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Herbicide Drift and Chemical Trespass: A Summary of 6 Years of Monitoring and Tissue Analysis

By: Prairie Rivers Network | Authors: Kim Erndt-Pitcher & Martin Kemper | 2024

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Photo pg.1: Red Oak with cupped and curled leaves – Photo Courtesy of Kim Erndt-Pitcher
Photo pg. 2: Post Oak with epicormic branching, a sign of declining health – Photo courtesy of Martin Kemper

Table of Contents

Executive Summary

Herbicide drift — the movement of toxic chemicals through the air to a non-target site — is damaging wild and cultivated plants and trees throughout Illinois, threatening human health, and impairing our ability to adapt to a changing climate. The sources of drift are primarily from Illinois' massive row crop industry, but they also include chemical lawn and turf treatments.

Over the past six years, Prairie Rivers Network (PRN) has been monitoring symptoms of herbicide drift and damage to non-target broadleaf plants and trees across rural and urban Illinois. Our Tree and Plant Health Monitoring Program has documented widespread symptoms of injuries year after year. More than 99% of the sites monitored exhibited symptoms every year. The consistent presence of symptoms across monitored regions indicates that exposure to herbicides is widespread and repeated exposures are playing a significant role in the decline of tree health in Illinois.

The impacts of drift — such as declining tree health and death — have become evident during our six years of monitoring. These declines in tree health have also been observed and documented by managers of public lands, private landowners, and outdoor enthusiasts across Illinois, and much of the Midwestern and Southern United States.

Declining tree health triggers a cascading series of adverse impacts to our natural areas, public spaces, and home landscapes alike. For example, tree die-offs can degrade woodland health and shock natural areas by promoting infestations of harmful and expensive-to-eradicate exotic plants. The loss of native tree and plant communities destroys wildlife habitat and depletes their food sources. These injuries also impair the vital role of trees and plants in moderating climate, sequestering carbon, improving air quality, and cooling urban areas. The death of valuable trees like oaks causes financial, aesthetic, and psychological distress to property owners and communities.

In addition to injuring trees, drift can harm pollinators and other beneficial insects through direct contact with airborne pesticides. And

Rough-leaved Dogwood with irregular margins and curling
Photo courtesy of Kim Erndt-Pitcher

contamination of plant material such as leaves, pollen, and nectar may deter consumption and reduce nutritional quality, hindering pollinator growth and reproduction. Negative impacts to invertebrates can ripple through the food web impacting the birds, fish, and mammals that depend on them for food.

Our monitoring and tissue sampling program indicates that current legal safeguards/protections and regulatory efforts are inadequate at protecting people and the environment from herbicide drift. Pesticide regulation and/or enforcement in Illinois is ineffective at controlling the off-target movement and impacts from herbicides. Regulation and enforcement need to be modernized to address the threats posed by the current use and misuse of pesticides across our landscape. The current system is plagued by: 1) significant under-reporting of harmful incidents, including damage caused by legal applications; 2) conflicts and hesitancy to disturb relations among neighbors; 3) public frustration with regulators; and 4) staff and funding shortages that hinder adequate enforcement.

The U.S. Environmental Protection Agency recognizes that only a small fraction (perhaps 1 out of 25 or more) of plant injuries from herbicide exposure are actually reported as formal complaints. Given the rise in off-target herbicide injuries observed in our study, and the widespread injuries noted by experts across the Midwest and South, it's probable that the actual percentage of reported injuries is even lower than this 4% documented rate. Protecting environmental and human health demands a reporting system that accurately assesses the frequency, distribution, and severity of herbicide drift injuries for the region.

Damage from off-target movement of toxic herbicides remains largely unrecognized across the state, in part because it is easily overlooked by the untrained eye. But, for those who know what to look for, the phrase, "once you see it, you can't unsee it," has become a refrain throughout Illinois and many parts of the Central and Southern United States. Simply put, herbicide drift and damage has recently become pervasive, even as it is largely unnoticed.

Over the last six years, PRN has collected and submitted 127 non-target foliage tissue samples for residue analysis. 115 of the 127 tissue samples – more than 90% – contained detectable levels of at least one herbicide. These detections included residues from 11 different herbicides.

Oak tree with curled leaves
Photo courtesy of Martin Kemper

To estimate how far herbicides are moving, we measured the distance from the sites with symptoms to the closest potential source for 545 drift events at 192 monitored locations. Of those, 82% of the observed distances exceeded 310 feet, 50% exceeded 500 feet, and 42% exceeded 1,000 feet.

Many herbicides (e.g. dicamba) frequently fail to remain on target due to their inherent physical and chemical properties. Despite applicators' efforts to follow the product label regulations, including buffer restrictions, these herbicides often drift far beyond their intended areas. We show that even very low concentrations of herbicides drift demonstrably far, causing widespread injury across the landscape.

No agency in Illinois adequately monitors injuries from herbicide drift. This is true despite the laws regulating registration, distribution, use, and disposal of pesticides, and despite years of information sharing, public comments, and complaints. No program measures concentrations of pesticides in the air that people in Illinois breathe. Nor is there adequate state- or federal-led monitoring of pesticide contamination in water resources. Additionally, no agency has a comprehensive science-based ecological monitoring program that measures geographic distribution, severity, and consequences of both acute and chronic exposures to drifting pesticides.

Illinois urgently needs an updated regulatory structure that accounts for the changes in use across the landscape. Not only has the use of many popular herbicides increased in recent years (Figures 2-6), but how we farm is vastly different. There are fewer buffering fencerows, fields are larger, equipment is larger, and fewer crops are being grown, and because spring weather is typically warmer and wetter due to climate change — the time window available for applications that follow the label guidelines is shorter. All of the aforementioned factors can increase pressure on applicators or heighten the risk of adverse effects on the environment.

We must also provide the necessary technical support to growers to help them diversify their farming systems. Tools such as integrated pest management are crucial to reduce reliance on herbicide-only weed control methods. We must move beyond the deeply incentivized conventional corn and soybean system and support the production of other crops such as alfalfa, wheat, oats, small grains, pumpkins, fruits, vegetables, etc.

Additionally, many rural and urban communities are needlessly treating broadleaf plants, or “weeds” in private and public areas, increasing the risk of drift and herbicide exposure to trees, gardens, children, and pets. The public should be made aware of the risks associated with these herbicides.

Finally, this widespread damage is occurring in the context of depleted state agencies with unmet staffing obligations needed for legal enforcement. If we are to protect our communities and environment from herbicide drift, we must not only educate, but we must understand the where and when of drift via ecological and environmental monitoring, and we must strengthen and improve regulations to adequately enforce the intent of the Illinois Pesticide Act. All of this requires enough funding for the responsible agencies to do this work.


Redbud with cupped leaves
Photo courtesy of Kim Erndt-Pitcher

By the Numbers

Overview of Monitoring Efforts (2018-2023):

Total Sites Monitored: 280 unique sites

- **Sites with Symptoms:** 279 sites (99.6%)
- **Repeat Visits:** 143 sites visited two or more years; 65 sites visited four or more years
- **Total Monitoring Instances:** 679 times
- **Symptoms Documented:** 677 instances (99.7%)
- **Symptom-Free Sites:** None since 2019

Herbicide Residue Analysis:

Tissue Samples Collected: 127 samples.

- **Samples with Detectable Herbicide Levels:** 90%
- **Total Herbicide Residues Detected:** 220 residues from 11 different herbicides.

Key Findings:

- **Annual Plant Injury:** Drift injuries recorded each year at nearly every site with multiple visits (142 of 143 sites).
- **Post Oak Hit Again and Again:** The state record post oak experienced at least 15 exposure events over five years (average of three per year).
- **Drift Event Source Identification:** Confidently identified potential sources for 545 drift events at 192 locations. Of those, 82% of observed distances exceeded 310 feet, 50% exceeded 500 feet and 42% exceeded 1,000 feet.
- **Sites More than a Mile from Source:** All six sites located more than a mile from any potential source had detectable pesticide residues.

Background & Purpose

In 2020, Prairie Rivers Network (PRN) issued a report on the first two years of the Tree and Plant Health Monitoring Program (TPHMP), which monitors for symptoms of herbicide injury in wild and cultivated plants [1]. That report documented symptoms of off-target herbicide drift at over 95% of the 130 locations monitored in 21 Illinois counties. This new 2024 report is an update and extension of the previous study. It summarizes six years of monitoring data and covers many more sites over a wider geographic area of the state. It provides data on the frequency of exposures across years as well as within single growing seasons. It identifies the plant species with symptoms of herbicide injury and documents the severity of those symptoms. This report also contains estimated distances from the closest potential source of herbicide exposure and presents results of tissue analysis performed for herbicide residues.

By collecting and reporting this data, PRN hopes to build awareness of the severity of the problems caused by herbicide drift and urge agency leaders and regional decision makers to take the necessary steps to protect the health of communities, our water, air, and natural areas from herbicide trespass.

Black Oak with leaf curling
Photo courtesy of Martin Kemper

Herbicide Drift

Pesticides, including herbicides, insecticides, fungicides, rodenticides, etc., can leave their intended application site and move through the environment in air, dust, pollen, surface water, and rainfall [2, 3]. Herbicides are some of the most widely used pesticides in the United States [4]. They are designed to kill plants through various pathways, such as disruption of root and shoot growth, protein synthesis, and photosynthesis inhibition.

Humans, animals, plants, water bodies, and other surfaces are exposed to herbicides as a result of drift from chemical lawn treatments, commercial turf care, right-of-way management, invasive species control, and agricultural production. The diversity and availability of premixed “weed and feed” lawn treatments, the cultural desirability of a lush green lawn, and the consequential rise of chemical lawn treatment companies all contribute to the damage observed in residential areas. Chemical turf treatments — in lawns, sports fields, parks, cemeteries, and public spaces — can injure native and ornamental plants, trees, and backyard vegetable gardens.

The largest source of drifting herbicides in Illinois, however, is from the production of agricultural commodities. Approximately 75% of Illinois land cover is in agricultural production, which is dominated by row crops, but also includes pasturelands and fruit/vegetable production [5]. The overwhelming majority of agricultural land (approximately 21.5 million acres) is dedicated to the production of corn and soybeans. Nearly all corn and soybeans grown in Illinois are genetically modified to be resistant to specific herbicides, which allow for the use of those herbicides throughout the growing season.

Herbicide applications typically begin in early spring as pre-emergent herbicides applied to kill weeds prior to planting. With the widespread adoption of herbicide-resistant crops, herbicides can now be used continually throughout the season over-the-top of growing and resistant plants and for weed control in double cropping systems. Early- and mid-season applications of herbicides are typically applied via a pull-behind spray boom (soil and foliar applications). However, mid- and late-season applications are also applied aerially via planes (crop dusting).

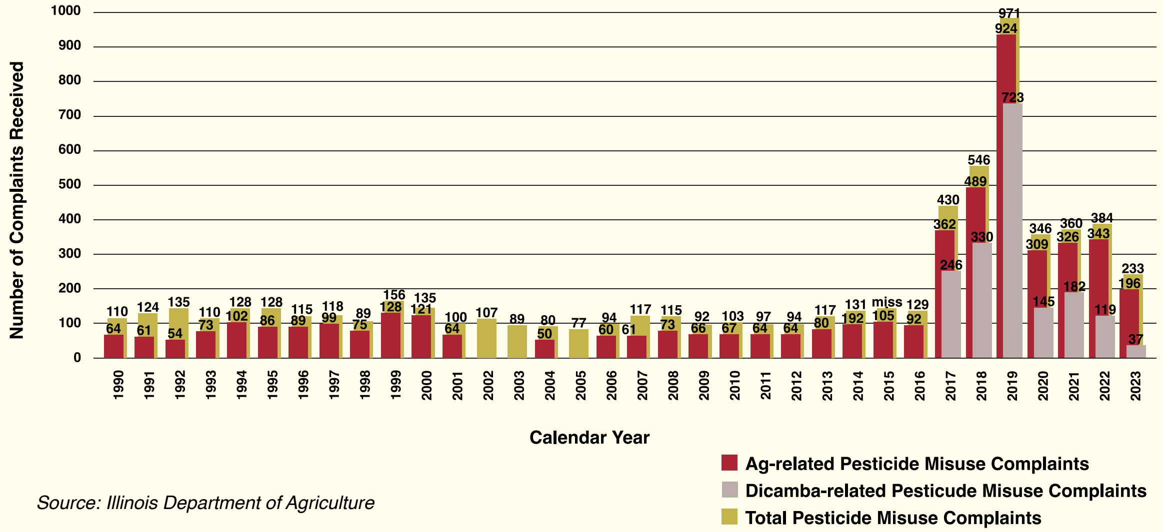
While damage has occurred to non-target plants since people began using herbicides in the 1950s, there has been an explosion of herbicide-related pesticide complaints throughout the Midwest and South in recent years. This increase in complaints is a symptom of the widespread use of herbicides throughout the growing season in an effort to combat ever-developing herbicide-resistant weeds.

In Illinois, official complaints of herbicide injury are filed with the Illinois Department of Agriculture. Figure 1 provides information on the total number of misuse complaints received by the Illinois Department of Agriculture. Complaints started to rise in 2017, coinciding with the first year of over-the-top (OTT) application of dicamba on dicamba-resistant soybeans (Figure 1).

Formal Pesticide Misuse Complaints Received & Investigated by the Illinois Department of Agriculture

Current as of 08/28/23

Figure 1



Source: Illinois Department of Agriculture

The majority of these formal complaints were for injuries to soybeans that were not genetically modified to be dicamba-tolerant. The increased use of both 2,4-D and dicamba coincided with rising occurrences of weeds resistant to the widely used herbicide glyphosate. With the lack of new herbicides being developed and the need to combat rapidly evolving herbicide-resistant weeds, growers (and manufacturers) turned to the use of these older, more volatile herbicides.

It is worth noting that unlike many other plants, soybeans are much less susceptible (approximately 10x less susceptible) to 2,4-D injury than to dicamba injury [6]. While off-target injuries associated with 2,4-D were occurring before the release of dicamba-resistant soybeans and cotton, the majority of them were likely unrecognized and unreported because they did not appear on soybeans. Due to the millions of acres of soybeans injured from the off-target movement of dicamba, knowledge of the symptoms of injury spread throughout the agricultural community. In 2019, Illinois had a record year for formal complaints of off-target injury, with well over 700 official complaints to the Illinois Department of Agriculture. Complaint numbers have since declined. Anecdotal accounts suggest that this is due to: 1) a perceived absence of accountability or enforcement for drift injuries (chemical trespass) after complaints; 2) the widespread planting of dicamba-tolerant soybeans to avoid injuries in this crop; 3) and a continuing lack of understanding of drift outside the agricultural community. However, evidence of off-target exposures to non-crop areas, in both rural and urban areas, have remained heightened and reports of injuries to trees have risen through this time period.

Aerial application of pesticides near a neighborhood
Photo courtesy of Martin Kemper

Figure 2-Figure 6 illustrate the lowest estimated agricultural use of five widely used herbicides. Note the increase in use of 2,4-D, dicamba, glyphosate and glufosinate, which coincide with the rise in herbicide-resistant weeds and the increased adoption of seed technologies with new herbicide-resistant traits. Atrazine, which is widely used in corn and a frequent pollutant in surface waters, has remained widely used over the years.

Use by Year & Crop

National Lowest Estimated Agricultural Use in Million Pounds of Five Widely Used Herbicides

Figure 2: 2,4-D

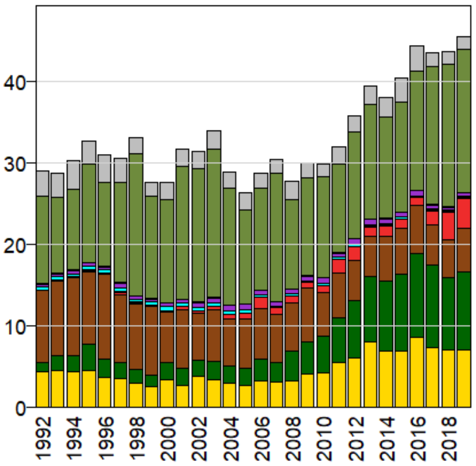


Figure 3: Dicamba

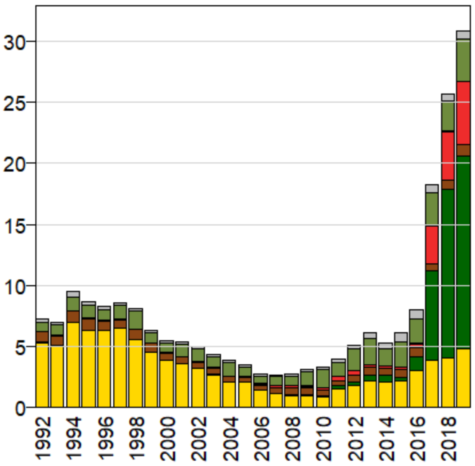
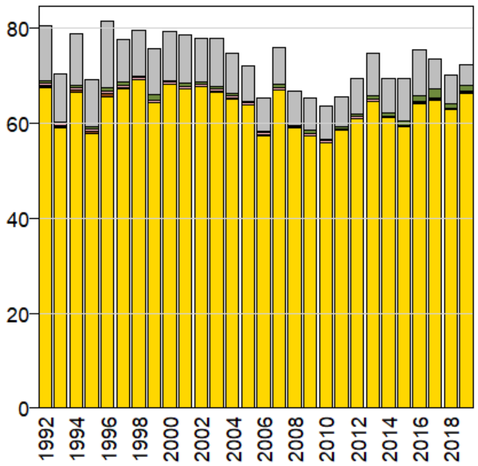


Figure 4: Atrazine



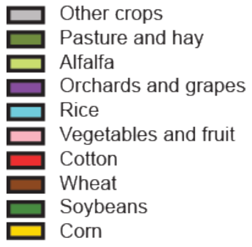


Figure 5: Glyphosate

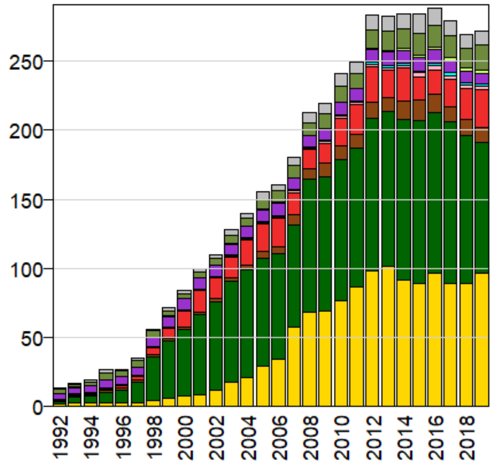
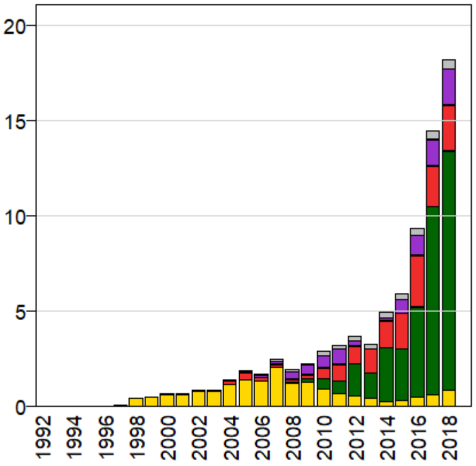


Figure 6: Glufosinate



Source: US Geological Survey, Pesticide National Synthesis Project

Regulatory Oversight – 3 Laws

The problem of herbicide drift is inevitably linked to the legal regulatory framework that governs herbicide use. Pesticide use in the United States is primarily regulated by federal law. The two most important federal laws are the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Food Quality Protection Act (FQPA).

States also have regulatory responsibilities. Some of these derive from the federal law. Especially relevant is that states are given the primary responsibility for enforcing applicator compliance with pesticide labels. In Illinois, the Illinois Pesticide Act also provides a framework for state regulation.

A thorough analysis of specific shortcomings of these laws and their implementation is beyond the scope and purpose of this report. However, below we provide a brief overview of these laws and highlight sections we believe are particularly relevant to the issue of herbicide drift. The reader is encouraged to keep in mind the clear and broad mandates of these laws and compare those to the findings we present in Sections 1-3, as well as the individual case studies of drift we present in Section 5.

Section 4 provides a summary critique of the complaint process administered by the state. We do so in part to underscore the call for creation of a science-based monitoring system that is discussed in Section 6.

Federal Insecticide, Fungicide, & Rodenticide

FIFRA, originally enacted in 1947 (and amended in 1972 by the Federal Environmental Pesticide Control Act and by the Pesticide Registration Improvement Act), was designed to address the registration, sale, distribution, use, and disposal of most pesticides used in the United States. The US Environmental Protection Agency (US EPA) is the federal agency responsible for enforcing FIFRA.

The agency states clearly, “Before EPA may register a pesticide under FIFRA, the applicant must show, among other things, that using the pesticide according to specifications will not generally cause unreasonable adverse effects on the environment.” FIFRA defines the term, “unreasonable adverse effects on the environment,” to mean the following: (section 136 (bb) of U.S. Code Title 7 Chapter 6 Subchapter II)

- Any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide.
- Any human dietary risk from residues that result from use of a pesticide in or on any food inconsistent with the standard under section 408 of the Federal Food, Drug, and Cosmetic Act (US EPA).

Research & Monitoring

The US EPA is also charged with research and monitoring regarding pesticides in the environment and human exposures (Section 136r of U.S. Code Title 7 Chapter 6 Subchapter II). The law reads:

Research – The Administrator shall undertake research, including research by grant or contract with other federal agencies, universities, or others as may be necessary to carry out the purposes of this subchapter, and the Administrator shall conduct research into integrated pest management in coordination with the Secretary of Agriculture.

National Monitoring Plan – The Administrator shall formulate and periodically revise, in cooperation with other federal, state, or local agencies, a national plan for monitoring pesticides.

Monitoring – The Administrator shall undertake such monitoring activities, including, but not limited to monitoring in air, soil, water, man, plants, and animals, as may be necessary for the implementation of this subchapter and of the national pesticide monitoring plan. The Administrator shall establish procedures for the monitoring of man and animals and their environment for incidental pesticide exposure, including, but not limited to, the quantification of incidental human and environmental pesticide pollution and the secular trends thereof, and identification of the sources of contamination and their relationship to human and environmental effects. Such activities shall be carried out in cooperation with other federal, state, and local agencies.

Pesticide Labels

Pesticide product labels are supposed to manage the potential risks from pesticides. Both state and federal agencies enforce pesticide label requirements and states are typically responsible for the education and certification of pesticide users. However, it is up to the user (applicator) to follow the label law.

Pesticide labels are legally enforceable, and state: "It is a violation of Federal law to use this product in a manner inconsistent with its labeling." The label is therefore the law. (Section 136j of U.S. Code Title 7 Chapter 6 Subchapter II).

Food Quality Protection Act

The US EPA is the federal agency responsible for implementing most pesticide regulations that are a part of the FQPA which amended the Federal Food Drug and Cosmetics Act. This law passed by Congress in 1996 contains regulations that were designed to improve safety associated with human exposures to pesticides. The act expanded requirements regarding pesticide tolerances established by the US EPA. To be deemed safe, a tolerance for a pesticide residue in food, must include an evaluation of exposures to the food in question by that pesticide and the aggregate exposure of individuals to that pesticide from all other routes of exposure (e.g., water, air), as well as the special susceptibility of children to exposures.

The following text excerpts from Section 346a of Title 21 Chapter 9 Subchapter IV, U.S. Code are valuable when trying to understand how the Act was designed to protect humans from pesticide exposures:

> *"[...] safe, with respect to a tolerance for a pesticide chemical residue, means that the Administrator has determined that there is a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue, including all anticipated dietary exposures and all other exposures for which there is reliable information" (part (b)(2)(A)(ii)).*

In addition, the FQPA requires US EPA to evaluate cumulative exposure effects, which are effects of related chemicals that have a common mechanism of injury:

> *"In establishing, modifying, leaving in effect, or revoking a tolerance or exemption for a pesticide chemical residue, the Administrator shall consider, among other relevant factors [...] available information concerning the cumulative effects of such residues and other substances that have a common mechanism of toxicity" (part (b)(2)(D)(v)).*

The FQPA also requires US EPA to take special precautions when evaluating risks of exposure to children:

> *"The Administrator[...] shall assess the risk of the pesticide chemical residue exposure based on [...] available information concerning the special susceptibility of infants and children to the pesticide chemical residues, including neurological differences between infants and children and adults, and effects of in utero exposure to pesticide chemicals" (part (b)(2)(C)(i) (ii)).*

The Illinois Pesticide Act

Each state appoints a government agency that is responsible for enforcing FIFRA's national regulations and any state-specific pesticide regulations. The Illinois Department of Agriculture (IDOA) is charged with enforcing FIFRA, as well as implementing the Illinois Pesticide Act. The Act requires that pesticide manufacturers register pesticides for use in the state. A primary purpose of the Illinois Pesticide Act is to "prevent adverse effects on man and his environment" from pesticide use in Illinois if not used properly and according to product label law. Based on this predication of misuse, investigations, and enforcement are prompted by complaints reported to IDOA after pesticide exposure and/or injury occurs to personal property, crops, public areas, people, or animals.

This reporting process was designed to address applicator error and particle drift, which often happens at the time of application. The complaint process is not a replacement for ecological monitoring, nor was it designed to address the current issues related to volatility, where misuse is not the cause of the injury (unless it is related to restrictions that impact volatility, e.g. temperature thresholds). It should be noted that it is widely accepted that only a small percentage of plant injuries symptomatic of herbicide exposure are reported to IDOA as complaints [7], and that the reasons for this are numerous and complex.

Overall, the pesticide misuse complaint process has numerous shortcomings that limit its ability to serve as a reliable and trustworthy tool for gauging the severity, geographic range, and frequency of pesticide-related injuries resulting from both legal use and illegal misuse. The reasons why the numbers of misuse complaints are not a reliable tool for assessing the effectiveness of regulatory measures or the safety of a product are discussed in detail in Section 4.

Left: Foliar application of pesticides – Photo courtesy of the United Soybean Boar
Right: Late Boneset with twisting, curling, and leaf deformation – Photo courtesy of Martin Kemper

Effects & Risks of Drift Exposure – 3 Concerns

Plant Health

The potential routes of exposure for living organisms to any pesticide, and in this case herbicides and their metabolites, are numerous. The complexity behind the routes of pesticide exposure to people remain poorly understood [8]. What is clear is that when used according to the label (which is the law), herbicide uses are much more likely to kill the intended plants in the target area with less off-site effects.

But once drift occurs, those herbicides are no longer controlled and chemical trespass occurs. Because winds can shift during applications, and because some herbicides can volatilize and drift for days or weeks after application, herbicides can and do injure non-target plants. Drift can land on all living and non-living things in an area whether it is a park, schoolyard, lake, home, garden, or forest.

Herbicides are applied at specific rates to quickly kill plants in a targeted area. The amount of a herbicide application that moves off-target is much less likely to be immediately lethal. However, sub-lethal exposures to herbicides can and do cause damage [9-11]. That damage can be particularly harmful, and even lethal, when it occurs multiple times a year and/or for multiple years in a row. For example, trees may rebound after stress (e.g., drought) or other damage or defoliation in a single year, but accumulated multi-year effects are often lethal — even on large and healthy trees.

Exposures to drifting herbicides can diminish an organism's ability to withstand other stressors [12]. Stress caused by other forms of pollution, extreme weather, attacks by pests and diseases, and climate change can be amplified by drift injuries, leading to a decline in health and eventual mortality [13].

Herbicide drift injuries to non-target plant species in Illinois have been observed for numerous consecutive growing seasons. Monitoring data collected indicate both chronic annual and repeated in-season exposures are occurring [14].

Early-season exposures can cause extensive injuries, particularly to some tree species such as oaks, which tend to be at the sensitive stages of bud swell and leaf emergence during this time. Symptoms of exposure in oaks include severe leaf stunting, curling, cupping, and deformation. Visible symptoms in trees will remain present throughout the entire growing season until leaf fall [9, 15]. Such injuries are likely to cause severe stress to trees, impacting their ability to photosynthesize and respire. Little is known about the unseen impacts of herbicide exposure to trees, particularly that of Plant Growth Regulators (PGRs). Injuries that are not easily observed may be occurring to the vascular systems and could also impact growth, respiration, reproduction, etc.

Exposure to growth regulator herbicides can also delay and reduce flowering in plants, diminish fruit, nut, and seed production, reduce leaf canopy area, stunt whole plants, and can have unseen impacts to plant growth and health [16-18]. Even where herbaceous species appear to recover or "grow out" of the injury, the greater health and vigor of injured herbaceous species depends on numerous factors and remains poorly understood.

Multiple exposures of a single herbicide, or mixes of more than one herbicide experienced throughout the growing season at a location, can intensify early season foliage injury. The combination of multiple exposures and the changing seasonal phases of plant functions and sensitivities may also increase the types of injuries experienced due to interaction of the chemicals. Plants undergo numerous vital processes that are susceptible to injury depending on the timing and rate of exposure and the type of herbicide used [11]. These include, but are not limited to: initial growth, leaf emergence, photosynthesis, food storage, flowering, fruiting, seed production, root production, and onset of dormancy.

Animal Health

The potential ecological impacts of acute and chronic herbicide injuries are alarming and complex. Herbicide drift injuries can have direct and indirect impacts on animals. Direct exposures can happen at the time of application or through environmental transport of herbicides and their metabolites after application. Insects and other animals may be also exposed to and negatively impacted by the consumption of contaminated plants or drinking water resources [19-21].

Indirect effects on insects and other animals include reductions in the nutritional quality or the quantity of plant tissue, pollen, nectar, seeds, nuts, and insect food resources as a result of herbicide drift injuries [22, 23]. These changes in the quality and quantity of trophic resources may impact individual development, reproduction, overall health, and ultimately species composition in a community [24, 25]. Aversion to contaminated forage may also result in bees, birds, and other animals traveling further distances for food resources [26]. Longer travel distances require greater energy expenditure and increases the risk of mortality from predators, weather events, and pesticide exposure.

Top Photo: White-tailed deer – Photo courtesy of Martin Kemper
Bottom Photo: Northern bobwhite quail – Photo courtesy of Martin Kemper

Human Health

Photo courtesy of Prairie Rivers Network

A comprehensive review of the impacts of pesticides, in particular herbicides, to human health is beyond the scope and purpose of this report. Throughout monitoring, locals understandably wondered with variations of concerned statements like, *"If herbicides are doing this to these plants/trees, what does it mean for me? I am also breathing this air…"*

There is a deficit of published information evaluating the human health impacts of the environmental loadings from the recent increased use of popular herbicides. Measuring non-occupational pesticide exposure is costly and time-consuming. Yet these studies play a critical role in establishing strategies that limit or eliminate risks of exposure, particularly to children and pregnant women.

A review of studies examining the exposures of inhabitants near agricultural areas to pesticides concluded that people living near agricultural fields are often exposed to different types and higher levels of pesticides than those living further away [8, 27, 28]. Pesticide residues have been found on numerous surfaces in and around homes, on playgrounds, and other places people spend considerable amounts of time [29-31]. Studies have shown that chemicals, such as 2,4-D, used in weed control in lawns and turf can be tracked in by pets and people, and are found in the air and on numerous surfaces in homes after application [32]. 2,4-D and other pesticides have also been found in the urine of children and adults [33].

Epidemiologic studies associate current exposures to pesticides with human health risks, despite the findings from pre-market animal studies [34]. Children, due to their activity level, inquisitive nature, and tendency to put items or hands in their mouth without washing them, are uniquely predisposed to exposure.

The American Academy of Pediatrics made a special statement regarding pesticides and their impacts to children:

> *"This statement presents the position of the American Academy of Pediatrics on pesticides. Pesticides are a collective term for chemicals intended to kill unwanted insects, plants, molds, and rodents. Children encounter pesticides daily and have unique susceptibilities to their potential toxicity. Acute poisoning risks are clear, and understanding of chronic health implications from both acute and chronic exposure are emerging. Epidemiologic evidence demonstrates associations between early life exposure to pesticides and pediatric cancers, decreased cognitive function, and behavioral problems. Related animal toxicology studies provide supportive biological plausibility for these findings. Recognizing and reducing problematic exposures will require attention to current inadequacies in medical training, public health tracking, and regulatory action on pesticides. Ongoing research describing toxicological vulnerabilities and exposure factors across the life span are needed to inform regulatory needs and appropriate interventions. Policies that promote integrated pest management, comprehensive pesticide labeling, and marketing practices that incorporate child health considerations will enhance safe use [35, 36]."*

Numerous studies examining the presence of pesticides in ambient air, surface water, indoor environments, and plant tissues illustrate the pathways for human exposures are many [1, 9, 14, 37-39].

Section 1:

Monitoring Herbicide Exposures – Findings

A detailed description of Prairie Rivers Network's monitoring protocol can be found in our 2020 report (pages 7-10) [1]. The date, location, and observer information were recorded at each site. Several ecological and landscape factors were also recorded, such as the vegetation type being investigated (e.g. upland forest, urban residential), potential drift source locations and associated distances, size of the monitored site, and any patterns (e.g., gradients) noted in overall drift symptoms. The symptoms of herbicide exposure were recorded on a species-by-species basis. Symptoms observed were recorded and the severity of those symptoms were rated. Ratings include a low, average, and high severity rating for each species monitored.

Special attention was given to evaluating and documenting the presence of symptoms in multiple species of plants and from multiple plant families at monitored locations. This is the most powerful means to identify herbicide exposure. In addition, we documented the presence of symptoms across plant types including trees, shrubs, vines, and herbaceous plants (*Table 1*) and recorded symptom presence in the ground layer, understory, and canopy when present. Documenting broad patterns this way reduces the chance of confusing herbicide exposures with factors that might be species or plant specific such as disease or pest outbreaks.

The collection of leaf tissues for the analysis of herbicide residues also adds corroborating evidence and is discussed later. But the information gained from tissue samples is primarily used to identify which herbicides are drifting, not whether drift is occurring.

Trees were a primary focus of our monitoring for several reasons: Most species are typically widely distributed across the state; symptoms can be documented in a variety of easily observed species; and trees have special cultural, biological, and financial value. Trees consisted of 38% of the species documented with exposure and 81% of the species monitored at all locations (*Table 1*). The top five species of trees documented with symptoms include Eastern Redbud, White Oak, Post Oak, Black Oak, and Pin Oak. A full list of species and the frequency at which they were monitored at locations can be found in Appendix A.

Oaks are a keystone species in Illinois [40, 41], therefore they were of particular concern. Our survey found that they were among the most frequently damaged trees. The 48 species of shrubs and woody vines documented with symptoms consisted of 18% of all species monitored. Additionally, the 115 herbaceous plant species documented with symptoms of exposure comprised 44% of species monitored.

Table 1

Plant Type	Species with Documented Exposures		Monitoring Events	
	# Species	% Total	Monitoring Frequency*	% Total
Trees	99	38	7127	81
Shrubs/Woody Vines	48	18	1041	12
Herbaceous Species	115	44	573	7

**Species that were monitored more than one time a year at a site are only included once/year.*

In general, only data from species demonstrating symptoms of herbicide exposure were recorded at the 737 monitoring site visits from 2018-2023. The number of species monitored during a visit ranged from 1 to 34, with an average of 12.4 plant species per visit. Over 99% of the recorded species demonstrated symptoms. A summary of frequency of species monitored per visit is provided in Appendix C.

1A: Evidence of Herbicide Drift Remains Widespread

PRN's original 2020 report provided evidence of frequent and widespread exposures to herbicide drift from 2018 to 2019. This new report summarizes four additional years of data through the 2023 growing season. **These data show the same high frequency of exposures over an even larger geographic area.**

Effort was made to expand the number of locations monitored each year. When possible, sites were visited yearly and a select few were visited multiple times throughout the growing season. From 2018 to 2023, a total of 280 unique locations were monitored for symptoms of herbicide drift exposures (*Table 2*). To understand possible regional or causal differences in exposures, we monitored a mix of both rural and urban sites. We classified 190 of the sites as rural (68%) and 90 as urban (32%). For those locations, there were a total of 737 monitoring visits performed over the years.

Table 2

Number of Locations Monitored and Monitoring Visits Performed by Year

Year	2018	2019	2020	2021	2022	2023	TOTAL
# Locations*	49	83	112	143	146	146	280
# Visits**	54	96	126	155	153	153	737

**Total is sum of unique locations, not the sum of annually visited locations*
*** Some locations were vistied >1 time during a growing season*

In total, PRN monitored sites in 40 counties out of Illinois' 102 during this period, *Table 3* summarizes county level data. Counties monitored are provided in Appendix B with associated frequency data.

Table 3

Counties Monitored & with Documented Herbicide Exposure (2018-2023)

Year	2018	2019	2020	2021	2022	2023	TOTAL
# Monitored	13	19	21	26	27	32	40
# with Symptoms	11	19	21	26	27	32	39

Efforts to observe and document injuries to our highest quality natural lands – those with special state protections under the Illinois Natural Areas Preservation Act, including Illinois Nature Preserves and Land and Water Reserves – were also prioritized. If possible, these high-quality natural areas were visited every year and new sites were added each year (*Table 4*).

Table 4

Illinois Nature Preserves or Land & Water Reserves Monitored (2018-2023)

Year	2018	2019	2020	2021	2022	2023	TOTAL
# Monitored	10	12	24	25	28	27	33
# with Symptoms	10	12	24	25	28	27	33

In addition, 11 sites identified by the Illinois Natural Areas Inventory, but not yet protected by the Illinois Natural Areas Preservation Act were also monitored because they are frequently under threat. Though unprotected, these sites are among our most important places to conserve becuase they often contain high quality or rare ecosystems, and/or threatened and endangered species (*Table 5*).

Table 5

Unprotected High-Quality Locations Monitored* (2018-2023)

Year	2018	2019	2020	2021	2022	2023	TOTAL
# Monitored	3	4	9	8	9	9	11
# with Symptoms	3	4	9	8	9	9	11

**Includes both Illinois Natural Areas Inventory sites and Natural Heritage Landmarks*

Of the 280 unique sites we have monitored to date, 279 demonstrated symptoms (99.6% of the sites). Of those, 143 sites were visited during two or more years, and 65 were visited four or more years between 2018 and 2023.

Table 6 presents data on our findings on the presence of herbicide drift on an annual basis. For the six-year period, those 280 sites were monitored 679 times. Herbicide exposure symptoms were documented 99.7% of the time (677 times). **Since 2019, not a single monitored site lacked symptoms.**

Table 6

Locations Monitored & Documented with Herbicide Exposure (2018-2023)

YEAR	2018	2019	2020	2021	2022	2023	TOTAL
# Monitored	49	83	112	143	146	146	679
# with Symptoms	47	83	112	143	146	146	677

1B: The Severity of Documented Symptoms is Troubling

The system for rating symptom severity is described in detail in our 2020 report (pages 8-9). Visual foliage injury (symptom severity) is rated on a scale of 0-10 with "0" meaning normal foliage development and "10" meaning foliage death. This 10-point system is consistent with US EPA's recommendations for rating herbicide related foliage injury [42].

Over the six-year period, overall symptom severity ratings at sites varied considerably from modest to very pronounced. One way to gauge overall site exposures is to look at the sites with at least one species which exceeds a particular severity rating threshold. Such an approach is a type of "index" approach, which essentially means sites with higher levels of observed foliage severity ratings roughly correlate with those receiving higher levels of exposures and plant injury, and vice versa.

Table 7 below includes a summary of the monitoring data using this approach for all 677 site visits during the entire project period. Of those visits, 674 (99.5%) identified at least one species with a high severity rating score of "≥ 2"; 635 (93.8%) identified at least one species with a high score of "≥ 4"; and 413 (61%) identified at least one species with a high score of "≥ 6." We use the high score because it should be a sensitive measure to differentiate between site level exposures. Average scores for these species would be lower (typically 1-2 points).

What do the scores mean? Very little is understood about how acute and chronic scores impact overall plant health of foliage, but effects are likely to be acute as well as cumulative. The information below aims to bring perspective to injury level ratings.

The relationship between foliar injury and dicamba exposures has been extensively studied for soybeans – an annual legume. Setting aside some statistical nuance, in making a determination about acceptable risk to soybeans from OTT dicamba product exposures, US EPA set a protective threshold of 10% foliage injury, due to an anticipated 5% (or more) reduction in soybean yield when foliage injury exceeds 10% [43].

On the symptom severity scale we used, 10% foliage injury corresponds to a score of "1." This number takes on added meaning in that soybeans, like most annual plants, are typically able to recover foliar integrity over time after such modest exposures (i.e., 10%). This is not true for the majority of perennial native plants and especially perennial woody species, like trees which are much less prone to recover (in-season) from exposures. **Therefore, we believe a reasonable working hypothesis is that level "1" injury to perennial woody plants produces not less, but as much or more injury, to perennial woody species compared to annual crop plants like soybeans.**

Exposure symptoms were regularly observed at levels higher than “1” in every category of plant classification. The highest levels of injury rankings were typically observed in trees. Most of the species in *Table 7* with “≥ 6” level foliage injury are perennial woody species, including trees. *Table 8* below provides annual symptom ratings for oaks (combined) over the project period. Every average annual injury level for oaks exceeds “2.5” (range 2.6 - 3.1). And the average high level of injury at sites with oaks present always exceeded “3.5” (range 3.6 - 4.5). Comparable annual foliage injury data for white oak, an important forest species and the state tree, is also shown, as is data for redbud, a widely planted native and ornamental tree. All values for these species range between “3” and “6”. In comparison to the U.S. EPA’s “acceptable risk threshold” of foliage injury to soybeans of “1”, these injury levels appear to be unacceptable.

Table 7

Locations Monitored & Documented with Herbicide Exposure (2018-2023)							
YEAR	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**TOTAL**
# Monitored	49	83	112	143	146	146	679
# with Symptoms	47	83	112	143	146	146	677
with Severity ≥ 2	47	82	112	143	146	144	674
with Severity ≥ 4	46	72	109	132	142	134	635
with Severity ≥ 6	36	43	67	78	107	82	413

Table 8

Foliage Injury – Annual Average & Average High Ratings (2018 – 2023)						
Year	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Oaks (LTM* Species)						
Average Rating	3.1	2.6	2.6	2.6	3.2	2.6
Average High Rating	4.5	4	3.9	3.6	4.2	3.6
# Observations	86	119	453	614	681	638
White Oak						
Average Rating	3.2	2.6	2.5	2.8	4	3.1
Average High Rating	5.6	5.4	4.8	4.5	5.9	4.8
# Observations	20	19	60	90	95	87
Redbud						
Average Rating	3.6	3.9	3	3.3	3.8	3.7
Average High Rating	4.4	4.5	3.9	4.1	4.7	4.5
# Observations	17	25	66	90	93	75

**LTM (long-term monitoring) = a composite of ratings for eleven frequently monitored oak species*

1C: Summary

Virtually all locations (99+%) monitored from 2018-2023 had symptoms present every year monitoring occurred. While the level of exposures appears to vary, this consistent presence of symptoms across monitored regions indicates exposure to herbicides is widespread and that herbicide drift is ubiquitous in the studied areas.

Section 2:

Testing for Herbicides in Foliage – Findings

In addition to field surveys and observations, leaf samples were collected from symptomatic species, and analyzed at nationally accredited laboratories. The purpose of tissue analysis was to identify herbicides present in symptomatic foliage.

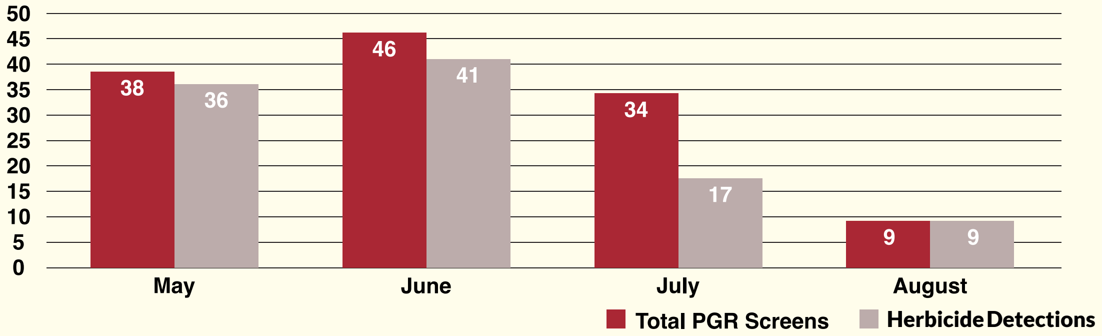
Lab tests for herbicide residues are extremely costly. The types of herbicides each sample was tested for were based on several factors: cost, symptoms observed, the date, and location. The growth regulator herbicides 2,4-D and dicamba were a consistent focus across years, and all samples were analyzed for these herbicides.

Rural, urban, and rural-urban interface locations were sampled. Care was taken to ensure that samples were not collected from locations containing evidence of herbicide use in the immediate vicinity or directly on or around the tree or plant sampled. **Additionally, more than 85% of the samples were taken greater than 100 feet from a field edge or other potential source of herbicide drift. Fifty percent (50%) were taken at 500 feet or greater.**

Over the last six years, PRN has collected and submitted 127 foliage tissue samples for residue analysis. Results are shown below (*Figure 7*).

Ninety percent (90%) of the 127 samples contained detectable levels of at least one herbicide. The 115 samples with detections contained 220 separate herbicide residues from 11 different herbicides.

Frequency of Herbicide Detections in all Samples by Month *Figure 7*

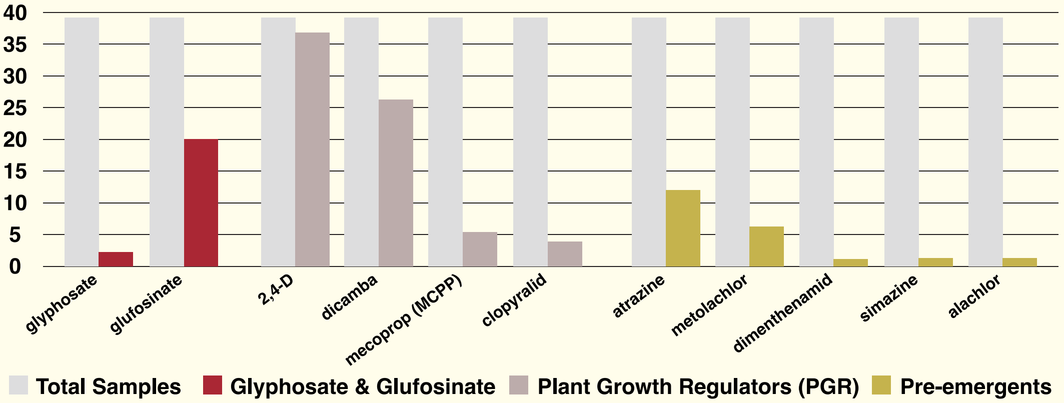


Due to budgetary limitations, all of the three herbicide test groups (called screens) were not analyzed for every sample. All 127 samples were tested for 2,4-D and dicamba, but not all were tested for the entire suite of Plant Growth Regulator (PGR) herbicides, glyphosate or glufosinate, or the pre-emergent screens. Therefore, analysis results shown are conservative, under-representing the actual frequency of several herbicides that could have been detectable in the samples (e.g. When samples were analyzed for the PGR screen alone, an average of one herbicide residue per sample was detected. When samples were tested using all three screens, an average of three (2.9) herbicide residues were detected per sample).

In total, 57% (219 of 381) of the standard screens that were considered as primary concerns in our monitoring areas and could have been employed on the 127 samples were actually tested. As noted, the frequency of some individual herbicide detections would likely be higher if all test screens had been run on all samples.

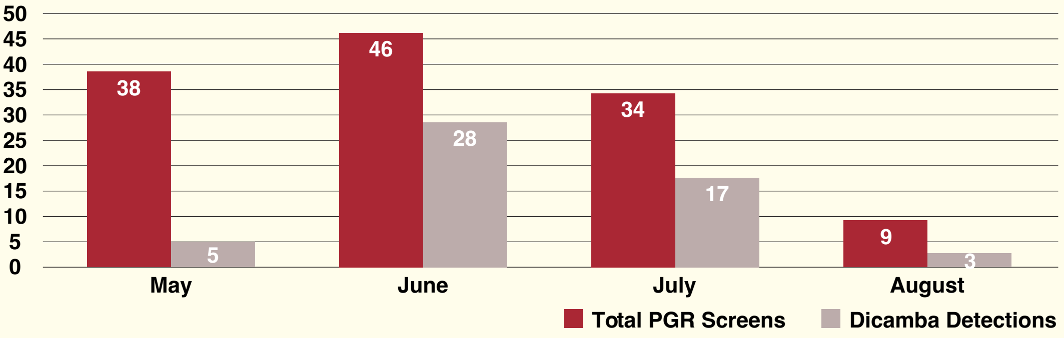
Figure 8 (on the next page) provides information on when all three types of screens were performed on leaf tissue samples.

Frequency of Detections for Three Herbicide Screens *Figure 8*



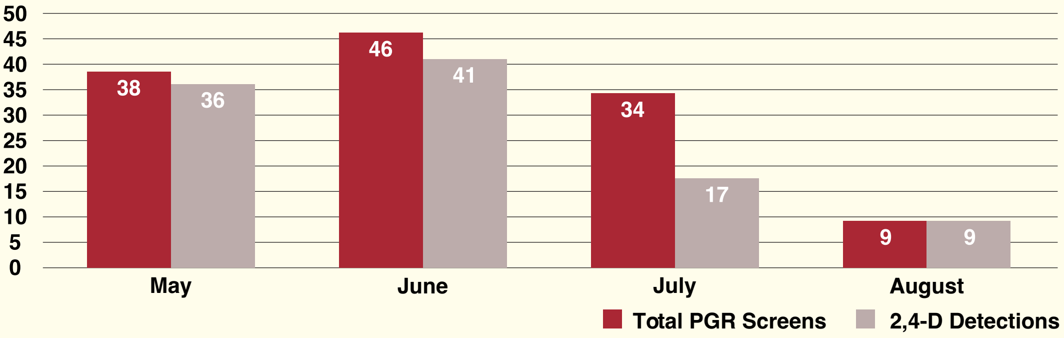
While all these herbicides could have multiple uses, mecoprop and clopyralid are considered signature* for lawn and turf management. (Clopyralid is banned as a residential lawn product, but can be used for other turf management.) Dicamba and 2,4-D are widely used in lawn care applications, but are also used across millions of acres of Illinois farmland throughout the growing season and both are known to cause injury related to drift. The other herbicides detected in tissue analysis are predominantly used in agriculture and include: atrazine, metolachlor, glufosinate, dimethenamid, simazine, and alachlor.

Dicamba Detections for PGR Screens by Month *Figure 9*



Figures 9 & 10 provide information on the seasonality of some PGR herbicide detections found in samples throughout the monitoring effort. *Figure 9* shows trends in detections of dicamba peaking in June, a time when over-the-top (OTT) use of this herbicide is at its highest for herbicide-resistant soybeans.

2,4-D Detections for PGR Screens by Month *Figure 10*



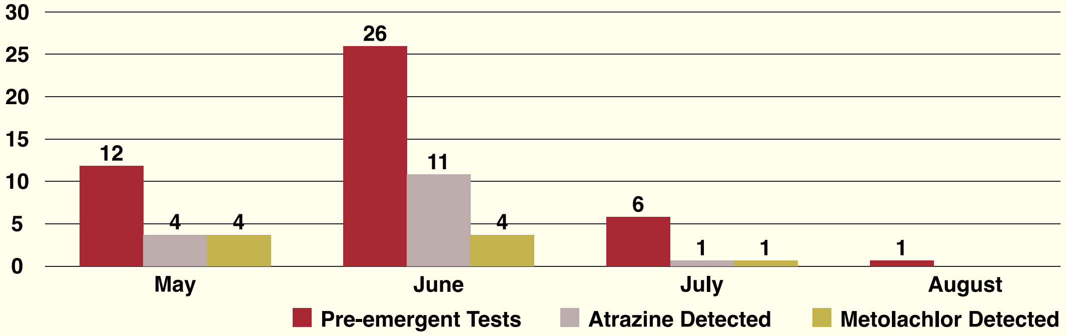
2,4-D was the most widely detected herbicide across all years. It is also the PGR herbicide that is most widely detected early in the growing season (*Figure 10*). This is significant because early spring is when many species of oaks are in the sensitive stages of bud swell and leaf emergence. Exposures during these developmental stages can severely impact leaf development, resulting in stunted, deformed, curled, and cupped leaves which will remain present throughout the growing season.

"signature": Clopyralid is also used as a burndown and as a post-emergence application on corn, as a stand-alone, and in product mixes (2 new ones in 2024) and tank mixes. Use on crops is increasing (USGS).

Atrazine is a chlorinated triazine systemic herbicide that controls annual grasses and broadleaf weeds before they emerge and is one of the most widely used herbicides in the US, particularly for growing corn. Metolachlor is a selective herbicide that has risen in popularity in recent years due to the prevalence of glyphosate-resistant weeds. Both herbicides are known to contaminate surface water [44-46]. *Figure 11* shows the number of leaf samples that were analyzed for these pre-emergent herbicides by month over the past four years. Atrazine was the most frequently detected pre-emergent herbicide in our analysis.

Atrazine & Metolachlor Detections for Pre-emergent Screens by Month

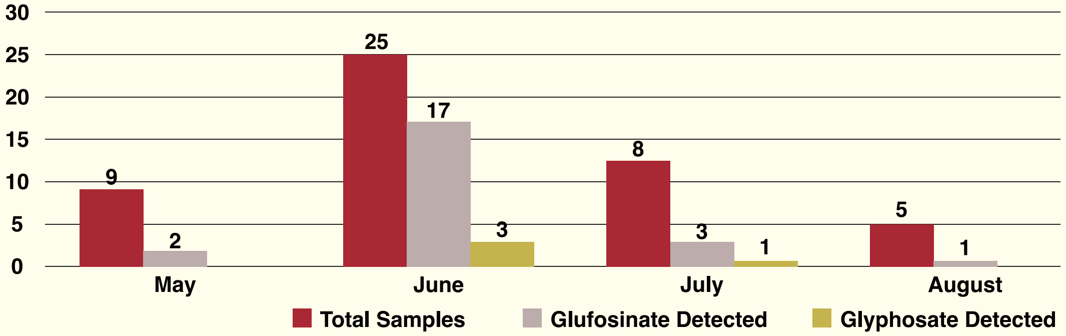
Figure 11



Test screens were also conducted for glyphosate and glufosinate, which are broad spectrum herbicides (*Figure 12*). Glufosinate has risen in popularity during recent years due to the prevalence of glyphosate-resistant weeds and the availability of glufosinate-resistant traits in corn and soy.

Glyphosate & Glufosinate Detections for Individual Screens by Month

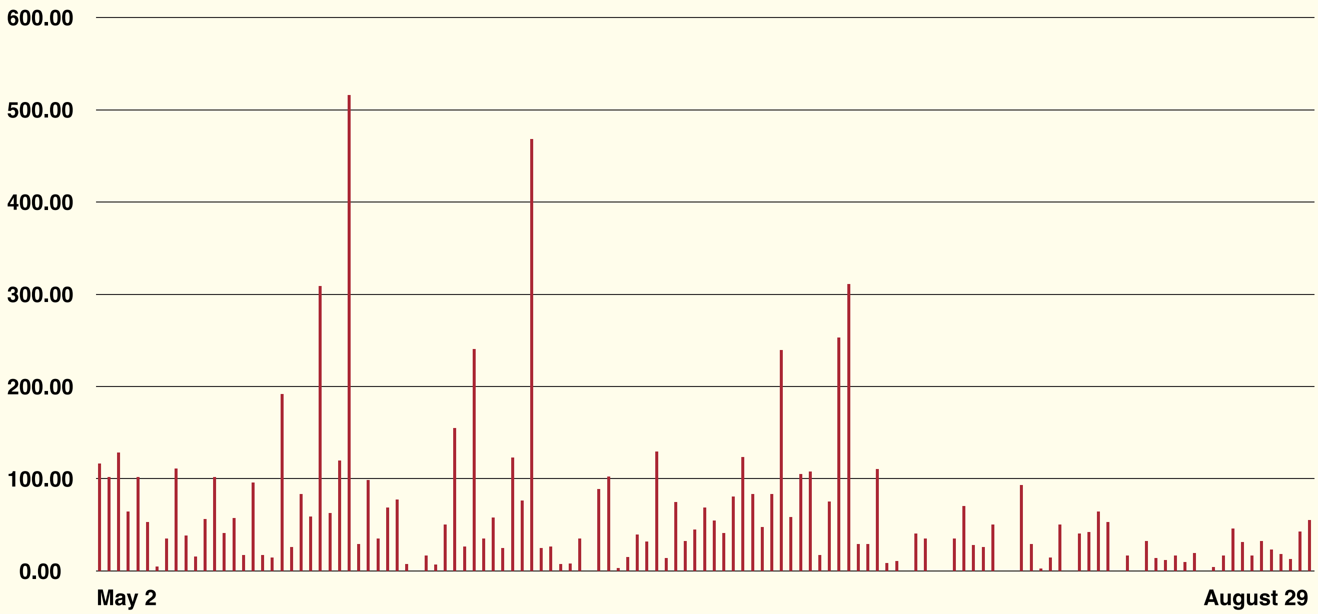
Figure 12



The monitoring data indicate drift is injuring plants every year, at almost every site we visited for more than one year (142 of 143 sites). Most locations were sampled once a year. While not all herbicide screens were run for every sample, *Figure 13* illustrates that residues can be detected even late in the growing season. Initial injuries, particularly severe injuries, to a plant in a growing season often produce long-lasting symptoms that can mask later exposures. This can create difficulty identifying multiple exposure events in a year simply by monitoring foliage symptoms. Tissue sampling, however, can detect instances of repeated in-season exposures. **Just the chronology of the residues detected in our samples indicates that exposures are likely occurring not just once a year, but also throughout each growing season.**

Composite of All Residues Detected per Sample by Date Measured in ppb (135 Days: May 2–August 29)

Figure 13



To better characterize the magnitude and range of within-year exposures, we studied the site containing the state record post oak in Washington County extensively over the six-year project span. Multiple tissue samples were collected from the state record tree for five consecutive years — four each in 2019 and 2020 and three each in 2021, 2022, and 2023 for a total of 17 samples.

The residue of at least one herbicide was detected in all 17 samples. Three samples contained three different herbicide residues and one contained four. When a new herbicide was detected in a series of samples, we recorded this as a separate drift event. If levels of a herbicide(s) markedly increased in a subsequent samples, we also recorded this as an additional drift exposure.

Such samples signal a unique exposure event has taken place and in these cases we classify them as “independent.” These “independent” exposures are labeled “yes” in the independent exposure column *(Table 7)*. However, if the same herbicide was detected in a subsequent sample but levels of that residue were reduced, we did not record that as an additional exposure. Items labeled “nd” mean we were not able to determine from the sample that a new or increased exposure had occurred.

The data from the state record post oak indicate that at least 15 different exposure events or exposure episodes likely occurred to it (and surrounding area) over the five-year period — an average of three such events per year. This finding corroborates what we see in *Figure 13* above and sharpens our understanding of the magnitude of multiple within-growing season exposures that are embedded in that data. And again, these data need to be viewed as conservative. A look at the data shows we were not able to test for all herbicides in all samples. If we had, it is almost certain we would have uncovered additional exposure events.

Table 9 shows the distribution of herbicide residues detected in samples and the specific residues in each sample taken for the several hundred-year-old, state record post oak. Results are ordered by date from May through August (2018-2023).

Table 9

Herbicide Detected in State Record Post Oak Ordered by Date

Sample Date	2,4-D	Dicamba	Atrazine	Metolachlor	Glyphosate	Glufosinate	Independent Exposure
14-May-19	yes	no					yes
27-May-19	yes	no					yes
05-Jul-19	yes	yes					yes
18-Jul-19	yes	yes					yes
24-May-20	yes	no					yes
18-Jun-20	yes	yes	yes	no			yes
11-Jul-20	yes	yes					yes
02-Aug-20	yes	no					yes
22-May-21	yes	no	yes	yes			yes
27-Jun-21	yes	no					nd
28-Aug-21	yes	no					nd
15-May-22	yes	no	no	no			yes
14-Jun-22	no	yes			yes	yes	yes
22-Jul-22	no	no			no	yes	yes
13-May-23	yes	no	no	yes	no	no	yes
09-Jun-23	yes	yes	yes	yes	no	no	yes
20-Jul-23	yes	yes			no	no	yes

Key:
"yes" = herbicide residue detected
"no" = tested for and not detected
"nd"= independent exposure is not determinable
"blank space" = was not tested for

Due to the tissue collection protocol we follow *(Appendix D)*, we conclude that all detections in our tissue analyses occurred from off-target movement of herbicides, whether particle drift or vapor drift. Overall, our results indicate that herbicide applications are not staying where they are intended in Illinois.

Black oak with stunted, cupped, and curled leaves
Photo courtesy of Martin Kemper

Section 3:

Measuring Distances of Herbicide Drift – Findings

During the time span of this report, the off-target movement of dicamba has been described as being "more substantial than any chemical movement previously experienced in U.S. agricultural history." It has damaged millions of acres of susceptible broadleaf species, including non-dicamba-tolerant soybeans. Seeing the uniformity of damage across soy fields and other impacted areas, weed scientists called this phenomenon a "landscape-level effect." Among the factors causing this harm are the "innate sensitivities" of many species to plant growth regulator herbicides including 2,4-D and dicamba, as well as the secondary movements of these chemicals into the air after application by ground equipment [47].

Many pesticides, including insecticides, herbicides, and fungicides, can move through the air by primary and secondary drift. Primary, or particle drift, occurs when spray droplets are blown away or evaporate before reaching their intended target during application.

Secondary, or vapor drift, occurs when a pesticide volatilizes after application. Volatilization can occur for several days after applications are made, often in substantial amounts. During a multi-year study, researchers in Maryland found an average annual loss of 4% of atrazine and 9% of metolachlor during the five days after application [48]. During one year, not included in the averages of the study, the loss of metolachlor reached 63% of the total applied (high soil moisture and high temperature scenario). Volatility losses of these "semi-volatile" herbicides greatly exceeded the quantities lost by surface runoff.

One objective of the Tree and Plant Health Monitoring Project has been to estimate how far herbicides are moving in the air across the Illinois landscape. The following pages provide an overview of how these distances were measured (and why these measures are extremely conservative), a summary of our findings, and a discussion of implications.

Distance data from the location of a monitored or tissue sampled site to the closest potential source was obtained using onsite investigations, satellite imagery, and digital map tools (e.g. Google Earth).

For these measures, a "potential source" was the closest land area that could be a source of drift to the monitored or tissue sampled location. Land areas identified as potential sources include agricultural fields or pastures, golf courses, transportation and utility rights of way, commercial, industrial, and residential areas, and areas of intense targeted herbicide treatments (e.g. invasive weed control). The area selected for measurement was always the closest area which could be a potential source for herbicide exposure.

Each distance measure we recorded was the distance from the selected potential source to the farthest point monitored with symptoms. **This method yields extremely conservative estimates of the distances over which drift is occurring for many reasons.** We mention only two.

First, potential sources were identified and used without evidence that any herbicide applications had occurred in the area, or whether any applications of herbicide that did occur caused the observed off-target symptoms. They simply represent the closest area from which drift could have originated.

Second, the distances were measured to the farthest point monitored away from the potential source. However, not once did this point represent the termination of observed drift symptoms. In no case (>500) did we actually observe a cessation of drift symptoms at the maximum distance reported here. In every case, the maximum distance was "capped" due to other factors such as a property boundary, a time or logistic constraint, or the maximum distance at a location that could be reached when there were multiple potential sources in the surrounding area.

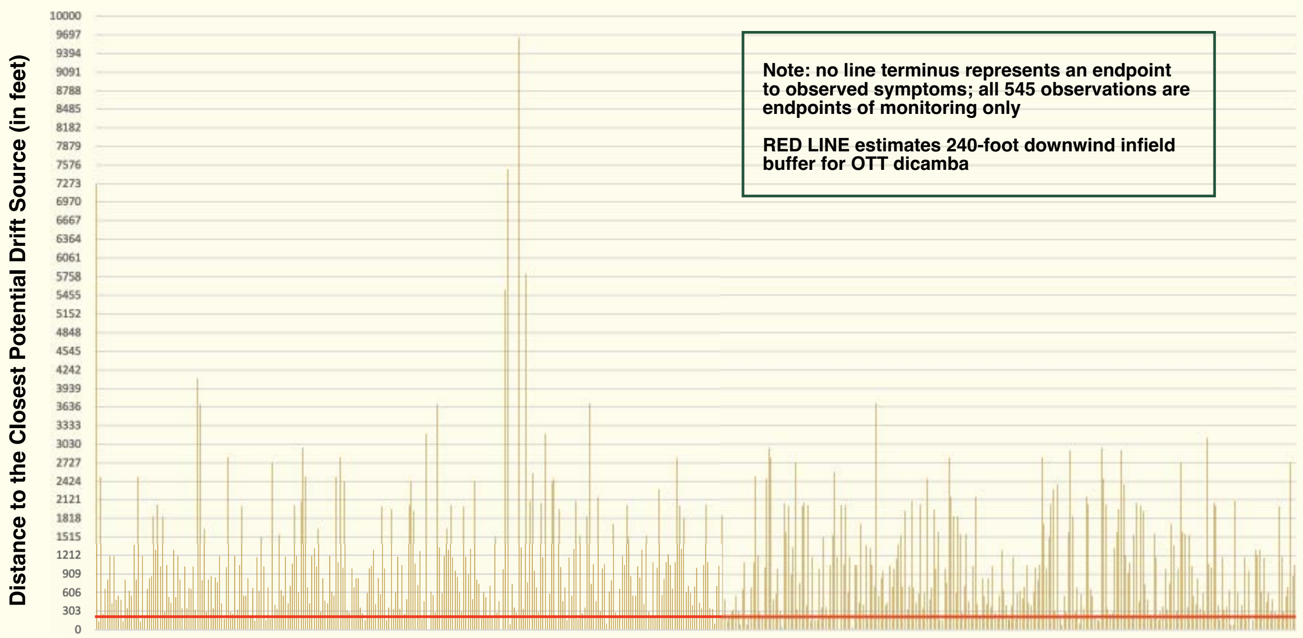
From 2018-2023, we have been able to ascertain the distance to a potential source with confidence for 545 drift events at 192 monitored locations. Data are presented in *Figure 14a*.

Figure 14b summarizes these individual distance measures by showing the number and percent of measured drift distances that exceed various distance thresholds. It also includes examples of several buffer requirements for herbicides as a reference for understanding the significance of the distance data.

For example, 99% of the observed distances would exceed the 57-foot omni-directional (side-field and upwind directions) buffer distance required for over-the-top (OTT) dicamba use in counties with federally endangered species. Eighty-two percent (82%) of the observed drift distances exceeded 310 feet, which is the downwind in-field buffer required when OTT dicamba products are applied in those same counties with federally endangered species (only a very small percentage of US counties have such a guideline). By law, this is the most stringent “safety buffer” we have been able to find for any of the herbicides detected in our tissue samples.

Distance to Closest Potential Source of Herbicide Drift for 545 Monitoring Visits (Observations from May 2, 2018 – October 10, 2023)

Figure 14a



Note: no line terminus represents an endpoint to observed symptoms; all 545 observations are endpoints of monitoring only

RED LINE estimates 240-foot downwind infield buffer for OTT dicamba

Figure 14b

Number and Percentage of 545 Herbicide Drift Observations Exceeding Distance Thresholds (2018-2023)

Distance (in feet)	# Exceeding Distance	% of All Observations	# Representing End of Drift	Example of Regulated Buffer Distance to Provide Off-target Drift Safety
15	545	100.0	0	downwind to stream edge – atrazine
30	543	99.6	0	downwind – 2,4-D Choline
57	542	99.4	0	omni-directional ESA species – OTT dicamba
100	533	97.8	0	
200	487	89.4	0	
240	482	88.4	0	standard downwind – OTT dicamba
250	481	88.3	0	downwind – 2,4-D
310	447	82.0	0	downwind ESA species – OTT dicamba
500	369	67.7	0	
1000	228	41.8	0	
1500	125	22.9	0	
2000	83	15.2	0	

The distance to the closest potential source of drift was also measured for each tissue sample location that contained detectable levels of a single or multiple herbicide(s). The individual distances are plotted in *Figure 15*. The data for distances are again summarized by showing the number and percentage of distances exceeding specific thresholds in *Figure 15b*.

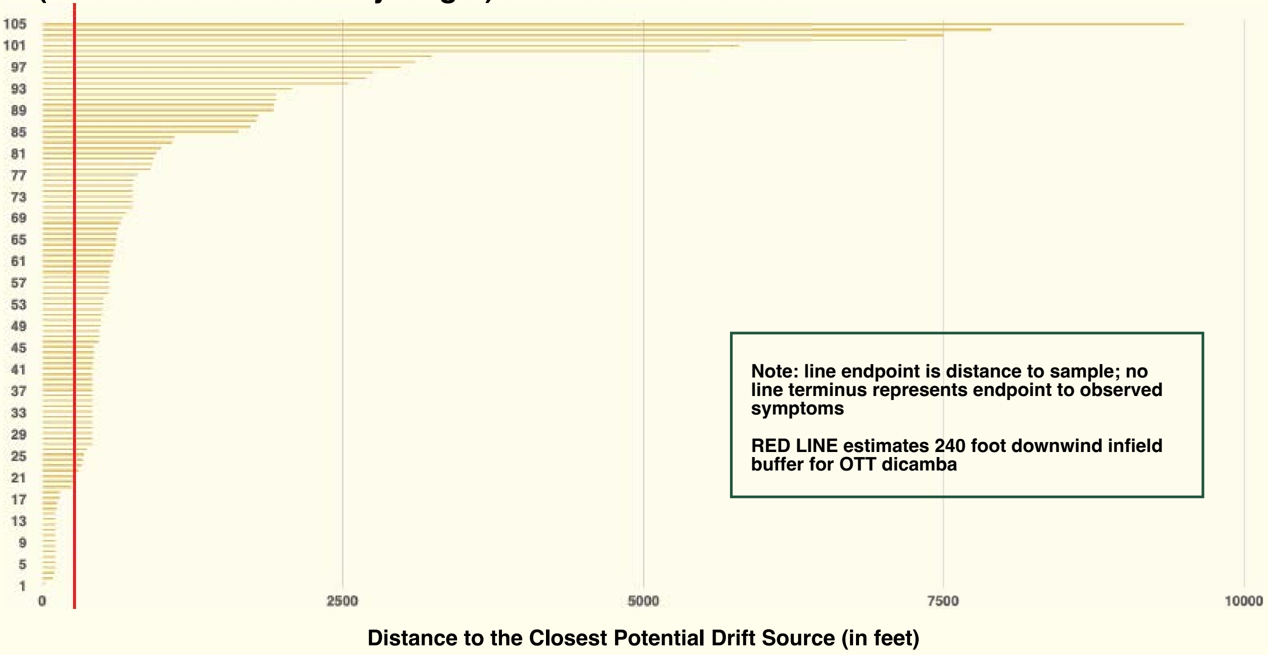
Overall, the drift distances observed for both monitoring and sites with tissue samples that contained residues of a herbicide(s) are very similiar. Ninety-nine percent (99%) of distances to locations where tissue samples were taken exceeded 57 feet and 79% exceeded 310 feet.

Distances measured to tissue sample locations were, on average, a little farther from potential source locations than those for monitored locations at minimum distances, and a bit nearer at the maximum distances.

The percentage of samples that contained detectable levels of herbicide residues did not diminish even beyond 1,000 feet (e.g., all six samples taken at >1 mile from a potential source contained residues *Figure 15a*).

Distance to Closest Potential Source of Herbicide Drift for 105 Tissue Samples (observations ordered by length) 2018 – 2023

Figure 15a



Note: line endpoint is distance to sample; no line terminus represents endpoint to observed symptoms

RED LINE estimates 240 foot downwind infield buffer for OTT dicamba

Figure 15b

Number and Percentage of Distances to the Closest Potential Source Exceeding Threshold for 105 Independent Tissue Samples (2018-2023)

Distance (in feet)	# Exceeding Distance	% All Observations	# Representing End of Drift	Example of Regulated Buffer Distance to Provide Off-target Drift Safety
15	105	100	0	downwind to stream edge – atrazine
30	104	99	0	downwind – 2,4-D Choline
57	104	99	0	omni-directional ESA species – OTT dicamba
100	103	98	0	
200	87	83	0	
240	87	83	0	standard downwind – OTT dicamba
250	86	82	0	downwind – 2,4-D
310	83	79	0	downwind ESA species – OTT dicamba
500	53	50	0	
1000	23	22	0	
1500	21	20	0	
2000	13	12	0	

The chemical residues detected in tissue samples from both rural and urban areas are of herbicides primarily and widely used in agricultural production. However, chemicals used for turf weed management in residential lawns and public spaces are also drifting and causing injury. Due to the proximity of both rural and urban sources of drift, it is reasonable to assume that the potential for drift injury would be greatest at the rural-urban interface. However, our data indicate that in general, entire urban areas, or at least significant portions of the largest metropolitan areas, may have a similar prospect of drift exposure as do rural areas.

Safety Buffers Aren't Effective

If the regulatory structure was working effectively, significant symptoms of injury would not be observed beyond the borders of application sites. Injurious concentrations of herbicides in air would be contained within the boundaries of each application site and any required safety buffer.

Safety buffers are untreated areas between application sites and sensitive areas. They are a recognition that herbicides can and do move off-target even when applied according to label directions. Buffers are supposed to provide a margin of safety such that drift does not damage unintended resources.

The US EPA decides what injuries are unacceptable in rural and urban non-crop areas using a labyrinth of complex models of risk assessment and management. They also use these models and select studies to establish safety buffers distances with precision down to the foot (e.g., "57 feet").

In the case of the drift exposures we have documented throughout Illinois, it is not necessary to understand the underlying workings of this system. In the end, the risk management process and models they use only serve their purpose if they work. Their effectiveness can only be evaluated by studying the areas they are supposed to protect.

Documented injuries regularly exceeded what most would consider acceptable injury, not only near the edges of potential sources of drift, but also at maximum distances measured from potential sources. The data in *Figures 14 and 15 (a and b)* illustrate that many herbicides are regularly moving well beyond application sites, regardless of label regulations including any additional safety buffers. Even with added safety buffers, the regulatory system for many herbicides is shown to be dramatically ineffectual at preventing off-target drift, and implies that the models of risk assessment and/or processes of risk management it depends on are flawed.

Additionally, there is evidence that the US EPA has ignored the recommendations of its own scientists when establishing buffers (e.g. for use of OTT dicamba products) [49].

There is No Observable Attenuation

The data in *Figures 14b and 15b* seem to show a reduction of both symptom observations and tissue samples with detectable residues as the distance from potential sources of drift increases.

However, our data actually do not support such an assumption or interpretation. The tabled data simply reflect the frequency of observations at the various distances. A full analysis of this issue would exceed the scope of this report. But in short, the "exceedances" reported in both monitoring and tissue sample data sets (*Figures 14b and 15b*) attenuate not because exposure symptom or residue detection percentages were diminishing. Rather, because of proximity to agricultural land and other potential sources, there are few locations where drift effects can be measured at increasing distances.

Our data suggests that, given the status quo of off-target drift protections in Illinois – a state where land uses are intermixed and natural lands are highly fragmented – there are few areas where there is a buffer large enough to protect natural and residential areas from exposure.

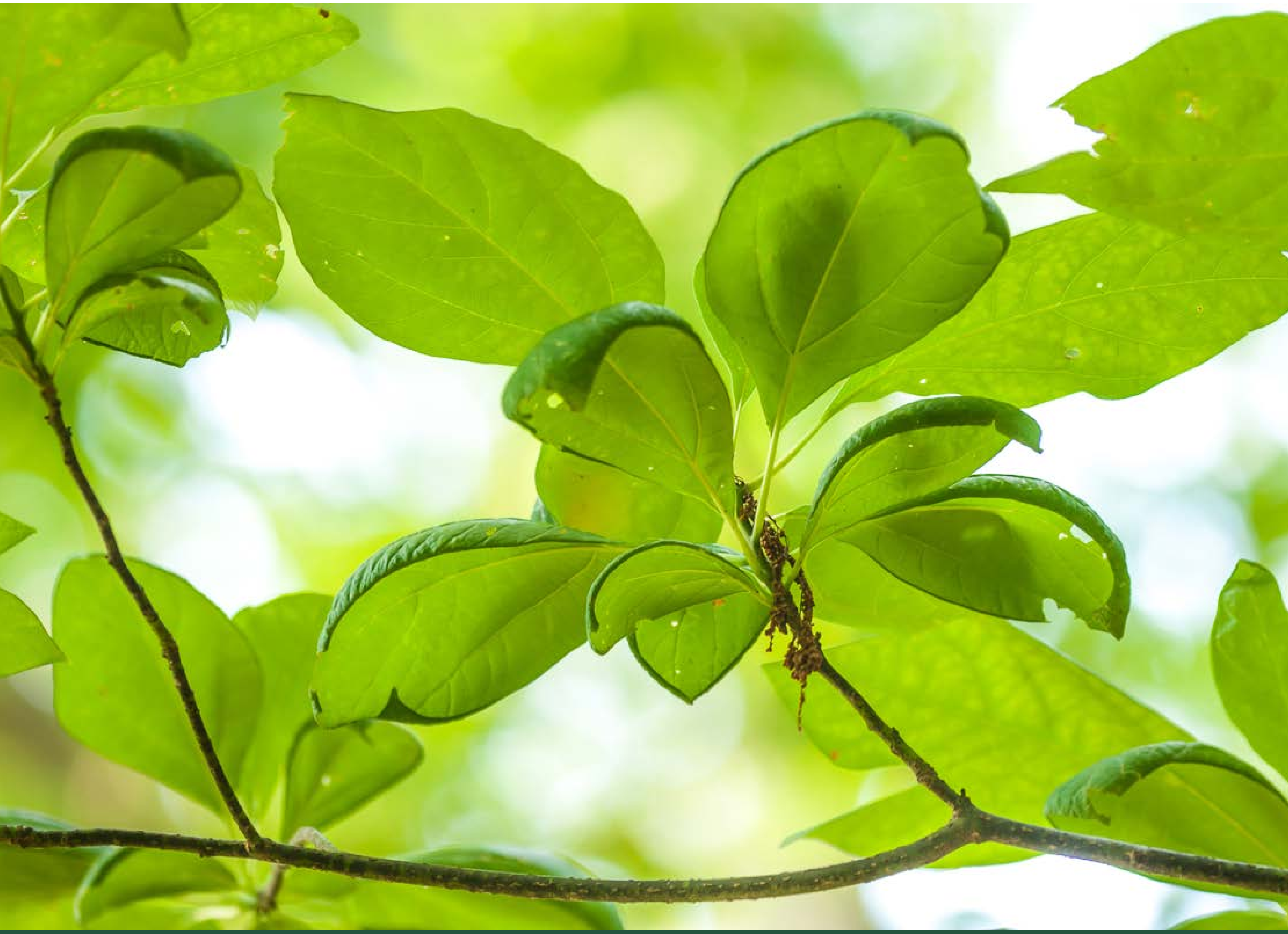
Sublethal Effects are Under the Radar

Symptoms observed in plants provide important information, regardless of how symptom or tissue residue levels are evaluated by regulatory agencies. Exposure to and non-target damage from herbicides is occurring, not only to plants, but to all living things in the area where symptoms are present.

Our data not only provide insight into landscape-level exposures, they also suggest other potential problems. For example, wild plant and native ecosystem performance across a broad swath of Illinois is occurring against a backdrop of recent and largely unrecognized herbicide exposures.

We have regularly spoken with biologists, tree professionals, educators, landowners, and farmers who had no awareness that drift symptoms were apparent all around – due in part to the “distance isolation” from any visible source of drift one naturally supposes is protective. Evaluations of a wide variety of biological phenomenon are not being informed by or controlled for these often invisible exposures. Many of the herbicides involved target broadleaf plants differently from needle and scale leafed plants, and appear to have different effects in closely related species.

The fact that our data demonstrate drift is occurring for herbicides that are widely thought to be low-volatile or semi-volatile suggests that other classes of “non-volatile” pesticides that are applied using common broadcast methods may also be causing unrecognized biological effects and injuries at locations well beyond application sites.



Sassafras with cupped and curled leaves
Photo courtesy of Martin Kemper

Section 4:

Illinois Regulatory Structures are Inadequate

The Illinois Pesticide Act was instituted in 1966 and, while there have been amendments and adjustments to the law over the years, these adaptations have been outpaced by the changes occurring in the chemical and agricultural industries. There are several aspects of the implementation and enforcement of the Illinois Pesticide Act that contribute to its inability to adequately protect the people and environment of Illinois from the harmful effects of pesticides. However, here we focus primarily on the shortcomings of the complaint process, due to its historical and continuing role in the assessment of the magnitude of off-target drift injury. We also briefly mention two additional issues, which exacerbate overall drift control efforts and which also need systemic amendment or replacement if control efforts are to succeed.

1 The existing pesticide misuse complaint process does not protect the people or the environmental health of Illinois.

The current and only complaint process for Illinois is based around reporting the misuse of a pesticide. It has numerous shortcomings that limit its ability to serve as a reliable and trustworthy tool for gauging the severity, geographic range, and frequency of pesticide-related injuries resulting from both legal use and illegal misuse.

Shortcomings of the current system include:

- The complaint system is designed to identify particle drift that is a result of applicator error. Many off-target drift incidents are not traceable to any misuses or known source. Therefore, these incidents are related more to product properties (e.g. volatility) than identifiable application misuse, and incidents are routinely not investigated with rigor and are often "closed" without identifying the source of injury.

- IDOA's required form for reporting herbicide injury states that is an "allegation of misuse." Yet, many individuals have no reason to suspect misuse, or have any knowledge of whether it occurred. They just know they have symptoms of herbicide injury. The allegation of misuse creates an ethical dilemma and barrier for anyone wishing to have their injury acknowledged and its causes investigated.

- In the case where injury due to misuse is suspected, the reporting of injury is dependent on the willingness of the injured party to implicate a neighbor of misusing a pesticide. This is an inherent disincentive to filing a complaint.

- "Reporting Fatigue" is widespread. This is a result of injured parties receiving no definitive answers or financial resolution for their complaint and having dealt with the social strife associated with complaining year after year. After repeated complaints with no relief from regulators and responsible agencies, many simply stop complaining.

- The 30-day "window" for reporting injury from the time of detection needlessly limits the number of reports filed each year. A 30-day window is more applicable to complaints where misuse is suspected and timeliness of investigations can be more critical. Given the increase in injuries occurring from volatilization, where no applicator error can be found, a system centered on documenting injury and not solely focused on the discovery of misuse would provide more information to state and federal regulatory agencies on the effectiveness of their regulations. Additionally, in perennial plants, such as trees, the symptoms remain present throughout the growing season. While it is desirable to document injury as soon as possible, it is more important to document that injury has occurred.

- The number of complaints that are filed, investigated, and attributed to off-target drift is used as the principal gauge of the level of annual off-target herbicide exposures by the

IDOA. And by extension of the state's role in FIFRA administration, this number is used by the US EPA for the same measure. It relies almost exclusively on the general public's ability to recognize the symptoms of herbicide injury and therefore lends itself to the issue of the chronic underreporting of injuries.

- The current process used for investigating off-target drift complaints is scientifically inadequate. Our informal discussions with numerous persons who have experience with complaints and the subsequent IDOA inspections reveal variations in the depth of site inquiry, inconsistent and sometimes obfuscatory identification of what are clearly herbicide drift symptoms, and most importantly, rarely utilize tissue sampling to identify offending herbicides when drift injuries are not directly attributable to application misuse. The lack of good science regarding off-target drift impedes both the agencies' and the public's understanding of the problem and further cloaks the issue in uncertainty.

- Using the current system as the sole method of evaluating the environmental impacts of a pesticide is wholly inadequate, particularly given the rise in use of highly volatile herbicides such as 2,4-D and dicamba across the agricultural landscape. The current process does not offer agencies, taxpayers, or individual landowners explanation or identified sources of pesticide injuries. Therefore, neither protection nor compensation for lost equity in forested lands, vegetable gardens, and private landscaping can be provided.

2 The enforcement structure in the Illinois Pesticide Act is insufficient to influence behavior changes related to off-label (illegal/misuse) applications. No authority is empowered to enforce label violations where and when they occur. Enforcement relies on after-the-fact identification of injury, an inherently unreliable system that vastly undermeasures drift injuries.

3 Penalties for off-label applications and misuse are assessed using a point system that is tepid and seems to provide little deterrent. While Illinois regulators have refined aspects of this system over the years, it remains problematic at deterring the off-label use of pesticides.

The way pesticides are currently regulated in Illinois is ineffective and needs to be modernized to address the threats posed by the changes in use (e.g. formulations, combinations, amounts, timing, etc.) across the landscape.

The current system is plagued by: 1) significant under-reporting of incidents, even those caused by legal applications; 2) conflicts, and avoidance of conflicts, among neighbors; 3) public frustration with the regulatory system; and 4) staff and funding shortages that hinder adequate enforcement and applicator accountability.

Victims of pesticide drift should have the option of filing a complaint, without any allegation of misuse and involvement with any other parties. IDOA also needs to increase the scientific scope and consistency of its investigations. This should increase the amount and quality of information shared with the US EPA during annual reporting and would likely help to alleviate some of the aforementioned problems. It would also provide the victim with a reliable means for registering a complaint that counts as an incident with the state pesticide regulator and that is not fraught with ethical issues or social pressures.

Even the US EPA has recognized that only a small percentage (1 out of 25, and likely more) of plant injuries that are symptomatic of herbicide exposure are actually reported as formal complaints [7]. Given the rise in off-target herbicide injuries observed in our study, and the prevalence of injuries noted by experts across the Midwest and South, even this number seems too high. There needs to be a system in place that accurately assesses the frequency, distribution, severity, and causes of herbicide drift injuries for the region.

Section 5:

Putting Things in Context

Seeing the impact drift has on the landscape is extremely important. And understanding the ecological and climatic impacts of repeated drift exposures are critical to the health of our environment. However, herbicide drift also impacts the people that live on and care for the landscapes that are being damaged. Those impacts are complex and take many forms, such as psychological stress, anxiety, despair, reductions in the enjoyment of the natural world, financial losses, and the degradation of family legacies, heritage, and endowments. This section highlights the experiences of different places and the people who enjoy and own those places.

Pecan leaves with curling and twisting
Photo courtesy of Martin Kemper

5.1

Champaign County

Champaign-Urbana: Drift Knows No Boundaries

Damaged Values: Urban Air Quality, School Yard Safety, Trust in Institutions

Redbud with cupped and curled leaved
Photo courtesy of Kim Erndt-Pitcher

In 2023, PRN expanded our Tree and Plant Health Monitoring Project in Champaign-Urbana. For several years, we monitored symptoms of off-target herbicide injuries in the Champaign-Urbana area. In order to better understand the injuries that were being observed and identify specific herbicides, we collected tissue (foliage) samples from 12 sites scattered across the metro area. A total of 13 samples from those sites were analyzed by an independent lab. Samples were collected from both public and private spaces, many on or near school grounds and were located on the edge and in the center of the community. One site was located approximately two miles from the nearest crop field. No samples were taken from locations with evidence or knowledge of prior herbicide use.

Visible symptoms were observed at all 12 sites. Twenty-nine species of plants, including 23 tree species, were documented with drift symptoms.

The accompanying tissue sample results from eight different plant species were stunning. Forty-nine different residues of eight different herbicides were detected in the 13 tissue samples — an average of four per sample. Only one sample had a single residue. All others contained three or more. One sample contained six different herbicides. Also surprising, the distance a sample was taken from the surrounding cropland made no difference in sample results, and herbicides used primarily or almost exclusively on row crops were found throughout the metro area. Distances to a potential source of drift for these latter herbicides range from about 100 feet for properties at the rural-urban interface to approaching 10,000 feet for those near the city center.

2,4-D was the most frequently detected herbicide (12 of 13 samples), followed closely by dicamba and glufosinate (11 of 13 samples each). Herbicides used primarily in lawn and turf applications (e.g., MCPP and clopyralid) were found in addition to those used almost exclusively in agriculture (e.g., atrazine, glufosinate). “Cross-over” herbicides — those used on lawns, though more extensively in agriculture (2,4-D, dicamba), were prevalent among the samples.

5.2

Champaign County

An Urbana School: Herbicide Drift Beyond Imagination

Damaged Values: School Yard Safety, Nature Preserve Integrity, Trust in the Pesticide Safety System

Bluestem Hall Nature School is a nature-based preschool (now offering K-1 classes) located on the southern edge of Urbana. It shares space with the adjacent Barnhart Prairie Nature Preserve, which is a vital part of the school's outdoor experiential learning program.

Both the school and prairie are on land set aside to conserve important elements of the native Illinois ecosystem and to foster an appreciation of nature among people. This is the legacy of the Grove and Barnhart families that farmed and stewarded this land for more than a century. The land, and the people enjoying it, including young children, have increasingly been impacted by herbicide drift blowing from nearby fields.

> **"In the spring and autumn each year for the past few years, our students are out playing and learning on our outdoor school campus when suddenly, and without warning or prior notification, our teachers smell, taste, and feel chemical spray that has drifted onto our property from nearby farms where they are being applied. Our worst-case scenario is when they are applied adjacent to our school property, and the boom sprayer passes by unannounced, flooding the area with chemicals, the wind often pushing it immediately in our direction. Our teachers have to run the children inside as quickly as possible so that they don't continue to breathe these chemicals, but we know that as soon as we can smell it, they are already landing on us. It's frightening and frustrating, and frankly, deeply unfair that our property rights and the bodily autonomy of these children are not protected."**
>
> *ABBIE FRANK, EXECUTIVE DIRECTOR OF BLUESTEM HALL NATURE SCHOOL*

Prairie Rivers Network included monitoring at this site in its assessment of herbicide drift in the Champaign-Urbana area. A tree foliage sample was collected from a fencerow between the school and prairie and a sample was also obtained from a wildflower species that grows in the Nature Preserve. Both were analyzed for herbicide residues.

Photo courtesy of Prairie Rivers Network

Monitoring occurred up to 900 feet from the closest potential source of drift which was cropland. The tissue samples were taken at a distance of approximately 400 and 600 feet from the same potential source. Both the school and schoolyard were located between the monitoring and the tissue sample sites and the closest potential source of drift.

Symptoms consistent with herbicide exposure were observed throughout the property, and there was no cessation of symptoms at the farthest distance. Exposure symptoms were documented on five species of trees near the school and prairie and four species of plants growing in the prairie. Tissue sample results identified four herbicides present in the foliage samples — 2,4-D, dicamba, atrazine, and glufosinate. They were doubtless transported there in the air.

> **"Our nature-based program is designed to cultivate magical, respectful, and wondrous connections between children and their natural environment. How can we do this if we are literally running indoors to escape the chemical drift in our community? It raises the question — who has the rights to air quality? And the answer is clearly not in favor of our smallest citizens."**
>
> *ABBIE FRANK*

5.3 *Kane County* Hidden in Plain Sight

Damaged Values: Restored Urban Pollinator and Woodland Habitat, Home Grown Vegetable Safety, Confidence in Regulations

Nestled in the tranquil suburbs of Kane County, the Hirsch family resides among a pastoral landscape of native forests and neighboring farmlands.

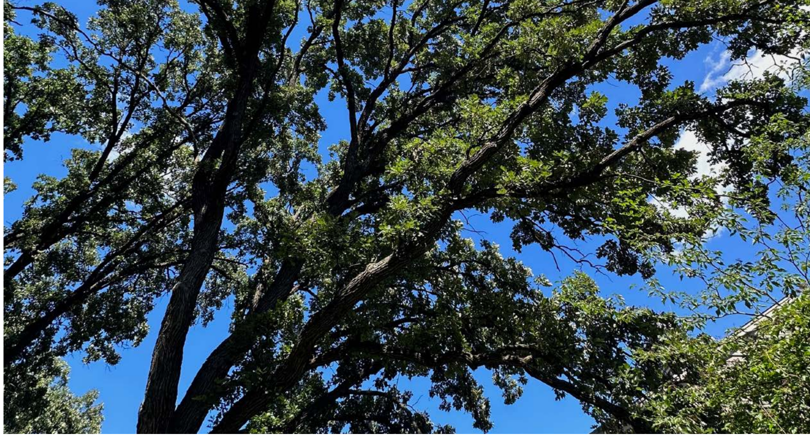
The family has set a commendable standard for their stewardship of their little piece of Illinois. Beneficial native prairie and forest plants create a colorful and pollinator friendly replacement for sterile turf grasses. The native forest stand provides a much-needed haven for wildlife.

Their commitment to gardening and cultivating homegrown food not only brings personal joy but also honors our common heritage and the planet.

Despite their best efforts, over the past decade herbicide drift from neighboring lawns and fields has cast a toxic shadow over their cherished landscape. Instead of health and vigor, the Hirsch family is now witness to the decline of oaks and other tree species, with symptomatic foliage and thinning canopies.

Their losses include:

- Two large oaks, several cherry trees, and native shrubs in the past three years — scenes repeated elsewhere in the neighborhood and community.
- Tree leaf drop throughout the entire growing season has created landscape work akin to a never-ending autumn. An uptick in spontaneous dropping of branches of all sizes adds another item of work, and concerns about safety.
- Pollinator plantings that show annual leaf disfigurations, bloom fail, and plant death.
- Chronic injury to their garden vegetables from off-target drift of nearby applications of lawn herbicides has become so commonplace, the produce is considered adulterated — unfit for consumption, and even composting.



Bur Oak showing thin canopy, branch die-back and epicormic sprouting – all signs of chronic health decline.

The Hirsch family has, on five occasions over the past seven years, filed complaints with the proper regulatory agency, the Illinois Department of Agriculture (IDOA). During IDOA visits, two tissue samples were taken. Both identified the presence of the herbicide 2,4-D in the affected plants.

Despite numerous inspections by IDOA and limited tissue sampling, investigations have lacked scientific rigor, failing to acknowledge or explore causes beyond applicator error, leading to no relief. Consequently, no solutions have been offered.

This experience mirrors countless others across Illinois — and including many who simply do not know.

> **“Herbicide drift has taken the joy from gardening and the respite of living in the woods, replacing it with the ongoing stress of damage and loss to trees and herbaceous plants. We have made the painful decision to forego harvest of our garden vegetables due to repeated herbicide exposures from the many lawn applications that take place in our neighborhood. The damage is everywhere we go. You cannot unsee it, once you know how to identify herbicide damage symptoms.”**
>
> *PATSY HIRSCH*

Bur Oak (left) showing stunting and cupping

Garden Bean (right) showing cupping and leaf puckering

Photos courtesy of Patsy Hirsch

5.4 *Edwards County*

Struggling to Preserve a Legacy

Damaged Values: Rare High Quality Barrens Natural Community, Dedicated Illinois Nature Preserve, Family Heritage

Beadles Barrens Nature Preserve, located in Edwards County, is a part-woodland, part-prairie natural community known as a "barrens." This high quality barrens remnant has been stewarded by the Beadles family for four generations and is magnanimously preserved for future generations as an Illinois Nature Preserve. It is anything but barren. It is home to an impressive diversity of colorful prairie wildflowers nestled within an oak dominated woodland. Recently, it has also become home to an unwelcome guest — off-target herbicide drift.

Over the past two years, Prairie Rivers Network has helped characterize the extent of injuries, which are clearly impacting the vitality and threatening the integrity of this historic Illinois landscape. Tissue samples were also collected in 2023 to identify drifting herbicides at this site.

Among PRN's findings:

- Twenty-two species from 10 different families of prairie and woodland plants were documented with herbicide drift symptoms. The highest symptom severity rating for shingle oak recorded in the six years of PRN's monitoring project was recorded here (2023).
- White oak mortality was recorded in 2023 after high levels of symptom severity were recorded in 2022.
- Approximately 1/4 to 1/3 of white oaks at the site appear to be recently dead.
- Symptoms of drift were relatively uniform throughout the site and were observed as far as 1/8 mile from the nearest potential source of drift (cropland).
- Herbicides detected in the foliage sample from shingle oak included 2,4-D, dicamba, and atrazine — common herbicides used in the surrounding agricultural environment.

White Oak – dead in 2023 after high injury level in 2022.

> **"My great great-grandfather bought 200 acres including this property in 1866 with the money he saved up from serving in the Union Army during the Civil War. I first started helping burn this area when I was 5 years old along with grandpa and my brothers in 1959. I started doing total management of the area in 1995. I have been doing the best I can to save this unique property and try to maintain a 'pre-settlement' post oak barrens appearance to it but seeing herbicide drift slowly killing post oaks that have survived 100 to 200 years is alarming. This unique community is being lost, there is no longer acorn production to ensure there is another generation of trees. These trees are so stressed. You can't help but wonder if the drift is the key factor impacting acorn production."**
>
> *ROGER BEADLES*

Severe injury in a Post Oak rated level "8" injury (on a scale of "0"-"10") in 2023

Photos courtesy of Martin Kemper

5.5

The Illinois Audubon Society's Threatened Sanctuaries

Herbicides at Sanctuaries: Again & Then Again

Damaged Values: Sanctuary Sanctity, State Nature Preserve, Forest Health, the Heritage of Two Families

Beginning in the 1970s, the Illinois Audubon Society added to its distinguished 75-year history of advocacy for wildlife by becoming an owner and active steward of sanctuaries that protect wild living things and the critical habitats upon which they depend. Today, it manages over 3,100 acres of sanctuary lands for the benefit of birds, other wildlife, and people.

That stewardship includes protecting those lands from harm. In recent years it has extended that stewardship by partnering with Prairie Rivers Network to monitor two sanctuaries for injury due to off-target herbicide drift. Their stories follow:

Strapping and curling in black oak leaves
Photo courtesy of Martin Kemper

Montgomery County

H & B Bremer Wildlife Sanctuary

Where Forest and Prairie Meet
Where People and Nature Meet
Where Past and Future Meet

In 1977, sisters Helen and Betty Bremer entrusted the Illinois Audubon Society to care for their beloved 200-acre farm and forest. After their passing, Illinois Audubon assumed stewardship of both the nature the sisters left behind, and their legacy of generosity. Today, hundreds of adults and youths encounter nature and that legacy at Bremer Sanctuary annually. And today, unfortunately, chemical trespass in the form of off-target herbicide drift has become a documented threat.

Starting in 2020, annual monitoring efforts have documented herbicide exposure to 40 native plant species here. The list includes eight species of oaks. A tissue sample of white oak foliage in 2022 confirmed the presence of 2,4-D. Symptoms of injury have been noted up to 1/3 mile from the nearest potential source of herbicide drift, suggesting vapor drift is a likely route of exposure.

Cupping and irregular margins on wild grape leaves
Photo courtesy of Martin Kemper

Hamilton County

Karcher's Post Oak Woods Nature Preserve

Rare High Quality Oak Flatwoods
Dedicated Illinois Nature Preserve
Treasured Family Heritage

The Karcher's Post Oak Woods Nature Preserve is an Illinois gem – a rare high quality southern flatwoods. The Illinois Audubon Society honored the family who transferred the land to them for permanent protection for future generations by acknowledging that foresight in the site's name. Seven oak species are hallmarks of this oak rich woodland. But over the past four years, off-target herbicide drift has become documented as an un-invited hallmark as well. Tissue samples taken from post oak foliage in 2022 and 2023 revealed the presence of 2,4-D, dicamba, atrazine, and metolachlor. In total, 27 native species of plants have been documented with symptoms consistent with herbicide exposure, including seven species of oaks. Canopy thinning in oaks is evident as well. Exposure symptoms have been documented at over 1,000 feet from the nearest potential source of drift, suggesting vapor drift is responsible.

5.6

Washington County

State Record Post Oak: Herbicide Record Holder

Damaged Values: State Record Tree, Family Heritage, Land Health, Confidence in Regulations

Shelley and Larry Harper live in southwest Illinois in Washington County. Their property includes a beautiful pond, surrounded by scattered oaks in a savanna-like setting bounded by woodland, fields, and the nearby community of Nashville. The property also boasts the "Harper Post Oak", a magnificent 200-plus-year-old state record tree. That oak and all of the trees on this property are a family heritage passed down across generations, most recently from father to daughter.

Since 2018, Prairie Rivers Network has documented drift injury on this 10-acre rural property every year. Now, most oaks show signs of declining health including the state record tree. Six of that record tree's younger oak neighbors became "hazard trees" and have been removed. Other oaks are on a similar trajectory.

To better understand the herbicide drift "trespass" occurring here, PRN began collecting tissue samples in 2019. During the past five years, 17 tissue samples have been collected. Results have been stunning. All 17 samples have had detectable levels of one to as many as four herbicides in individual samples. Herbicides found most frequently include 2,4-D, dicamba, and atrazine. Metolachlor, glyphosate and glufosinate were also detected. Just as disturbing were indications of 15 differentexposure events during this five-year period. And there were likely more, as not all herbicides were tested for in each sample, and some exposures were likely not detectable on the dates of sampling.

The owner has filed six complaints with the Illinois Department of Agriculture over the same time span — the only regulatory recourse. During the ensuing inspections, IDOA took no samples, reported it could not find misuse of herbicides, and has taken no meaningful action. The owners have experienced no relief in exposures or attendant damage.

> **"I now sometimes think – how do people NOT see the tree damage all around them, and question it? But you don't know what you don't know. Ignorance is bliss! Until it's not. My hope is that the herbicides used, and drift laws will change – so that we, our son and grandkids will be able to enjoy our pastureland trees alive and thriving, instead of piles of cut firewood where our old-growth trees used to be."**
>
> *SHELLEY HARPER*

State record post oak with thinning canopy
Photo courtesy of Prairie Rivers Network

Section 6:

Lack of Comprehensive Environmental Monitoring

Multiple states have identified herbicide drift as a major threat to native ecosystems and in particular to forest health.

In Illinois, the Illinois Department of Natural Resources (IDNR), which is not a regulating authority of pesticides, and Illinois Nature Preserves Commission (INPC) have trained staff to monitor and document symptoms of drift injury to public and private lands under their oversight. They have documented and reported injuries to the IDOA since 2019. Additionally, the Illinois Natural History Survey (INHS) was contracted in 2023 by the Illinois Nature Preserves Commission to monitor for symptoms of herbicide drift and collect tissue samples from plants. A summary of their findings was presented at a special meeting of the Illinois Nature Preserve Commission on April 11, 2024.

In their study, they found evidence of herbicide drift at nearly all of the nearly 200 representative locations they sampled across the state. This result is nearly identical to our observations for 2023 and corroborates our findings of almost universal exposures we documented for the entire six years of PRN monitoring. The INHS tissue samples were analyzed for more herbicides than our samples and included insecticides and fungicides, both of which were found at numerous locations. The INHS findings provide new insight into both the number of pesticides that are drifting and further illustrate the uncertainty surrounding the adequacy of current drift modeling.

A comparison of the herbicide tissue sample analysis employed by INHS with those of PRN is beyond the scope of this report. However, our preliminary conclusion is that after accounting for some differences in field sampling methodology and laboratory quantification limits for specific pesticides, the INHS results are in broad agreement with our own findings for six years of tissue sample analysis related to herbicide drift.

Notwithstanding the monitoring efforts detailed above, and despite the authority to do so, and despite years of repetitive citizen complaints, information sharing, and public comments by Prairie Rivers Network and many other stakeholders, no federal or state agency vested with regulatory authority over pesticides in Illinois is performing adequate study of this issue. No program measures concentrations of drifting pesticides, including herbicides, in the air. Nor is there adequate state-led monitoring of water resources for pesticide contamination. Additionally, no federal or state agency has a comprehensive science-based ecological monitoring program that measures the consequences of both acute and chronic exposures to drifting pesticides. Illinois also lacks agency initiatives regarding potential public health issues related to these exposures.

Section 7:
What Illinois Needs

Illinois urgently needs an updated regulatory structure that accounts for the changes in pesticide use across the landscape. This includes a strengthening of the current laws and additional regulations that adequately protect children, specialty crops, and high quality ecosystems. Not only have we greatly increased the use of certain herbicides, but how we farm is vastly different. There are fewer fencerows, fields are larger, equipment is larger, fewer crops are being grown, and springs are typically warmer and wetter – a result of climate change – limiting the time available for applications that follow the label guidelines.

We must also provide the necessary technical support to growers to help them diversify their farming systems. Tools such as integrated pest management are crucial to reduce reliance on herbicide-only weed control methods. We must move beyond the deeply incentivized conventional corn and soybean system and support the production of other crops such as alfalfa, wheat, oats, small grains, pumpkins, fruits and vegetables, etc.

Additionally, rural and urban communities are needlessly chemically eliminating broadleaf plants from private and public areas, increasing the risk of drift and herbicide exposure to trees, gardens, children, and pets. The public should be made aware of the risks associated with these herbicides.

Illinois also needs a comprehensive monitoring program that measures the presence of pesticides in the environment and evaluates acute and chronic effects of herbicides and other pesticides on ecosystems. This widespread damage is also occurring in the context of state agencies that are operating on limited funds and with diminished staff needed for regulation enforcement. If we are to protect our communities and environment from herbicide drift, we must not only educate communities, perform ecological and environmental monitoring, and strengthen regulations, we must also adequately fund the agencies responsible for enforcement of the Illinois Pesticide Act.

Finally, Illinois needs to take immediate actions to stop the drift. We need relief from the ongoing effects of out-of-control pesticide drift. In this report, we show that our backyards, schoolyards, cemeteries, parks, forests, and natural areas are regularly subjected to herbicide drift related injuries to plant life that are commonly more than three times – and too often more than five times – as severe as the US EPA considers acceptable injury to an annual field crop.

Whatever an acceptable system of control is, it is not what we have. Our current system for preventing off-target exposures and injury is demonstrably ineffective. Those who study the frequency and magnitude of these off-target exposures have increasingly been raising concerns about their public health implications. By providing real science where it counts – the places the system is supposed to protect – PRN is adding to that rising tide of concern new documentation of widespread herbicide exposures and a poignant reminder there are environmental, as well as an economic and social costs, that are accruing month-by-month, year-by-year, as well.

Stunted, deformed, and cupped leaves of a White oak (Illinois State Tree) with Monarch (state pollinator)
Photo courtesy of Lou Nelms

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Appendix A

PRN Species Level Monitoring Data: 2018 – 2023

Species are arranged into three categories by plant type (Trees, Shrubs and Woody Vines, and Herbaceous Species). Type column abbreviations include W-Vine = Woody Vine; H-Vine = Herbaceous Vine; A-Forb = Annual Forb; B-Forb = Biennial Forb; P-Forb = Perennial Forb. Native Status column abbreviations are N = Native; A = Adventive. Some Scientific Name entries are taxa identified at the genus level only. These represent permitted identifications in field evaluations where sub-generic identification is problematic.

The Monitor Frequency column is the number of times this species was monitored. The Exposure Frequency column records the number of times that the species was recorded with symptoms consistent with herbicide exposure.

Scientific and common names, and plant type and native status follow Taft et. al (1997); updates to taxonomy (from Taft et. al.) generally follow Yatskievych (1999, 2006, 2013).

Tree Species in PRN Tree and Plant Health Monitoring Database 2018-2023: Frequency Monitored, Frequency with Exposure Symptoms, Plant Type, Native Status

Scientific Name	Common Name	Monitor Frequency	Exposure Frequency	Type	Native Status
Cercis Canadensis	Eastern Redbud	397	395	Tree	N
Quercus alba	White Oak	393	388	Tree	N
Quercus velutina	Black Oak	384	383	Tree	N
Quercus stellata	Post Oak	381	381	Tree	N
Quercus palustris	Pin Oak	337	336	Tree	N
Quercus imbricaria	Shingle Oak	336	336	Tree	N
Quercus rubra	Red Oak	325	325	Tree	N
Acer negundo	Box Elder	321	321	Tree	N
Carya	Hickory	314	310	Tree	N
Ulmus	Elm	309	306	Tree	N
Celtis occidentalis	Hackberry	260	257	Tree	N
Prunus serotina	Wild Black Cherry	236	236	Tree	N
Fraxinus	Ash	189	185	Tree	N
Diospyros virginiana	Persimmon	184	184	Tree	N
Quercus macrocarpa	Bur Oak	165	164	Tree	N
Celtis laevigata	Sugarberry	163	163	Tree	N
Cornus florida	Flowering Dogwood	156	156	Tree	N
Platanus occidentalis	Sycamore	153	152	Tree	N
Sassafras albidum	Sassafras	141	137	Tree	N
Acer saccharum	Sugar Maple	136	135	Tree	N
Acer saccharinum	Silver Maple	126	123	Tree	N
Quercus bicolor	Swamp White Oak	123	122	Tree	N
Quercus marilandica	Blackjack Oak	120	120	Tree	N
Acer rubrum	Red Maple	119	118	Tree	N
Morus rubra	Red Mulberry	116	114	Tree	N
Quercus muehlenbergii	Chinkapin Oak	96	96	Tree	N
Liriodendron tulipifera	Tulip Poplar	96	96	Tree	N
Carya illinoensis	Pecan	94	94	Tree	N

Morus alba	White Mulberry	91	91	Tree	A
Juglans nigra	Black Walnut	89	87	Tree	N
Liquidambar styraciflua	Sweet Gum	77	77	Tree	N
Pyrus calleryana	Ornamental Pear	68	68	Tree	A
Quercus shumardii	Shumard Oak	50	49	Tree	N
Quercus pagoda	Cherrybark Oak	38	38	Tree	N
Catalpa	Catalpa	34	34	Tree	N
Betula nigra	River Birch	29	29	Tree	N
Ulmus americana	American Elm	28	28	Tree	N
Maclura pomifera	Hedge Apple	28	28	Tree	A
Nyssa sylvatica	Sour Gum	24	24	Tree	N
Populus deltoides	Cottonwood	20	20	Tree	N
Quercus lyrata	Overcup Oak	18	18	Tree	N
Ailanthus altissima	Tree-of-heaven	16	16	Tree	A
Morus	Mulberry	16	16	Tree	N/A
Ulmus rubra	Slippery Elm, Red Elm	16	16	Tree	N
Quercus acutissima	Sawtooth Oak	16	16	Tree	A
Gymnocladus dioicus	Kentucky Coffee Tree	15	14	Tree	N
Quercus phellos	Willow Oak	12	12	Tree	N
Robinia pseudoacacia	Black Locust	12	12	Tree	N
Gingko biloba	Gingko	12	11	Tree	A
Carya ovata	Shagbark Hickory	12	11	Tree	N
Prunus persica	Peach	11	11	Tree	A
Asimina triloba	Pawpaw	11	11	Tree	N
Crataegus	Hawthorn	11	11	Tree	N
Prunus	Cherry - Plum	10	10	Tree	N
Ostrya virginiana	Hop Hornbeam	10	10	Tree	N
Malus domestica	Apple	10	10	Tree	A
Koelreuteria paniculata	Golden-Rain Tree	10	10	Tree	A
Ulmus alata	Winged Elm	9	9	Tree	N
Vaccinium arboreum	Farkleberry	8	8	Tree	N
Amelanchier arborea	Shadbush, Juneberry	7	7	Tree	N
Gleditsia triacanthos	Honey Locust	7	7	Tree	N
Tilia americana	American Linden, Basswood	7	7	Tree	N
Populus heterophylla	Swamp Cottonwood	7	7	Tree	N
Castanea	Chestnut	7	7	Tree	N
Crataegus viridis	Green Hawthorn	6	6	Tree	N
Carya texana	Black Hickory	6	6	Tree	N
Quercus falcata	Southern Red Oak	6	6	Tree	N
Rhamnus caroliniana	Carolina Buckthorn	6	6	Tree	N
Taxodium distichum	Bald Cypress	6	6	Tree	N
Acer spp.	Maple	6	6	Tree	N
Ulmus pumila	Siberian Elm	6	6	Tree	A
Platanus x acerifolia	London Plane Tree	6	6	Tree	A
Quercus laurifolia	Laurel Oak	5	5	Tree	A
Carya glabra	Pignut Hickory	5	5	Tree	N
Malus spp.	Crabapple	5	5	Tree	A
Crataegus mollis	Red, Downy Hawthorn	5	5	Tree	N

Castanea mollissima	Chinese Chestnut	5	5	Tree	A
Broussonetia papyrifera	Paper Mulberry	5	5	Tree	A
Acer platanoides	Norway Maple	4	4	Tree	N
Quercus nigra	Water Oak	4	4	Tree	A
Salix spp.	Willow	3	3	Tree	N
Aesculus glabra	Ohio Buckeye	3	3	Tree	N
Pyrus communis	Pear	2	2	Tree	A
Forestiera acuminata	Swamp Privet	2	2	Tree	N
Fagus grandifolia	American Beech	2	2	Tree	N
Quercus michauxii	Swamp Chestnut Oak	2	2	Tree	N
Carya tomentosa	Mockernut Hickory	2	2	Tree	N
Celtis tenuifolia	Dwarf Hackbery	2	2	Tree	N
Salix nigra	Black Willow	1	1	Tree	N
Magnolia	Magnolia	1	1	Tree	A
Nyssa aquatica	Tupelo Gum	1	1	Tree	N
Morus nigra	Black Mulberry	1	1	Tree	A
Tilia cordata	Littleleaf Linden	1	1	Tree	A
Pistacia chinensis	Chinese Pistache	1	1	Tree	A
Aesculus hippocastanum	Horse-chestnut	1	1	Tree	A
Psorothamnus spinosus	Smoketree	1	1	Tree	A
Quercus coccinea	Scarlet Oak	1	1	Tree	N
Quercus ellipsoidalis	Hills Oak	1	1	Tree	N
Cornus alternifolia	Alternate-leaved Dogwood	1	1	Tree	N
Carpinus caroliniana	Blue Beech, Musclewood	1	1	Tree	N
Quercus Quercus	White Oak Group	1	1	Tree	N
Carya aquatica	Water Hickory	1	1	Tree	N
Carya cordiformis	Bitternut Hickory	1	1	Tree	N
Carya laciniosa	Kingnut Hickory	1	1	Tree	N
Crataegus crus-galli	Cock-spur Hawthorn	1	1	Tree	N
Metasequoia glyptostroboides	Dawn Redwood	1	1	Tree	A
Juglans regia	English Walnut	1	1	Tree	A
Acer palmatum	Japanese Maple	1	0	Tree	A

Shrub and Woody Vine Species in PRN Tree and Plant Health Monitoring Database 2018 – 2023: Frequency Monitored, Frequency with Exposure Symptoms, Plant Type, Native Status

Scientific Name	Common Name	Monitor Frequency	Exposure Frequency	Type	Native Status
Toxicodendron radicans	Poison Ivy	350	350	W-Vine	N
Vitis spp.	Grape	218	215	W-Vine	N
Cornus drummondii	Rough-leaved Dogwood	63	61	Shrub	N
Campsis radicans	Trumpet Creeper, T. Vine	46	46	W-Vine	N
Ilex decidua	Ilex decidua	39	38	Shrub	N
Symphoricarpos orbiculatus	Coralberry	35	35	Shrub	N
Viburnum prunifolium	Black Haw	25	25	Shrub	N
Rhus copallinum	Dwarf Sumac	25	25	Shrub	N
Elaeagnus umbellata	Autumn Olive	20	20	Shrub	A
Sambucus canadensis	Elderberry, Common Elder	14	13	Shrub	N

Cephalanthus occidentalis	Buttonbush	14	14	Shrub	N
Rosa setigera	Prairie Rose	13	12	Shrub	N
Parthenocissus quinquefolia	Virginia Creeper	13	13	W-Vine	N
Rhus glabra	Smooth Sumac	13	13	Shrub	N
Rubus occidentalis	Black Raspberry	12	11	Shrub	N
Corylus americana	Hazelnut	11	9	Shrub	N
Smilax spp.	Greenbriar	11	11	W-Vine	N
Bumelia lanuginosa	Chittam Wood	9	9	Shrub	N
Cornus spp.	Dogwood	9	9	Shrub	N
Menispermum canadense	Canada Moonseed	9	9	W-Vine	N
Rhus aromatica	Fragrant Sumac	9	9	Shrub	N
Rubus spp.	Blackberry	8	7	Shrub	N
Rubus allegheniensis	Common blackberry	7	7	Shrub	N
Cornus racemosa	Gray Dogwood	7	7	Shrub	N
Rosa multiflora	Multiflora Rose	7	7	Shrub	A
Euonymus atropurpureus	Wahoo, Burning Bush	5	5	Shrub	N
Staphylea trifolia	Bladdernut	5	5	Shrub	N
Ampelopsis cordata	Raccoon Grape	5	5	W-Vine	N
Syringa vulgaris	Lilac	4	3	Shrub	A
Viburnum opulus	European High Bush Cranberry	4	4	Shrub	A
Ceanothus americanus	New Jersey Tea	3	3	Shrub	N
Hypericum prolificum	Shrubby St. John’s Wort	3	3	Shrub	N
Euonymus hederaceus	Wintercreeper	3	3	Shrub	A
Cornus amomum	Pale Dogwood, Silky, Blue Fr	3	3	Shrub	N
Euonymus spp.	Burning Bush	2	2	Shrub	A
Lonicera sempervirens	Trumpet Honeysuckle, Scarlet H	2	2	Shrub	A
Chaenomeles japonica	Quince	1	1	Shrub	A
Viburnum lentago	Nannayberry	1	1	Shrub	N
Viburnum spp.	Viburnum	1	1	Shrub	N
Vaccinium pallidum	Lowbush Blueberry	1	1	Shrub	N
Rubus flagellaris	Common Dewberry	1	1	Shrub	N
Celastrus orbiculatus	Oriental Bittersweet	1	1	W-Vine	A
Lonicera japonica	Japanese Honeysuckle	1	1	W-Vine	A
Ptelea trifoliata	Wafer Ash, Hoptree	1	1	Shrub	N
Hydrangea arborescens	Wild Hydrangea	1	1	Shrub	N
Clematis virginiana	Virgin’s Bower	1	1	W-Vine	N
Weigela spp.	Weigela	1	1	Shrub	A
Amorpha fruticosa	False Indigo Bush	1	1	Shrub	N
Lindera benzoin	Spicebush	1	1	Shrub	N
Ilex verticillata	Winterberry	1	1	Shrub	N
Celastrus scandens	American Bittersweet	1	1	W-Vine	N

Herbaceous Species in PRN Tree and Plant Health Monitoring Database 2018 – 2023: Frequency Monitored, Frequency with Exposure Symptoms, Plant Type, Native Status

Scientific Name	Common Name	Monitor Frequency	Exposure Frequency	Type	Native Status
Phytolacca americana	Pokeweed	62	61	P-Forb	N
Solidago canadensis	Canada Goldenrod	40	40	P-Forb	N
Silphium integrifolium	Rosinweed	29	29	P-Forb	N
Hackelia virginiana	Stickseed	24	24	P-Forb	N
Vernonia missurica	Missouri Ironweed	23	23	P-Forb	N
Solidago ulmifolia	Elm-leaved Goldenrod	18	18	P-Forb	N
Helianthus divaricatus	Woodland Sunflower	18	18	P-Forb	N
Eupatorium serotinum	Late Boneset (L. Thoroughwort)	18	18	P-Forb	N
Rudbeckia subtomentosa	Fragrant Coneflower	12	12	P-Forb	N
Silphium laciniatum	Compass Plant	11	11	P-Forb	N
Silphium perfoliatum	Cup Plant	10	10	P-Forb	N
Verbesina alternifolia	Yellow Ironweed, Wingstem	9	9	P-Forb	N
Solidago caesia	Bluestem Goldenrod	8	8	P-Forb	N
Solidago rigida	Rigid Goldenrod	8	8	P-Forb	N
Silene stellata	Starry Campion	7	7	P-Forb	N
Penstemon digitalis	Foxglove Beard-tongue	7	7	P-Forb	N
Solidago buckleyi	Buckley's Goldenrod	7	7	P-Forb	N
Solidago speciosa	Showy Goldenrod	7	7	P-Forb	N
Scrophularia marilandica	Figwort	7	7	P-Forb	N
Impatiens capensis	Spotted Touch-me-not	7	7	A-Forb	N
Eupatorium sessilifolium	Eupatorium sessilifolium	7	7	P-Forb	N
Aureolaria flava	Smooth False Foxglove	7	7	P-Forb	N
Verbesina helianthoides	Yellow Crownbeard	7	7	P-Forb	N
Monarda bradburiana	Monarda, Bradbury Monarda	6	6	P-Forb	N
Silphium spp.	Rosinweed	6	6	P-Forb	N
Parthenium integrifolium	Wild Quinine, Am. Feverfew	6	6	P-Forb	N
Dioscorea quaternata	Wild Yam	6	5	H-Vine	N
Apocynum cannabinum	Indian Hemp	6	6	P-Forb	N
Ambrosia trifida	Giant Ragweed	6	6	A-Forb	N
Helianthus mollis	Downy Sunflower	6	6	P-Forb	N
Laportea canadensis	Wood Nettle	5	4	P-Forb	N
Ageratina altissima	White Snakeroot	5	5	P-Forb	N
Hylodesmum glutinosum	Pointed Tick Trefoil	5	5	P-Forb	N
Coreopsis tripteris	Tall Coreopsis, T. Ti	5	5	P-Forb	N
Baptisia alba	White False Indigo	5	5	P-Forb	N
Monarda fistulosa	Wild Bergamot	5	5	P-Forb	N
Symphyotrichum anomalum	Blue Aster	5	5	P-Forb	N
Veronicastrum virginicum	Veronicastrum virginicum	4	3	P-Forb	N
Cirsium altissimum	Tall Thistle	4	4	P-Forb	N
Dasistoma macrophylla	Mullein Foxglove	4	4	P-Forb	N
Erechtites hieracifolia	Fireweed, Pilewort	4	4	A-Forb	N
Stachys tenuifolia	Smooth Hedge Nettle	4	4	P-Forb	N
Silphium terebinthinaceum	Prairie-dock	4	4	P-Forb	N

Erigeron philadelphicus	Erigeron philadelphicus	3	3	P-Forb	N
Liatris squarrulosa	Southern Blazing-star	3	3	P-Forb	N
Symphyotrichum spp.	Aster	3	3	P-Forb	N
Hibiscus laevis	Halberd-leaved Rose Mallow	3	3	P-Forb	N
Symphyotrichum novae-angliae	New England Aster	3	3	P-Forb	N
Eupatorium purpureum	Purple Joe-Pye-weed	3	3	P-Forb	N
Euthamia graminifolia	Grass-leaved Goldenrod	3	3	P-Forb	N
Desmodium cuspidatum	Bracted Tick Trefoil	3	3	P-Forb	N
Asclepias syriaca	Common Milkweed	3	3	P-Forb	N
Asclepias purpurascens	Purple Milkweed	3	3	P-Forb	N
Symphyotrichum patens	Late Purple Aster	3	3	P-Forb	N
Smilax pulverulenta	Dark Green Carrion Flower	3	1	H-Vine	N
Solidago juncea	Early Goldenrod	3	3	P-Forb	N
Ratibida pinnata	Yellow Coneflower	2	2	P-Forb	N
Symphyotrichum oolentangiense	Sky-blue Aster	2	2	P-Forb	N
Rudbeckia spp.	Coneflower	2	2	P-Forb	N
Elephantopus carolinianus	Elephant’s Foot	2	2	P-Forb	N
Symphyotrichum laeve	Smooth Aster	2	2	P-Forb	N
Smilacina racemose	False Solomon’s Seal	2	2	P-Forb	N
Eryngium yuccifolium	Rattlesnake Master	2	2	P-Forb	N
Boehmeria cylindrical	False Nettle	2	2	P-Forb	N
Symphyotrichum drummondii	Drummond’s Aster	2	2	P-Forb	N
Ruellia strepens	Smooth Ruellia	2	2	P-Forb	N
Liatris pycnostachya	Prairie Blazing-star	2	2	P-Forb	N
Teucrium canadense	American Germander	2	2	P-Forb	N
Aquilegia Canadensis	Columbine	2	2	P-Forb	N
Vernonia fasciculate	Common Ironweed	2	2	P-Forb	N
Zizia aurea	Golden Alexanders	2	2	P-Forb	N
Amsonia tabernaemontana	Willow Amsonia, Blue Dogbane	2	2	P-Forb	N
Capsicum spp.	Pepper	1	1	A-Forb	A
Rudbeckia hirta	Black-eyed Susan	1	1	P-Forb	N
Campanula Americana	American Bellflower	1	1	A-Forb	N
Boltonia asteroids	False Aster	1	1	P-Forb	N
Cicuta maculate	Water Hemlock	1	1	B-Forb	N
Bidens spp.	Tickseed	1	1	A-Forb	N
Thalictrum revolutum	Waxy Meadow Rue, Skunk M. R.	1	1	P-Forb	N
Aureolaria grandiflora	Yellow False Foxglove	1	1	P-Forb	N
Asclepias tuberosa	Butterfly Weed	1	1	P-Forb	N
Asclepias hirtella	Tall Green Milkweed	1	1	P-Forb	N
Asclepias spp.	Milkweed	1	1	P-Forb	N
Asarum canadense	Wild Ginger	1	1	P-Forb	N
Arnoglossum atriplicifolia	Pale Indian Plantain	1	1	P-Forb	N
Aristolochia serpentaria	Virginia Snakeroot	1	1	P-Forb	N
Arisaema triphyllum	Jack-in-the-Pulpit	1	1	P-Forb	N
Scutellaria lateriflora	Mad-dog Skullcap	1	1	P-Forb	N
Verbena urticifolia	White Vervain	1	1	P-Forb	N
Helenium autumnale	Sneezeweed	1	1	P-Forb	N
Passiflora lutea	Yellow Passion Flower, Small PF	1	1	H-Vine	N

Solidago patula	Rough-leaved Goldenrod	1	1	P-Forb	N
Perilla frutescens	Beefsteak Plant	1	1	A-Forb	A
Lobelia inflate	Indian Tobacco	1	1	P-Forb	N
Lobelia cardinalis	Cardinal Flower	1	1	P-Forb	N
Phlox paniculata	Garden Phlox	1	1	P-Forb	N
Phlox pilosa	Prairie Phlox	1	1	P-Forb	N
Physalis spp.	Ground Cherry	1	1	A-Forb	
Hibiscus lasiocarpus	Hairy Rose Mallow	1	1	P-Forb	N
Physostegia virginiana	Obedient Plant	1	1	P-Forb	N
Symphyotrichum turbinellum	Prairie Aster	1	1	P-Forb	N
Helianthus annuus	Common Sunflower	1	1	A-Forb	A
Desmanthus illinoensis	Illinois Mimosa	1	1	P-Forb	N
Gillenia stipulate	Indian Physic, Am. Ipecac	1	1	P-Forb	N
Podophyllum peltatum	Mayapple	1	1	P-Forb	N
Polygonum cespitosum	Creeping Smartweed	1	1	A-Forb	A
Oxalis stricta	Tall Wood Sorrel	1	1	A-Forb	N
Symphyotrichum shortii	Short’s Aster	1	1	P-Forb	N
Prenanthes aspera	Rough White Lettuce	1	1	P-Forb	N
Eupatorium altissimum	Tall Boneset	1	1	P-Forb	N
Pycnanthemum tenuifolium	Slender Mountain Mint	1	1	P-Forb	N
Echinacea purpurea	Purple Coneflower	1	1	P-Forb	N
Frasera caroliniensis	American Colombo	1	1	B-Forb	N
Desmodium perplexum	Perplexing Tick Trefoil	1	1	P-Forb	N
Solidago drummondii	Drummond’s Goldenrod	1	1	P-Forb	N
Smilax lasioneuron	Carrion Flower	1	0	P-Forb	N

References:

Taft, John & Wilhelm, Gerould & Ladd, Douglas & Masters, Linda. 1997. Floristic Quality Assessment for vegetation in Illinois, a method for assessing vegetation integrity. Erigenia. 15.

Yatskievych, G., 1999. Steyermark’s Flora of Missouri. Volume 1. Revised ed. Missouri Department of Conservation, Jefferson City.

Yatskievych, G., 2006. Steyermark’s Flora of Missouri. Volume 2. Revised ed. Missouri Department of Conservation, Jefferson City.

Yatskievych, G., 2013. Steyermark’s Flora of Missouri. Volume 3. Revised ed. Missouri Department of Conservation, Jefferson City.

Appendix B

PRN County Level Monitoring Data: 2018 – 2023

County List	
County	**# of Locations**
Bond	22
Cass	1
Champaign	16
Christian	7
Clinton	10
Cumberland	2
De Witt	3
Edwards	2
Effingham	3
Fayette	5
Ford	1
Franklin	4
Hamilton	3
Jackson	11
Jefferson	11
Johnson	1
Kane	2
Lawrence	2
Logan	8
Macon	2
Madison	7
Marion	3
Mason	2
McLean	3
Menard	5
Monroe	5
Montgomery	6
Morgan	2
Perry	6
Piatt	1
Randolph	11
Richland	1
Sangamon	8
Shelby	1
St. Clair	23
Tazewell	1
Union	14
Wabash	1
Washington	59
Wayne	4

Appendix C

Number of Species Recorded per Monitoring Visit: 2018-2023

This table shows the number of species recorded for all 737 PRN monitoring visits for the years 2018-2023. Visits recording a single species were usually sites where a tissue sample was taken and/or which previously had already been monitored more extensively the same growing season. Mean number of species monitored per visit was 12.4 which includes all visits including the "tissue sample" visits.

Frequency of Number of Species Monitored per Visit												
# of Species	1	2-4	5-7	8-10	11-13	14-16	17-19	20-22	23-25	26-28	29-31	32-34
Frequency	40	63	150	94	70	79	82	83	37	25	9	5
Total Visits	737											

Appendix D

Plant Tissue Sampling Form for Herbicide Residue Testing - page 1 of 2

Sample ID ________________________

Site ID:________________________________ County:________________ Date: ____________

Observer Name: ______________________________ City: _____________________________

Phone #__________________________________ e-mail:______________________________

Witness Name(s):____

Pre-Collection: Plant Species (one only): ______________________ Number Sampled: ______

1. Record injury data for the sampled species on page 2 of this form. Complete a Tree & Plant Health Monitoring Report (TPHMR) form if additional affected species are present and monitored (recommended).

TPHMR completed for additional monitored species: No Yes Date: _________

2. Label outside of 1 gal. ziplock bag with: *sample ID, species, date,* & *collector initials* (with Sharpie)

3. Label clean shop towel with: *sample ID, species, date, & collector initials*

Collection:

4. Clean cutting tool(s) Date___________ Time___________ Initial_________

5. Start: put on clean nitrile gloves Date___________ Time___________ Initial_________

6. Obtain one gallon leaves; place in ziplock bag (keep out of sun)

7. Finish: seal bag Date___________ Time___________ Initial_________

8. In cooler w/cold pack? no if yes → Date___________ Time___________ Initial_________

9. Photograph typical sample of leaves on shop towel - add time labeling to towel

Date___________ Time___________ Initial_________

10. Refrigerate on returning from field if shipping in less than 72 hours (otherwise place in freezer)

Indicate which: freezer / refrigerator Date___________ Time___________ Initial_________

Documentation and Shipping:

Fill out and copy *lab submission form*, ensure site (sample) ID and all other data conform with 1) *this form* and 2*) monitoring form* Date____________ Time__________ Initial_________

Remove sample from storage and place *lab submission form* in a separate pint size ziplock bag and attach to outside of sample bag Date____________ Time_________ Initial_________

Ship **<u>on freezer packs</u>** overnight express, next day delivery, preferably early in week (not over weekend)

Date____________ Time_________ Initial_________

Plant Tissue Sampling Form for Herbicide Residue Testing - page 1 of 2

Sample ID ____________________________

Site ID:______________________________ County:________________ Date: ____________

Observer Name: ______________________________ City: _____________________________

Phone #__________________________________ e-mail:_______________________________

Witness Name(s):____

Pre-Collection: Plant Species (one only): ______________________ Number Sampled: ______

1. Record injury data for the sampled species on page 2 of this form. Complete a Tree & Plant Health Monitoring Report (TPHMR) form if additional affected species are present and monitored (recommended).

TPHMR completed for additional monitored species: No Yes Date: _________

2. Label outside of 1 gal. ziplock bag with: *sample ID, species, date,* & *collector initials* (with Sharpie)

3. Label clean shop towel with: *sample ID, species, date, & collector initials*

Collection:

4. Clean cutting tool(s) Date___________ Time___________ Initial_________

5. Start: put on clean nitrile gloves Date___________ Time___________ Initial_________

Appendix E

Exerpt from Tree and Plant Health Monitoring Report (2020)

Results Part 1: Symptom Monitoring

As previously stated the goal of this effort is to gather baseline information, by means of a rapid ecological assessment, on the frequency, geographic distribution, severity, and timing of injuries that are symptomatic of possible off-target herbicide exposure. Based on their time and skill-level, volunteers selected which species to monitor at a location. Therefore, there may have been other species demonstrating symptoms of possible PGR herbicide exposure present at each location that were not monitored.

The majority of plants monitored were trees. However, shrubs, woody vines, perennial forbs, and annual forbs were also monitored. Observers were asked to record the most prominent symptoms. There were 596 unique observations of species with injuries recorded during 2018 and 2019. Many species had more than one symptom. The most common symptoms observed in leaves were: curling and cupping, twisting and deformation, irregular margins, and sideways growth (epinasty). The most common symptoms observed in shoots were growth suppression or deformation. Of secondary symptoms, chlorosis was the most frequently observed. Necrosis, dieback, and death were also observed.

Site Overview

There were a total of 153 visits in 2018 and 2019 to 102 monitoring sites. Several sites were visited (monitored) more than once in a growing season. In addition, some of the sites were monitored in both years. Of the 49 sites in 2018, 47 had symptoms. All 81 sites monitored in 2019 had symptoms. Monitoring sites were located in 21 counties. Due to limited availability of volunteers, the majority of the sites monitored were located in Washington, Jackson, Logan and St. Clair counties. Volunteers were asked to estimate the size of a site if the exact acreage was unknown. Site size ranged from 1 to 50 and 40 acres respectively for 2018 and 2019 (Table 1).

Table 1: Total, Average, Minimum, and Maximum Acres for Sample Occurrences

	2018	2019	Combined
Number of sites monitored	49	81	102*
Number of visits to sites	51	102	153
Total acres	455	393	838
Average acres monitored per visit	10.6	6.6	8.2
Minimum acres monitored	1	1	-
Maximum acres monitored	50	40	-

* Total number of unique sites for both years combined; including four soybean fields and one orchard.

Rating System and Severity of Symptoms

A total of 70 species, 55 of which are native to Illinois, were monitored and showed symptoms. Twenty-six of the twenty-nine plant families represented are native to Illinois. This report focuses on non-crop plants, therefore we removed one monitoring report containing a large number of fruit trees (approx. 2000) which are a specialty crop, and 4 reports which were for symptoms on soybean fields. White oak and redbud were the most commonly monitored native species. The most commonly monitored species varied from 2018 to 2019. However, oaks are prominent in both years (Table 2).

A few sites were large enough to have more than one subunit or “location” monitored., (e.g., a site where two subunits were monitored represents two separate locations). Hence the number of locations monitored is greater than the number of sites monitored. Table 2 below includes information from all monitored locations.

Table 2: Ten Most Frequently Monitored Tree Species by Location

2018		2019	
Species	**Locations Monitored**	**Species**	**Locations Monitored**
White oak (Quercus alba)	26	Eastern redbud (Cercis canadensis)	36
Post oak (Quercus stellata)	25	Post oak (Quercus stellata)	33
Eastern redbud (Cercis canadensis)	23	Black oak (Quercus velutina)	32
Black oak (Quercus velutina)	21	White oak (Quercus alba)	26
Boxelder (Acer negundo)	17	Sycamore (Plantaus occidentalis)	25
Pin oak (Quercus palustris)	13	Boxelder (Acer negundo)	24
Bur oak (Quercus macrocarpa)	8	Poison ivy (Toxicodendron radicans)	22
Hickory sp. (Carya sp.)	7	Hickory sp. (Carya sp.)	22
Blackjack oak (Quercus marilandica)	6	Pin oak (Quercus palustris)	16
Sycamore (Plantaus occidentalis)	6	Elm sp. (Ulmus sp.)	15

Tables 3, 4, & 5 summarize the ratings of symptoms by plant type.

Table 3: Average Rating of Symptoms by Plant Type Across all Species and Locations

Year	Tree	Shrub	Woody Vine	Perennial Forb	Annual Forb
2018	3.1	5.5	1.2	2	5
2019	2.6	2.4	1.9	3.6	5

Table 4. Average Maximum Rating for Symptom by Plant Type Across all Species and Locations

Year	Tree	Shrub	Woody Vine	Perennial Forb	Annual Forb
2018	4.2	7	3.2	3	6
2019	3.4	3.1	2.8	5.1	6

In 2018, 45 out of 49 locations monitored had at least one species with symptoms that were rated a 5 (moderate) or greater. Of those 45, 29 locations had symptoms that were rated a 7 or higher (severe). In 2019, 59 of the 83 locations monitored had symptoms that were rated at 5 or higher and of those 59 locations, 28 had symptoms that were rated at a level 7 or higher.

Table 5. Locations with Severe Symptoms

Year	Number of locations monitored	Number of locations with symptoms rated 5 +	Number of locations with symptoms rated 7 +
2018	49	45	29
2019	83	59	28

As previously noted, volunteers were encouraged to monitor locations where multiple species, across many families and plant types were present. They were not encouraged to record every species they noticed with symptoms, rather to select several that were representative of the plants expressing symptoms at that site. While trees were the main focus of this monitoring project, other plant types were reported as well. Table 6 is a summary of the number of individuals reported showing symptoms by plant type.

Table 6. Total Individuals Monitored and with Symptoms by Plant Type

Plant type	Locations with plant type reported 2018	Locations with plant type reported 2019	Total Individuals monitored	Individuals with symptoms
Trees	49	82	8791	7670
Shrubs	2	9	161	159
Woody Vines	4	26	2006	1305
Perennial Forbs	2	6	1220	958
Annual Forbs	1	1	215	215
			12393	10307

Note: The number of individuals demonstrating symptoms at sites where some individuals are asymptomatic (i.e., symptom rating of "0") was estimated using the formula:

Number of symptomatic individuals = total number of individuals observed – ((1/highest symptom rating) x total number of individuals observed)

This formula weights the asymptomatic ("0") class more heavily than higher rated classes and weights the asymptomatic class more heavily at lower ranges of symptom severity (e.g., 0-3) than at higher ranges (e.g., 0-7). It provides a more conservative estimate of symptomatic individuals than a comparable "flat" frequency distribution. It generally agrees with observations in the field.

Table 7. Ranking of Average Maximum Symptom Rating for 15 Most Monitored Species - 2018		
Species	**Average Maximum Symptom Rating**	**Plant Type**
Ohio buckeye (Aesculus glabra)	7	Tree
Persimmon (Diospyros virginiana)	7	Tree
White oak (Quercus alba)	6.1	Tree
Blackjack oak (Quercus marilandica)	6	Tree
Hackberry (Celtis occidentalis)	6	Tree
Post oak (Quercus stellata)	5.7	Tree
Black oak (Quercus velutina)	5.2	Tree
Elm sp. (Ulmus sp.)	5	Tree
Red oak (Quercus rubra)	5	Tree
Kentucky coffeetree (Gymnocladus dioicus)	5	Tree
Hickory sp. (Carya sp.)	4.9	Tree
Box elder (Acer negundo)	4.9	Tree
Pin oak (Quercus palustris)	4.8	Tree
Sycamore (Platanus occidentalis)	4.2	Tree
Sugar maple (Acer saccharum)	4.2	Tree
Eastern redbud (Cercis canadensis)	4.2	Tree

Table 8. Ranking of Average Maximum Symptom Rating for 15 Most Monitored Species - 2019

Species	Average Maximum Symptom Rating	Plant Type
Black-eyed susan (Rudbeckia hirta)	7	Perennial Forb
Ashy sunflower (Helianthus mollis)	7	Perennial Forb
Post oak (Quercus stellata)	6	Tree
Sweet coneflower (Rudbeckia subtomentosa)	6	Perennial Forb
White wild indigo (Baptisia lactea)	6	Perennial Forb
Eastern cottonwood (Populus deltoides)	5.5	Tree
White oak (Quercus alba)	5.2	Tree
American chestnut hybrid (Castanea sp.)	5	Tree
Cup plant (Silphium perfoliatum)	5	Perennial Forb
Rosinweed (Silphium integrifolium)	5	Perennial Forb
Kentucky coffeetree (Gymnocladus dioicus)	5	Tree
Swamp white oak (Quercus bicolor)	4.6	Tree
Eastern redbud (Cercis canadensis)	4.6	Tree
Black oak (Quercus velutina)	4.5	Tree
Box elder (Acer negundo)	4.1	Tree

Results Part 2: Herbicide Residue Analyses for Injured Plants

Trees that were symptomatic of PGR herbicide exposure were sampled during the 2019 growing season. With the exception of one location, volunteers had no knowledge of when possible exposures occurred. When symptoms of PGR herbicide were observed in multiple species, across multiple families at a location, a sample was taken from a symptomatic tree(s) according to protocol. In most cases, there was no knowledge of when symptoms began to be expressed.

Samples were analyzed for the presence of a suite of five plant PGR herbicides, which included Clopyralid, MCPA, dicamba, 2, 4-D, and Picloram. The limit of detection for all 5 herbicides was 0.005 PPM. Only 2, 4-D or dicamba residues were detected in collected samples. A total of 24 samples were collected from trees, of which 20 had detectable levels of PGR herbicides at the time of sampling. (One sample, with no detectable residue, was a second sample of the same tree that had detectable levels earlier in the year.) Twenty-three separate PGR herbicide residues were detected in those twenty samples. Seventeen of these samples had detectable residues of one herbicide at the time of sampling. Three of the samples had detectable levels of both 2, 4-D and dicamba. Four samples had no residues or had residues below the limit of quantification.

The twenty-four tissue samples were collected at fifteen monitored locations in six counties during the 2019 growing season. Thirteen of the monitored locations had samples taken where residue of at least one PGR herbicide was detected. Leaf tissue samples were collected from 6 counties (Table 9).

Addendum to Hidden in Plain Sight

Pesticide Drift In Public Spaces

May 2025-September 2025
Published April 2026

Pin oak, southern Illinois: leaves cupped, drooped, stunted, strapped, chlorotic—Photo courtesy of PRN

Project Purpose

This study expands on our previous data set consisting of six years of pesticide (primarily herbicides and fungicides) drift monitoring and leaf tissue sampling across Illinois, summarized in our 2024 report "Hidden in Plain Sight". Up to this point, our ability to monitor and sample locations multiple times throughout the growing season has been extremely limited. Therefore, the current study was designed to gather exposure information at numerous sites throughout the summer months.

All samples collected were analyzed to identify the presence of pesticides in public spaces where people work and children play: parks, playgrounds, and schoolyards. Approximately 50% of schools, public parks, and playgrounds in Illinois are within ½ mile of agricultural land, or other large areas (such as a golf course) that typically apply pesticides.

As noted in "Hidden in Plain Sight", many of the pesticides that are widely used in agricultural production or turf management are known to volatilize, even with proper application under appropriate environmental conditions (Bedos et al., 2002), and travel far from their application site (Mayer et al., 2024).

Our previous results have shown at least some symptoms of herbicide exposure at every site sampled. The purpose for this addendum is to present a summary of the number and type of pesticides (herbicides and fungicides) that are detectable in public spaces across Illinois. To our knowledge, this is the first ever survey of its kind in the nation.

Methods & Sampling Locations

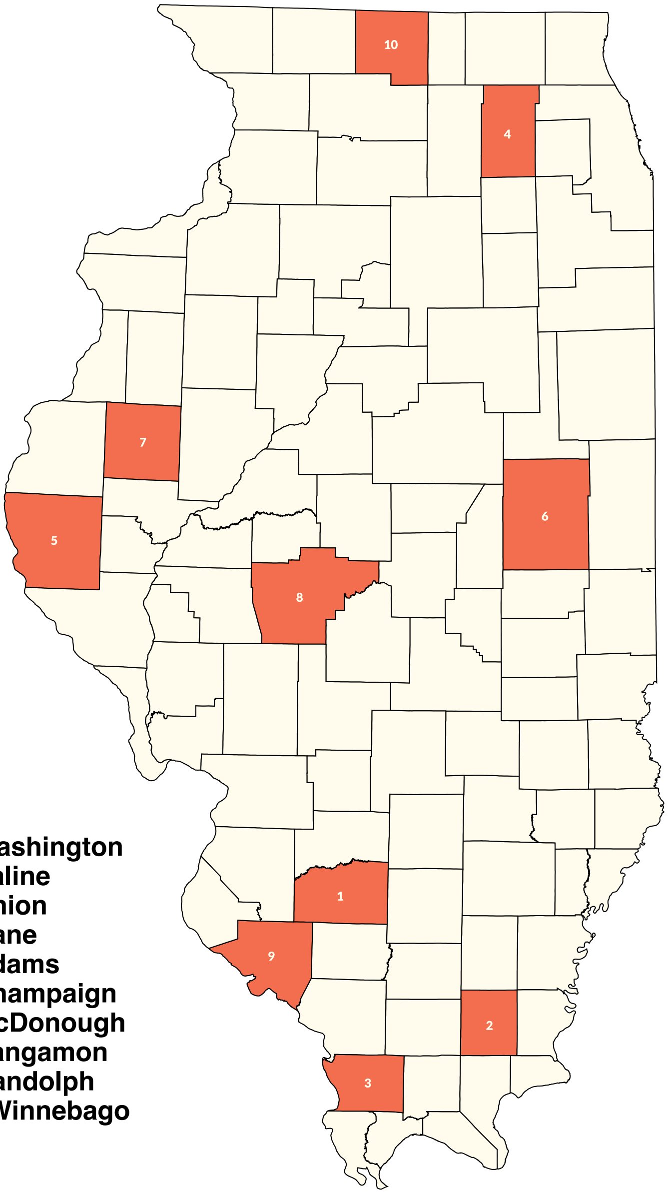
During May, June, July, August, and September of 2025, 10 public parks and/or school playgrounds were sampled monthly. Sites are identified by county throughout this report. Both trees and herbaceous plants were monitored for symptoms of herbicide injuries at each site during the months of May, July, and September. Trees selected for pesticide testing were located near areas of play, walking paths, ponds, or picnic areas, and remained constant for each site throughout the duration of the project. Foliage samples were taken monthly, and were analyzed as previously described in the 2024 report. In order to diversify monitoring methods and better evaluate the frequency and types of pesticide drift events we also deployed silicone monitoring bands monthly. Foliage samples and band samples were analyzed using the same mass spectrometer to reduce differences in data output and standardize the methodology.

Sites were selected based on geographic region, importance to the surrounding community, and relevant socioeconomic and human health data factors, such as asthma and cancer rates. Each site varied in proximity to agricultural lands, golf courses, and other potential sources of pesticide drift. Four locations were selected in Southern Illinois, four across Central Illinois, and two in Northern Illinois.

Compass plant, northern Illinois: leaves curled, twisted, deformed—Photo courtesy of PRN

Map of Illinois Counties Where Parks & Schoolyards Were Monitored & Sampled

Figure 1



1. **Washington**
2. **Saline**
3. **Union**
4. **Kane**
5. **Adams**
6. **Champaign**
7. **McDonough**
8. **Sangamon**
9. **Randolph**
10. **Winnebago**

Results & Discussion

A total of 88 samples were collected and analyzed. They included 50 samples of leaf tissue and 38 monitoring bands (out of 40 deployed bands, 2 bands were unrecoverable). Leaves and monitoring bands were analyzed for 60 compounds in total, but no one sample was tested for all 60. In order to maximize the number of samples analyzed across the state, we prioritized analysis of the most common herbicides and fungicides used during the month they were collected.

A total of 296 detections of 18 pesticide compounds were identified in the 88 samples. There were 211 instances of 17 different pesticides identified in leaf tissue samples. There were 85 instances of 10 different pesticides identified in monitoring band samples. One pesticide, dimethenamid, was only found with monitoring bands.

Redbud, central Illinois: leaves cupped, irregular margins, deformed, chlorotic—Photo courtesy of PRN

Site Location	May	June		July		August		September	
County	Leaf	Band	Leaf	Band	Leaf	Band	Leaf	Band	Leaf
Washington	2	3	4	3	4	5	7	1	6
Saline	3	4	3	3	6	3	4	0	6
Union	2	3	4	3	2	0	3	0	3
Kane	1	3	4	3	2	2	5	0	2
Adams	4	3	3	4	5	2	6	0	4
Champaign	3	3	5	4	6	1	9	0	5
McDonough	3	4	2	4	3	1	7	0	5
Sangamon	3	3	5	3	6	1	3	0	4
Randolph	2	3	6	3	5	0	7	3	6
Winnebago	2	4	4	3	3	0	7	0	5

Table 1: Number of pesticides detected in each leaf sample and monitoring band each month at each monitoring site.

At least one pesticide was found at each sampling event. Every month, between 1 and 10 pesticides were detected at each site (Table 1). As a general rule, we observed that bands were more effective at capturing pre-emergent herbicides such as metolachlor, acetochlor and atrazine, as well as fungicides. Leaf tissue analysis was effective at capturing growth regulator herbicides and glufosinate. If the same pesticide was detected in a band and leaf tissue during the same testing period, we recorded that as one exposure event. This reasoning is discussed in more detail in Figure 3. All tests are reported as presence or absence of the pesticide. Pesticide detectability varies between species and can be influenced by weather conditions, but some with long half-lives may remain detectable for more than 30 days after their exposure/uptake by the plant. Whether or not a detection result was considered a new drift event is discussed below (Figure 3).

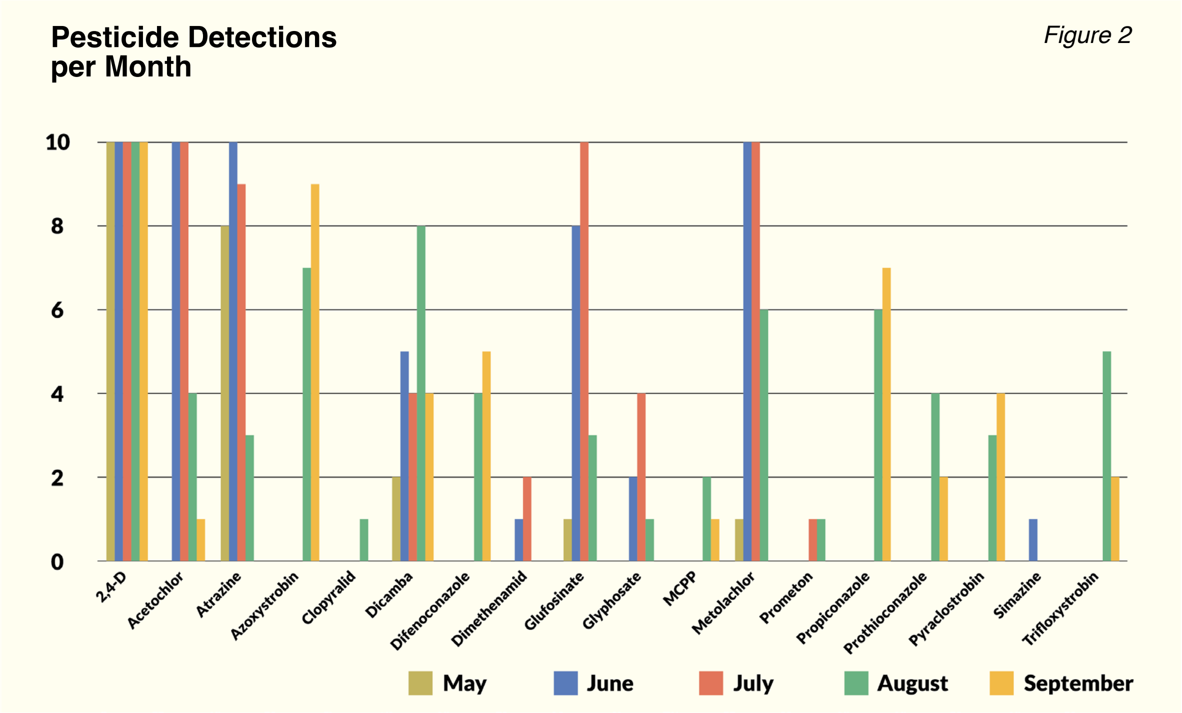


Figure 2: Illustrates the number of times a pesticide was detected across sites and months.

All 10 sites in 10 Illinois counties demonstrated the presence of herbicides and/or fungicides during 5 warm weather months in 2025. The plant growth regulator herbicide, 2,4-D, was detected more often than other pesticides. This is partly because it is one of the most widely used herbicides in Illinois.

There were exposures to 2,4-D, dicamba, and metolachlor every month, and atrazine, acetochlor, and glufosinate in 4 of the 5 months of the study. Several of the pesticides detected are banned in some other countries due to human health and/or environmental concerns (e.g., carcinogenicity, endocrine-disrupting activity, groundwater contamination, and/or drift injurious to crops).

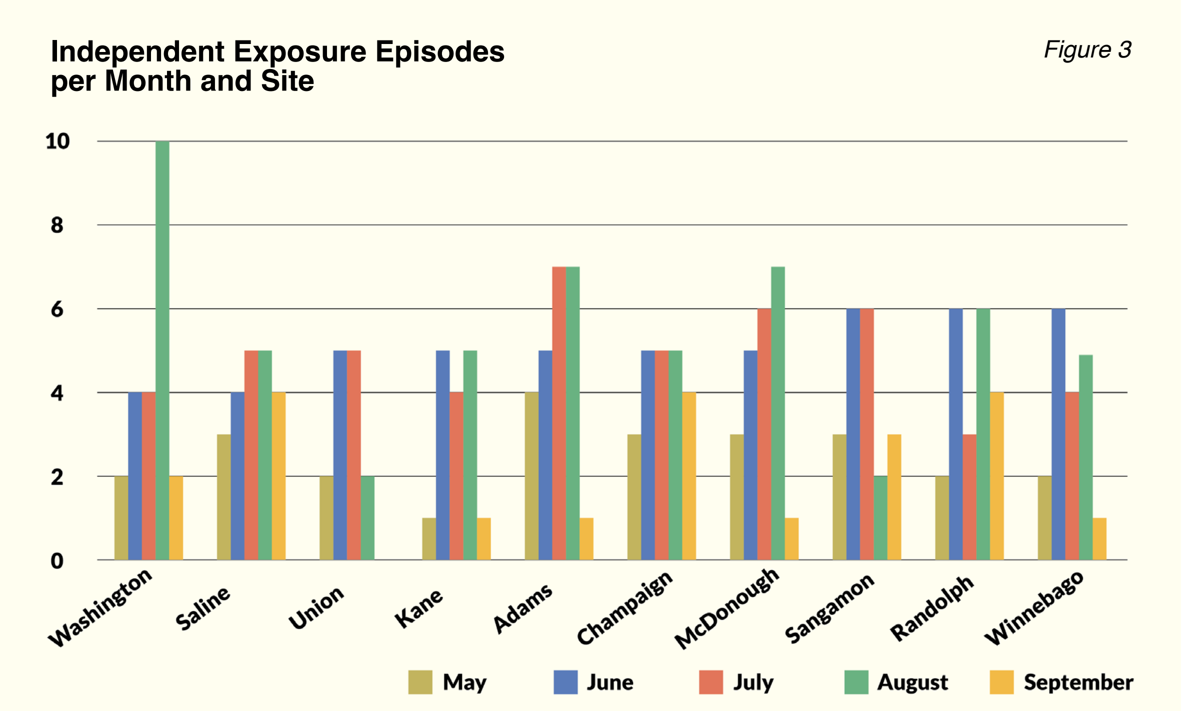


Figure 3: Illustrates the number of independent exposure episodes (IEE) for each month at every site.

We utilized the same method to determine an independent exposure episode (IEE) as we did previously in our 2024 summary report. When a new herbicide was detected during a sampling period (via tissue or monitoring band), we recorded it as a separate drift event. If levels of a herbicide(s) increased in a subsequent sample, we also recorded this as an independent exposure. Due to the monthly replacement of the bands, any time a compound was found on a band, it was an IEE.

The months of June, July, and August had the most IEEs recorded at each site. Adams County had the highest number of IEEs for any of our monitoring locations for the entire project with 24. Washington County had the highest total of IEEs for one month—10 in August.

It is important to recognize that while we can document drift events through the appearance or worsening of symptoms in plants, or through periodic repeated sampling, these results should be considered a baseline, and this is the minimum amount of exposures that are occurring. We still cannot fully determine the total number of drift events at each site, how far pesticides are traveling, or how many locations those pesticides are coming from. Additionally, due to financial constraints, not all pesticides that could be airborne were included in our analysis.

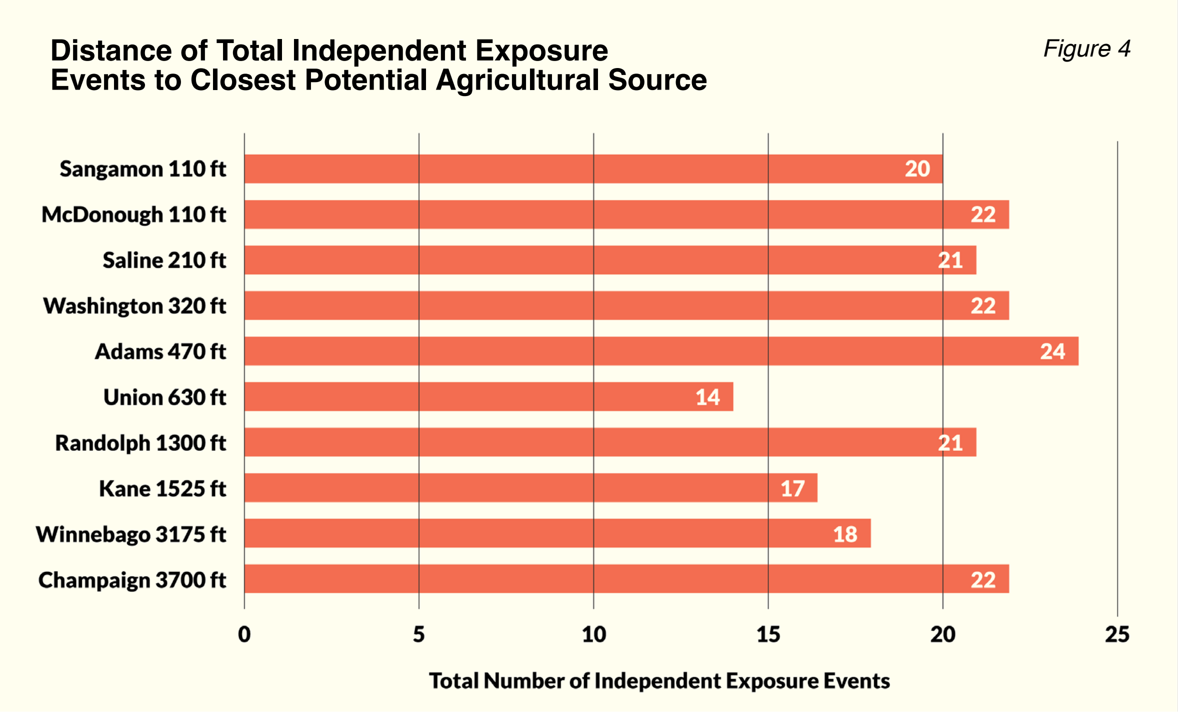


Figure 4: Illustrates the distance of the sampled tree and monitoring band location to the closest potential source of drift. Notice that there is little difference in detection numbers between sites with nearby and far away potential sources, highlighting how far pesticides are traveling.

With the exception of one park (Saline County) where drainage maintenance and minimal herbicide application occurred on a stream bank before monitoring began, no evidence of herbicide use was present at any of the sites. Many parks and schools confirmed that no pesticides (including herbicides) were used on the grounds, including sports fields.

As with our full data set that was published in 2024, distance data from the location of a sampled tree or monitoring band to the closest potential source was obtained using onsite investigations, satellite imagery, and digital map tools (e.g., Google Earth). Due to the variety of pesticides detected in our sampling and the differing uses for them, selecting a potential source for every pesticide detection would prove cumbersome.

Land areas that could be identified as potential sources include agricultural fields or pastures, golf courses, transportation and utility rights of way, commercial, industrial, and residential areas, and areas of intense targeted herbicide treatments (e.g., invasive weed control). Due to the presence of chemicals associated with cropland applications and/or the proximity of cropland at all sites, Figure 4 only identifies distances to the closest potential cropland.

The distances we present are significant underestimates of how far pesticide drift is actually traveling across the landscape. Two key reasons may explain this. First, potential sources were identified as the closest area from which the drift of pesticides present in samples could have originated—not as confirmed application sites or proven causes of—the observed off-target symptoms or contamination. Second, no distance measured was the "end" of drift; it is just a point beyond which we did not or could not measure in a particular circumstance. These observations do not suggest a threshold distance beyond which there would be no pesticide exposure.

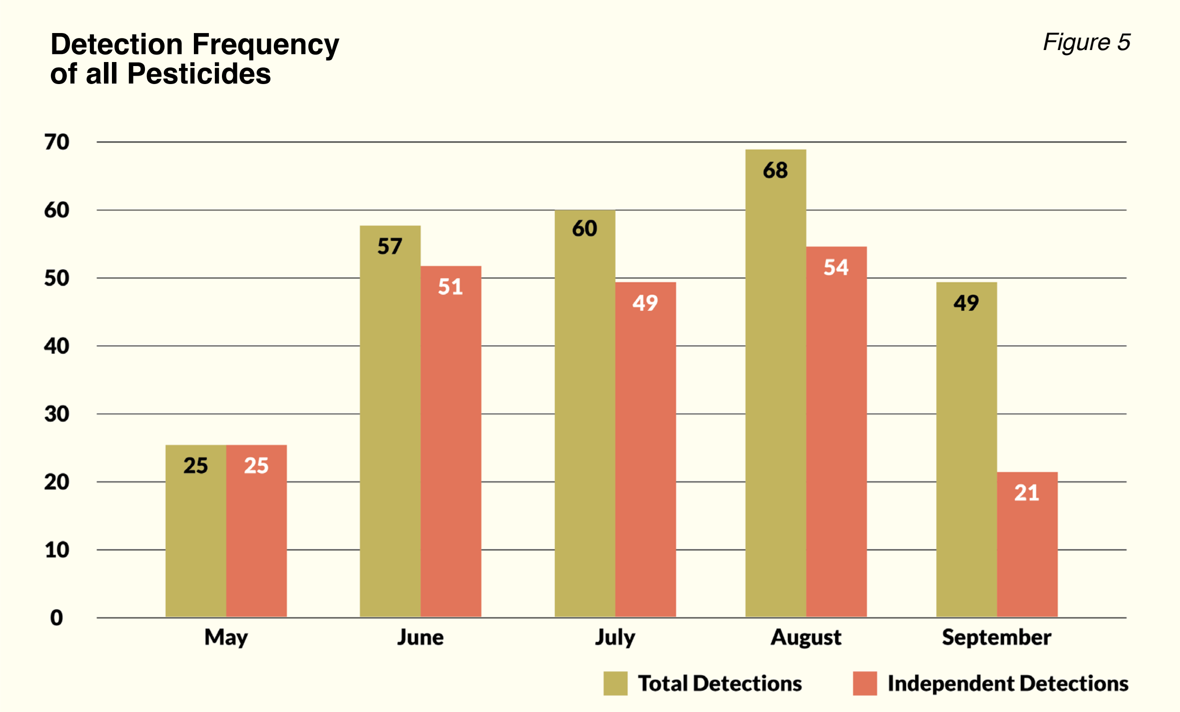


Figure 5: Illustrates the total number of times a pesticide was detected at all sites each month. At any given site, if a pesticide was found in a band and leaf tissue sample in the same month, it was recorded as a single detection.

While pesticide detections and drift events occurred at each site every month throughout the growing season, June, July and August had the most pesticides detected in bands and leaf tissues (Figure 5). As mentioned previously, they were also the months with the most IEEs.

Conclusions

Pesticide drift and chemical trespass were evident, not only in trees monitored for physical symptoms of drift, but in the analysis of leaf tissue and monitoring bands from all 10 locations in 10 Illinois counties during each of the five sampling periods in 2025. Even with these limited sample numbers, an average of 20 (range 14 to 24) separate pesticide exposure events were detected at the 10 study sites.

Pesticides frequently detected include chemicals considered by the International Agency for Research on Cancer to be possible (2, 4-D (2018)) or probable (glyphosate (2017)) carcinogens. They also include chemicals that are banned in some other countries (glyphosate, atrazine, acetochlor, simazine). Herbicides were detected throughout the growing season, and in late summer months detections of fungicides were also frequent. These findings also include exposure to atrazine, a restricted use pesticide. Restricted use pesticides are chemicals recognized by the U.S. EPA to have the potential to be harmful to the environment and cause injury to applicators or bystanders.

These data demonstrate frequent and likely long-lasting exposures to pesticides throughout the five warm weather months at the 10 study sites in 2025. Due to both drift generated during applications and subsequent secondary drift (e.g., vapor drift), exposures are unarguably occurring at all hours in outdoor parks and school yards, including peak outdoor activity times for children and adults. These data reinforce and extend observations recorded in our previous report (2024) that suggest, given the documented distances over which drift is occurring, that similar chemical trespass into both public and private outdoor spaces is the norm in Illinois, rather than the exception—and we could find no regions or public spaces that were unaffected in our monitoring.

It is increasingly obvious that current herbicide/fungicide use practices are not preventing human or plant exposures to chemicals from off-target pesticide drift.

Post Oak, southern Illinois, chronic exposure symptoms: thinning canopy, branch dieback (impending mortality)—Photo courtesy of PRN

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Pin Oak, southern Illinois: leaves curled, stunted, drooped, deformed, disoriented, chlorosis—Photo courtesy of PRN