Beyond Pesticides: Protecting Health and the Environment with Science, Policy, and Action

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Pesticides *and* You

Highly Destructive Pesticide Effects Unregulated

Widely used fungicide found to adversely affect enzyme common to all cells

FEATURES

Communities Act as Health and Environmental Threats Escalate

As the complexity of chemical interactions in the environment and their effect on living organisms explodes, we are in a period of diminishing regulation. So, we turn to local decision makers—whether in households or on farms, school or park districts, or local governments—to consider the threats of pesticides and make the decision to eliminate their use.

In this issue of *Pesticides and You*, we highlight a science piece published by the American Association for the Advancement of Science about the effect of a fungicide on organisms well beyond its target, a fungus. The article reports, "The ability of [the fungicide] fludioxonil, to act on a sugar-metabolizing enzyme common to all cells, and to produce the damaging compound methylglyoxal, may mean that the pesticide has more potential to harm non-fungal cells than previously thought." This pesticide's original use on stored seeds expanded to grains, vegetables, fruits, ornamental plants, and then to produce to extend shelf life after harvesting, all without full understanding or acknowledgment of its widely destructive effect.

With this, we again call for, in our communities and in all policy reform efforts, the adoption of the precautionary principle, the implementation of organic practices and products as the default in land and building management, and the end to this massive testing of pesticides on people and the environment by the chemical industry.

EPA, in February, announced that it is reapproving the weed killer glyphosate/Roundup despite the evidence of threats of cancer and DNA damage. Same for the neonicotinoid insecticides that are indiscriminately killing pollinators, polluting waterways, and killing keystone aquatic species. Good science is no longer integral to federal and most state regulatory decisions, which rely on EPA.

Approaching Reform with Alternatives

When we advance reform, we do not want to just tinker with a failed risk assessment-based regulatory system—with scaled backed improvements to enforcement, taking a few bad pesticides out of use, or improving mitigation measures for farmworker and farmer protection in excessively dangerous working conditions. We want to eliminate the use of these toxic materials, starting from the ground up. This means that we, as a part of our decision making process—whether in a community or a federal law—must look at whole ecological and biological systems, the range of interactions that are possible, and reject any harm. With alternatives available, there is no reason to accept anything less. This may leave a very small opportunity for use in public health emergencies. Integral to reform, then, is an alternatives analysis at the time a pesticide registered.

This is not a new position for Beyond Pesticides. It is why we began pushing for organic in 1981 when we were founded, creating the foundation for the change urgently needed in our communities and nation. We do not have time to tinker, accept half-measures, or reject precaution as a matter of policy and practice.

Aggressively Advancing Organic

The importance of organic cannot be overstated. As major corporations see market opportunities, we cannot accept the weakening of the original organic law's rigorous process, as is happening more and more. We will hold groups that waver, either by their words or their silence, accountable to the tough standards that birthed the burgeoning organic sector, as we did in a recent OrganicEye release on new appointees to the National Organic Standards Board. When the Organic Trade Association, representing the largest food and agribusiness operations, or other groups equivocate or are silent (and therefore complicit) on issues that challenge organic values, principles, and law, we have a duty to call it out. Whether it is support for "organic" hydroponics or USDA eliminating the default sunsetting (removing) of synthetics in organic production, we have a duty to call it out. We must protect the integrity of organic as the solution to pollution, as we confront the climate crisis and dramatic declines in biodiversity.

Local Action Leads the Way

Meanwhile, the work to eliminate pesticide use in communities is inspiring. In January, we testified before the Committee on Health in the New York City Council on legislation to remove toxic pesticides from public parks and playing fields. We told the committee that, "[W]e need to eliminate hazardous materials, not with chemical-by-chemical bans, but with a comprehensive program for land management that adequately restricts all pesticides."

Got Science?

Finally, this was reported in a January 1, 2020 front page *New York Times* piece, "A top panel of government-appointed scientists [Science Advisory Board], many of them handpicked by the Trump administration, said . . .that three of President Trump's most far-reaching and scrutinized proposals to weaken major environmental regulations are at odds with established science."

We are plowing ahead.

Jay Feldman, executive director of Beyond Pesticides

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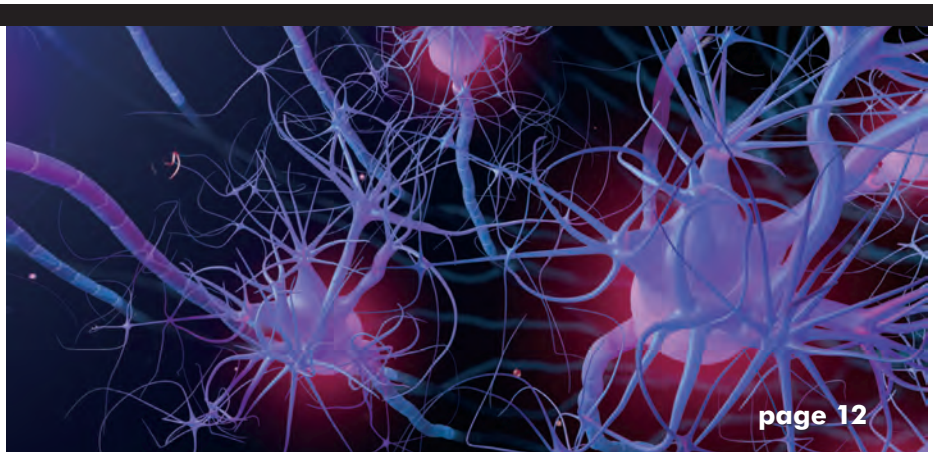

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FEATURES

DEPARTMENTS

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Conceptual illustration of neuron cells of the human nervous system.

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Are Buffer Zones Protection from Pesticide Drift

I'm trying to push my state officials to enact buffer zones around toxic pesticide use for areas like schools, hospitals, and neighborhoods. Can you tell me what a safe distance from pesticide spray would be? I've seen a lot of different numbers around the web, but none seem like a sure thing.

L., Raleigh, NC

L.,

Unfortunately, the answer to your question in many states and communities has been based more on politics and current economic dependency than what the science shows. A study by Texas A&M University finds that pesticides can volatilize into a gaseous state and be transported rapidly over long distances through wind and rain. A U.S. Geological Survey report reached similar conclusions, finding, "After they are applied, many pesticides volatilize into the lower atmosphere, a process that can continue for days, weeks, or months after the application, depending on the compound. In addition, pesticides can become airborne attached to wind-blown dust." The Childhood Autism Risks from Genetics and the Environment (CHARGE) study at the University of California, Davis finds that pregnant women who live within one mile of agricultural fields treated with insecticides are more likely to have their child develop autism. For women who live less than one mile from crops sprayed with organophosphate insecticides during their pregnancy, researchers found the likelihood of their child being diagnosed with autism increased 60%.

Based on that data, we can say that in order to protect children and other sensitive sites, buffer zones should be *at least* one mile or more depending on local conditions. But, chemical-intensive farms resist the adoption of buffer zones and leverage their political connections to limit these protections as much as possible. In Kaua'i County, Hawaii, as a result of rampant poisoning through pesticide drift, large demonstrations fought for and achieved modest buffer zones up to 500 feet around sensitive sites like schools and hospitals, only to have them reversed after a pesticide industry lawsuit. Pressure mounted on the state legislature, which enacted 100 foot buffers around schools, but only for the most highly toxic pesticides on the market. Advocates in California pushed for one mile buffer zones around school sites, but the state only went as far as a quarter mile, and only during school hours. In France, mayors in several localities began implementing 500-foot buffer zones after resident complaints. The pesticide industry complained about the impact on business, and French President Emmanuel Macron enacted countrywide buffers of 50 feet around residential sites in order to head off additional local restrictions. Advocates rightly say these restrictions are meaningless. "It must be an April Fools [joke]," said Yann Arthus-Bertrand, president of the advocacy group Good Planet. "I can't believe that lobbyists have more weight than public health concerns. It's insulting for people who have been fighting for so long against the use of pesticides."

The fight for buffer zones and the elimination of pesticide use around sensitive areas is a critical part of the movement for a pesticide-free future. The pesticide industry fights hard against these proposals because it sees them as the proverbial camel's nose under the tent. In a broader sense, the industry understands that crops can be grown without their toxic products, and buffer zones for health and environmental protection address externalities or costs that are now borne by victims and the larger society. As advocates who fight for the strongest proposals, we continue to change the calculus for policy makers by telling the stories of individuals affected by drift, causing health, environmental, or property damage. Please keep us apprised of your progress and do not hesitate to contact us for technical information and strategies to fight back against pesticide industry disinformation.

SHARE WITH US!

Beyond Pesticides welcomes your questions, comments, and concerns. Have something you'd like to share or ask us? We'd like to know! If we think something might be particularly useful for others, we will print your comments in this section. Mail will be edited for length and clarity, and we will not publish your contact information. There are many ways you can contact us: Send us an email at *info@beyondpesticides.org*, give us a call at 202-543-5450, or send questions and comments to: 701 E Street SE, Washington, DC 20003.

What Pesticides Are Most Concerning?

There are a lot of pesticides in the news right now—glyphosate, chlorpyrifos, neonicotinoids, and atrazine. Which of these chemicals is your organization particularly focused on getting rid of?

Alexandra, Ithaca, NY

Alexandra,

The short answer is all of the above. Many folks will remember back when Rachel Carson wrote *Silent Spring* that the focus was on eliminating use of DDT. But, Ms. Carson's critique was not limited to one specific pesticide or chemical class. Her book elevated the scientific literature on the danger of DDT. However, she took pains to highlight the wide range of daily chemical insults that people experience without their consent. "Yet new and more deadly chemicals are added to the list each year and new uses are devised so that contact with these materials has become practically worldwide," Ms. Carson wrote in *Silent Spring*. In this context, it is simply not an effective long-term and sustainable strategy to ban one chemical after another.

We rid ourselves of DDT, and eventually nearly all chemicals in its class of organochlorines (pesticides including chlordane, aldrin, endrin and dieldrin). But, organophosphates (pesticides including malathion, chlorpyrifos, diazinon, parathion, and hundreds) were developed as "regrettable substitutions." As independent science accumulated on these chemicals after they were already in wide use, many have been banned or restricted. The pesticide industry, in fact, uses this process to argue the need to keep its highly toxic chemicals on the market, invoking a false fear that farmers, landscapers, or building managers will have to use more of a different toxic chemical, or that their livelihood will be destroyed without the ability to use the pesticide subject to the ban or restriction. The chemical industry prepares for these minor disruptions in the market—synthetic pyrethoids and neonicotinoids were poised and ready to replace the organophosphate insecticides.

The pesticide industry is prepared for the individual chemical focus, one after another—playing a game of "whack-a-mole" that perpetuates toxic chemical-laden and dependent systems, and continually growing profits for its shareholders.

While we at Beyond Pesticides do support pesticide bans on the chemicals you mention, we are determined to fight for structural change to our country's approach to pest management on farms, lawns, landscapes, gardens, and in buildings.

Readers of this journal are familiar with our persistent call for a broadscale transition to organic agriculture and land management. The need for this movement is rooted in the understanding that removing one hazardous active ingredient from the market is going to leave thousands still in use and incentivize new ones. Instead, we advance both policies and practices that embrace a "systems approach" to soil and building management, which eliminates toxic pesticide use, prevents pest problems, and contributes to addressing dramatic threats associated with disease and illness, the climate crisis, and biodiversity decline.

The success of organic farming, a $50 billion industry with use of only organic-compatible products approved through a board of independent stakeholders, the National Organic Standards Board, shows that the path forward does not rely on the chemical industry's next toxic chemical as a substitute for the one just banned.

FROM THE WEB

Excerpt from Beyond Pesticides Action of the Week (11/25/2019): Ask Congress to demand an Investigation into EPA's Dismissal of Science. Continuing its marathon of deregulation to benefit the chemical industry, the Trump administration's Environmental Protection Agency (EPA) announced its proposal to increase the amount of the weed killer atrazine allowed in U.S. waterways by 50% during the chemical's registration review—a stark reversal of previous proposals to significantly reduce atrazine levels in the environment.
Beedy comments: EPA was set up to regulate toxics, including pesticides, which are basically biocides. We depend on our ecosystem and the living creatures that compose it, including ourselves. EPA must be allowed to do its job according to scientific understanding, not fettered by corporate power of the industries that produce the toxic substances. Our current administration has no understanding of how life works, only of how money might be made, regardless of the future. Let EPA do its work. Fetter the industry.
Sandy comments: It is unbelievable that this government would do this to us knowing that the science proves the harm it is sure to do. Congress must be held accountable!

Excerpt from Beyond Pesticides Daily News Blog (12/19/2019): Environmental Group Sues to Ban Rodenticides that Threaten Endangered Species in California. Identifying ongoing risk to endangered species, the environmental group Center for Biological Diversity (CBD) announced an intent to sue California pesticide regulators to cancel the registration of four rodenticides in California.
Matt comments via Facebook: The amount of times mountain lions have died in Santa Monica Mountains National Recreation Area has usually been because of these poisons.
Babette comments via Facebook: Enough with the killer pesticides; start thinking about our wildlife and how important they are to this planet! Humans are never excused from killing the living, so stop killing everything in sight!

Regulators Sit on Sidelines as Hazards Documented

Synthetic Pyrethroids Linked to Cardiovascular Disease

A University of Iowa College of Public Health study, published in *JAMA (Journal of the American Medical Association) Internal Medicine*, demonstrates that an increase in exposure to synthetic pyrethroid insecticides is associated with higher risks of death from cardiovascular disease and other causes. These compounds—inhaled, ingested, or absorbed through the skin—are highly neurotoxic, and linked to certain cancers, endocrine disruption, and suppression of the immune system, as well as respiratory and reproductive impacts. The authors of the study, "Association Between Exposure to Pyrethroid Insecticides and Risk of All-Cause and Cause-Specific Mortality in the General US Adult Population," gathered data on 2,116 adults, aged 20 or older, from the *National Health and Nutrition Examination Survey.*

Chemical Exposure Causes Decline in Children's IQ

Exposure to environmental chemicals in the U.S. since the turn of the century has resulted in millions of lost IQ points, hundreds of thousands of cases of intellectual disability, and trillions of dollars of lost economic activity. This is according to a study, "Trends in neurodevelopmental disability burden due to early life chemical exposure in the USA from 2001 to 2016: A population-based disease burden and cost analysis," led by a team of scientists at New York University (NYU) Grossman School of Medicine, published in the journal *Molecular and Cellular Endocrinology.* "Although people argue against costly regulations, unrestricted use of these chemicals is far more expensive in the long run, with American children bearing the largest burden," says senior study co-author and pediatrician Leonardo Trasande, MD, director of the Division of Environmental Pediatrics of NYU Medical School. Prenatal exposure represents a critical window when these effects can be particularly pronounced and result in lasting damage to a child. While using the insecticide chlorpyrifos as an exposure of concern, study authors warn that switching to another toxic pesticide is problematic. "Without proper toxicological testing standards for industrial chemicals in the United States we run the risk of introducing [substitute] chemicals that are just as bad, or even worse, for human health," the study reads.

Pesticides were estimated to result in over 26 million lost IQ points and over 110,000 cases of intellectual disability, totaling roughly $735 billion in economic costs. The total impact of all the chemicals studied by researchers, including flame retardants, lead, mercury and pesticides combined, is estimated at nearly 200 million lost IQ points, and almost 1.2 million cases of intellectual disability, costing the U.S. economy an astounding $7.5 trillion.

FLUORIDE EFFECTS IN THE WOMB

A birth cohort study in Canada finds that elevated levels of fluoride exposure during pregnancy are associated with lower IQ scores in 3- to 4-year-old children. The research, "Association Between Maternal Fluoride Exposure During Pregnancy and IQ Scores in Offspring in Canada," published in the journal *JAMA Pediatrics,* builds on previous analyses that suggest high fluoride exposure is related to adverse effects to children's neurodevelopment. Researchers recommend that pregnant mothers should reduce fluoride intake during pregnancy. Noting the controversial subject matter, *JAMA Pediatrics* editor Dimitri Christakis, M.D. said research was subjected to "additional scrutiny for its methods and the presentation of its findings." The authors of this study note, "The beneficial effects of fluoride predominantly occur at the tooth surface after the teeth have erupted. Therefore, there is no benefit of systemic exposure to fluoride during pregnancy for the prevention of caries [tooth decay] in offspring. The evidence showing an association between fluoride exposure and lower IQ scores raises a possible new concern about cumulative exposures to fluoride during pregnancy, even among pregnant women exposed to optimally fluoridated water." David Bellinger,

PhD, professor of neurology at Harvard Medical School and Boston Children's Hospital, notes that the effect size is comparable to what is seen with childhood lead exposure. Dr. Bellinger told National Public Radio that various routes of exposure, such as food, tea, and toothpaste, should be considered.

The use of the pesticide sulfuryl fluoride, allowed in food production since 2004, in combination with fluoride use in water fluoridation, creates unacceptable hazards under EPA and National Academy of Sciences (NAS) scientific determinations. Beyond Pesticides, Fluoride Action Network, and Environmental Working Group successfully petitioned EPA in 2006 and EPA announced a phase out in 2011 (to take effect in 2014), a decision that was reversed by a 2014 Farm Bill provision, which orders EPA not to follow the law and science that requires agency action to protect health.

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Ecological Disaster

Thousands of fox, coyote, and other carnivores will continue to be poisoned to death by hydrogen cyanide after EPA re-approved the use of M-44 "cyanide bombs" in December. Cyanide bombs are small, poison-filled land mines baited with food and placed on rural land to kill predators of grazing livestock. "EPA is blatantly ignoring its fundamental duty to protect the public, our pets and native wildlife from the cruel, lethal impacts of cyanide bombs lurking on our public lands," said Kelly Nokes, an attorney with Western Environmental Law Center. Non-lethal predator management and deterrence are effective and critically important to healthy ecosystems, avoiding cascading adverse ecosystem effects (trophic cascades).

The End of Science in Regulatory Decision Making

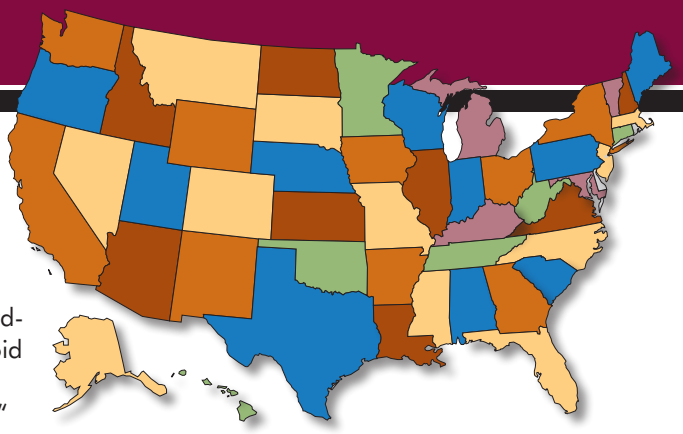
The *Scientific Integrity Act*, H.R. 1709, was introduced by U.S. Rep. Paul Tonko (D-NY) to restore scientific integrity to government agency decision making. Attacks on science in federal agencies have increased significantly in the Trump administration. H.R. 1709 finds that "science and the scientific process should inform and guide public policy decisions on a wide range of issues, including improvement of public health, protection of the environment, and protection of national security."

Reported in a front page January 1, 2020 *New York Times* piece, "A top panel of government-appointed scientists [Science Advisory Board], many of them handpicked by the Trump administration, said on Tuesday that three of President Trump's most far-reaching and scrutinized proposals to weaken major environmental regulations are at odds with established science." These most recent rollbacks involve protection of waterways, limitations on vehicle emissions, and use of scientific data to support health regulations. Without reliance on science, an agency's determination is by definition "arbitrary and capricious," resulting in rulemaking that can be found illegal in the courts. Quoted in *The Times*, Vermont Law School professor Patrick Parenteau said, "The courts basically say if you're going to ignore the advice of your own experts you have to have really good reasons for that . . . that go to the merits of what the critiques are saying."

Scientific Critiques Challenge EPA's Failure to Regulate

Over a dozen groups joined with Beyond Pesticides in January to tell EPA that it has failed to meet the statutory standard for continued registration of five pyrethroid insecticides. They raise several human health and environmental concerns—synergistic effects of combined active ingredients in common formulations, a large number of adverse effects incidents, endocrine disruption, vulnerability of children to exposure, and threats to pollinators and endangered species. The comments criticize the agency's ability to ensure that pesticide products commonly available for insect control are safe, do not expose the public to serious hazards or uncertainties, and are necessary, given the availability of alternatives.

Separate comments challenge EPA's analysis of the weed killer paraquat**,** prohibited in over 30 countries, including all of the EU and China, and linked to Parkinson's disease and possible endocrine disruption. The agency's risk assessments infer that changes in labeling will mitigate risks, despite serious uncertainties and data gaps in its assessment. The comments cite deficiencies in the assessments, several exceedances of unacceptable risk, and a failure to demonstrate that paraquat can be used without serious adverse effects. The groups urge the agency to ban the chemical.



Bird Population Decline Tied to Pesticides

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Birds are facing an existential crisis. Three billion birds have disappeared since 1970. Two out of three birds are threatened by climate change. In spite of this, the nation's most important bird protection law, the *Migratory Bird Treaty Act* (MBTA) is being weakened by the Trump Administration's Department of the Interior. The *Migratory Bird Protection Act*, H.R. 5552, introduced by U.S. Representative Alan Lowenthal (D-CA) and cosponsored by 18 bipartisan cosponsors, is intended to restore the critical protections removed by the Trump administration.

Songbirds Threatened. The poisonous farm fields that migratory birds forage reduce their weight, delay their travel, and ultimately jeopardize their survival, according to research, "A neonicotinoid insecticide reduces fueling and delays migration in songbirds," published in the journal *Science*. Like their effects on other pollinator populations, neonicotinoid insecticides generally are not causing acute poisoning and immediate death, but instead precipitating a cascade of sublethal impacts that reduces their fitness in the wild. As the authors told *Environmental Health News*, the study is a call not simply to ban neonics or one class of chemical, but to transition the entire farming system to sustainable bird, and bee-friendly practices.

Bird Habitat Threatened in Arkansas. A citizen science monitoring project of Audubon Arkansas has found evidence of contamination from the weed killer dicamba far from the genetically engineered soybean and cotton fields, documenting nearly 250 observations of dicamba symptomology across 17 Arkansas counties.

Community scientists were trained by Audubon to detect typical dicamba contamination symptoms, such as leaf cupping (just as it sounds, the leaf takes on a concave shape), epinasty (a distorted leaf growth pattern), and chlorosis (yellowed leaves because of insufficient chlorophyll), and to look for multiple symptoms on one plant, uniform symptoms throughout a plant, and instances of numerous plants in an area exhibiting symptoms. Species found to be affected include oak, redbud, and sycamore trees, and muscadine and trumpet vine plants.

Dan Scheiman, PhD, bird conservation director for the organization, after launching the project last spring, said, "Spraying dicamba on millions of acres of soybean and cotton is an uncontrolled experiment that puts sensitive habitats at unacceptable risk. In a landscape full of genetically engineered crops, the atmospheric build-up of volatized dicamba may result in significant damage to our state natural areas, wildlife management areas, national wildlife refuges, family farms, and the wildlife they harbor."

Studies Show Sustainability Only Achieved without Pesticides

Treated Seeds Offer No Benefit. The actual utility of pesticides to achieve their purported goals is an under-recognized failing of the regulatory review of pesticide compounds for use. A study published in *Scientific Reports* exposes the faulty assumptions underlying the use of neonicotinoids—the most widely used category of insecticides worldwide. The study, "Neonicotinoid seed treatments of soybean provide negligible benefits to US farmers," demonstrates that use of neonicotinoids (neonics) to treat seeds—a very common use of these pesticides —actually provides negligible benefits to soybean farmers in terms of yield and overall economic benefit. In a 2014 report, the U.S. Environmental Protection Agency (EPA) concluded that soybean seed treatments with neonicotinoid insecticides provide little or no overall benefits in controlling insects or improving yield or quality in soybean production.

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However, the agency does not evaluate efficacy or essentiality in its pesticide registration process, despite calls from advocates to do so.

Neonicotinoids are systemic pesticides that move through a plant's vascular system and are expressed in pollen, nectar, and guttation droplets (droplets exuded on the tips or edges of leaves of some vascular plants). They can also persist in the environment—in soil and water—for extended periods. Neonics are applied to seed, as well as to crop soils and to plant foliage. Corn and soybean seed treatments represent the largest uses of neonics in the U.S.—somewhere between 34% and 50+% of the soybean crop and for nearly all field corn. This contrasts dramatically with metrics from the decade prior to the introduction of neonics to the marketplace, when a mere 5% of soybean acreage was treated with insecticides. The pesticide is also applied liberally to cotton, oilseed rape, sugar beet, vegetable, and pome, stone, and citrus fruit crops.

Regenerative Agriculture Undermined by Pesticide Use

Pesticides and Soil Health, a report by Friends of the Earth, focuses on an often overlooked aspect of soil health, "that eliminating or greatly reducing toxic pesticides is key to building healthy soils and ecosystems for a healthy planet." Beyond Pesticides has long maintained that toxic pesticide use has no place in organic and regenerative land management practices and that they can and should be eliminated. According to Jay Feldman, executive director of Beyond Pesticides and former member of the National Organic Standards Board (NOSB) said, "Pesticide reduction strategies that allow continued use of toxic substances undermine the soil biology and biodiversity that is critical to healthy plants and unnecessary to achieving pest management goals." "It's past time to talk elimination of toxic pesticides and nothing short of that," he said.

Toxic pesticides have a diverse range of unintended impacts, including cancer and other diseases to those exposed via usage or drift, and crop loss. Lesser known is the impact that pesticides have on the microbes that live in the soil. The report notes that a teaspoon of healthy soil holds billions of soil microorganisms. These bacteria and fungi provide a range of services to plants, such as access to necessary nutrients like nitrogen and phosphorus. In exchange, plants provide these tiny life forms with carbon in the form of carbohydrates. As the climate crisis continues to wreak havoc, this process of carbon sequestration is integral to carbon drawdown (decline) in the atmosphere. Pesticides, therefore, pose a threat to the capacity of soil to play a role in the fight against the climate crisis.

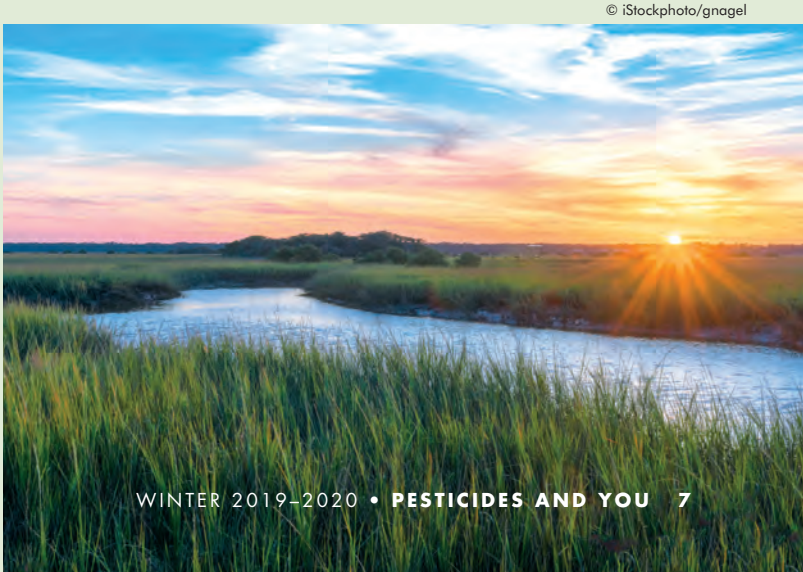
Toxic chemicals damage the soil microbiota by decreasing soil microbial biomass and altering the composition of the soil microbiome. Fungi-rich soil improves productivity and increases carbon sequestration capacity. Soil degraded by toxic pesticide use sequesters less carbon than soil with a diverse array of microbiota.

While no-till (eliminating tillage) practices are often associated with regenerative practices that reduce erosion and preserve microbes, the report states, "Data indicates that the majority of no-till farmers rely on herbicides such as glyphosate, the active ingredient in Roundup. In fact, 86% of *No-Till Farmer* readers said they planned to plant Roundup Ready corn in 2017, while 80 percent planned to plant Roundup Ready soybeans, and some 92 percent planned to use glyphosate for weed control."

Synthetic Fertilizers Disrupt Carbon-Capturing Ability of Salt Marshes

Salt marshes, areas of coastal grassland regularly flooded by saltwater, provide a major global service by sequestering and storing carbon in the form of organic matter. However, research finds that nitrates from synthetic fertilizers found in agricultural runoff could change the microbial composition of the salt marshes to encourage organic matter decomposition and carbon release instead of capture. The study, "Nitrate addition stimulates microbial decomposition of organic matter in salt marsh sediments," was published in *Global Change Biology*.

Led by scientists at the Marine Biological Laboratory (MBL), Woods Hole, and Northeastern University, the study—conducted on salt marsh sediments located in Plum Island Sound, MA—evaluated three core samples from the site, sectioning each one into shallow, mid, and deep sediments. The results indicate that nitrates stimulate the production of dissolved inorganic carbon, leading to decomposition of organic matter that would otherwise remain stable in salt marsh sediments. First author Ashley Bulseco, PhD, wrote, "Traditionally, we have viewed salt marshes as resilient to nitrogen pollution, because the microbes there remove much of the nitrogen as gas through a process called denitrification. But this research suggests that when nitrate is abundant, a change occurs in the microbial community in salt marsh sediments that increases the microbes' capacity to degrade organic matter. This potentially reduces the ability of the marsh to store carbon."



Europe Moves Against Pesticides

Insecticide Chlorpyrifos Ban. The European Union (EU) voted to ban the neurotoxic insecticides chlorpyrifos and chlorpyrifos-methyl from use beginning February 1, 2020. The EU regulatory committee decided not to renew approvals following a European Food Safety Authority (ESFA) finding, released in August, that there is no safe exposure level for chlorpyrifos. The decision to protect the public in the EU differs from the trajectory of the U.S., where individual states are forced to step up to act in lieu of an independent, science-based federal regulatory system. Chlorpyrifos damages fetal brains and produces cognitive and behavioral dysfunction, particularly in children. Prenatal and early life exposure to chlorpyrifos is linked to lower birth weight and adverse neurodevelopmental effects, including reduced IQ, loss of working memory, attention disorders, and delayed motor development. Farmworkers are at heightened risk of acute exposure effects of the chemical (including accidents and spills), which can cause respiratory paralysis and death.

Banning a Bee-Toxic Insecticide. The European Commission (EC), in January, 2020 decided not to propose to renew approval of the neonicotinoid pesticide thiacloprid, citing both environmental and health concerns related to the pesticide's use and resulting exposure. The decision was approved by a majority of EU governments last fall. The EC based its decision on EFSA findings published in January 2019, which highlighted concerns about human toxicity and high concentrations in groundwater. European Commissioner for Health and Food Safety, Stella Kyriakides, commented, "There are environmental concerns related to the use of this pesticide, particularly its impact on groundwater, but also related to human health, in reproductive toxicity."

France Pulls Glyphosate. France made headlines in the great, global

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glyphosate (Roundup) debate. In December, the French health and safety agency ANSES (Agence Nationale de sécurité sanitaire de l'alimentation, de l'environment et du travail—Agency for Food, Environmental and Occupational Health and Safety) made preliminary decisions within its review of authorizations for the 69 glyphosate (Roundup) weed killer products allowed for sale in the country. ANSES called for immediate withdrawal of authorization for 36 of those products "due to a lack or absence of scientific data which would allow all genotoxic risk to be ruled out."

Malibu, California Circumvents State Preemption Law

In a hard-earned win, the city of Malibu, California collaborated with the Coastal Commission to ban toxic pesticide use in their community. While the city had already voted to ban all toxic pesticides back in 2016, the state's pesticide law preempts, circumvents, or prohibits, a municipality from restricting private use of pesticides more stringently than the state. However, the Coastal Commission, as a state agency that establishes agreements with municipalities—known as a "Local Coastal Program" or "LCP"—circumvents the preemption issue. The municipal agreement document codifies regulations that are set up between the Coastal Commission and a local jurisdiction. In December, Malibu City Council unanimously voted to amend Malibu's LCP to ban the use of toxic pesticides. According to activist Joel Schulman of Poison Free Malibu, "We're basing our local coastal program amendment on what [unincorporated L.A.] County did in 2014." That year, L.A. County and the Coastal Commission banned anticoagulant rodenticides and some toxic pesticides in the unincorporated Santa Monica Mountains Coastal Zone LCP. In September 2017, a Superior Court rejected a lawsuit challenging the decision and affirmed the ability of the Coastal Commission to work with municipalities to restrict pesticide use.

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New York Gov Opts for Regulatory Phase Out of Chlorpyrifos

The Governor of New York, Andrew Cuomo, vetoed legislation to ban the brain-damaging insecticide chlorpyrifos in December, then issued an immediate ban on aerial application, and proposed a regulatory phase-out that bans all uses by December 2020, with an exception for the application to apple tree trunks extended to July 21, 2021. The proposal is subject to a public comment period.

Pesticide Use Violates Human Rights

United Nations and others find adverse effects and global human rights violations

Illustrations by Meghan Taylor

DEBRA SIMES

As is the case in many countries, the conversation about the use of pesticides has been especially vigorous in the past few years. Switzerland is a case in point: it is undergoing deep scrutiny of pesticide use, and the UN Special Rapporteur on Toxics, Baskut Tuncak, has now said publicly that pesticide companies' behavior is "seriously deficient" regarding human rights (especially those of children), and that the Swiss government should act more aggressively to phase out use of these hazardous chemicals. In February, 2019, enough signatures were collected to run a referendum in 2020 entitled, "For a Switzerland free of synthetic pesticides." The government's Parliament is on record as opposing the measure. Advocates for the measure point to widespread contamination of farmland and waterways.

GREATER PUBLIC AWARENESS, MORE POLICY DEBATES

Recently, the pesticide debate has ratcheted up several notches, not only in the U.S., but also globally, due to greater public awareness of the health and environmental threats of pesticide use, more and more research underscoring those threats, and pointedly, the cascade of litigation against Monsanto (now owned by Bayer) for harm to individuals who have used its glyphosate-based products. Public awareness in Switzerland is also mounting in response to global developments, recent discoveries that small streams in Swiss agricultural areas are heavily polluted with pesticides, and broadening recognition that pesticides are linked to a plethora of harms to human health, pollinators, waterways, farmworkers, wildlife, ecosystems and biodiversity, and more. In 2017, a UN report found that human rights are adversely affected by pesticide use: not only has industrialized agriculture not succeeded in "eliminating world hunger," it has hurt human and environmental health and well-being.

Corporate disregard for the impacts of pesticide products (which is enabled by the Environmental Protection Agency [EPA] in the U.S.), rampant malfeasance, and undue influence on governmental regulation all underscore the "seriously deficient" description used by Mr. Tuncak. He commented in an interview with the website swissinfo.ch,

> "There is a serious deficiency in terms of the human rights due diligence carried out by pesticide manufacturers and other chemical companies in terms of what happens after

the point of sale. . . . Most chemical companies have a very shallow approach to human rights due diligence."

Mr. Tuncak admonished the Swiss government for failing to hold businesses accountable for ensuring chemical safety, and phasing out chemicals of concern. He also critiques countries broadly for their lack of accountability to the pledges made under the *Strategic Approach to International Chemicals Management* (SAICM) framework, saying that the agreement "hasn't made a significant dent in phasing out highly hazardous pesticides in the past 13 years."

In 2014 and again in 2017, Mr. Tuncak was appointed UN Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes. The swissinfo.ch interview with him touched on his UN charge to assess how pesticides impact human rights, and his thoughts about the responsibilities of governments and industry.

THE VULNERABILITY OF CHILDREN

His first comments in the interview went right to the heart of concerns about health impacts of pesticides:

> "What really concerns me is the widespread exposure of children during sensitive periods of development and how chemicals are found to be more and more hazardous at lower and lower exposure levels over time. Health trends ranging from declining sperm count to rising breast cancer rates are increasingly being associated with exposure to these chemicals in childhood. Particularly concerning is the way multiple chemical exposures can combine and interact with each other to impact health. Yet the few risk assessments that have been completed focus on the risk of exposure to individual substances, and don't consider the human rights of the child. We are discovering all kinds of nuanced effects of these chemicals on health, which increasingly is changing the way we think about diseases and disabilities that develop later in life. I find this widespread prevalence of childhood exposure very concerning not only based on the science, but also the values, principles and rights of children that are recognised by nearly 200 countries."

The Swiss government has been a bit "all over the map," and certainly inconsistent, on the matter of pesticide regulation. Critics note, for example, its glacial implementation of a narrowly focused pesticide reduction plan passed in 2017 that purports to reduce by 50% the risks of long-term soil and water pollution by adopting more-sustainable agricultural policies. At the same moment, the Federal Office of Agriculture (FOAG) issued a statement saying it is not possible to dispense with pesticides altogether. On the ground, activists have advanced the *Clean Drinking Water and Healthy Food initiative*, which aims to cut subsidies to farmers who use pesticides or antibiotics, and the so-called *Neuchâtel Initiative,* which looks to ban pesticide use in the country, as well as importation of food containing pesticides—both of which should end up going to the ballot box.

In June, 2019, FOAG banned 12 pesticides that contain chlorpyrifos and chlorpyrifos-methyl, which are commonly used on potatoes, vegetables, berries, and grapes. Yet the ban, which affects a total of 26 products, also allows three of them to continue to be sold for another year. The Swiss parliament is currently considering two additional initiatives to restrict the use and sale of pesticides.

MOVING TOWARD SUSTAINABLE AGRICULTURE

Further, ARC2020—a multi-stakeholder platform of more than 150 civil society networks and organizations (from 22 European Union member states) that work on issues affected by the EU's Common Agricultural Policy—has noted that Switzerland has made progress on the sustainable agriculture front, including reducing use of what Europeans refer to as Plant Protection Products (PPPs), which are synthetic pesticides, herbicides, fungicides, etc.

ARC2020 wrote in March 2019, "The strict Swiss regulatory regime places biodiversity at the heart of agricultural policy. Subsidies for Swiss farmers are pegged to compliance with regulations on pesticide use, nutrient budgets, crop rotation and livestock. Farmers are also required to set aside 7% of farmland for Biodiversity Promotion Areas (BPAs), such as grassland, hedgerows and wildflower strips. Direct payments for ecosystem services are designed to compensate farmers for loss of income. Agroscope's role is to develop direct and indirect alternatives to pesticides. 'We only resort to synthetic plant protection products once all other measures have been exhausted.'"

THE RIGHT TO HEALTH, A LIVABLE CLIMATE, AND CLEAN AIR, WATER, AND FOOD

The human rights issues related to pesticide use comprise one aspect of a broader question being discussed across global societies—whether people have inherent rights to health, a livable climate, and clean oceans, air, water, and/or food. The UN Office of the High Commissioner on Human Rights website notes, "A safe, clean, healthy and sustainable environment is integral to the full enjoyment of a wide range of human rights, including the rights to life, health, food, water and sanitation. Without a healthy environment, we are unable to fulfil our aspirations or even live at a level commensurate with minimum standards of human dignity. At the same time, protecting human rights helps to protect the environment. When people are able to learn about, and participate in, the decisions that affect them,

they can help to ensure that those decisions respect their need for a sustainable environment."

Beyond Toxics, an Oregon-based environmental organization, lays out the rationale for viewing pesticide use and other issues through a human rights lens: "Human rights norms are not arbitrary. They are ethical standards recognized by citizens in our country and by peoples around the world as moral duties and protections that everyone should be able to expect from their governments. If governments, or businesses regulated by governments, violate these norms, they are violating formally recognized standards of justice."

MONSANTO CHALLENGED FOR ENGAGING IN ECOCIDE

In 2017, the International Monsanto Tribunal—which was established by the Monsanto Tribunal Foundation, an initiative of civil society groups—litigated Monsanto to hold it accountable for crimes against nature and humanity, and ecocide. The presiding judges, having heard testimony from experts, witnesses, and victims in The Hague, Netherlands, home to the UN International Court of Justice, delivered their legal opinion on Monsanto's impact on issues including human rights, food access, environmental health, and scientific research. Their conclusion: that Monsanto has engaged in practices that have negatively affected people's right to a healthy environment, to food, and to health, and that if ecocide were recognized as an international criminal law, the corporation would possibly be found guilty.

THE INTERSECTION OF HUMAN RIGHTS AND ENVIRONMENTAL PROTECTION EXPANDS

On a different frontier, in the U.S. courts, the question of human rights in the face of the climate emergency is currently before the Ninth Circuit Court of Appeals in *Juliana v. United States,* a lawsuit brought by a group of 21 young people. The plaintiffs' case "demands that the government step up to protect today's children, and future generations, from the worst effects of climate change. It says they risk being deprived of their 'rights to life, liberty, property, and public trust resources by federal government acts that knowingly destroy, endanger, and impair the unalienable climate system that nature endows.'"

In April 2019, a report, *The Human Right to a Clean and Healthy Environment in Climate Change Litigation,* by Samvel Varvastian, a legal researcher at Cardiff University, examined issues raised in lawsuits in the U.S., the Netherlands, Switzerland, Columbia, and Pakistan, and points to cautious optimism about the human rights bases of the suits. Environmental law professor at Wake Forest School of Law and former special rapporteur for Human Rights at the UN, John Knox, commented, "One of the valuable aspects of human rights is that they set out certain basic protections that we think are necessary for human dignity, equality and freedom.... And so while the challenges may change and evolve, the need to protect people's basic human rights should remain a constant."

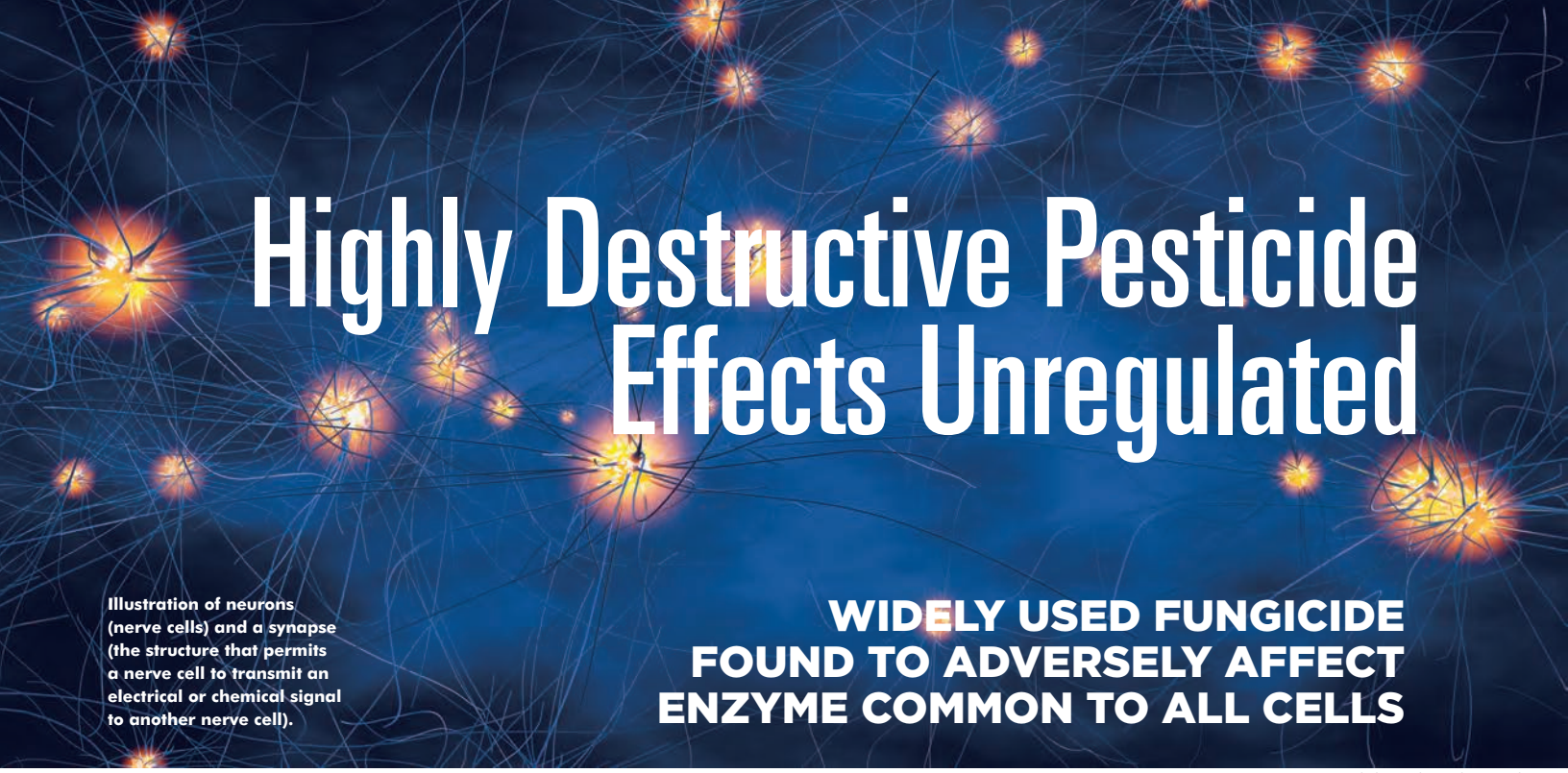
The "rights" lens was posited, vis-à-vis pesticide use, back in 2004 by noted scientist and activist Sandra Steingraber, PhD, in a Rachel Carson Memorial Lecture held by Pesticide Action Network, UK, on the issue of human rights and people's unwitting exposure to chemicals in air, food, and water. (Excerpts of this talk were published by Beyond Pesticides in "Contaminated Without Consent: Why our exposure to chemicals in air, food, and water violates human rights.")

The human rights of farmworkers and their families, and child farmworkers, are often acutely at issue because of intensive pesticide use. Beyond Pesticides advocates for a precautionary approach to the use of chemicals, and asserts that organic approaches to agriculture and land management represent the real solutions to the threats of chemical-intensive agricultural production. It supports steps that bring the world closer to the day those are realized.

About Mr. Tuncak

Mr. Tuncak is the founder of Common Rights, a multi-disciplinary advisory firm on sustainable development and human rights. He is an attorney and chemist, specializing in toxic pollution related matters. Mr. Tuncak has nearly 20 years of professional experience in private and public sectors, divided between work as a research scientist with pharmaceutical and biotechnology companies and senior legal positions with non-profit organizations and research institutions. He has served as an advisor to various initiatives of the United Nations agencies, national governments, public-interest organizations and philanthropic donors and currently serves as UN special rapporteur on toxic substances. Mr. Tuncak is an adjunct professor at Boğaziçi University (Turkey).

See interview with Mr. Tuncak *at bp-dc.org/human-rights.*



Highly Destructive Pesticide Effects Unregulated

Illustration of neurons (nerve cells) and a synapse (the structure that permits a nerve cell to transmit an electrical or chemical signal to another nerve cell).

WIDELY USED FUNGICIDE FOUND TO ADVERSELY AFFECT ENZYME COMMON TO ALL CELLS

DEBRA SIMES

EDITOR'S NOTE. *To our non-scientist readers, we urge you to wade through this article and share it with those making decisions on pesticide use and food choices. The take-home message from the research discussed here is that the complexity of pesticide effects on cells and enzymes in the body, and organisms generally, are not understood to the extent that they should be. And yet, people in positions of authority push for pesticide use, sometimes because they simply defer to regulators, believe that because a pesticide is on the market it must be safe, or have been trained to use the chemicals. Sometimes, without knowing the science, or lack of science, they feel that the pest control needs are more important than any potential harm, known or unknown, of the pesticide use. In this piece, the unknowns associated with the chemical effect that is the subject of this article turns out to have dramatic and frightening effects. —Jay Feldman*

This is a story about a chemical pesticide, a fungicide, in wide use for which the mode of action, i.e., the ability to cause harm, has not been fully understood. It is not a story unique to this pesticide. Rather, it is an important reality to consider when deciding to use a pesticide or allowing a pesticide to be used. The question is whether the chemical could be broadly problematic beyond the target organisms, in this case fungi?

In its coverage of a study published in March, 2019, the American Association for the Advancement of Science publication, EurekAlert, reported that, "The ability of [the fungicide] fludioxonil to act on a sugar-metabolizing enzyme common to all cells, and to produce the damaging compound methylglyoxal, may mean that the pesticide has more potential to harm non-fungal cells than previously thought. Although fludioxonil has been deemed safe for use, the authors…suggest that the effects of this widely used pesticide has upon animals be re-examined."

The research study, "Phenylpyrrole fungicides act on triosephosphate isomerase to induce methylglyoxal stress and alter hybrid histidine kinase activity," published in *Scientific Reports* and led by T. Tristan Brandhorst, PhD (in the lab of Bruce Klein, PhD, University of Wisconsin–Madison and UW School of Medicine and Public Health), sheds light on that mechanism and raises the alarm about implications of the discovery.

THE USE AND HISTORY OF A FUNGICIDE

Among the myriad pesticides used in agriculture is fludioxonil, a phenylpyrrole fungicide, which was developed to treat seeds during storage. However, it has come to be used commonly on grains, vegetables, fruits, and ornamental plants during cultivation, and, making it even more widespread (more on this below), to treat produce after it has been harvested to extend "shelf life." Though fludioxonil is effective in killing fungi, the mode, or mechanism, of action for this pesticide was previously not well understood.

Fludioxonil was introduced in 1993–1994 by Ciba-Geigy (now Syngenta), and pesticides that include the compound are now marketed under various brand names, including Cannonball, Switch, Medallion, Helix, Celest, Apron, Agri Star Fludioxonil, Dyna-shield Fludioxonil, Maxim, Scholar, Spirato, and others. Syngenta promotes it for use on "targeted fungi, such as snow mold, seedborne and soilborne *Fusarium*, [and] seedling blights or bunts." Its use has increased in the 25 years since its introduction, and particularly in the last few, ratcheting up concern about its features and impacts.

THE MECHANISM CAUSES CELL DEATH

In a previous investigation, Drs. Brandhorst and Klein pointed to the uncertainty about how fludioxonil actually causes fungi

cell death, asserting that this uncertainty merits a reevaluation by the U.S. Environmental Protection Agency (EPA) of its potential impacts on human health, noting reports of the fungicide's ability to disrupt hepatic (liver), endocrine, and neurological systems. Prior to this current study, it was believed that fludioxonil targets hybrid histidine kinase (HHK), a protein in fungal cells. Regarding the mechanism of action, Syngenta has theorized that fludioxonil binds to HHK, activating a biochemical process that causes fungal cells to kill themselves. In 2016, Dr. Klein's lab team found that, although fludioxonil needs HHK in order to kill fungi, the pesticide and protein do not directly interact.

The scientists in Dr. Klein's lab turned to the hypothesis that oxidative stress—a common effect of pesticides on their targets—might be the linchpin. (Oxidative stress is an imbalance between cells that are oxygen-producing free radicals and antioxidant defenses in the body.) Yet, the team found that, when they exposed fungi to various kinds of oxidative stress, cells remained healthy. Then, the researchers discovered that fludioxonil inhibits an enzyme related to cellular sugar metabolism, causing (via a spike in methylglyoxal release) activation of the deadly HHK cascade.

DAMAGING ALL CELLS

Dr. Brandhorst notes, "The take home lesson is that fludioxonil is multifactorial. It is not compromising cells by one solitary mechanism. It has potential to damage cells in a variety of ways." He references a 2007 investigation that demonstrated that, in fungi, disruption of glutathione homeostasis (which manages oxidative stress) synergistically enhances the toxicity of fludioxonil, suggesting that an oxidative stress response pathway may overshadow osmoregulation functions (maintenance of constant osmotic pressure in the fluids of an organism by the control of water and salt concentrations). Glutathione is primarily an intracellular antioxidant, which protects cells against the effects of free radicals—which can include damage to DNA. Fludioxonil has been shown to have DNA damaging impacts on human liver cells, and Dr. Brandhorst suspects that glutathione depletion (a signaling event that regulates the activation of cell death pathways) may ultimately be identified as a factor in fludioxonil-related hepatic (liver) damage. The enzyme-suppressing action of fludioxonil on an enzyme common to all cells is at the heart of the alarm this research is raising, but it is not the only reason the fungicide needs to be reevaluated.

PERSISTENCE, TOXICITY, AND ESCALATING TOXICITY

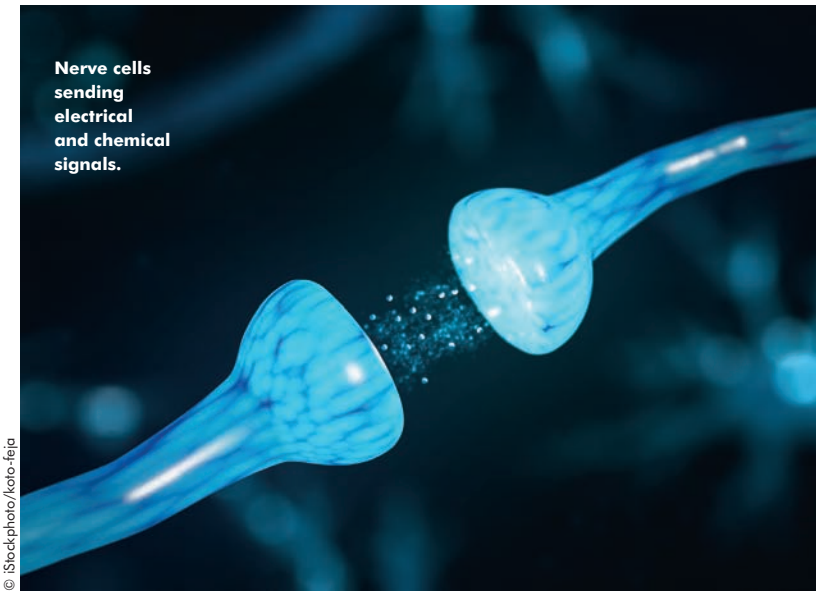
Fludioxonil persists in soil—near the surface for weeks, and for years if it ends up deeper in the soil, where sunlight cannot speed its degradation; it is also a "super toxin" for earthworms. The fungicide's extensive post-harvest use on food crops is of particular concern because it eliminates the chance for wind, rain, and ultraviolet-visible (UV-vis) light to break down the compound, and once applied, the waxy fungicide is not easily removed by rinsing. Further, UV-vis treatment of produce (which is sometimes done to reduce pathogens on fresh fruits and vegetables) actually significantly increases the toxicity of fludioxonil.

The enzyme-suppressing action of fludioxonil on an enzyme common to all cells is at the heart of the alarm this research is raising, but it is not the only reason the fungicide needs to be reevaluated.

The fungicide also is an EPA Category I toxic substance—"highly toxic and severely irritating"—to aquatic plants, bacteria, insects, fish, and aquatic invertebrates, generating concern about its use near water bodies or shorelines. Beyond all that, the lead author indicates that "there is also reason to believe that breakdown products [new chemicals formed in the environment] of this pesticide may be 100 times more toxic than fludioxonil itself."

SYNERGY NOT EVALUATED

In addition, the issue of synergistic action among multiple pesticide compounds, or active and adjuvant ingredients in a pesticide, is woefully under-addressed by regulators. Synergistic action was explained simply and long ago by Beyond Pesticides in its journal *Pesticides and You*: "The concept of interaction is fundamental to understanding the processes by which chemical mixtures act. If the effect is simply additive, the sum of the effects is the same as if we were exposed to each chemical individually. Synergy occurs when the effect



Nerve cells sending electrical and chemical signals.

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of a mixture of chemicals is greater than the sum of the individual effects."

REGULATORY FAILURES

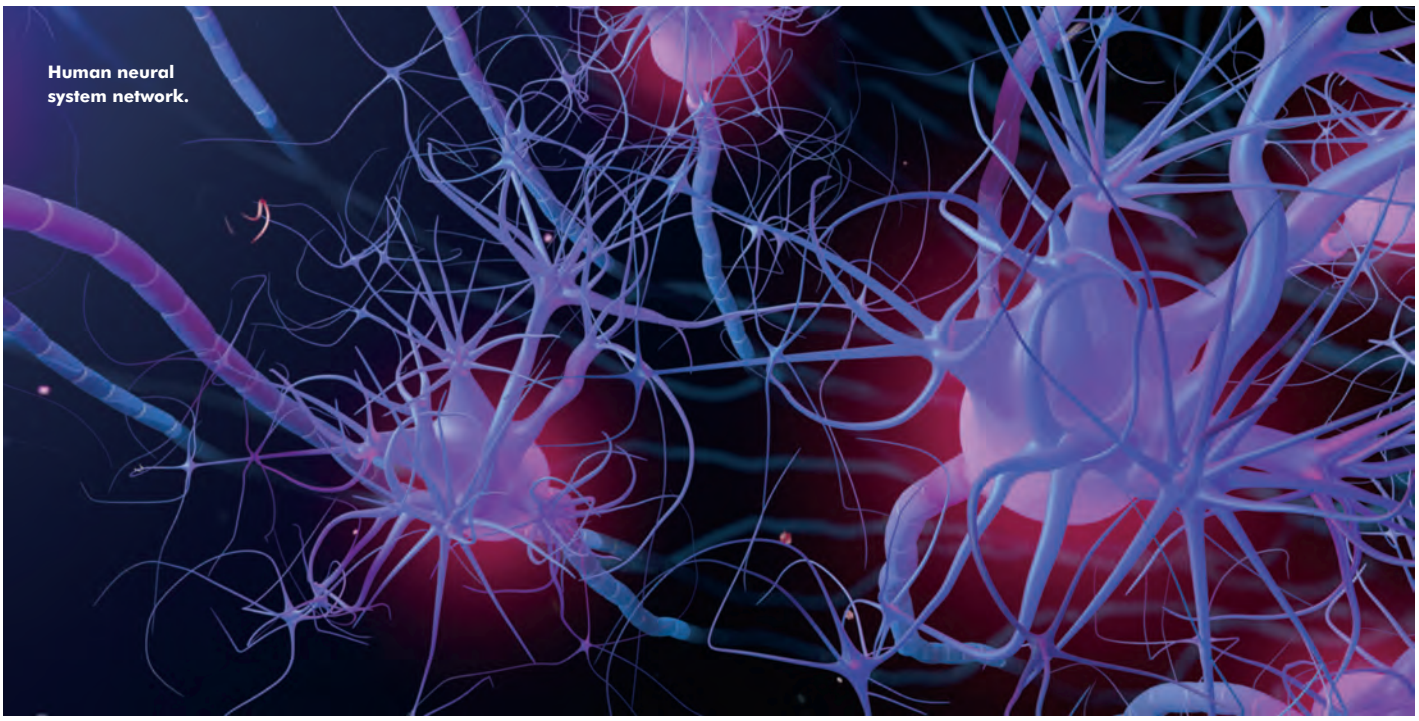
The federal bodies in the U.S. that are supposed to ensure the safety of both chemicals used in the environment, and those used on food crops and products—EPA, and the Food and Drug Administration (FDA), respectively—fail to do so. Another passage from the *Pesticides and You* article offers background: "In 1996, EPA was required for the first time to consider cumulative pesticide exposures in limited circumstances under the *Food Quality Protection Act* (FQPA). [That Act], which amends the *Federal Insecticide, Fungicide and Rodenticide Act* and the *Federal Food, Drug, and Cosmetic Act*, recognizes that real-world pesticide exposures do not occur as single discrete exposures to a specific pesticide, but rather in combination [with] several pesticides at once.... To address the issue of multiple pesticide exposures, FQPA directs EPA to consider combinations of pesticides that have a common mechanism of toxicity when setting tolerances" ["acceptable" levels of pesticide residue in agricultural products]. Because this statutory mandate is a narrow one, confined to compounds that have a "common mechanism of toxicity," many chemicals are never evaluated by EPA for their synergistic potential.

Thus, EPA continues not to evaluate comprehensively for synergistic effects, which can be more toxic than exposure to a single compound. In 2016, the Center for Biological Diversity wrote a report on this: *Toxic Concoctions: How the EPA Ignores the Dangers of Pesticide Cocktails*. Adding to the concern about fludioxonil's mechanism of action and the implications for all organisms, including humans, is its synergistic potential. A 2012 study by French researchers found that a mixture of fludioxonil and cyprodinil, another fungicide, yields data suggesting cytotoxic (lethal to cells) and genotoxic (damaging to DNA) effects at low concentrations, and with a significantly higher effect of the mixture than would be expected from an exposure response to the individual fungicides. This study by Dr. Brandhorst, et al. adds to the growing body of research on the interactive effects of pesticides on human health and the environment.

RESPONSE: TAKING A PRECAUTIONARY APPROACH

Beyond Pesticides advocates for a far more precautionary approach to pest management in land management and agriculture, with a transition to organic methods as the ultimate goal. In 1998, a gathering of scientists, philosophers, lawyers, and environmental activists produced this statement on the Precautionary Principle (known as the Wingspread Statement):

> When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof. The process of applying the precautionary principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action.*



Human neural system network.

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* Wingspread statement.1998. *https://www.sehn.org/sehn/wingspread-conference-on-the-precautionary-principle*.

ANALYSIS AND COMMENTARY

Supporting Life in the Soil—The Foundation of an Organic System

Hydroponic production defies the foundational organic principle of "feed the soil, not the plant"

ERIC SIDEMAN, PHD, JAY FELDMAN, AND TERRY SHISTAR, PHD

The organic industry is at a crossroads. After experiencing 20 years of exponential growth under a rigorous law, the *Organic Foods Production Act* (OFPA) *of 1990*, the oversight by a stakeholder board, the National Organic Standards Board (NOSB), and a transparent public engagement process, elements of organic standards are eroding in ways that tarnish the values, principles, and standards of organic. The decision to allow organic labeling of hydroponic food production by the National Organic Program (NOP) at the U.S. Department of Agriculture, which the NOSB failed to repudiate, is a turning point because it defies the principles of organic production embedded in the history of organic and the law.

Hydroponics may have value, but its soil-less medium and dependence on a soluble synthetic food source defy organic principles. At the same time, the intent of Congress is defied by the erosion of the NOSB process of sunsetting—or automatically removing on a five-year cycle— synthetic materials on the *National List of Allowed and Prohibited Substances,* unless reinstated after a rigorous reassessment. This happens as the industry and its major trade group, the Organic Trade Association, is unable or unwilling to stop this trend, which many of its members view as great for the growth of the industry. Advocates, like Beyond Pesticides, and its project OrganicEye, and some in the industry see the hydroponic and sunset decisions as undermining organic integrity and long-term growth. The battle lines between adherence to organic standards and an eroding of those standards have become increasingly clear over the last decade.

The question is whether consumers, environmentalists, farmers, and industry allies will be able to protect the organic label and the law. What is at stake in this battle is not just the label and the law, but a form of agriculture and food production that confronts the major public health and environmental threats to life—climate crisis and biodiversity decline and the insect apocalypse— through the elimination of petroleum-based synthetic chemicals and the sequestration of carbon in land management. A massive and urgent transition is needed to truly organic practices if we have a chance at a livable future. This transformation requires consumer support of organic and a belief in its integrity in the marketplace, which includes paying a higher price at grocery checkout to save the future. It should be noted that the cost of chemical-intensive agriculture with the impact of pollution cleanup, industrial chemical plant accidents, lower IQ in children exposed to pesticides, and more is all borne by consumers (taxpayers).

What follows is an explanation of one of the many ways the present NOP policy regarding hydroponic and some other container crop production systems has, since the adoption of the final organic rule in 2000, strayed from the foundational principles of organic farming.

BACKGROUND

"Feed the Soil, Not the Plant" is the mantra of organic farming. The early definitions of organic farming reflect this. For example, the definition and subsequent discussion of organic farming in Rodale's *Encyclopedia of Organic Gardening* says that "organic gardening is a system where fertile soil is maintained by applying nature's own law of replenishing it. . ." The long discussion of organic farming, organic matter and organic methods here, and in all the other masterful publications about organic farming of the mid-twentieth century, go into detail about how the system is centered on providing food for the microorganisms and all the other critters in the soil. It is their decomposition of this food (organic matter) that provides the mineral nutrients that plants need to grow.

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ORGANIC REGULATIONS

Organic regulations began in the 1970s by private, usually nonprofit, organizations. The 2000 federal organic rule and these early production guidelines for organic farming are similar in requiring the feeding of the soil instead of feeding the plant. The heart of the early guidelines was that slow release sources of minerals and organic matter must be added to the soil through crop rotation with green manures (nitrogen fixing cover crops or intercropping), livestock manures, compost, etc.

SOIL BUILDING STANDARDS IN THE ORGANIC FOODS PRODUCTION ACT (OFPA)

Hydroponic and growing in containers are inconsistent with the following:

- OFPA §6513(b) An organic plan shall contain provisions designed to foster soil fertility, primarily through the management of the organic content of the soil through proper tillage, crop rotation, and manuring.

- §6517 (b) Content of list. The list established under subsection (a) shall contain an itemization, by specific use or application, of each synthetic substance permitted under subsection (c)(1) or each natural substance prohibited under subsection (c)(2).

- §6517(c)(1) Exemption for prohibited substances in organic production and handling operations. The National List may provide for the use of substances in an organic farming or handling operation that are otherwise prohibited under this chapter only if—
  - (A) the Secretary determines, in consultation with the Secretary of Health and Human Services and the Administrator of the Environmental Protection Agency, that the use of such substances—
    - (i) would not be harmful to human health or the environment;
    - (ii) is necessary to the production or handling of the agricultural product because of the unavailability of wholly natural substitute products; and
    - (iii) is consistent with organic farming and handling;

NOP followed OFPA and the original certifiers insistence on soil management in the Final Rule. Sections 205.203 (a), (b) and (c) say that the producer "must . . . maintain or improve the physical, chemical, and biological condition of soil," "must manage crop nutrients and soil fertility through rotations, cover crops and application of plant and animal materials," and "must manage plant and animal materials to maintain or improve soil organic matter. . ."

SUBSTANCES OF HIGH SOLUBILITY ARE ALLOWED, BUT REGULATED

Substances of high solubility, i.e., those materials that provide nutrients directly to the plant because they are quickly taken up into the plant with the soil solution, have always been allowed. However, these materials are counter to foundational organic principles, so they have always been strictly regulated. The early certification agencies allowed them, but limited their use. OFPA leaves a place for them, but requires that soil management be the heart of organic production. The final rule allows them, BUT limits their use to essentially rescue treatments of a soil that otherwise is managed by methods consistent with organic principles. NOP put such materials into 205.602—Nonsynthetic substances prohibited for use in Organic Crop Production: 1) Calcium chloride is limited to treating a physiological disorder; 2) Potassium chloride must be used in a manner that minimizes chloride accumulation in the soil; 3) Sodium nitrate is restricted to no more than 20% of the crop's total nitrogen requirement. [The NOSB recommended prohibiting sodium nitrate in 2011.]

NOP FINAL RULE REGULATES HIGH SOLUBILITY SUBSTANCES

The preamble to the final rule says, "Based on the recommendation of the NOSB, the final rule would prohibit use of these [high solubility] materials, unless the NOSB developed recommendations on conditions for their use and the Secretary added them to the National List." At the time, the discussion focused on mined substances of high solubility, because concentrated, highly soluble plant nutrient materials other than mined sources were not available. The new materials of high solubility that are now used (especially in hydroponic and some other types of container production) require regulation that ensures that the foundational principle of organic production is upheld—feed the soil, not the plant.

CONCLUSION

Advocates of organic, integral to the history and focus on supporting soil biology and biodiversity, are seeking to ensure adherence to the values, principles, and practices that grew the sector to exponential growth and will support its continued expansion. To sustain life, the future urgently requires a transformation of mainstream chemical-intensive agriculture to organic, with consumers, environmentalists, farmers, and industry allies joining together to effect the changes necessary.

— Eric Sideman, PhD, is crop specialist emeritus, Maine Organic Gardeners and Farmers Association (MOFGA); Jay Feldman, executive director, Beyond Pesticides; and, Terry Shistar, PhD, ecologist, science consultant, board member, Beyond Pesticides.

COST COMPARISON

Organic vs Chemical Land Management

SYMPTOM
Dandelions

CAUSE
Compacted Soil
Low pH
Nutrient Imbalance

An organic approach corrects nutrient and pH per a soil test and focuses on soil aeration.

A chemical approach focuses on killing the weed. However, this is only a short-term solution.

Unless the reason why dandelions are in the turf is addressed, chemical land managers will more likely than not be back next season to spray again.

The organic approach saves money on material inputs like pesticides, by providing long-term solutions.

DIFFERENTIATING TWO APPROACHES

While chemical land management focuses on treating symptoms, the organic approach is a preventive approach that addresses root causes. In this context, unwanted organisms (pests, including insects and weeds) are the symptoms of a problem caused by poor soil health.

Organic land management emphasizes managing weeds and insects through the building of soil conditions and employing cultural practices, such as aeration, overseeding, dethatching, and proper mowing and watering. Nutrients are cycled naturally and, if determined to be necessary by a soil test, soil amendments are used to feed biological life in the soil, which in turn feeds the plant.

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With the **chemical approach**, focus is placed on using synthetic, petrochemical pesticides and fertilizers that adversely affect life in the soil. These chemicals are typically applied based on a calendar date, or by a "see and spray" approach to weed and insect management. Soil tests and cultural practices are not prioritized.

CHEMICAL-INTENSIVE	ORGANIC
• Treats **symptoms**; "see and spray," ignore underlying conditions that contribute to pest issue. • Pesticides and fertilizers are fossil fuel-based **synthetics** that are harmful to to soil biology and biodiversity. • Does **not** often focus on cultural practices.	• Addresses **root causes**; focus on **soil health** through testing and analysis. • Uses **naturally derived** fertilizers and pesticides with a systems-based approach, nurturing soil biology and biodiversity. • Prioritizes **cultural practices** for turf management, such as aeration, overseeding, dethatching, and proper watering.

ORGANIC SAVES OVER TIME

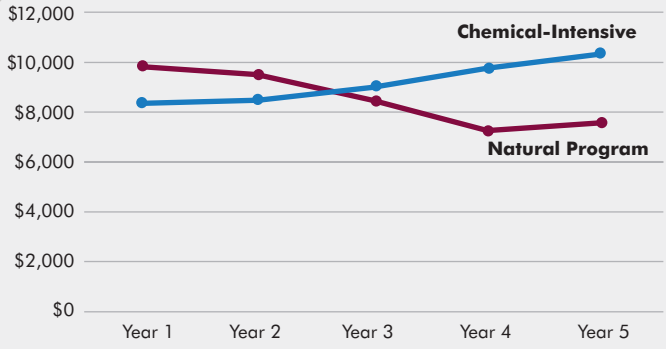
Healthy soil reduces the need for expensive outside inputs

COST COMPARISONS

A report from the non-profit Grassroots Environmental Education and organic turf expert Chip Osborne, with Osborne Organics, concludes that, once established, ***an organic turf management approach results in savings greater than 25% over chemical management***.[1] While initial expenditures over the first two years may be slightly higher, ***costs decrease as soil biology improves***. Healthy soil reduces the need for expensive outside inputs.

Harvard University's experience with the organic approach on its campus found similar results. There were initial costs required to train staff, purchase equipment, and improve soil health, but at ***maturity costs are now expected to stay the same as its previous chemical-based program***.[2]

Connecticut's Department of Energy and Environmental Protection (encourages residents to maintain landscapes with organic practices. They note, "If your lawn is currently chemically dependent, initially it may be more expensive to restore it. ***But in the long-term, an organic lawn will actually cost less money. Once established, an organic lawn uses less water and fertilizers, and requires less labor for mowing and maintenance***."[3]



The cost to manage a football field using natural programs is less expensive than chemical-intensive programs over time.

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ORGANIC TRENDS ARE EMERGING NATIONWIDE

In 2019, the City of South Miami completed a two-year pilot program that required city staff and contractors to follow practices intended to eliminate toxic pesticide use, and limited inputs only to organic-certified products. A city memorandum codifying these practices into law describes the success of this approach regarding cost. It reads, "Thus-far, this initiative has been a qualified success, allowing the city to cut down on its waste-footprint significantly at relatively little expense, and providing a model for other local government to use as guidance."[4]

Healthy soil has a rich diversity of microbial life. Feed the soil, not the plant for long-lasting, resilient ecosystems!

[1] Osborne, Charles and Wood, Doug. 2010. A cost comparison of Conventional (Chemical) Turf Management and Natural (Organic) Turf Management for School Athletic Fields. *http://www.grassrootsinfo.org/pdf/turfcomparisonreport.pdf.*

[2] Harvard Facilities Operations Maintenance. 2009. Harvard Yard Soils Restoration Project—Summary Report. See slide 26. *http://www.treewiseorganics.com/HarvardYardProject2-25-09.pdf.*

[3] Connecticut Department of Energy and Environmental Protection. 2019. Organic Lawn Care: Your neighbors will "go green" with envy! *https://www.ct.gov/deep/cwp/view.asp?a=2708&q=382644#Expensive.*

[4] Alexander, Steven: City Manager. 2019. City of South Miami Inter-Office Memorandum. *https://beyondpesticides.org/assets/media/documents/SouthMiami_FL_Organicordinance.pdf.*

CONSIDERING EXTERNALITIES

There are costs from the chemical approach not captured by the shelf price of a pesticide bottle or bag of synthetic fertilizer. While chemical manufacturers profit, the public pays a steep price through increased health care expenditures and the need to clean up environmental contamination.

A 2016 literature review determined **the health costs from pesticide use in the U.S. to be $15 billion annually**. The most significant cost is death due to chronic pesticide exposure, such as fatal outcomes after contracting cancer.[5] The authors indicate that **environmental costs of pesticide use total roughly $8 billion**, but that is likely an underestimate due to the difficulty in pricing ecosystem services (economic value of nature, such as pollination and nutrient cycling) and obtaining accurate data on wildlife mortality.[6]

A study from Seattle Public Utilities determined that, by moving toward natural and organic practices, some of these external costs can be recouped. Households switching from synthetic to natural practices generate roughly $75 in ongoing public health, ecological, water conservation, and hazardous waste management benefits each year.[7] Cost savings came primarily from reducing the use of chemical pesticides and fertilizers and the need for irrigation.[8]

CONCLUSION: ORGANIC IS WORTH IT

Cost concerns of switching from chemical to organic land management should be considered negligible over the long-term. There may be some initial upfront costs for staff training, or the purchase of new material or equipment, but these costs decline significantly as focus shifts to root causes and soil health improves. The transition to organic also captures additional external health and environmental costs that are currently borne by the public at-large.

Organic land management represents an economically viable approach for individual homeowners, landscapers, local parks departments, and school districts willing to commit to the change in practices organic land management entails.

[5] Bourguet, Denis and Guillemaud, Thomas. 2016. The Hidden and External Costs of Pesticide Use. *Sustainable Agriculture Reviews*. Vol 19, pp 35-120. *https://link.springer.com/chapter/10.1007/978-3-319-26777-7_2*.
[6] Ibid.
[7] Morris, Jeffery and Bagby, Jennifer. 2008. Measuring environmental value for Natural Lawn and Garden Care practices. *The International Journal of Lifecycle Assessment*. Vol 13, Issue 3, pp226–234. *https://link.springer.com/article/10.1065/lca2007.07.350*.
[8] Ibid.

INDAZIFLAM (Alion,™ Specticle™ and Esplanade™)

BEWARE: IS THIS THE ROUNDUP WEED KILLER ALTERNATIVE?

EDITOR'S NOTE. *This factsheet is based on a review of U.S. Environmental Protection Agency (EPA) reports, New York State Department of Environmental Conservation reviews, and the Australian Pesticides and Veterinary Medicines Authority assessment.*

SUMMARY

Indaziflam (N-[(1R,2S)-2,3-dihydro-2,6-dimethyl-1H-inden-1-yl]-6-[(1RS)-1fluoroethyl]-1,3,5-triazine-2,4-diamine) is a pre-emergent and post-emergent weed killer with a broad spectrum of action against annual grasses and broadleaf plants. It was originally registered by Bayer CropScience in 2010 under a conditional registration for residential areas. Since then, its uses have been expanded to citrus, tree nuts, grapes, sugarcane, and more. This review identifies inadequacies in study design, species tested for reproductive toxicity, and endocrine disruption. EPA issued an emergency exemption to expand uses in 2018 through 2020 on forage and grass, fodder, and hay grown on rangeland and pastures. Despite its high cost and the lack of data to evaluate it, some look at indaziflam as a potential alternative to glyphosate (Roundup).[1]

Indaziflam's primary mode of action is inhibition of seedling emergence and root development, by inhibiting cellulose biosynthesis (CB Inhibitor). Originally not registered for food production, uses now include woody trees, shrubs, and vining fruits and nuts.

In mammals, the nervous system is the major target for toxicity, and adverse effects observed on the thyroid in rat studies indicate a potential for endocrine disruption. Indaziflam shows no evidence of carcinogenicity, according to EPA.

As an herbicide, indaziflam is extremely toxic to aquatic and terrestrial plants. Adverse impacts to nontarget plants are expected from all of the labeled uses. Data for indaziflam are inadequate to fully assess chronic toxicity to fish, chronic toxicity to estuarine/marine invertebrates, and endocrine disruption in fish and birds. Without data or sufficient evidence to demonstrate otherwise, an unacceptable risk to fish, aquatic invertebrates, and birds is presumed.

ChemicalWATCH Summary Stats

Chemical Name: Indaziflam; N-[(1R,2S)-2,3-dihydro-2,6-dimethyl-1H-inden-1-yl]-6-[(1RS)-1fluoroethyl]-1,3,5-triazine-2,4-diamine

CAS Registry Number: 950782-86-2

Trade Names: Alion™, Specticle™ and Esplanade™

Toxicity Rating: Toxic.

Signal Words: Caution, Warning.

Health Effects: Neurotoxicity, adverse effects on thyroid at low doses. Higher doses affect sexual organs and reproduction.

Environmental Effects: Highly toxic to aquatic and terrestrial plants.

GENERAL

Indaziflam is a fluoroalkyltriazine herbicide, part of the broader triazine herbicide family. It differs from other triazine herbicides in having a fluoroethyl group in place of a chloride in the chlorotriazines (e.g., atrazine).

Indaziflam is registered for application to residential and commercial areas (lawns, ornamentals, and hardscapes including patios, walkways, etc.), turf (parks, cemeteries, golf courses, sod farms, sports fields, and commercial lawns), field-grown ornamentals, and Christmas trees, commercial nursery and landscape plantings, and forestry sites. Food use sites include woody trees, shrubs, vine fruits, and nuts.

Indaziflam products include, in addition to products containing concentrations of indaziflam alone, products that also contain diquat dibromide, isopropylamine salt of glyphosate, synthetic amorphous silica, for homeowner use to control annual grasses and broadleaf weeds. There are indaziflam formulations with the herbicides 2,4-D, dicamba, mecoprop, and penoxsulam.

[1] D. Chiotti, L. Ritter, D. Schlenk, C. Wilen, and K. Schiff, 2020. Alternatives to Glyphosate for Vegetation Management in Los Angeles County: A technical report. Southern California Coastal Research Project. SCCWRP Technical Report #1103. *http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/1103_GlyphosateAlternativesPanel.pdf*.

HUMAN HEALTH RISK

The nervous system is the major target for toxicity in mammals. Evidence of neurotoxicity (e.g., decreased motor activity, clinical signs, and neuropathology) was observed in rats and dogs, in acute, subchronic, and chronic toxicity studies.

Organs affected by indaziflam in mice and rats include the kidney, liver, thyroid, stomach, seminal vesicles, and ovaries. Adverse effects on the thyroid indicating potential endocrine disruption include increased thyroid stimulating hormone (TSH) and thyroid histopathology. Chronic exposures also led to atrophied small seminal vesicles (produce semen) in male rats and glandular erosion/necrosis in the stomach and blood-filled ovarian cysts/follicles in female mice.

Developmental toxicity is evidenced by decreased fetal weight with decreased maternal body weight gain and food consumption. Decreased pup weight and delays in sexual maturation were observed in offspring in the rat two-generation reproductive toxicity study, along with clinical signs of toxicity, at a dose causing parental toxicity.

Indaziflam shows no evidence of carcinogenicity in the two-year dietary rat and mouse bioassays. All genotoxicity studies that were conducted on indaziflam were negative. Testing in acute lethality studies with indaziflam resulted in low toxicity via the oral (Category III), dermal (Category III), and inhalation (Category IV) routes of exposure. Indaziflam was not an irritant to eyes (Toxicity Category IV) or skin (Toxicity Category IV), and was not a skin sensitizer.

Despite the evidence of endocrine disruption, EPA reduced the required additional margin of safety from 10X safety factor to 1X.

ENVIRONMENTAL FATE

Indaziflam and its principal degradate, fluoroethyldiaminotraizine (FDAT), have a potential to leach to groundwater. Indaziflam is expected to be moderately mobile to mobile in soil, moderately persistent to persistent in aerobic soil, persistent in anerobic soil, and persistent in aerobic and anaerobic aquatic environments. Indaziflam is subject to aqueous photolysis in clear shallow waters. Indaziflam is not volatile and therefore it is not likely to be transported via atmospheric processes. Indaziflam degradates are more mobile than the parent, and were detected in field studies at the deepest depths sampled —particularly the degradate FDAT, which is mobile to highly mobile.

EFFECTS ON NONTARGET PLANTS AND ANIMALS

Aquatic Organisms

Indaziflam is categorized as highly toxic to freshwater and estuarine/marine fish, moderately toxic to highly toxic to estuarine invertebrates, and slightly toxic to moderately toxic to freshwater invertebrates on an acute exposure basis. Subchronic toxicity studies are only available for freshwater fish and invertebrates using the species *P. promelas* and *D. magna*, respectively. The one chronic freshwater fish toxicity endpoint used in this assessment was based on fry (young fish), survival, total length, and dry weight, with sublethal effects immediately preceding mortality at the highest concentrations tested. Of the parameters assessed in the one submitted invertebrate life cycle study, indaziflam inhibits both parental (F0) growth and reproduction. Effects to offspring (F1) were not evaluated.

Results of aquatic plant toxicity studies of technical grade indaziflam indicate that this pesticide is extremely toxic to aquatic plants. Risk Quotients (RQs) for all vascular aquatic plants exceed the agency's aquatic plant risk Level of Concern (LOC) by up to two orders of magnitude. Risks to aquatic plants are expected across all of the proposed uses evaluated.

In addition, degradate toxicity data on aquatic vascular and nonvascular plants indicate that indaziflam-olefin and indaziflam-hydroxyethyl are of equal or similar toxicity to the parent indaziflam. Indaziflam-hydroxyethyl, FDAT, and triazine indanone demonstrate toxicity to these same taxa at magnitudes 2–7 times less than the parent.

Terrestrial Organisms

Indaziflam is categorized practically nontoxic to birds and mammals on an acute oral basis and (and to birds on a subacute dietary exposure basis). Reproductive toxicity has been observed in mammals. Parental effects include tremors in females, decreased body weights and body weight gains, decreased food consumption, and effects on kidneys in males. Offspring effects include decreased body weights, body weight gains, and secondary delays in sexual maturation. Evidence of reproductive toxicity includes delayed sexual maturation. Results of available toxicity studies on terrestrial invertebrates indicate that indaziflam in short-term exposures is practically nontoxic to honey bees and earthworms, but toxic to earthworms in extended exposures. Seedling emergence and vegetative vigor in terrestrial plants are affected by indaziflam at application rates much lower than the registered uses.

Thus, evidence indicates that adverse effects can be expected to nontarget terrestrial plants and birds. A screening level assessment does not predict direct risk to mammals. Direct adverse effects on terrestrial invertebrates are uncertain.

UNCERTAINTIES AND DATA GAPS

EPA used the fathead minnow early-life stage test results to characterize chronic toxicity for fish. This is inappropriate because EPA estimated the risk to be based on a chronic no effect value higher than the acute lethality value, indicating that the fathead minnow used for the acute study is less sensitive than other fish species. In addition, the study did not address reproduction endpoints, and actual measured concentrations in the aquatic tests were improperly determined. EPA should require that these tests be repeated.

Endocrine disrupting (thyroid and reproductive) effects observed in rat studies warrant Tier II Endocrine Disruptor Screening Program tests, which have not been conducted.

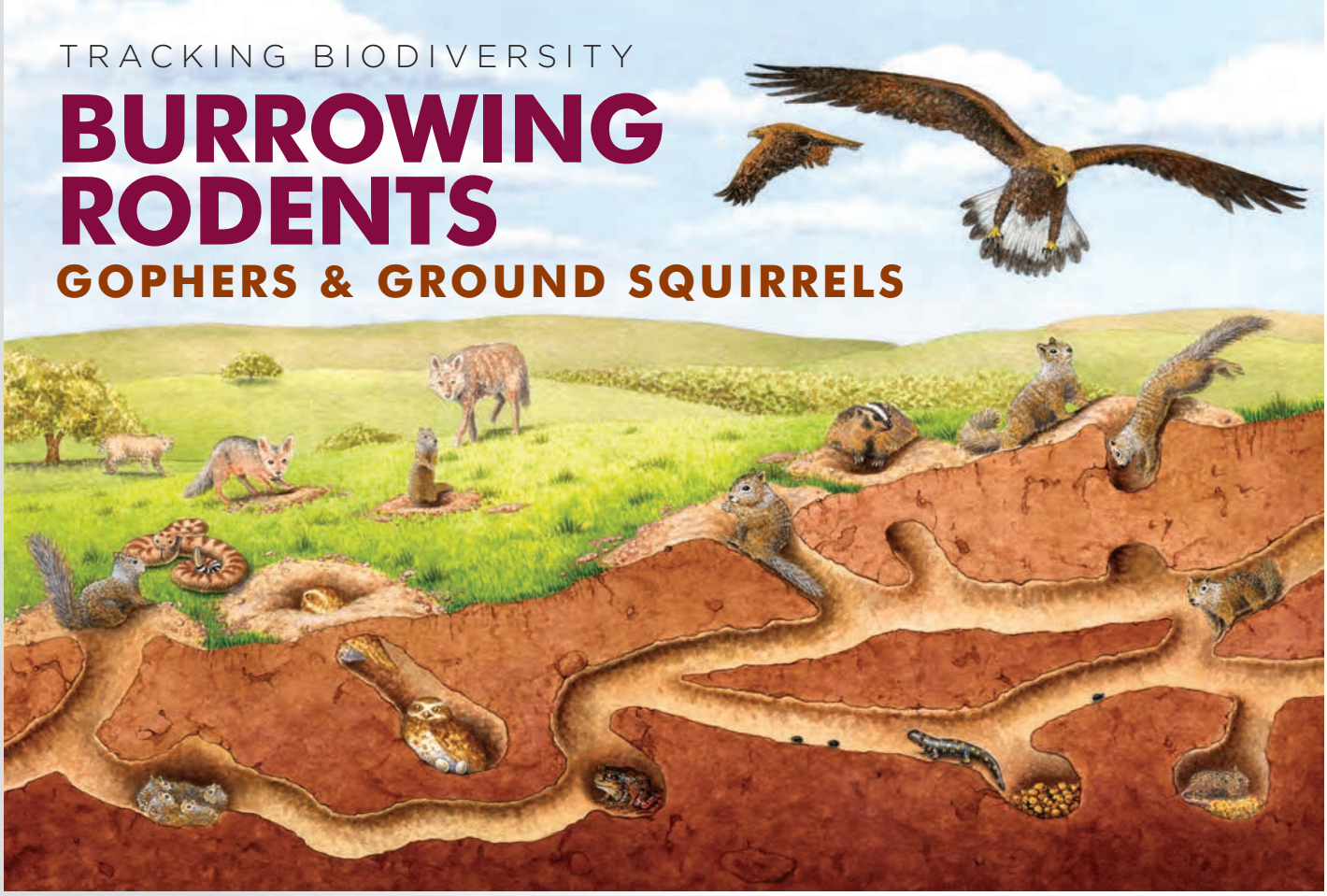
CONCLUSION

The statutory standard requiring sufficient data to demonstrate indazifam will not pose any unreasonable adverse effects on the environment has not been met, so all registrations should be suspended until these data are available and fully assessed to confirm otherwise.

TRACKING BIODIVERSITY

BURROWING RODENTS

GOPHERS & GROUND SQUIRRELS



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TERRY SHISTAR, PHD

Gophers and ground squirrels are an important part of the ecosystem in which they live, although they are viewed as a nuisance because of the underground burrows, tunnels, and mounds that they create for their habitat. Gophers and ground squirrels have some similarities, but the biggest difference is that ground squirrels live in colonies, while gophers are usually solitary. Key to the role they play in supporting the ecosystem in which they live is the fact that both gophers and ground squirrels share their burrows with other animals.

Gophers are called "pocket gophers" because of the external fur-lined cheek pouches, extending to their shoulders, in which they carry food and nesting materials. Gophers are rarely seen above ground, and their burrow systems may cover an area of 200 to 2,000 square feet, with shallow tunnels for feeding, and deeper tunnels for food storage and nesting. Gophers do not hibernate. They are nocturnal herbivores who eat roots from their underground tunnels and foliage grabbed from around a hole.

Gophers push earth to the surface as they dig burrows. The mounds thus formed may be distinguished from molehills by their shape—in the form of a crescent or horseshoe, as opposed to the mole's volcano-shaped mound. The shallow tunnels of moles tend to create a ridge of soil on the surface, while gopher tunnels are deeper and do not show up on the surface.

Ground squirrels range in size from chipmunks, who weigh a few ounces, to prairie dogs weighing 1–3 pounds, to groundhogs (also known as woodchucks), averaging around 8 pounds. They are known for sitting upright as they look for danger. Ground squirrels of all sorts live communally in burrows underground. Most ground squirrels are mainly herbivorous, consuming roots, seeds, fruits, buds, and foliage. They also eat fungi, some insects, and some have been observed eating other small animals and eggs. The herbivorous diet and burrowing behavior have earned these animals the label of "pests."

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Gophers and ground squirrels use their burrows to seek safety from predators and shelter from bad weather, hibernate, sleep, raise young, and defecate. The burrow has separate chambers devoted to different uses. However, the burrows serve other functions as well. They help to aerate the soil, capture snowmelt and rainfall that would otherwise run off and cause erosion, and fertilize the soil. They help in seedling establishment of the seeds that the rodents harvest and store, and in distributing mycorrhizal fungi. Even more importantly, the burrows are home to many other animals, some of whom are predators of rodents.

Furthermore, these rodents and their burrows form the basis of large ecosystems. Many other animals, including some endangered species, depend on the burrows of gophers and ground squirrels. The following describes the importance of ground squirrels in California:

"Belowground, the burrows are sheltered and cool no matter the weather above. This comfortable climate draws a diverse cast of grassland animals—mice, voles, tarantulas, and several species of beetles that live exclusively in rodent tunnels. Then there are the local amphibians. Ground squirrels actually make it possible for moisture-loving amphibians to live in the hot, dry hills of the Diablo Range. As the weather warms and ponds dry up, California red-legged frogs, western toads, ensatina salamanders, and California tiger salamanders retreat to the cool refuge of squirrel burrows—often while the squirrels are still living inside. The frogs and toads come and go, but the taxicab-tinted tiger salamanders move in for the long haul: they stay underground for up to ten months each year, emerging only in winter to breed. With this crowd, squirrel burrows are almost mini-ecosystems of their own. Worms and beetles crawling out of the walls may get eaten by the amphibians, while mice and voles go after the squirrels' caches of nuts and seeds. Larger creatures—burrowing owls, coyotes, and San Joaquin kit foxes—often enlarge abandoned burrows and convert them into dens. But ground squirrels do even more for grassland ecosystems than spread seeds and build shelters. Plentiful and prolific, they are a dinnertime mainstay for most of California's savanna predators. Local badger populations depend almost entirely on ground squirrel colonies, says retired district naturalist Ron Russo. And studies of golden eagles in the park district show that ground squirrels may comprise up to 70 percent of their diets when the birds are rearing their young. DiDonato says the sheer abundance of ground around San Antonio Reservoir and Sunol Regional Wilderness supports the densest population of nesting golden eagles anywhere in the world. And back when grizzly bears prowled California, they dug out entire colonies for a snack."[1]

Similarly, prairie dogs appear to be a keystone species, since other organisms in the food chain are so dependent on them:

"Interestingly enough, the survival of many other species seems to hinge on the survival of the prairie dog. About 90% of the [black footed] ferret's diet consists of prairie dogs. In addition, the golden eagle, ferruginous hawk, and swift fox diets include a large percentage of prairie dogs. According to Nicole Rosmarino/Southern Plains Land Trust, the mountain plover appears to be a prairie dog obligate or, at the very least, is highly dependent on prairie dogs for survival, using the borrows for breeding, nesting, and feeding. Burrowing owls, prairie falcons, badgers and a host of other prairie animals are associated with prairie dog colonies. In fact, some ecologists consider the prairie dog to be a keystone species of the prairie. According to Miller et al., nearly 170 species rely on prairie dog colonies to some extent for their very survival. Miller further concludes that the prairie dog fits the definition of a keystone species because prairie dogs affect the ecosystem structure, function, and composition in a way that is not duplicated by other species."[2]

A number of the inhabitants of rodent burrows are threatened or endangered species, including black-footed ferret, California red-legged frog, California tiger salamander, Northern Idaho ground squirrel, and Utah prairie dog.

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BOX 1

Managing Land with Burrowing Rodents

With an understanding of the ecosystem benefits of ground burrowing rodents, the goal of landscapers seeking to protect the playability of a sports field or the mowability and aesthetic impact on a grass yard or flower and vegetable garden is to create a deterrent for these animals to settle in the middle of your property. If you are in a position to let nature take its course, the ecosystem will find an equilibrium with natural predators reducing the population. Owls like to eat rodents and, over time, act as effective pest managers of rodents.

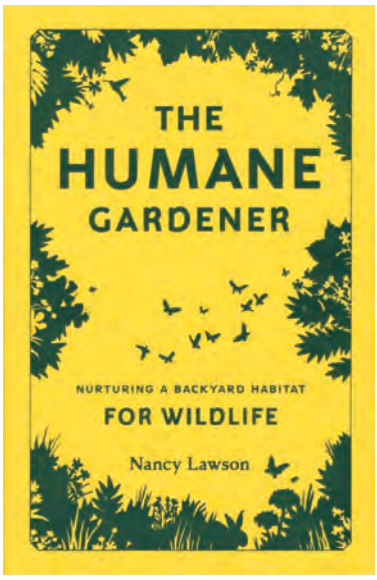
However, with the pressure to maintain a field or a garden, the key to a successful program that respects burrowing rodents' role in the ecosystem, while discouraging them from choosing your site, is to reduce the animal's food source and shelter, encouraging them to find another place to inhabit. Small mesh heavy gauge wire fencing, with two feet buried in the ground and three feet aboveground can exclude prairie dogs. Trenches may serve as barriers to other burrowing rodents. Plants that are cited as repelling gophers and ground squirrels include gopher purge (*Euphorbia lathyrus*), castor bean (*Ricinus communis*), and garlic. In extreme cases, unwanted burrowing animals can be effectively managed in both agricultural and residential settings through use of traps, barriers, natural predation, and other physical methods. Predators include gopher snakes, corn snakes, rat snakes, owls, hawks, great blue herons, weasels, bobcats, coyotes, and domestic dogs and cats.[3]

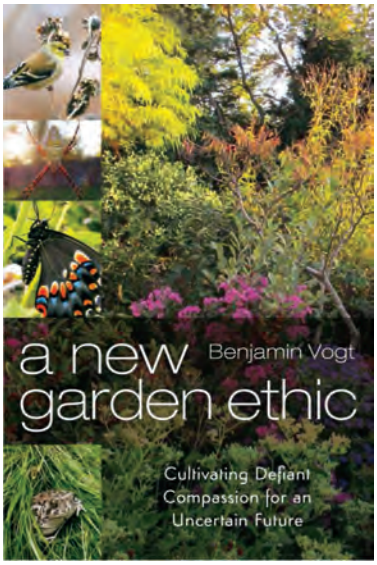
Understanding the role that organisms play in the broader ecosystems provides the basis for seeking to avoid the use of poisons that have indiscriminate effects among numerous organisms and creates an imbalance that escalates pest problems. In the case of gophers and ground squirrels, finding a way to tolerate these rodents by separating them from susceptible plantings will help conserve other species that depend on them and their burrows.

[1] Lord of the Burrows: *The Incredible Edible Ground Squirrel*, *http://baynature.org/articles/jan-mar-2008/lord-of-the-burrows*.
[2] *http://environmentalchemistry.com/yogi/environmental/200706prairiedogreconciliation.html*.
[3] Pesticide Research Institute, 2014. *Technical Evaluation Report for Exhaust Gas*. *https://www.ams.usda.gov/sites/default/files/media/Carbon%20Monoxide%20TR.pdf*.

Reviewed by Terry Shistar, PhD

Gardening for Biodiversity





Just as gardeners enjoy reading books about gardening during the winter, and birders enjoy reading about birds, I like books with ideas for increasing biodiversity—ideas that do not require a lot of money or big machinery to implement. So, I went looking for new books. I came up with three.

Attracting Birds, Butterflies, and Other Backyard Wildlife, by David Mizejewski of the National Wildlife Federation, is a well-organized presentation of the topic—beginning with an assessment of your land and its current plants, followed by chapters on meeting the critical needs for wildlife. Chapters deal with food, water, cover, nesting places, and sustainable gardening practices. Beautiful color photographs grace every page. There are lists of species to encourage and instructions for making bird baths, feeders, nesting boxes, and more. Of the three books covered here, this one offers the most practical guidance.

The Humane Gardener, by Nancy Lawson, covers much of the same ground as *Attracting Wildlife*, and is also illustrated with many color photographs. It offers illustrated stories about particular wildlife gardens. Ms. Lawson also emphasizes ways to keep wildlife safe from pesticides, machinery, and other hazards. As implied by its title, the book deals at length with wildlife seen as "pests"—suggesting not only humane ways to deal with them, but also a frame of reference recalling who was here first, who encroached on whose home, and who is endangering whom. This context implies a more cooperative relationship between humans and non-humans.

A New Garden Ethic, by Benjamin Vogt, PhD, differs from the previous books in lacking color photographs and focusing on the philosophy of gardening, rather than specific practices. As the title indicates, the author seeks an ethical foundation for today's gardens.

When I chose the books for this review, I tried to avoid those with a strictly nativist philosophy. The belief that all of the plants in our environment should be those that are native to the place has resulted not only in practical and philosophical conundrums, but has also led to ill-advised herbicidal campaigns to eradicate so-called "invasive species." Peter Del Tredici, PhD, a botanist, author, and former senior research scientist at Harvard University's Arnold Arboretum, gives cogent reasons that non-native plants are often good elements of urban environments in his book *Wild Urban Plants of the Northeast*, reviewed in the Spring 2019 issue of *Pesticides and You*.

However, the three books covered in this review all do have a strong bias toward growing native plants in gardens designed to support wildlife. Notwithstanding Dr. Del Tredici's approach to urban plants, there are convincing reasons to emphasize natives while gardening to support native wildlife. The reasons are practical and biological—native wildlife has evolved with native plants—as well as ethical. *A New Garden Ethic* discusses the ethical reasoning at length. As Dr. Vogt says, "The whole world is now a garden—a space altered by human influence." In this context, the native plant garden can be seen as a necessary part of preserving biodiversity.

Attracting Birds, Butterflies, and Other Backyard Wildlife. *Expanded Second Edition by David Mizejewski. Creative Homeowner, 2019. 176 pages.*

The Humane Gardener: Nurturing a Backyard Habitat for Wildlife. *Princeton Architectural Press, 2017. 224 pages.*

A New Garden Ethic: Cultivating Defiant Compassion for an Uncertain Future. *New Society Publishers, 2017. 192 pages.*

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