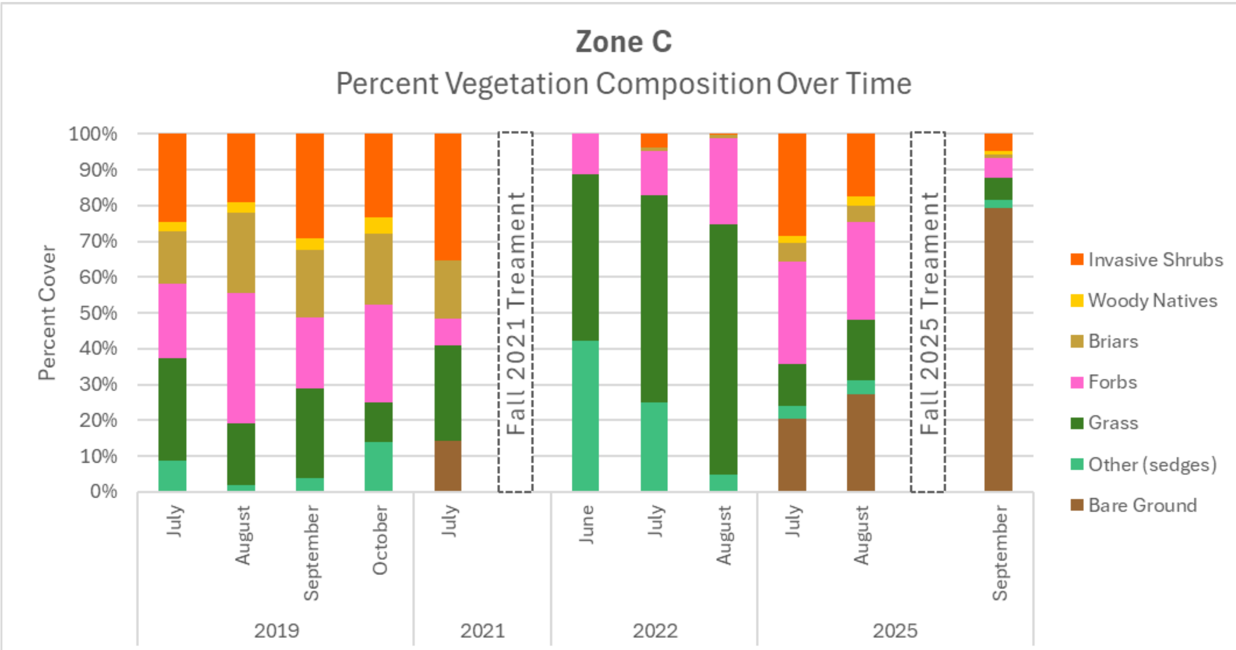


Figure 8. Percent vegetation composition of Zone C from 2019-2025.

Structurally vs. Ecologically Incompatible Species

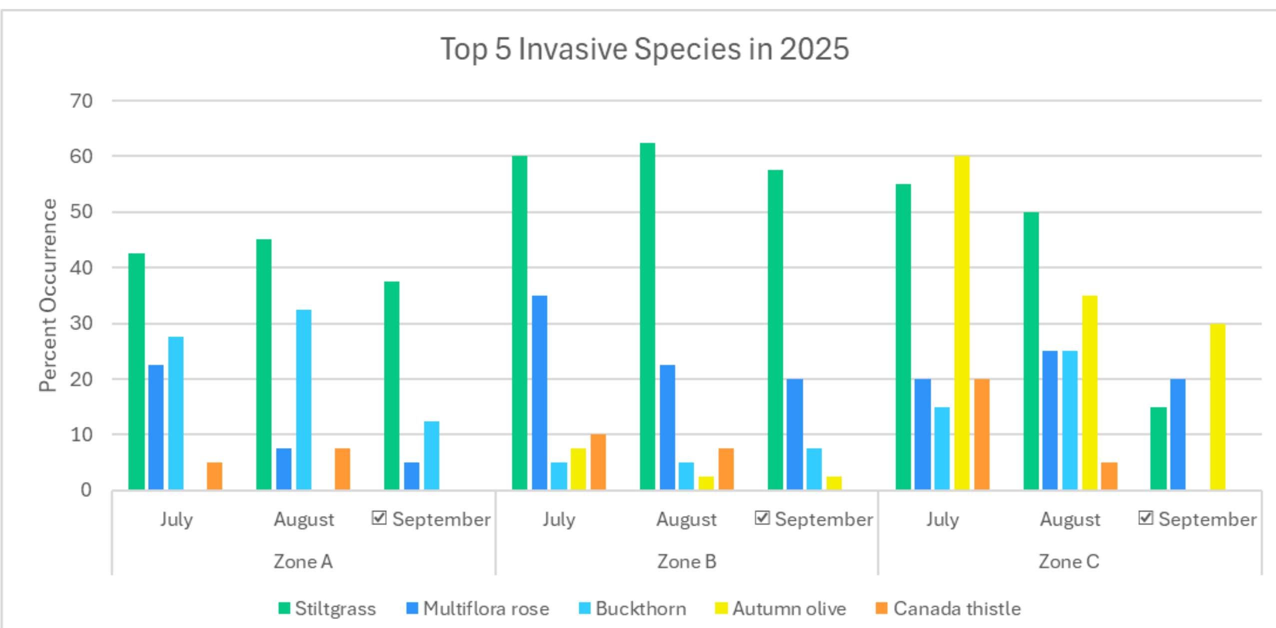


Figure 9. Top 5 invasive species occurrences in Zones A, B, and C in 2025. ☑ indicates the month following the 2025 treatments.

Data collection began differentiating invasive plant species in 2025. In July 2025, 12 invasive species were noted. Japanese stiltgrass (Microstegium vimineum) was the most prevalent invasive species in Zones A and B and the second most prevalent in Zone C (Figure 9). By pipeline operator regulatory requirements, Japanese stiltgrass is structurally compatible, meaning it does not threaten pipeline infrastructure, despite contributing to loss of ecosystem function (what one might term "ecologically incompatible"). This mismatch in compatibility standards for Japanese stiltgrass is emblematic of similar dilemmas for other species observed across the country. Figure 10 visualizes some common examples to illustrate the challenging and inconsistent relationship between structural and ecological incompatibility. While a utility/pipeline operator vegetation manager is not expected to share the exact same objectives and priorities of a restoration ecologist, closer alignment between the two will result in better shared outcomes for not only humans but ecosystems overall. A decision-making framework for how to manage structurally compatible species on ROWs can be found in "Considerations for Management of Structurally Compatible Species (Non-native, Noxious, Or Invasive)", a publicly available best management practices publication produced by the Utility Arborist Association.

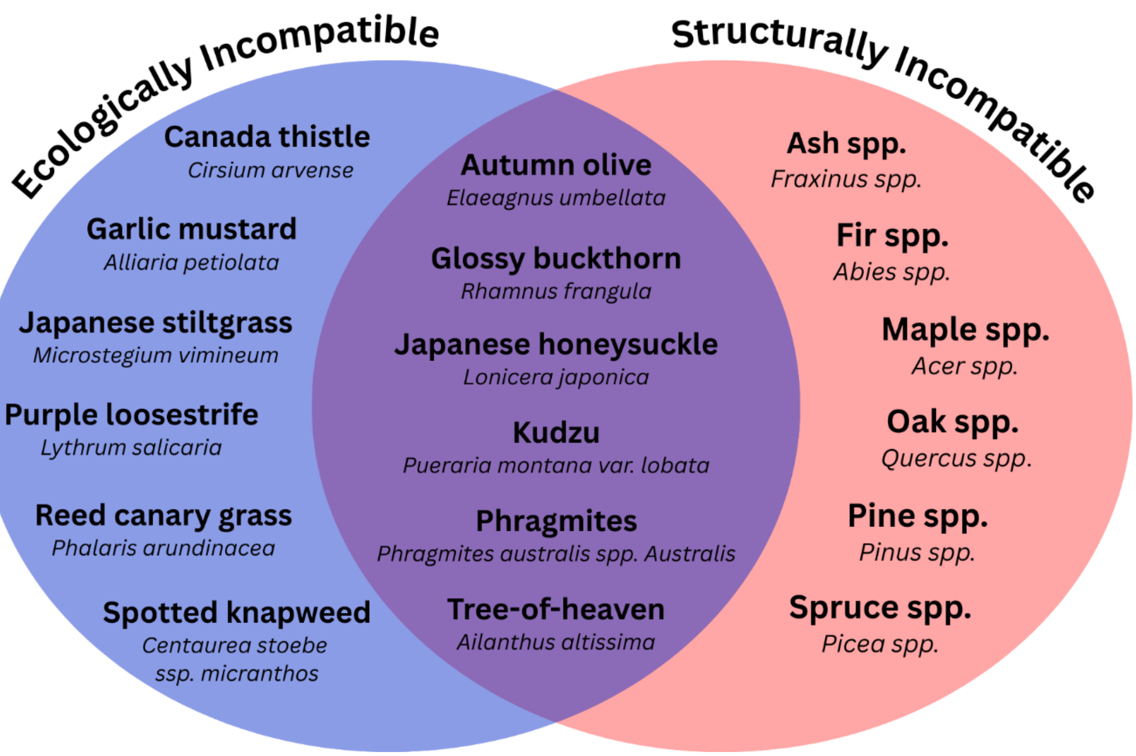


Figure 10. Venn diagram depicting examples of ecologically and structurally incompatible vegetation species.

As utilities and pipeline operators progress on their sustainability journeys and expect more from their IVM personnel, vegetation management programs are becoming more proactive and effective in controlling incompatible species. On this particular Columbia Gas system, glossy buckthorn (Rhamnus frangula) is a great example. Glossy buckthorn was not previously documented until dense populations of knee-high seedlings were observed in 2025 across all three zones. Further exploration revealed that a few mature off-ROW individuals were fruiting and supplying seed. Showcasing the adaptability and effectiveness of a maturing IVM program, modified contracts quickly included this new species in the prescriptions, and contractors were trained to identify and treat it. Taking an extra and voluntary step, a Memorandum of Understanding was signed between the utility and the University to allow utility contractors to treat the isolated off-ROW buckthorn patch thus eliminating the seed source and reducing future problems.

Conclusions

- Mechanical controls without follow-up chemical controls are not functionally effective or economically efficient means of reclamation when re-sprouting woody vegetation is present.
- Deferred maintenance results in higher monetary costs, wasted treatment effort, and delayed ecological benefits.
- Proactively treating ecologically incompatible species can reduce long-term vegetation maintenance for a utility/pipeline operator and increase ecological integrity, provided that their treatment is economical and that continued encroachment from off-ROW populations is considered.
- Future vegetation monitoring efforts should focus on peak blooming periods, namely July and/or August. Additionally, the year leading up to/following IVM treatment cycles should be prioritized.

Some content contained in this report was published in an article "IVM Case Study from an Ohio Pipeline Corridor: Insights on Treatment Comparisons, Deferred Maintenance, and Ecological vs Structurally Incompatible Vegetation" by the Utility Arborist Association and International Right of Way Association. We discovered a mistake in the published article that we would like to acknowledge and correct. The third figure titled "Vegetation Cover of Zones A & B in July 2019-25" contains a mistake in the Zone B 2025 bar data, the category values were mistakenly assigned to the incorrect categories. This figure also combined the vegetation categories other and bare ground in the years 2021 and 2025, by doing this the other category is unfairly weighted without the proper calculations to address it. Both mistakes are remedied in this expanded version of the article.

Acknowledgements

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