



The Harbinger

Newsletter of the Illinois Native Plant Society

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"...dedicated to the study, appreciation, and conservation of the native flora and natural communities of Illinois."



A prairie restoration in Marshall County in July. Photo by Katie Kucera.

In This Issue

INPS News • Pollen, Nutrition, and Bumble Bee-Plant Interactions
Soil Invasion History and Impacts on *Lespedeza cuneata* Invasion and Native Legumes
Do Preserved Plants Match the Volatile Organic Compound Profiles of Live Plants?
Journal Article & iNaturalist Roundup • Botany Humor

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INPS News

2026 INPS Annual Gathering



The 2026 Annual Gathering hosted by the Forest Glen Chapter is happening from Friday evening, September 25 to Noon Sunday, September 27, 2026. It will be located at the University of Illinois Research Park, Forbes building at 1816 S. Oak Street, Champaign, Illinois 61820. *Hope to see you there!*

Third Annual Pawpaw Festival



The Third Annual Pawpaw Festival returns to Paw Paw Veterans Park in Paw Paw, Illinois, on Saturday, Sept. 26, 2026, beginning at 10:00am. Admission is free, and the day includes fresh pawpaw fruit and trees, tastings, pawpaw food and drinks, live music, local vendors, kids' activities, tram tours, and educational programming. www.pawpawfest.org
Facebook event: www.facebook.com/events/2309307889578898/

Message from the Editor

I hope everyone is having a hot burl summer! A recent trip to look for rare plants in northern Illinois yielded some amazing finds, like a large flowering population of round-leaved sundew (*Drosera rotundifolia*)! In this issue, we are highlighting research from our previous grantees. They covered a wide variety of topics, including pollen nutritional value for bumble bees, invasive plant soil dynamics, and volatile organic compounds (VOCs) in plants. Our research grant program continues to yield fascinating results, and our newest awardees will be announced in the fall issue. Until then, enjoy the cooler weather and rich colors of late summer into fall.

–Brian Charles, Editor



Submissions to the newsletter are always welcome!

Please contact editor Brian Charles (brianmc4@illinois.edu). Deadlines are March 1, June 1, September 1, and December 1 for the spring, summer, fall, and winter issues respectively.

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Chapter News

For information about each chapter, visit our website at
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Using pollen to identify nutritional value of bumble bee-plant interactions within northern Illinois

By K.C. Carter

Across the prairies and urban landscapes of northern Illinois, bumble bees carry out one of the most essential ecological roles on Earth: pollination. Foraging bouts link plants through pollination syndromes, sustaining both wild ecosystems and agricultural crop production. Yet these interactions are becoming increasingly fragile due to habitat loss, land use change, and the spread of non-native plants. These factors have reshaped many floral communities, leaving scientists and land managers asking a vital question: are the remaining plant communities truly meeting the needs of native pollinators?

A recent project funded by the Illinois Native Plant Society supported K.C. Carter, a Pollinator Ecologist at the Illinois Natural History Survey, to answer that question by looking beyond which plants bumble bees visit and focusing instead on what pollen they actually collect. By analyzing pollen carried by bumble bees and measuring its nutritional content, the study provides a new perspective on how plant communities support pollinators. The findings reveal a complex network of interactions, where both native and non-native plants play important roles, and where nutritional quality may be just as important as plant diversity.

Northern Illinois once supported vast expanses of tallgrass prairie, an ecosystem rich in flowering plants that provided continuous food for pollinators throughout the growing season. Today, less than 0.01% of that prairie remains (White, 1987). What persists is often fragmented into small patches surrounded by agriculture, urban development, or early successional forest (Plate 1). In these altered landscapes, bumble bees must navigate a mosaic of habitats to find the pollen and nectar they need to survive and reproduce.



Plate 1 – Small tallgrass prairie remnant surrounded by early successional forest.

Bumble bees depend heavily on pollen as a source of protein and lipids, which are essential for colony growth and reproduction. Not all pollen is equal, however; different plant species vary widely in their nutritional composition, and bees must balance their diets to meet their energetic needs. A landscape filled with flowers may still fall short if those flowers do not provide the right balance of nutrients.

To better understand these dynamics, we conducted field surveys across six sites in northern Illinois, ranging from high-quality prairie remnants to more disturbed areas. During the growing season, we recorded bumble bee visits to flowers and collected pollen loads directly from bees (Plate 2). These pollen samples were then analyzed using DNA metabarcoding, a technique that identifies plant species based on the genetic material found in the pollen, allowing researchers to reconstruct the breadth of plants each bumble bee had visited (Tommasi et al., 2021).



Plate 2 – Federally endangered, Rusty-patched Bumble Bee (*Bombus affinis*) worker, carrying pollen in her corbiculae. Photo credit: Kyle Price, Environmental Solutions & Innovations, Inc.

The results revealed a more comprehensive picture of bumble bee foraging compared to traditional observation-based surveys alone. During the 2025 field season, 1,178 bumble bees were recorded, of which 61 carried pollen loads. To increase sample size and ensure representation of all bumble bee species known to occur in northern Illinois, these samples were supplemented with 31 additional pollen samples for the analyses. These included samples from the federally endangered Rusty-patched Bumble Bee (*Bombus affinis*) and Species of Greatest Conservation Need in Illinois, Southern Plains Bumble Bee (*B. fraternus*), American Bumble Bee (*B. pensylvanicus*), and Half Black Bumble Bee (*B. vagans*) (Plates 3a – 3d).



Plate 3a – Rusty-patched Bumble Bee (*Bombus affinis*)

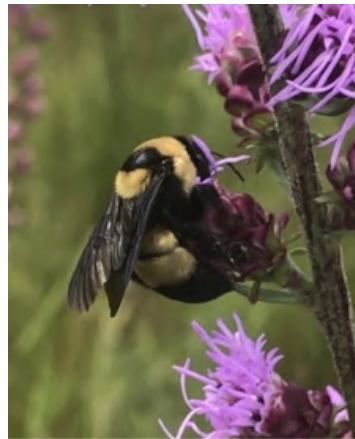


Plate 3b – Southern Plains Bumble Bee (*Bombus fraternus*)

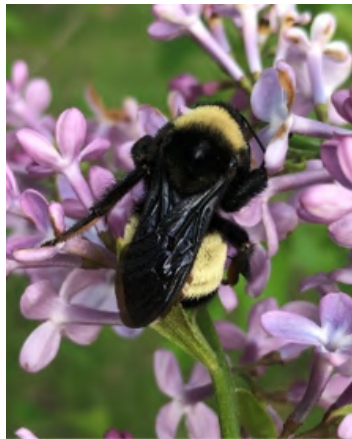


Plate 3c – American Bumble Bee (*Bombus pensylvanicus*)

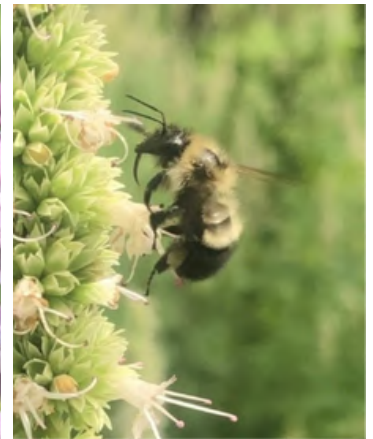


Plate 3d – Half-black Bumble Bee (*Bombus vagans*)

The field observations documented a relatively small number of interactions (42 interactions between 10 bumble bee species and 21 plant species), but pollen analysis revealed 877 interactions between 10 bumble bee species and 207 plants. Many of these interactions were uncommon or easily missed in the field observations, including visits to tall trees and shrubs, rare plants, or brief foraging events, and perhaps even incidental pollen collection. Bumble bees in the study showed broad and flexible diets, collecting pollen from between 13 - 113 plants per species. Some plant groups stood out as particularly important. Members of the Fabaceae and Asteraceae dominated the pollen samples. Genera such as *Baptisia*, *Dalea*, *Desmodium*, and

Silphium appeared repeatedly across samples, suggesting that they play central roles in supporting bumble bee communities.

Even within this general pattern, differences among bumble bee species were evident. Some species relied heavily on a narrow set of plants, while others foraged more broadly. The federally endangered Rusty-patched Bumble Bee, for example, showed more specialized foraging patterns, often using a distinct subset of plants that were not as commonly visited by other species (*Silene*, *Arnoglossum*, and *Silphium*). These differences highlight the importance of maintaining a diverse plant community that can support both generalist and more forage-selective bumble bees (Wood et al., 2019).



Plate 4a – Wood Betony
(*Pedicularis canadensis*)



Plate 4b – Missouri
Gooseberry (*Ribes
missouriense*)



Plate 4c – Sundial Lupine
(*Lupinus perennis*). Photo
credit: Isabel Dalton.



Plate 4d – Wild White Indigo
(*Baptisia lactea*). Photo
credit: Isabel Dalton.

Seasonality also played a key role in shaping interactions. Early in the spring, bees relied on a different set of plants than they did in mid-summer or fall. The dominant genera in the bumble bee-collected pollen changed across months: *Pedicularis* and *Ribes* in April, *Lupinus* in May, *Baptisia* in June, *Dalea* in July, and *Helianthus* in August (Plates 4a – 4f). The shift in foraging patterns reflects the changing availability of flowers, as different species bloom at different times. A continuous blooming phenology is therefore essential to support bumble bees throughout their life cycle, from queen emergence in the spring to the production of gynes in early fall.



Plate 4e – Purple Prairie
Clover (*Dalea purpurea*)



Plate 4f – Sawtooth Sunflower
(*Helianthus grosseserratus*)

One of the most concerning findings of the study was the role of non-native plants in the pollination networks (*Trifolium*, *Melilotus*, *Securigera*, and *Lotus*). While native plants were important for maintaining the overall structure of the network, many non-native species linked different groups of plants and bumble bees across the network and across seasons. These species often had long flowering periods and were widely available across sites, making them accessible to all 10 bumble bee species.

The presence of non-native plants raises important questions for conservation. On one hand, they can provide valuable resources, especially in degraded landscapes where native plants are scarce. Though, on the other hand, reliance on non-native species may reflect a loss of native biodiversity and the functions it supports. Our results suggest that while non-native plants can help maintain connectivity in the short term, long-term conservation should focus on restoring native species that can fulfill similar roles.

In addition to mapping interactions, our study examined the nutritional content of pollen collected from both plants (Plate 5) and bumble bees. The results showed protein content ranged widely among plant species, as did lipid levels, leading to a broad spectrum of protein-to-lipid ratios across plant communities. These ratios are important because bees require a balanced diet of nutrients rather than simply maximizing one component (Vaudo et al., 2016).

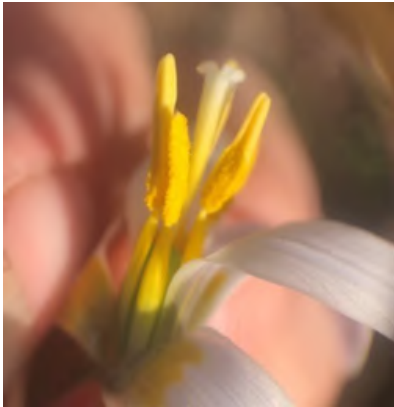


Plate 5 – Example of pollen on anthers of White Fawnlily (*Erythronium albidum*)

Interestingly, the nutritional composition of pollen varied across the season, with peaks in protein availability occurring during key life stages of bumble bees. Early spring and late summer were characterized by higher protein levels, aligning with periods when queens emerge and when colonies produce new reproductive individuals (“gynes”). These seasonal patterns suggest that the timing of floral resources is closely linked to the nutritional needs of bees.

Pollen collected directly from bumble bees reflected these patterns but also revealed additional complexity. Individual bees often carried mixtures of pollen from multiple plant species, resulting in blended nutritional profiles. Even within a single plant family, nutritional content varies substantially, indicating that bees may need to forage from multiple sources to achieve a balanced diet.

These findings emphasize that pollinator conservation cannot rely on simple measures such as planting more flowers or increasing plant diversity alone. The identity, timing, and nutritional quality of those plants all matter. A diverse community that includes key native species with complementary flowering times and nutritional profiles is more likely to support healthy and resilient pollinator populations.

The study also highlights the value of combining different approaches to understanding plant-pollinator interactions. Traditional field observations remain important, but they capture only part of the picture. By incorporating pollen analysis, researchers can gain a more complete understanding of how bees actually use the landscape. This integrated approach can help identify which plants are truly important for supporting pollinators and which may be overlooked using standard methods.

For land stewards and restoration managers, these insights offer practical guidance. Planting efforts should prioritize species that are both widely used by bees and nutritionally beneficial. Native members of the Fabaceae and Asteraceae families are strong candidates (Plates 6 – 7), as they provide key resources across the season. At the same time, maintaining a variety of plant species ensures that different pollinators, including specialists, have access to the resources they need.

Restoration strategies should also consider the timing of bloom. Ensuring that flowers are available from early spring through late summer can help bridge gaps in resource availability and support bees throughout their life cycle. In some cases, carefully selected non-native plants may provide temporary support, but long-term goals should focus on establishing native species that can sustain pollinator communities without compromising ecosystem integrity (Zinnen et al., 2025).



Plate 6 – Field of Purple Prairie Clover (*Dalea purpurea*), a native Fabaceae, in Cook County, IL. Photo credit: Kyle Price, Environmental Solutions & Innovations, Inc.



Plate 7 – Field of various fall blooming Asteraceae species

The challenges facing pollinators are complex, but studies like this provide a clearer path forward. By understanding not just who interacts with whom, but also what those interactions provide, researchers and conservationists can design more effective strategies to support pollinators in an ever-changing world.

Bumble bees are resilient, adaptable insects, but they depend on the landscapes we create and manage (Plate 8). Supporting them requires attention to detail, from the diversity of plants to the nutrients contained within a grain of pollen. As efforts to restore prairies and improve habitat continue, integrating ecological interactions with nutritional understandings offers a promising way to ensure that these landscapes truly meet the needs of the pollinators they are meant to support.

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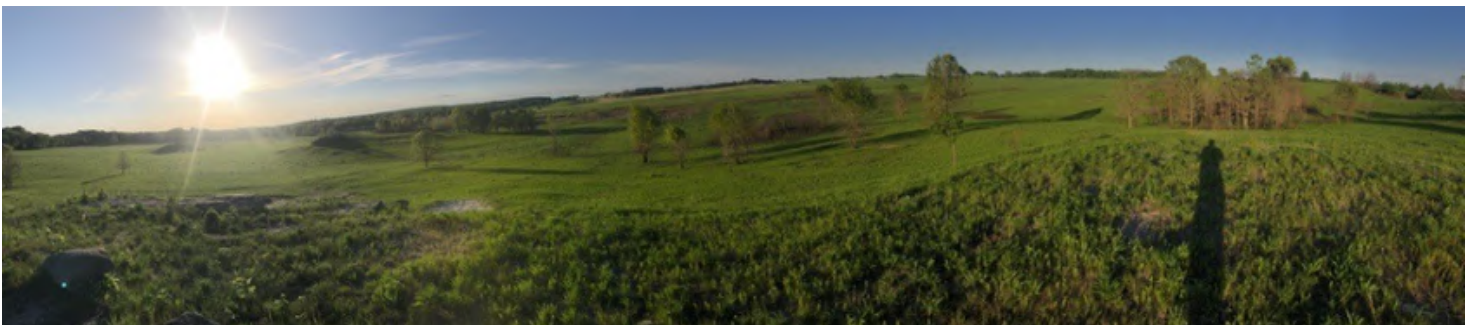


Plate 8 – Nachusa Grasslands, Lee and Ogle Counties, IL, a beacon for habitat restoration.

Soil invasion history in a restored prairie increases nodulation for the invasive legume *Lespedeza cuneata* but not the native legume *Desmodium illinoense*

By Mac Johnson

Invasive plants pose a risk to the biodiversity and essential functions of ecosystems, but how do they successfully invade novel ranges? Although aboveground competition for resources is a major determinant of invasive plant outcomes, the soil environment represents another important source of variation which may influence the establishment of invasive species (1, 2). Plants can alter the soil environment over time through changes in nutrient levels and microbial communities, potentially influencing the growth of subsequent plants through altered soil properties known as legacy effects (3, 4). Legacy effects that enhance the performance of non-native species may contribute to the invasive success of introduced plants in novel ranges, especially plants that are highly dependent on soil microbial communities such as legumes (5). Legumes are a unique group of plants that associate with rhizobia, nitrogen-fixing bacteria in the soil that form nodules along the roots of legumes. Because so many legumes have become invasive outside of their native range, the specialized legume-rhizobium relationship has been proposed as an important factor mediating the spread of non-native legumes into novel ranges (6, 7).

An invasive species of concern to North American tallgrass prairies is the legume *Lespedeza cuneata* or “silky bush clover” which was originally introduced to combat erosion and serve as cattle fodder (8). *L. cuneata* produces more seeds and aboveground growth compared to native congeners (9) and forms dense stands that can shade out native plants (10, 11, 12). Additionally, the soil microbes that *L. cuneata* encounters and associates with in new environments may also contribute to the invasive success of this legume.

Rhizobia from the genera *Rhizobium*, *Bradyrhizobium*, *Mesorhizobium*, *Sinorhizobium*, and *Burkholderia* have been identified in *L. cuneata* nodules, indicating that this invasive legume functions as a generalist host that can associate with several types of bacterial symbionts (13, 14). Previous studies report increased nodulation and biomass in *L. cuneata* when grown in invaded soils compared to soils where *L. cuneata* was absent, but variability in the strength of this legacy effect between sites poses a challenge for determining the relative importance of different factors during invasion (15, 16, 17).

In order to develop effective management strategies for controlling *L. cuneata*, we need a better understanding of how this legume invades new environments and interacts with native plant communities (18, 19, 20). Hosting both native species and the natural invader *L. cuneata*, the Pollinator Habitat Restoration Experiment (PHRE) in Urbana, IL is an excellent site for studying legacy effects associated with *L. cuneata* invasions in a recently restored prairie. The PHRE site was converted from agricultural fields and seeded with native plants in 2018 but has since been invaded by *L. cuneata*. Because the legacy effects associated with *L. cuneata* may also impact the growth of co-occurring native legumes by shifts in soil rhizobia pools, it is important to understand how invasion history and plant diversity differentially affect the growth of native legume species compared to *L. cuneata*.



A flowering *Lespedeza cuneata* individual from PHRE

To determine how soil invasion history (presence or absence of *L. cuneata*) and native plant diversity (high diversity or low diversity) influence the growth of native legumes compared to *L. cuneata*, I grew the following legume species in a greenhouse and inoculated them with soil from PHRE: *Lespedeza virginica*, *Dalea purpurea*, *Desmodium illinoense*, *Lespedeza cuneata*. Both *D. illinoense* and *D. purpurea* were seeded in PHRE whereas *L. virginica* was not present in the initial restoration seed mixture; however, all three of these legume species are native to IL. Plants were grown in a low-nutrient potting mixture to promote nodule formation, inoculated with live field soil as seedlings, and harvested after three months of growth to compare biomass and nodulation by species and treatments. I also grew bacteria from root nodules and identified them with DNA sequencing to compare the nodule communities between *L. cuneata* and native legumes.

There was no effect of soil invasion status or plant diversity on biomass accumulation and nodulation in *D. illinoense*; however, *L. cuneata* produced significantly more nodules when inoculated with invaded soils compared to uninvaded soils. *D. illinoense* generally formed more nodules than *L. cuneata* and produced more biomass with increasing nodule count, but *L. cuneata* showed no relationship between nodule count and biomass accumulation. Plant mortality was relatively high in this experiment at 51%, likely due to a combination of stressful growing conditions and nutrient limitations. Mortality was lower in *D. illinoense* (30%) and *L. cuneata* (33%) compared to *D. purpurea* (54%) and *L. virginica* (93%). Moreover, only *D. illinoense* and *L. cuneata* formed nodules after being inoculated with live field soil. The increased mortality and lack of nodulation in *D. purpurea* and *L. virginica* were unexpected and could reflect symbiont limitations or reduced stress tolerance relative to *Desmodium* and *L. cuneata*. Both rhizobia and non-rhizobia were isolated from the root nodules of *D. illinoense* and *L. cuneata* spanning multiple bacterial genera. Although *Pseudomonas* sp. were the most abundant bacteria isolated from both species' nodules, *D. illinoense* generally hosted more non-rhizobia in its nodules compared to *L. cuneata* including including *Flavobacterium*, *Sphingobium*, *Caulobacter*, and *Bacillus* strains. The frequency of rhizobia recovered from nodules was relatively low, possibly due to the slow growth rate of rhizobia like *Bradyrhizobia*.

These results support earlier studies' observations that *L. cuneata* produces more nodules in soils with a history of invasion, but the lack of a corresponding increase in biomass with increasing nodulation is inconsistent with previous work and may reflect an accumulation of poor-quality rhizobia in invaded soils (15, 16). Although *D. illinoense* did not respond to soil invasion history, differences in nodule endophyte

communities compared to *L. cuneata* and its high survivorship in the greenhouse identify *D. illinoense* as a promising candidate for investigating legacy effects associated with *L. cuneata*. This work

highlights the advantage of soil inoculation experiments in uncovering the soil legacy effects of invasive plants and sets up a strong foundation for future research in this system.

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The scent of yesterday: investigating whether preserved plants accurately and reliably provide information on the volatile organic compound profiles of the live plant

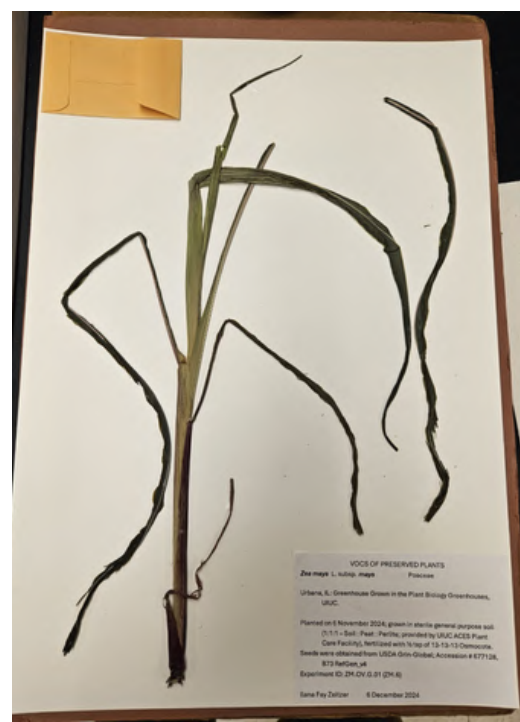
By Ilana Zeitzer

Lilac, honeysuckle, mint and pine; each of these plants is valued by us for their scent, and we use or mimic their scent in cleaning products, body products, and candles. Since ancient times, humans have loved many plant species for their scent just like thousands of animals. What we recognize as a plant's scent is a collection of molecules scientists call volatile organic compounds (VOCs). The EPA's definition of VOCs is "organic chemical compounds whose composition makes it possible for them to evaporate under normal indoor atmospheric conditions of temperature and pressure" [1]. Essentially, these compounds are found as gases under normal temperatures (volatile) and contain carbon (organic), giving them their name. Our noses are able to detect these compounds in the air and thus we smell the scent of the plant.

The importance of VOCs is not limited to simply smelling nice or bad; they play a variety of roles for the plant and the greater ecosystem as chemical signals. Plant VOCs are a means of communication not limited to one species. Plants, animals, fungi, bacteria, and archaea are all able to detect and respond to VOCs. More specifically, plant VOCs can assist with pollinator attraction, herbivore and disease defense, stress adaptation, communication within and between plants, and communication with beneficial microbes such as mycorrhizal fungi [2-5]. The effect of VOCs is dependent on both the individual VOCs emitted, the mixture, and the concentrations of the VOCs which collectively are known as VOC profiles, just like how perfumes may contain mixtures of different scents and in different quantities making them distinct from other similar perfumes. These profiles are not static, but change based

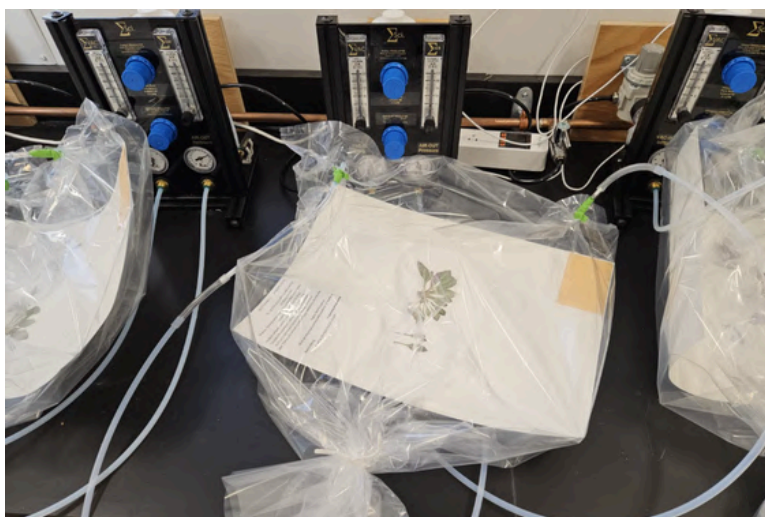
on the environment and health of the plant [6].

The study of plant VOCs is part of the field of chemical ecology, which is a younger field just over 40 years old that is regularly updating methodology with new technologies [4]. The relatively young age of this field of science and the advances in technology mean there is a lack of long-term datasets where populations are monitored over the years. This limits the questions researchers can investigate. However, other areas of plant science utilize herbarium specimens to study older plant populations (up to about 3400 years old) [7, 8]. Herbarium specimens are plants preserved by scientists and interested community members for reference and use by future researchers. With over 406 million herbarium specimens around the world, this is a potential untapped resource for chemical ecology studies [8]. Additionally, the equipment required to measure VOCs is not available everywhere. Researchers in remote areas often have to dry plants before bringing them into a lab with the proper equipment. A handful of studies have used dried specimens or herbarium specimens to investigate the VOC profiles of plants, but none have directly compared live and dried plants or how the profiles change after drying [9-11].



Therefore, I designed a study specifically to investigate the changes in VOC profiles of several plant species before harvesting and after either air drying or oven drying (both common methods for herbarium specimens). I was also curious how persistent VOCs were as the specimens aged after drying and whether there were predictable changes. The first question investigated which compounds remain or disappear with drying, and whether the compounds that remain or disappear can be grouped in predictable ways. The second question investigates the changes in quantities and whether older specimens can still be reliable sources of data. I specifically used four native prairie plants, *Andropogon gerardii* (Big Bluestem), *Oenothera biennis* (Common Evening-primrose), *Rudbeckia hirta* (Black-Eyed Susan), and *Heliopsis helianthoides* (Early Sunflower). While many local herbariums have numerous specimens of these species spanning decades, these plants have few to no records of their aboveground VOC profiles, as many studies focus on either model organisms or only on the flowers of plants.

I began by growing the four plant species in a greenhouse setting in which they were exposed to the same conditions. Once the plants were mature, I measured their aboveground (leaf and stem) VOC profiles by sealing the plants in containers and forcing clean air through while capturing the VOCs (see image below). I then dried the plants either in a plant press at room temperature or in an oven which mimics how most herbarium specimens are dried. After two weeks, all the plants were fully dried, and I measured their VOC profiles again. I repeated the measurements again after 4, 12, 24, 36, 48, and 52 weeks of being stored in cabinets. Utilizing a GC-MS (Gas chromatography-mass spectrometry) machine, I was then able to identify the VOCs present and their quantities released by gram of plant tissue. This allowed me to compare and investigate which VOCs continued to be emitted after drying and how they decreased over a year.



I am still working through this data, but the measurements of these plants were successful, and I am seeing significant decreases in VOCs after preservation and continual decreases over the course of a year, except for the alkane group of compounds. Of my four species, *O. biennis* had a 50% reduction in VOC compounds immediately following preservation (week 0) which was the lowest reduction. *H. helianthoides* experienced the greatest decrease in compounds present with a reduction of 71%. Overtime, the compounds present continued to decrease, with less than 30% of the original compounds present in plants by week 24 and by week 52 I detected only 10% of the original compounds found in *O. biennis*. Interestingly, while most compounds decreased in the overtime post-preservation, the opposite was true for the alkane hydrocarbons (hexadecane, heptadecane, pentadecane, etc.) which increased in the preservation samples in

most cases. This may be due to microbial production of VOCs on preserved specimens as bacteria and fungi are known to produce alkanes (Hagaggi et al. , 2025), or they may be released by the plants during the preservation process.

My findings so far indicate that a significant portion of the VOCs are lost with preservation, and alkane compounds become overrepresented. In the future, I hope to investigate whether the destructive methods (grinding, rehydrating) provide more complete VOC

profiles than non-destructive methods (used here). If destructive methods are comparable to non-destructive collection methods, then these partial profiles can be obtained from preserved plants without destroying the plant specimens, allowing future researchers to continue to use these samples. However, the findings so far indicate that this method of VOC collection on preserved plants provides a significantly reduced VOC profile with over representation of alkanes, and specimens older than three months are likely not suitable for profiling.

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Journal Article Roundup & iNaturalist News

Check out these recently published **journal articles**:

- Zinnen, J., Lindholm, S., Spyreas, G., Zaya, D., Matthews, J. **Patterns of ecological conservatism in regional plant species pools.** Biodiversity and Conservation 35, 162 (2026).
<https://doi.org/10.1007/s10531-026-03320-0>
- **Wild type plants are superior to cultivars when it comes to attracting pollinators, study says:**
<https://greatlakesecho.org/2026/06/03/wild-type-plants-are-superior-to-cultivars-when-it-comes-to-attracting-pollinators-study-says/>



Are you on **iNaturalist**? Here are some interesting botanical observations and discussions from Illinois plant observers this growing season:

- In April, Grant Fessler (@grantfessler) shared some neat photos of ***Dicentra cucullaria* (Dutchman's breeches) fruits** and their elaiosomes.
- Also in April, Gregory Hayes (@gregory_hayes) found **an interesting dandelion: *Taraxacum hollandicum***. Do you know your dandelions?
- In May, Ryan Sorrells (@rynxs) tracked down a **130-year-old record of *Gratiola quartermaniae* (Quarterman's hedge-hyssop)** in Will County.
- In June, Jake Smith (@jakes26) got deep into grass ID and **shared an observation of *Dichanthelium boreale* (northern witchgrass)**.
- In July, Karina Torres (@kmtorres) shared an observation of ***Asimina triloba* (common pawpaw)** with an **interesting fungal associate**.
- Also in July, Daniel Pohl (@danielpohl) started some conversation on **hybrid bladderwort, *Utricularia* × *neglecta***, an introduced species in Illinois.

Botany Humor

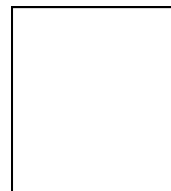




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