THREATENED BIODIVERSITY and ECOSYSTEMS

BEES/POLLINATORS | JULY 27, 2023

Insufficient Scientific Evidence on Mitigation Measures To Protect Pollinators from Pesticides, Study Finds

A study published in the *Journal of Economic Entomology* calls into question the scientific literature on measures established to protect bees from pesticides. The study analyzes actions taken by pesticide users to reduce the risk of pesticides on non-target organisms, known as "mitigation measures." Ultimately, the study finds that there is insufficient evidence to support the effectiveness of bee-protecting mitigation measures.

"Almost all research was centered around protecting honey bees. However, honey bees are a managed species that is not endangered," Edward Straw, PhD, a postdoctoral researcher in the School of Agriculture and Food Science at University College Dublin in Ireland and lead author on the study, says, "When we try to protect bees, we really want to be protecting wild, unmanaged bee species, as these are the species which are in decline."

The study includes a chart of mitigation methods that have been tested in the scientific literature. The mitigation measures under evaluation include: restricting pesticide application to certain times of day, restricting the application of pesticides during weather events, removing flowering weeds that attract pollinators, applying repellents to deter pollinators, and more. The researchers find that there are few empirical tests on the most widely used mitigation measures, and they conclude that more and stronger scientific evidence is required to justify existing mitigation measures to help reduce the impacts of pesticides on bees while maintaining crop protection.

With bees playing a crucial role in pollinating crops, it is important to ensure that they are adequately protected from the harmful effects of pesticides. Beyond Pesticides has long advocated to protect and enhance biodiversity, prevent crop loss, as well as protect pollinator populations, human health, and wildlife.

The study also finds that only one category of mitigation measure appears to be more thoroughly covered with 12 studies—repellents, which are used to repel bees from visiting crops recently treated with pesticides. "It is an interesting idea, but it is not yet ready to be used," says Dr. Straw. "It would need to be tested on a diversity of bee and insect species, and if it is only repellent to one or two species, all the other bees would still be exposed to the pesticide."

However, the researchers caution that the number of studies alone is not

a sufficient measure of the effectiveness of a mitigation measure. The quality of the research is also important, and evidence from multiple continents and multiple species is needed to determine whether a measure works. Jay Feldman, executive director of Beyond Pesticides, says, "Even the most effective mitigation measures are not adequate to protect pollinators and human health." Beyond Pesticides has documented drift through air and the migration of pesticides into groundwater with toxic runoff.

With bees playing a crucial role in pollinating crops, it is important to ensure that they are adequately protected from the harmful effects of pesticides. Beyond Pesticides has long advocated the protection and enhancement of biodiversity, prevention of crop loss, and safety of pollinator populations, human health, and wildlife. For more information, see Beyond Pesticides' organic agriculture and Bee Protective page.

SOURCE: Edward A Straw and Dara A Stanley, *Journal of Economic Entomology*, Volume 116, Issue 5, October 2023, pages 1604–1612, https://doi.org/10.1093/jee/toad118.

BEES/POLLINATORS | JULY 8, 2023

Degradation of Color Discrimination Associated with Glyphosate Exposure Impairs Bees' Foraging Ability

A study published in *Science of the Total Environment* finds glyphosate can adversely impact sensory and cognitive processes in bumblebees (*Bombus terrestris*). Glyphosate exposure impairs bees' learning of aversive stimuli like electric shocks paired with specific color discrimination. Additionally, the pesticide reduces attraction to UV (ultraviolet) light, specifically the color blue, and temporarily impacts locomotion and phototaxis (movement in response to light). These impairments to sensory and cognitive processes render foraging difficult for these glyphosate-exposed pollinators and make them vulnerable to predators. The study highlights that symptoms of widespread chemical exposure may reduce foraging efficiency and adversely affect ecosystems, especially those dependent on insect pollinators.

Pollinator decline directly affects the environment, society, and the economy. Without pollinators, many plant species, both agricultural and nonagricultural, will decline or cease to exist as U.S. pollinator declines, particularly among native wild bees, limit crop yields. In turn, the economy will take a hit, since much of the economy (65 percent) depends upon the strength of the agricultural sector. As the science shows, pesticides are one of the most significant stressors for pollinators. In a world where habitat loss and fragmentation show no sign of abating, scientists have

concluded that the globe cannot afford to continue to subject its critically important wild insects to these combined threats. Therefore, studies like these emphasize the need to establish monitoring and conservation to protect species that provide essential ecosystem services. The study notes, "The high-throughput paradigm presented in this study can be adapted to investigate sublethal effects of other agrochemicals on bumblebees or other important pollinator species, opening up a critical new avenue for the study of anthropogenic stressors."

Glyphosate-based herbicides (GBHs) are the most common herbicides used globally. Previous studies evaluating chronic glyphosate or GBH exposure assessed the survival, development, physiology, colony thermoregulation, or gut microbiota specific to honey bees. However, few studies have tested field-realistic exposure to glyphosate on non-honey bees' (e.g., bumblebees) cognitive performance. This study investigates how long-term glyphosate exposure affects locomotion, movement in response to light, and learning in bumblebees using an automated high-throughput assay with a control UV and green or blue light.

Control bumblebees in the study prefer UV light to blue light. Yet, glyphosate-treated bumblebees' attraction to UV light decreases, with these treated bees having no preference between UV light or an alternative color. Additionally, control bees who experienced electric shocks when paired with blue wavelengths (CS+) vs. UV light always chose UV light. In contrast, glyphosate-treated bees could not differentiate between blue and UV light regardless of electric shock when in blue light. The study highlights, "Our results raise the question of whether an impairment in the detection of the sky compass could also have played a role. Furthermore, UV reflectance and UV patterns are important parameters of flower coloration, strongly influencing the foraging efficiency and flower choices of bees. To sum up, even a slight shift in UV sensitivity could have broad implications for these pollinators."

Clean air, water, and healthy soils are integral to ecosystem function, interacting between Earth's four main spheres (i.e., hydrosphere, biosphere, lithosphere, and atmosphere) to support life. However, toxic pesticide residues readily contaminate these spheres, frequently in soils, water (solid and liquid), and the surrounding air at levels exceeding U.S. Environmental Protection Agency (EPA) standards. The scientific literature demonstrates pesticides' long history of adverse environmental effects, especially on wildlife, biodiversity, and human health. Most notably, pesticides are immensely harmful to pollinators. Over the last decade and a half, increasing scientific evidence shows a clear connection between the role of pesticides in the decline of honey bees and wild pollinators (e.g., wild bees, butterflies, beetles, birds, bats, etc.).

The agricultural industry relies on insect pollinators for plant pollination and crop productivity. Globally, the production of crops dependent on pollinators is worth between $253 and $577 billion yearly. Hence, pesticide use fails to support sustainability goals, decreasing agricultural and economic productivity and social (human/animal) and environmental well-being.

Almost five decades of extensive glyphosate use has put animal, human, and environmental health at risk as the chemical's ubiquity threatens 93 percent of all U.S. endangered species. Although the direct effects of pesticides on pollinators are concerning, the indirect impacts on pollinator habitats are equally troublesome. Glyphosate use in mono-crop agriculture and genetically engineered crops can drift onto and destroy adjacent habitats. Habitat destruction results in the loss of species biodiversity and stable ecosystem processes integral to sustainability.

When looking at pesticide exposure, glyphosate represents only one class out of thousands of agrichemicals that pollinators may encounter. Pesticide use poses one of the most significant threats to bumblebees and places their entire life cycle at risk. A 2018 study found that commonly used neonicotinoid insecticides begin to kill off bumblebees during their nest-building phase, as exposure makes it more difficult for a queen to establish a nest. Exposure to neonicotinoids results in bumblebee colonies that are much smaller than colonies not exposed to these systemic insecticides. Moreover, a 2017 study finds that neonicotinoid exposure decreases pollination frequency and results in fewer social interactions. That is likely because neonicotinoids alter bumblebee feeding behavior and degrade the effectiveness of bumblebees' classic "buzz pollination" process. Research published in 2017 determined that fungicides also play an essential role in bumblebee declines by increasing susceptibility to pathogens. Additionally, EPA assesses the toxicity of individual active ingredients on bees through various testing methods when regulating pesticides. However, EPA does not require the testing of multiple active or "inert" ingredients to the same degree, despite evidence demonstrating these chemicals harm pollinators.

While it is evident that factors like pesticides, parasites, habitat destruction, and poor nutrition contribute to the decline of the American bumblebee, the combined stressors can act together (synergistically) to increase bee mortality.

The study shows chronic exposure to glyphosate can reduce bumblebees' ability to connect aversive stimuli like an electric shock with visual indications when partaking in learning tasks. The inability of bumblebees to learn these warnings puts these pollinators at risk of predation and disease when looking for food. However, this study only adds to the scientific literature on the adverse effects of chemical exposure on pollinator health, especially in sublethal concentrations. A lack of fine-color discrimination skills can threaten bumblebee survivability through a decrease in colony fitness and individual foraging success. Much research attributes the decline of insect pollinators (e.g., commercial and wild bees and monarch butterflies) over the last several decades to the interaction of multiple environmental stressors, from climate change to pesticide use, disease, habitat destruction, and other factors. In the U.S., an increasing number of pollinators, including the American bumblebee and monarch butterfly, are being added or in consideration for listing under the *Endangered Species Act*, with specific chemical classes like systemic neonicoti-

noid insecticides putting 89 percent or more of U.S. endangered species at risk.

Furthermore, this study shows the potential of a fully automated, high throughput assay for sublethal effects testing on wild and solitary bees for chemical exposure, not just honey bees. The study concludes, "Glyphosate exposure impacted bumblebee physiology and nervous system function in several ways, from sensory perception to cognition. This could result from a broad disruption of brain maturation or function. Further research will be needed to elucidate glyphosate's mechanism of action on insect cognition, as well as to evaluate if this effect is temporary or permanent."

Pollinator protection policies need improvement to safeguard not only all pollinators but the crops they pollinate as well. Beyond Pesticides holds that we must move beyond pesticide reduction to organic transition and commit to toxic pesticide elimination in agricultural systems to prevent the crop loss presented in this study. Pesticide elimination can alleviate the effect of these toxic chemicals on humans and wildlife.

SOURCE: Morgane Nouvian, et al., Glyphosate impairs aversive learning in bumblebees, *Science of The Total Environment*, Volume 898, 2023, https://doi.org/10.1016/j.scitotenv.2023.165527.

BEES/POLLINATORS | AUGUST 29, 2023

Pollinator Health: Common Fungicide Linked to Changes in Honey Bees' Brain through Oxidative Stress

A study published in *Insect Biochemistry and Molecular Biology* finds the widely used azole fungicide, tebuconazole, has damaging impacts on the redox homeostasis (the process of maintaining balance between oxidizing and reducing reactions) and fatty acid composition in honey bees' brain via oxidative stress. Acute, field-realistic sublethal exposure to tebuconazole decreased the brain's antioxidant capacity, key antioxidant defense systems, and oxidative degradation and alteration of lipids (fats) in the brain. Thus, this study adds to the scientific literature on the adverse effects of chemical exposure on pollinator health, especially in sublethal concentrations. Degenerating cognitive skills can threaten honey bee survivability, decreasing colony fitness and individual foraging success. Much research attributes the decline of insect pollinators (e.g., domesticated and wild bees and monarch butterflies) over the last several decades to the interaction of multiple environmental stressors, from climate change to pesticide use, disease, habitat destruction, and other factors.

Pollinator declines directly affect the environment, society, and the economy. Without pollinators, many plant species, both agricultural and nonagricultural, will decline or cease to exist, as U.S. pollinator declines, particularly among native wild bees, depress crop yields.

In turn, the economy will take a hit, since much of the economy (65 percent) depends upon the strength of the agricultural sector. As the science shows, pesticides are one of the most significant stressors for pollinators. Additionally, the devastating impacts of pesticides on bees and other pollinators is part of a larger pattern of what has been called by scientists as the "insect apocalypse." In a world where habitat loss and fragmentation show no sign of abating, scientists have concluded that the globe cannot afford to continue to subject its critically important wild insects to these combined threats. Therefore, studies like these emphasize the need for improved assessment for environmentally relevant levels of chemical exposure to honey bees.

The study notes, "[R]edox imbalance and oxidative stress-related negative consequences may be factors of crucial importance in the background of neurotoxicity and cognitive impairment observed by the abovementioned research groups in tebuconazole-exposed bees. Therefore, it is vital to understand whether tebuconazole may have a negative impact on the redox homeostasis of honeybees, possibly contributing to the development of further pathological conditions."

Using adult honey bees, the researchers exposed the bees to acute sublethal, field-realistic concentrations of tebuconazole in high, medium, and low doses. The researchers analyzed the fatty acid composition and oxidative factors in the brain of honey bees, including total antioxidant capacity (TAC), state of the glutathione defense system, the activity of glucose-6-phosphate dehydrogenase (G6PDH), superoxide dismutase (SOD), and xanthine oxidase (XO), and the production of malondialdehyde (MDA).

The results show tebuconazole has a profound impact on oxidation in the brain. It decreases antioxidant capacity, reducing the ratio of oxidized glutathione for preventing damage to important cellular components and disrupting antioxidant enzymatic defense systems, inducing lipid (fat) peroxidation (oxidative degeneration of fats) through elevated malondialdehyde levels. This alters the fatty acid profile in honey bee brains.

The scientific literature demonstrates pesticides' long history of adverse environmental effects, especially on wildlife, biodiversity, and human health. Most notably, pesticides are immensely harmful to pollinators. Over the last decade and a half, increasing scientific evidence shows a clear connection between the role of pesticides and the decline of honey bees and wild pollinators (e.g., wild bees, butterflies, beetles, birds, bats, etc.). Pollinators' decline directly affects the environment, society, and the economy. Globally, the production of crops dependent on pollinators is worth between $253 and $577 billion yearly. Hence, pesticide use fails to support sustainability goals, decreasing agricultural and economic productivity and social (human/animal) and environmental well-being.

The study emphasizes the role of oxidative in pesticide toxicity among nontarget species. An alteration in redox homeostasis has an association with many diseases and neurodegenerative disorders and is a significant factor in regulating cell growth and senescence (aging cells). Tebuconazole is a (tri)azole compound that can directly impact cellular metabolic processes like antioxidation. The chemical has a history of affecting bee behavior, foraging effectiveness, pollination, learning, and colony development, indicating impact on the brain. Behavioral changes and a decrease in cognitive function have a strong correlation with triazole-induced oxidative stress.

Although literature on oxidative stress, neurodegenerative disorders, and honey bees is lacking, this study provides evidence that future studies must assess how pesticides impact cognitive function among invaluable insects. Additionally, triazole fungicides can work synergistically with other bee-toxic pesticides, like neonicotinoids (insecticide), amplifying adverse effects on health. In fact, systemic neonicotinoid insecticides put 89 percent or more of U.S. endangered species at risk. The study attributed pesticide toxicity to the ongoing pollinator crisis, highlighting that more extensive research on triazole-mediated health effects is essential for the conservation of honey bees and endangered pollinators. The researchers say, "The present study highlights the negative impact of tebuconazole on honeybees and contributes to the understanding of potential consequences related to azole exposure on pollinator insects' health, such as the occurrence of Colony Collapse Disorder (CCD)." Pollinator protection policies need improvements to safeguard all pollinators and the crops they pollinate.

SOURCE: Máté Mackei, et al., Detrimental consequences of tebuconazole on redox homeostasis and fatty acid profile of honeybee brain, *Insect Biochemistry and Molecular Biology,* Volume 159, 2023, https://doi.org/10.1016/j.ibmb.2023.103990.

MORE ON THIS SUBJECT

Western Bumblebee Declines a Result of Pesticides and Climate Change, No End in Sight—January 25, 2023

Study on National Pollinator Declines Blames Pesticides, Pests, and Extreme Weather—February 1, 2023

Neonicotinoids Combined with Other Pesticides Elevate Hazards to Honey Bee—February 22, 2023

Pesticides and the Climate Crisis: Bumble Bee Behavior Thwarted by Temperature and Chemical Exposure—April 6, 2023)

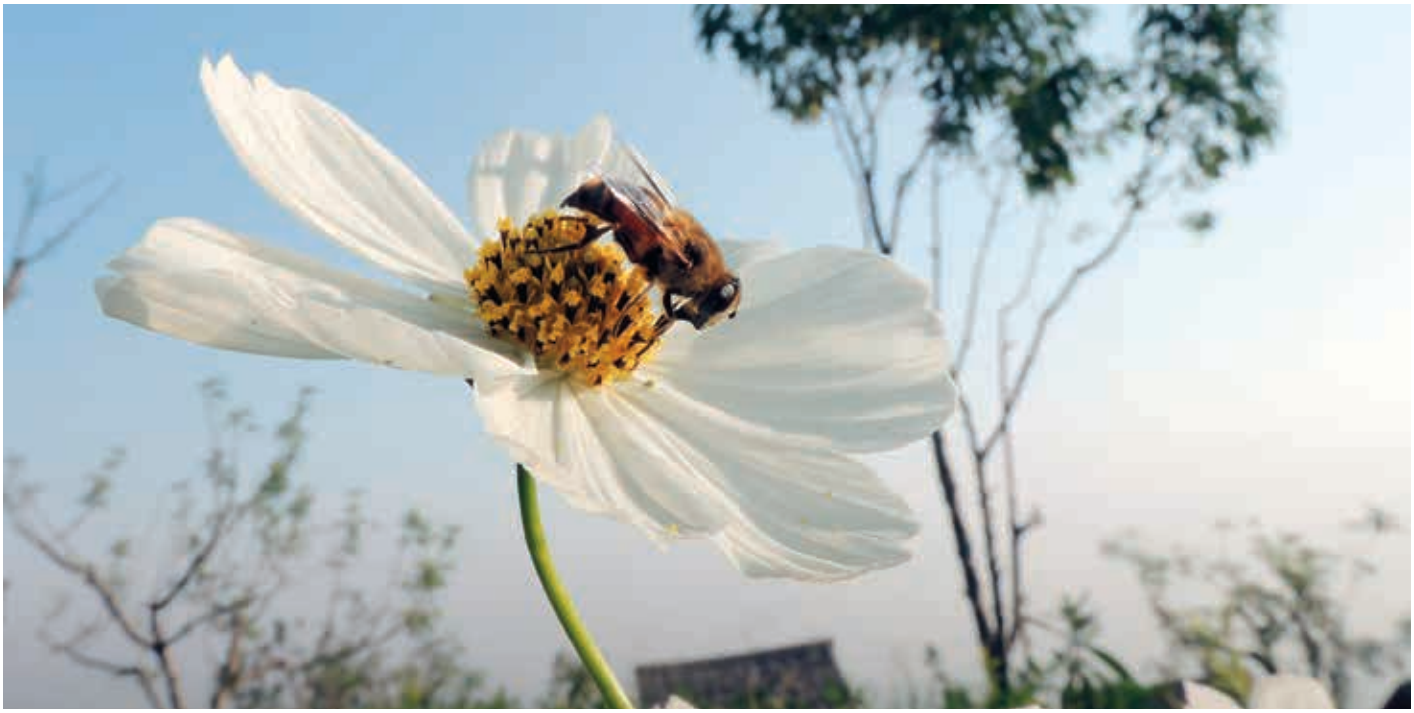
Soils in Urban and Natural Lands Equally Contaminated, Study Finds—April 11, 2023

Beehive Products Contain Concentration of Pesticide Residues High Enough To Be a Risk to Consumer Health—May 18, 2023

Pesticide Threat to Pollinators Decreases Agricultural and Economic Productivity, and Food Security—June 22, 2023

Ecosystem Critical to All Pollinators: Popular and Unpopular Pollinator Guide—2023

Pollinator Health: The Climate Crisis Weakens Bees' Ability to Withstand Pesticide Exposure—September 13, 2023



MICROBIOME HAZARDS | DECEMBER 12, 2023

Scientific Literature Review Again Identifies Pesticide Disruption of Bee Gut Microbiota

A review published in *Nature Reviews Microbiology* finds pesticides can disrupt honey bee (*Apis mellifera*) microbiota (bacteria) in their gut, altering the immune system, metabolism, behavior, and development. Many studies emphasize that chemical-driven agricultural systems harm or kill the sensitive pollinators on which they are dependent. Previous studies have linked adverse impacts on bee microbiome to pesticide exposure. Toxic pesticides readily contaminate the ecosystem with residues that have become pervasive in food and water commodities. In addition to this study, the scientific literature commonly associates pesticides with human, biotic, and ecosystem harm, as a doubling of toxic effects on invertebrates, like pollinators, has been recorded since 2004.

Pollinator declines directly affect the environment, society, and the economy. Many agricultural and nonagricultural plant species will decline or cease to exist without pollinators. In turn, the economy will take a hit, since much of the economy (65 percent) depends upon the strength of the agricultural sector. As the science shows, pesticides are one of the most significant stressors for pollinators. Additionally, pesticides have a devastating impact on bees,

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other pollinators, and insects generally, resulting in what scientists call the "insect apocalypse."

The review explores the relationship between microbiota in the gut of bees and the effects on bees' health and biological function, including microbial interactions within the stomach, processes in bee biology and health, and impact of agricultural practices. Since bacteria in the bee's gut occupy differing niches, their interaction with the host and each other can vary. Gut microbiota protects against pathogens and parasites, processes dietary or bodily components, and interacts with species within the host. Decreased microbial abundance and diversity can negatively affect honey bee health and survival. Without these microbiota, gene expression (a gene relaying information to produce a function) can change, weakening immune response, metabolic process, and development. Additionally, antibiotic exposure is a concern among agricultural exposure, since antibiotic treatments

lessen microbial abundance in the gut, hampering the absorption of nutrients, weight gain, immunity, and development of bee larvae.

The intestines host a group of microorganisms (microbiota) that form the gut microbiome. Gut microbiota, including bacteria, archaea, viruses, and fungi, play a crucial role in regulating lifelong digestion, as well as the immune and central nervous system. Ample evidence demonstrates environmental contaminants like pesticides negatively affect gut microbes. Through the gut microbiome, pesticide exposure can enhance or exacerbate the adverse effects of additional environmental toxicants to the body. Since the gut microbiome influences metabolism, it can mediate some toxic effects of environmental chemicals. However, with prolonged exposure to various environmental contaminants, critical chemical-induced changes may occur in the gut microbes, effecting adverse health outcomes. However, honey bees are not the only insects facing harm from environmental contaminants like pesticides, as all pollinators are in peril from exposure to environmental pollutants.

Like gut microbes, soil microbes are essential for the standard functionality of the soil ecosystem. Toxic chemicals damage the soil microbiota by decreasing and altering microbial biomass and soil microbiome composition (diversity). Pesticide use contaminates soil and causes changes in soil composition that results in "vacant ecological niches, so rare organisms become abundant and vice versa." The resulting soil ecosystem is unhealthy and imbalanced, with a reduction in the natural cycling of nutrients and resilience. Thus, plants grown in such conditions are more vulnerable to parasites and pathogens.

Regarding the impacts of exposure, the duration of pesticide exposure is more important than the amount of pesticide to which a bee is exposed. Longer exposure times result in more significant disturbances but likely vary by pesticide mode of action.

Like previous literature, this review shows that pesticide use can disturb and shift the abundance of specific microbes in the bee gut microbiome. Pesticide-induced disturbances occur primarily in one of two ways—either directly harming microbes or indirectly harming the host's (bee) health and subsequently shifting the microbiome. An unfavorable environment produced by the bee's gut can create an environment less suitable for certain microbes. Moreover, regarding the impacts of exposure, the duration of pesticide exposure is more important than the amount of pesticide to which a bee is exposed. Longer exposure times result in more significant disturbances but likely vary by pesticide mode of action. A 2018 study found that exposure disrupts honey bee microbiota, and a 2015 study found that it results in sublethal effects on honey bee navigation and foraging success. Moreover, studies suggest "inerts" may play a role in pollinator harm.

SOURCE: E.V.S. Motta, The honeybee microbiota and its impact on health and disease. *Nature Reviews: Microbiology,* 22, 122–137 (2024). https://doi.org/10.1038/s41579-023-00990-3.

MORE ON THIS SUBJECT

Common Fungicide Adds to Growing List of Pesticides Linked to Gastrointestinal and Microbiome Damage—January 26, 2023

Chemical-Driven Agriculture Damages Microbial Health of Bee Colonies—March 21, 2023

BIRDS | FEBRUARY 8, 2023

Garden Pesticide Use Harms Local Bird Populations, Study Authors Say "We Should Simply Ban These Poisons"

Spraying pesticides around one's garden negatively impacts local bird populations, according to research published by scientists at the University of Sussex, UK in Science of the Total Environment. Although this reasoning sounds common sense to those versed in the works of Rachel Carson, it underscores the immense importance of carrying on the legacy of her work and continuing to educate the public about the ongoing dangers posed by modern pesticides. As the study authors write, "Overall, our study shows that garden bird abundance and richness is strongly influenced by both extrinsic and intrinsic factors, and suggests that garden management, particularly regarding pesticide use, has a significant effect on bird life."

Researchers collected data by partnering with the British Trust for Ornithology, which conducts annual citizen-science counts of bird populations in UK gardens. Nearly 24,000 residents participate in the survey, which also includes information about the urbanization level surrounding their gardens, and other habitat characteristics. A group of these volunteers were provided with a questionnaire about their pesticide practices between 2020–2021, recording information on how often the pesticides were

applied, as well as the pesticide brand name. After removing incomplete or unusable data, 615 individual gardens were incorporated into the study.

To determine the factors impacting bird populations, researchers created a garden quality index (GQI) and surrounding quality index (SQI). GQI scores include factors such as the type and number of trees, the proportion of the garden planted with flowers, shrubs, vegetables, or allowed to be wild, the quality of shrubs and hedges, and the presence of water features. SQI scores include aspects like the type of nearby habitat (ex. woodland, scrubland, marsh) or nearby water body. To determine impacts to birds, researchers analyze both bird abundance (total number of birds) and richness (total number of bird species) per recorded bird counts.

In general, bird abundance is found to be highest in rural areas when compared to urban and suburban areas. Gardens that have higher GQI scores also record more bird abundance and richness, while SQI appears to only affect richness.

Among study participants, 34.1 percent indicate they applied pesticides, with over 60 percent of that use being herbicides, followed by molluscicides (slug killing products) around 35 percent, insecticides at roughly 30 percent, and fungicides at 10 percent. Pesticide spraying impacts the effect a positive SQI factor has on bird richness. Specifically, "species richness increases with the surrounding quality, both for gardens that do not use pesticides and for gardens that applied pesticides, but this effect is significantly less strong when pesticides are applied," the study finds. Scientists zeroed in on three active ingredients—the weed killer glyphosate, the neonicotinoid insecticide acetamiprid, and the synthetic pyrethroid deltamethrin—resulting in the most damaging pesticide impacts to bird species' richness.

While abundance is not impacted on an overall basis, individual species do show population declines with the use of specific pesticides. The house sparrow, for example, although perhaps the most established invasive bird in the United States, is in steep decline in the UK. Results show that house sparrow abundance declines by 12 percent in gardens applying any pesticide, but is nearly 25 percent lower in gardens specifically using glyphosate.

While abundance is not impacted on an overall basis, individual species do show negative relationships with the use of specific pesticides.

The study authors, including world renowned entomologist Dave Goulson, PhD, say their results support the need for restrictions on pesticide use. "The UK has 22 million gardens, which collectively could be a fantastic refuge for wildlife, but not if they are overly tidy and sprayed with poisons. We just don't need pesticides in our gardens. Many towns around the world are now pesticide free. We should simply ban the use of these poisons in urban areas, following the example of France," Dr. Goulson told The Guardian.

As Beyond Pesticides reported in 2022, France enacted sweeping restrictions on both public and private use of toxic pesticides in sensitive landscaped areas. The policy implemented throughout populated areas in France generally tracks with similar restrictions enacted in most Canadian provinces, but only by a

small but growing number of U.S. cities like South Portland and Portland, ME.

That pesticides are locally harming bird populations should come as no surprise; what is perhaps most concerning to advocates is that over one in three well-intentioned gardeners regularly apply toxic pesticides that put the birds they undoubtedly appreciate at risk.

In *Silent Spring*, Rachel Carson in the first chapter writes *A Fable for Tomorrow*: "There was a strange stillness. The birds, for example—where had they gone? Many people spoke of them, puzzled and disturbed. The feeding stations in the backyards were deserted. The few birds seen anywhere were moribund; they trembled violently and could not fly. It was a spring without voices. On the mornings that had once throbbed with the dawn chorus of robins, catbirds, doves, jays, wrens, and scores of other bird voices there was now no sound; only silence lay over the fields and woods and marsh."

Already, data show that the U.S. has lost three billion birds since the 1970s –29 percent of the abundance seen during that decade. This study and its authors have a loud and clear message to all readers to relay to their friends and family: Stop the home and garden use of pesticides. The choices people make, whether to address a pest through chemical or ecological pest management, have a major impact on the health of the wildlife in their immediate area; wildlife that many residents come to know well, and care about, as they watch their comings and goings in their ecosystem.

SOURCE: Cannelle Tassin de Montaigu and Dave Goulson, Habitat quality, urbanisation and pesticides influence bird abundance and richness in gardens, *Science of The Total Environment*,Volume 870, 2023, https://doi.org/10.1016/j.scitotenv.2023.161916.

MORE ON THIS SUBJECT

Agricultural Pesticide Use the Primary Driver of Bird Declines in Europe—May 19, 2023

Study Confirms Continued Bird Decline as EPA Fails to Restrict Neonicotinoid Insecticides—July 21, 2023

BUTTERFLIES | MAY 26, 2023

Study Shows 50 Percent Decline in Butterfly Population Across the European Union, 1990–2011

The use of pesticides in agriculture, transportation, and domestic settings has created a disastrous conflict for the human species. Two irreconcilable facts confront humans as they try to adapt to the consequences of earlier choices: One, industrial civilization came to believe that because some insects, fungi, and other organisms like to eat the same plants humans eat, humans can kill them with impunity; two, because some insects and other organisms are necessary to the health and reproduction of plants, humans need to protect them. At no point in

history have people acknowledged that it is very difficult to kill the "bad" actors while protecting the "good" ones. There are not really two sides to the biological fact; rather, pesticides and biodiversity meet each other on a single plane, like a Möbius strip.

Among the most dire effects of pesticides are their ruination of pollinators. Bees spring to mind as the primary pollinators, but they are by no means the only ones. Butterflies, often regarded as mere ornamental additions to a landscape, are actually significant pollinators themselves. Monarchs pollinate many flowers, including calendula and yarrow. Other butterflies pollinate dill, celery, fennel, cilantro, lettuce, peas, and basil, among other important food plants. Butterflies are also known to be excellent indicators of ecosystem health, so if an environment has lots of butterflies it is reasonably robust.

The European Union has just released a report, the European Grassland Butterfly Index in Europe, 1991–2020, as part of the EU's attempt to "halt the loss of biodiversity and the degradation of ecosystem services in the EU . . . and restore them, in so far as feasible, while stepping up the EU contribution to averting global biodiversity loss." The Grassland Butterfly Index is one of the EU's tools to identify trends in "genetic, species and ecosystem/landscape diversity." The survey includes counts of 17 species of butterflies from 19 countries. Results show that, "Grassland butterflies have undergone a huge overall decrease in numbers. Their populations declined by almost 50% from 1990 to 2011" across the EU member states. This is derived from the Indicator, which has declined by 32 percent over the last decade. Intensification of farming is the major culprit for grassland butterflies, and climate, especially heat waves and drought, is close behind. Industrial farming not only destroys habitat, but it uses poisonous chemicals as well.

In addition to documented declines in Europe, research documents declines of 58 percent between 2000 and 2009 in the U.K. and of 33 percent over 1996–2016 in the state of Ohio in the U.S. Even steeper declines have been documented for Monarch butterflies, with an 80 percent decline of Eastern monarchs and 99 percent decline of Western monarchs.

Butterflies and moths belong to the order *Lepidoptera*. Unfortunately, some 70 percent of agricultural pests—many of them moths at various life stages—also belong to this order. This puts butterflies smack in the bullseye for many pesticides. As Beyond Pesticides has repeatedly reported, the neonicotinoid pesticides destroy insects' nervous systems, and they are not picky as to species. Their effects on bees caused the EU to ban three neonicotinoids in 2013—clothianidin, thiamethoxam and imidacloprid—but in the U.S. the Environmental Protection Agency (EPA) is just getting around to pondering whether they are harmful enough to ban.

Until the last few years, EPA had never considered a pesticide's effects on endangered species in its registration process. In 2019, the Center for Food Safety sued EPA, and a California federal judge ruled that "EPA had unlawfully issued 59 pesticide registrations between 2007 and 2012 for a wide variety of agricultural, landscaping and ornamental uses," according to the Center for Food Safety.

Last year, EPA admitted in response to that ruling that these three neonicotinoid pesticides are "likely to adversely affect from two-thirds to over three-fourths of America's endangered species—1,225 to 1,445 species in all," including many butterfly species. On May 5 of this year, EPA released new analyses of these neonics' effects on endangered species. These more fine-grained analyses focuses on the species most at risk of extinction, and the results represent a "five-alarm fire," according to the Center for Biological Diversity's environmental health director, Lori Ann Bird. EPA identifies 25 insect species and upwards of 160 plants dependent on insect pollination whose existence is most perilous. This step by EPA is one in a long line of glacial movements that may result, if the winds of fate do not reverse, in the removal of these chemicals from the market.

Clothianidin is used on cotton, but cotton growers may be shooting themselves in the foot by using it. In 2021, *Science* reported on a study of cotton pollination showing that the services of butterflies and hoverflies add approximately $120 million annually to the $1.8 billion cotton industry in Texas. They do this by visiting different cotton flowers and appearing at different times than bees do. The researchers counted 40 bee species, 16 fly species, and 18 butterfly species in the cotton fields they examined. The study estimates that about 50 percent more flowers are visited by all pollinators than if bees were the sole actors. More broadly, according to the Center for Regenerative Agriculture and Resilient Systems at California State University Chico, the efforts of wild native bees and other pollinators are worth $3 billion.

Change at the federal level is too slow, according to environmental advocates, but many efforts at smaller scales, from scientists to farmers to individual citizens, are afoot. Butterflies may have been left out of much consideration of the pollinator crisis and development of ways to assess ecosystem health in general, but they are great poster children for both problems. They are what might be called "charismatic minifauna"—beautiful and beloved by people all over the world. In the U.S., many citizens participate in butterfly counts every year, organized by the North American Butterfly Association. These can be very helpful to researchers trying to assess how quickly ecosystems are collapsing. Home gardeners can help pollinators in many ways, with one caveat: Milkweed, the mainstay of monarch support, may contain pesticide residues that harm monarch caterpillars if the milkweed plants come from a nursery. Some caterpillars do eat foods humans like, but most of these are moth larvae, and the damage butterflies may cause is surely outweighed by their insects' benefits.

There are also moves to modify farming practices. As Beyond Pesticides

has noted, hedgerows are a good way to help many species of native pollinators. Hedgerows of small trees, low shrubs and native plants provide refuges for these insects and can also help control pesticide drift across field boundaries.

In Oregon's Willamette Valley, vineyards are starting to incorporate pollinator habitat between their rows of vines. Buzz Cover Crop Seeds of Philomath, Oregon sells seed packets for pollinator-friendly field cover crops and pathways between grapevine rows that have multiple benefits and help reduce chemical applications. Oregon also offers a "pollinator paradise" license plate, the fees for which support pollinator research at Oregon State University.

Some state and federal transportation agencies are acting. The Federal Highway Administration (FHA) and numerous state departments are incorporating pollinator-friendly policies. FHA publishes a handbook, "Roadside Best Management Practices that Benefit Pollinators." Even airports, some of the most habitat-destroying and contaminated lands in the world, may be changing: the National Academy of Sciences has published a report, "Considerations for Establishing and Maintaining Successful Pollinator Programs on Airports."

The pollinator crisis makes it clear that the template for sustainable human life must change. The toxic Möbius strip of pesticide use versus biodiversity must be broken and reassembled to promote the smooth flow of life. Without drastic reduction in the creation and use of pesticides, the plant and animal systems needed to survive will collapse. It is not enough to preserve European honey bees and not the plethora of other volunteer pollinators that exist all over the world. People and policymakers must practice "what's good for the bee is good for the butterfly" agriculture without delay. For details on issues in organic agriculture, see Beyond Pesticides' Keeping Organic Strong webpage.

SOURCE: European Environment Agency, *Grassland Butterfly Index in Europe* (1991–2021), 2023.

INSECT DECLINE | FEBRUARY 15, 2023

More Dramatic Insect Decline Confirms Inadequate Action on Looming Biodiversity Collapse

Areas designated to protect insects fail to do so for over 75 percent of global species, according to a study, "Three-quarters of insect species are insufficiently represented by protected areas," published in the online journal *One Earth*. Protected Areas (PAs) act as a safeguard for biodiversity. However, PAs in North America, Eastern Europe, Southeast Asia, and Australia do not meet the minimum coverage requirements to safeguard global insect species assessed in the study. PAs are discussed in the 2020 *Nature* article, "Area-based conservation in the 21st

century," in which the authors state that, in view of the global biodiversity crisis, national governments must do much more to increase protected areas with "coverage across different elements of biodiversity (ecoregions, 12,056 threatened species, 'Key Biodiversity Areas' and wilderness areas) and ecosystem services (productive fisheries, and carbon services on land and seas)." The authors write, citing the UN Convention on Biological Diversity (to which the United States is not a signatory), "To be more successful after 2020, area-based conservation must contribute more effectively to meeting global biodiversity goals—ranging from preventing extinctions to retaining the most-intact ecosystems—and must better collaborate with the many Indigenous peoples, community groups and private initiatives that are central to the successful conservation of biodiversity." [Note that Beyond Pesticides' community-based program, Parks for a Sustainable Future, eliminates petrochemical pesticides and fertilizers and develops land management programs in sync with nature and biodiversity.]

The lack of coverage in PAs leads to underestimates of global insect distributions. The study reports, "Given this substantial local variation, the extent to which insect species are covered by PAs globally remains obscure, meaning we are unable to track the progress of insect conservation globally."

All insects encounter multiple stressors besides pesticides, including parasites and poor nutrition, that act together to increase the risk of mortality. Despite being the driver of many ecosystem processes and functions/services, insects lack adequate consideration in global conservation assessments. Additionally, insects only constitute eight percent of the assessed species in the International Union for Conservation of Nature (IUCN) Red List of threatened species. Therefore, reviews like these highlight the need to address all factors that can exacerbate adverse impacts on insects, especially when threatened by uninhibited chemical pollutants. Lead researcher Shawan Chowdhury, PhD cautions, "Many insect species are declining within protected areas because of threats such as rapid environmental change, loss of corridors, and roads inside protected areas."

Using the Global Biodiversity Information Facility (GBIF), researchers measure global insect representation, mapping the distribution of all existing insect species that appeared at least three times in GBIF records (89,151 species). Study researchers compare insect coverage in protected areas to the geographical range of species to determine:

1. "[t]he extent of occurrence (EOO; area within the shortest continuous boundary encompassing all known occurrence records) and,
2. area of occupancy (AOO; the area within the EOO estimated to be occupied [by said species]."

The resulting map of designated protected areas for species shows that "76% of 89,151 insect species assessed globally do not meet minimum target levels of PA coverage," inadequately protecting at least 76 percent of global insect species. Thus, the researchers caution this study as a call for the expansion of PAs for insects to ensure worldwide biodiversity.

The United Nations states that 80 percent of the 115 top global food crops depend on insect pollination, with one-third of all U.S. crops depending on pollinators, according to the U.S. Department of Agriculture (USDA). However, research finds that many insect populations are in decline, including managed and wild pollinators. Monarchs are near extinction, and commercial beekeepers continue to experience declines that are putting them out of business. The continued loss of mayflies and fireflies disrupts the foundation of many food chains. Additionally, the decline in many bird species has links to insect declines. Since the 1970s, three billion birds have vanished.

Despite habitat fragmentation and climate change, extensive use of pesticides, like neonicotinoids, sulfoxaflor, pyrethroids, fipronil, and organophosphates, increase the potential risk and indiscriminate threat to all insects. Research shows that residues from neonicotinoids (including seed treatments) and sulfoxaflor accumulate and translocate to pollen and nectar of treated plants. Both pyrethroids and fipronil impair bee learning, development, and behavioral function, reducing survivability and colony fitness. However, "inert" ingredients in these products cause similar or more severe impacts on insect populations, such as disruption in bee learning behavior through exposure to low doses of surfactants. With the global reliance on pollinator-dependent crops increasing over the past decades, a lack of pollinators threatens food security and stability for current and future generations.

The geographical range of species varies from small to large. Thus, some species can have high coverage within PAs, while others have little to no coverage in PAs, depending on range size. Despite the growth in PAs for endangered species, insects still face existential risk factors like habitat destruction, chemical exposure, and food insecurity. The study researchers link the lack of data on surveying insect species and an underestimation of geographical range size attributes to gaps in PAs conservation. Even animals in larger protected areas, like U.S. wildlife refuges, experience similar health risks from chemical pesticide exposure. Additionally, the U.S. Geological Survey (USGS) routinely finds widespread pesticide contamination of surface waters throughout the U.S. Scientists warn that neonicotinoids, and other pesticides, pose a direct threat to both insect and non-insect wildlife, including birds, aquatic animals, and other wildlife, which absorb pesticide sprays and vapors through respiration, as well as ingestion via food. Pesticide spraying in or around PAs threatens the survivability and recovery of species that reside there, as many pesticides are highly toxic to human and animal health. Therefore, studies like these are significant, especially since the globe is going through the

Holocene Extinction, Earth's 6th mass extinction, with one million species of plants and animals at risk of extinction.

Most animals on this Earth are insects, who play a significant role in sustaining the ecosystem despite their size. Insects found in nature preserves are consistently contaminated with over a dozen pesticides, calling into question the ability for these areas to function as refuges for threatened and endangered species. With rampant pesticide use and ubiquitous contamination, it is imperative that lawmakers and regulators embrace stronger measures to reverse the ominous trajectory society continues to follow, especially with the ongoing global insect apocalypse.

As has been widely reported, pollinators (such as bees, monarch butterflies, and bats) are a bellwether for environmental stress, as individuals and as colonies. Pesticides intensify pollinators' vulnerability to health risks (such as pathogens and parasites), with pesticide-contaminated conditions limiting colony productivity, growth, and survival. However, ending toxic pesticide use can alleviate the harmful impacts of these chemicals on species and ecosystem health.

Beyond Pesticides captured the bigger picture in its introduction to its 2017 National Pesticide Forum, *Healthy Hives, Healthy Lives, Healthy Land*: "Complex biological communities support life." For more information on the insect apocalypse, see the Beyond Pesticides article in our *Pesticides and You* journal, Tracking Biodiversity: Study Cites Insect Extinction and Ecological Collapse.

SOURCE: Shawan Chowdhury, et al., Three-quarters of insect species are insufficiently represented by protected areas, *One Earth*, 6, 139–146 February 17, 2023, https://doi.org/10.1016/j.oneear.2022.12.003.

AQUATIC CONDITIONS | FEBRUARY 14, 2023

Harming Wildlife, Pesticides in Waterways Run into the Great Lakes Year-Round

The waterways that flow into the Great Lakes are experiencing year-round pesticide contamination that exceeds benchmarks meant to protect aquatic life, according to research published in Environmental Toxicology and Chemistry by scientists at the U.S. Geological Survey (USGS). "What you use makes it into the water," study coauthor Sam Oliver, PhD told the *Milwaukee Journal Sentinel*. These data buttress growing calls from pesticide reform advocates that new laws are needed to protect the nation's increasingly threatened waters.

USGS scientists conducted their analysis on 16 tributaries that feed into the Great Lakes, including sites that correspond to urban, agricultural, and undeveloped land. Samples were taken at locations closest to the lake the tributary flowed into over a period of roughly one year from October 2015 to September 2016. Each sample was tested for 231 pesticides and their breakdown products. Researchers used aquatic life benchmarks set by the U.S. Environmental Protection Agency (EPA) and created a relative hazard index (RHI) for the study to evaluate whether specific sites should be prioritized for further protections.

Across every sampled tributary, pesticides were found. Accordingly, 96 percent (190 out of 198) of samples taken contained pesticides or their breakdown products. Scientists detected 104 of the 231 pesticide and breakdown products analyzed, with 80 percent of samples containing at least 10 different compounds. Herbicides represented the most frequently detected chemicals, with the hormone disrupting weed killer atrazine and its breakdown products (deethylatrazine and hydroxyatrazine) the most common of the bunch, detected in more than 75 percent of samples. Among insecticides, the neonicotinoids imidacloprid and clothianidin were most frequent, in 44 percent of samples. The most commonly detected fungicide was carbendazim, found in 51 percent of test samples. Notably, researchers detected 31 breakdown products that were of unknown hazard that are not captured by current EPA toxicity databases.

The presence of pesticide compounds exceeding aquatic life thresholds was found to occur throughout the entire year. This speaks to the dangers of pesticide breakdown products. The study notes, "For some individual parent pesticides, transformation products extended the 'exposure season,' or the proportion of the year that aquatic biota are exposed to pesticides at a given site." Based on analysis of the samples collected, the toxicity of breakdown products extends exposure hazards an average of nearly two months after the detection of the parent pesticide.

Researchers indicate that human disturbance in the form of urban and agricultural pesticide use represents the most polluted sites, but even samples in undeveloped land along the St. Louis River experience several instances where aquatic toxicity benchmarks are exceeded. The most contaminated site is along the Maumee River that flows into Lake Erie, where 72 different chemicals were detected during the study's duration.

Prior research shows the Maumee River to be particularly contaminated, with evidence that pesticide use is affecting the fertility of minnows in the stream, though this finding is likely just the tip of the iceberg. Likewise, Lake Erie is perhaps the Great Lake with the most sickened ecology, subject to a long history of contamination and toxic algae blooms.

While agricultural practices appear to correlate with peaking pesticide contamination during the growing season, urban runoff represents a larger overall proportion of the contamination flowing into waterways. With little to no natural soils to filter contamination, and impervious surfaces creating massive outflows of polluted water, this finding is unsurprising. Research conducted by USGS and EPA on urban runoff across the country in 2019 found 215 of 438 sampled toxic compounds present in the water. The sheer number of different chemicals and thus potential for even more toxic mixtures presents significant risks to health and the environment.

It is evident that the toxic soup that many U.S. waterways are carrying is unsustainable and threatens the foundation of many food chains. Imbalances in aquatic environments can ripple throughout the food web, creating trophic cascades that further exacerbate health and environmental damage.

SOURCE: Samantha K. Oliver, et al., Pesticide Prioritization by Potential Biological Effects in Tributaries of the Laurentian Great Lakes, *Environmental Toxicology and Chemistry*, Volume 42, Number 2, pp. 367–384, 2023.

AQUATIC CONDITIONS | MARCH 10, 2023

193 Countries in the United Nations Approve Treaty to Stop the Oceans from Dying

Following years of discussions and negotiations, 193 United Nations member countries have just approved—for the first time—a draft treaty for protection of the globe's "high seas" and their denizens. The March 4 adoption of the draft marks the achievement of a potential legal framework for such protections, but is also the beginning of "a long journey to ensure the world's oceans are adequately protected for future generations," according to coverage by *New Scientist*. As research out of Boston College identifies, the oceans are badly polluted by multiple substances—including pesticides and other agricultural runoff; industrial and petrochemical waste; and the synthetic chemicals embedded in plastics—that threaten human health. The treaty, which must be adopted by member states and then ratified by at least 60 countries to take effect, could be a critical development for meeting the COP15 "30 by 30" goal of protecting 30 percent of the world's land and sea by 2030 to slow and arrest global biodiversity losses. Beyond Pesticides has long covered the ecological harms of ocean pollution.

The treaty represents a step toward implementation of President Biden's 2021 "America the Beautiful Initiative," proclaiming "the first-ever national conservation goal established by a President—a goal of conserving at least 30 percent of U.S. lands and waters by

2030." That said, the U.S. has a poor track record on approval of UN environmental treaties; approval requires a two-thirds majority affirmative vote in the Senate, and failure on that would block a Presidential signature and ratification.

Consensus on the draft treaty—titled "Agreement under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction"—was not easy. Since 2004, nations have been in discussions about how to create environmental protections for international waters, but these repeatedly got bogged down around issues related to fishing rights, resource rights, funding, and allocation of the benefits of marine genetic resources (MGRs) derived from deep-sea corals, seaweeds, sponges, krill, and bacteria—in which the pharmaceutical and cosmetic industries are very interested. Since 2022's COP15 summit, pressure from global NGOs and the so-called "high ambition coalition" (the U.S., United Kingdom, European Union [EU], and China) has mounted, and is credited with helping to get consensus on the treaty "over the line." Promises of more funding, including roughly US$857 million from the EU, also greased the wheels.

The world's oceans occupy 70 percent of the planet's surface. They generate half of the oxygen humans breathe, host 95% of the biosphere of the Earth, and are, in the aggregate, the largest carbon sink.

This treaty addresses the world's "high seas," defined as oceans that lie in international waters and thus, are not subject to national regulations. Stockholm University's Frida Bengtsson was quoted by *New Scientist*: "The high seas belong to everyone; juridically, they're seen as 'the common heritage of mankind,' just as space or the moon." The high seas include the Pacific, Atlantic, Indian, and Southern oceans, which host important areas of unique marine habitat and significant biodiversity that are under real threat from pollution, overfishing, and climate change. Roughly two-thirds of our oceans—covering about half the planet—are in the "high seas" category, which also means there are few legal protections in place for them, especially related to environmental threats or risks.

The world's oceans occupy 70 percent of the planet's surface. They generate half of the oxygen humans breathe, host 95 percent of the biosphere of the Earth, and are, in the aggregate, the largest carbon sink. They are a primary regulator of global climate; and they are in trouble.

The research referenced above was the first to conduct a focused examination of ocean pollution's impacts on human health; it reviewed nearly 600 scientific reports on various aspects of maritime contamination. Published in *Annals of Global Health* and released at the Monaco International Symposium on Human Health & the Ocean in a Changing World, the research paper concluded that ocean pollution is worsening, and that when the toxins from that pollution return to terra firma, they threaten the health and well-being of more than three billion people worldwide.

Lead researcher Philip Landrigan, MD, director of the Boston College Global Observatory on Pollution and

Health, and the university's Global Public Health Program and Global Observatory on Planetary Health, commented in a news release: "People have heard about plastic pollution in the oceans, but that is only part of it. Research shows the oceans are being fouled by a complex stew of toxins including mercury, pesticides, industrial chemicals, petroleum wastes, agricultural runoff, and manufactured chemicals embedded in plastic. These toxic materials in the ocean get into people, mainly by eating contaminated seafood. . . . We are all at risk, but the people most seriously affected are people in coastal fishing communities, people on small island nations, indigenous populations, and people in the high Arctic. The very survival of these vulnerable populations depends on the health of the seas."

The research team's central findings were these:

- Mercury pollution is widespread in the oceans, accumulating to high levels in predator fish; once in the food chain, this poses documented risks to people who consume these fish.
- Burning coal is the primary source of mercury contamination; mercury toxins vaporize as coal burns and eventually land in ocean waters.
- Coastal pollution—industrial waste, agricultural runoff, pesticides, and human sewage—has increased the incidence of damaging algal blooms, which produce toxins associated with neurological harms, dementia, amnesia, and death.
- Plastic waste in the oceans (to the tune of 8 to 10 million tons a year) is ubiquitous; it breaks down mechanically into microplastic particles that contaminate and can kill fish, seabirds, and other marine organisms; virtually all humans now harbor these microplastics in their bodies.

The 5 Gyres Institute has amplified very recent research (published on March 8) that identifies a shocking metric: there is now a great and growing "plastic smog" in the world's oceans, comprised of 170 trillion plastic particles. From the paper abstract: "Today's global abundance is estimated at approximately 82–358 trillion plastic particles weighing 1.1–4.9 million tonnes. We observed no clear detectable trend until 1990, a fluctuating but stagnant trend from then until 2005, and [then] a rapid increase until the present. This observed acceleration of plastic densities in the world's oceans, also reported for beaches around the globe, demands urgent international policy interventions."

Plankton, which comprise small and microscopic plant, animal, bacterial, and fungal organisms, are the basis of the ocean food chain. They are consumed by krill, which are eaten by fish, which are then consumed by larger ocean creatures, and by terrestrial animals—including billions of human beings.

Read recent Beyond Pesticides coverage of the damaging impacts of ocean pollution (from plastics, synthetic agricultural pesticides and fertilizers, pharmaceutical waste, etc.) on marine biodiversity, and on plankton, in particular. Plankton, which comprise small and microscopic plant, animal, bacterial, and fungal organisms, are the basis of the ocean food chain. They are consumed by krill, which are eaten by fish, which are then consumed by larger ocean creatures, and by terrestrial animals—including billions of human beings. Plankton could credibly be considered "über-keystone species" for their function as the basis of the marine (and a significant part of the terrestrial) food chain. Their plummeting numbers—a global population drop of 40 percent since 1950—should sound a dire alarm.

The researchers' recommendations on mitigating the pollution pipeline to the oceans include:

- Create, expand, and safeguard marine protected areas.
- Shift rapidly from use of fossil fuels for energy to renewables (wind, solar, tidal, and geothermal).
- Eliminate coal combustion entirely, and tightly control all industrial uses of mercury.
- Reduce plastics production and ban production of single-use plastics.
- Promote effective waste management and recycling.
- Reduce agricultural releases of nitrogen, and phosphorus, as well as animal waste, industrial discharges, and discharge of sewage into coastal waters.
- Execute robust monitoring of ocean pollution and extend pollution control programs to cover all countries.
- Support research on the extent, severity, and human health impacts of ocean pollution.

Given the state of the world's oceans, and the peril represented by their intensive contamination, this treaty cannot happen fast enough. In 2022, the United Nations' Intergovernmental Oceanographic Commission outlined the variety of threats the oceans face:

- Climate change warms and acidifies waters, causing death of coral reefs and threats to other ocean organisms, as well as thermal expansion of sea water (water molecules become more distant from one another) because of warmer temperatures, leading to more wetland flooding, erosion, and contamination of littoral agricultural lands.
- Plastic pollution causes physical damage to ocean creatures (entanglement, suffocation, lacerations, infection, and internal injury); 80 percent of ocean plastic originates with terrestrial human activity, largely littering/inappropriate plastic disposal; 8 million tons of plastic end up in the oceans *every year*.
- Nonpoint source pollution is the runoff from land to ocean (including pesticides and fertilizers from agricultural lands and other managed turf), precipitation, and atmospheric deposition.

- Petrochemical/oil spills.
- Ocean dumping is intentional discharge from industry, sewers, oil tankers, and entities that discard trash into the seas.
- Shipping and transport "contribute" waste and trash to the oceans; these activities account for a big chunk of the economic activity supported by oceans (90 percent of global trade uses sea routes); dredging to expedite shipping disturbs ecosystems; maritime transport generates 30 percent of global emissions of nitrogen oxides and sulfur oxides; the shipping industry also generates noise pollution that harms marine organisms.
- Extractive industries, such as deep-sea mining and offshore oil drilling.
- Fishing and fishing gear contribute significantly to ocean pollution by leaving behind harmful (often plastic) debris; industrial fishing nets (usually plastic), abandoned or lost, are a chief problem.

A critically important impact of the treaty would be the creation of international marine protected areas in which destructive activities, such as industrial fishing, deep sea mining, or offshore/deep water petroleum drilling could be restricted. Among the general principles embedded in the draft treat are:

- The Precautionary Principle.
- The polluter pays.
- The common heritage of humankind
- Equity, including the fair and equitable sharing of benefits.
- Integrated, ecosystemic approaches.
- Recognition of the special circumstances of small island developing states and least-developed countries.

In response to affirmation of the draft treaty, UN Secretary-General Antonio Guterres said that it would prove "crucial for addressing the triple planetary crises of climate change, biodiversity loss, and pollution." World Wildlife Fund's Jessica Battle commented, "What happens on the high seas will no longer be 'out of sight, out of mind.' . . . We can now look at the cumulative impacts on our ocean in a way that reflects the interconnected blue economy and the ecosystems that support it."

Dr. Landrigan sounds a hopeful note, saying, "The key thing to realize about ocean pollution is that, like all forms of pollution, it can be prevented using laws, policies, technology, and enforcement actions that target the most important pollution sources. Many countries have used these tools and have successfully cleaned fouled harbors, rejuvenated estuaries, and restored coral reefs. The results have been increased tourism, restored fisheries, improved human health, and economic growth. These benefits will last for centuries."

Beyond Pesticide emphasizes that the transition from conventional, chemical-intensive agricultural and land management practices and products to organic would all but eliminate one important source of toxic ocean pollution.

SOURCE: United Nations General Assembly, United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction, March 4, 2023; Madeleine Cuff, What is the UN high seas treaty and will it save the world's oceans?, New Scientist, March 6, 2023; Philip J. Landrigan, MD, et al., Human Health and Ocean Pollution, Annals of Global Health, 2020; 86(1): 151, 1–64. DOI: https://doi.org/10.5334/aogh.2831.

AQUATIC CONDITIONS | AUGUST 4, 2023

Transport of Pesticides through Waterways Raises Serious Contamination Problems

The results of an Australian study published in *Nature* strike a contrast between land and water contamination with pesticide active substances (PAS), highlighting contamination as pesticides are transported through waterways. The study results on water transport raise serious contamination issues. Only about one percent of the pesticides entering rivers degrade, so that long stretches of waterways and the oceans suffer the direct impact of a pesticide's active ingredient. The lack of degradation also means that water organisms are being exposed to levels of pesticides exceeding many of the regulatory threshold limits set by governments. Although observation data are highly variable, the authors note that measured concentrations of pesticides in some river reaches of North America, East Asia and Europe exceed one or more regulatory threshold limits "at least once a year." Further, the pesticides can bioaccumulate at each level of the aquatic food web, which can multiply concentrations by a thousand or more in the highest trophic levels, according to the study authors.

The study finds that more than four-fifths of PAS are degraded in the soil, leaving about 10 percent of the original chemical in the soil as residue. Nearly half of these residues migrate into deeper layers of the soil where there are fewer microorganisms to break down the active ingredient. This means that a PAS accumulates in aquifers, mostly in its original chemical form. Aquifers are the source of most well water.

The authors of the study, through their assessment of hydrology and

biogeochemistry, have developed their estimate of how much pesticide remains on land, how much reaches the oceans, and how pesticides behave in both ground and surface waters along the way. Understanding how pesticides behave in the global water cycle, from wells and ponds to rivers and the oceans, has been lacking.

The authors note, "[I]n many observed cases PAS may degrade into a cascade of daughter substances which can be as toxic as the parent and occasionally even more persistent." For example, in 2021 Beyond Pesticides covered a study of pesticide metabolites, stating that "neonic [neonicotinoid] metabolites, such as desnitro-imidacloprid and descyano-thiacloprid, are more than 300 and ~200 times more toxic to mammals, respectively, than the parent compound imidacloprid."

Globally, approximately 3.3 million tons of pesticides are applied to crops every year. While most of these pesticides are applied on land, some portion of everything on land gets into water and ends up in the ocean eventually. Pesticides are no exception.

The scientists assess the hydrology and biogeochemistry of PAS for the 92 most-used pesticides based on 2015 data. The PAS are a fraction of the total mass of pesticide compounds applied to crops, amounting to 1.1 million tons—a third of the total global usage. Of this, the researchers calculate that 783 tons of PAS are released to the oceans annually. So, according to this study, a fraction of the total reaches the oceans. Active ingredients are virtually the only component of pesticide compounds whose toxicity is tested and regulated, so both the "inert" or "inactive ingredients" and chemicals resulting from geochemical or microbial action or disinfection processes are omitted from calculations of pesticide harms. For example, as Beyond Pesticides noted in its coverage of the pesticide metabolites study, "Nearly half of all breakdown products (transformation products) from four common-use environmental pesticides produce stronger endocrine (hormone) disrupting effects than the parent compound."

The rivers receiving the most pesticide runoff from land include the Mississippi and the Sacramento in the U.S., the Parana in Argentina, the Ganges in India, the Yangtze, Pearl and Yellow, in China, and the Irrawaddy and lower Mekong in South Asia. These are not all of the rivers that discharge the most PAS into the oceans, however. The Danube and the Amazon joined the group in that category. In all, fifteen of the most important rivers in the world discharge at least 5,000 kg of PAS each to the oceans annually. The effects of pesticides on the oceans—unlike those of fertilizers, which deplete oxygen and cause harmful algal blooms—are not well understood.

The researchers calculated another measure of the pesticide burden by comparing their estimates to actual observations in specific locations in North America, the European Union, and Australia. They found that their model "generally underestimated observations," which means that the burden on rivers and oceans is likely also heavier than they had predicted.

The most common chemicals in the modeled waters are glyphosate, metam potassium (a soil disinfectant), chlorothalonil and chlorpyrifos. The ratios of pesticide types in rivers were estimated at just over half as herbicides, about 36 percent multipurpose pesticides, about 11 percent fungicides and 0.6 percent insecticides. The ratio reaching the oceans was even more unbalanced,

with about 63 percent herbicides, a little over a quarter multipurpose pesticides, about 10 percent fungicides and 0.7 percent insecticides.

A final result of the study: The group analyzes which variables exert the most control over how much PAS remain unchanged in soils and how much is discharged to the oceans. In both cases, the main predictor is the rate of application to fields. For soil residues, annual soil water saturation, temperature and organic carbon content come next. For the oceans, the next most controlling variables are the surface area of the crop treated with pesticides, the surface area of the watershed, and the length of the river.

The study is a first approximation of the scale of the problem posed by pesticides traveling through planetary waters. Its results suggest that pesticides' deleterious effects on the biosphere extend much farther than manufacturers claim. Over time, the global water cycle ensures that everything on land, including mountains, reaches the sea, and putting anything into water diminishes any control humans might have over it. To interrupt the cascade of pesticide catastrophes, understanding the source is critical: the fields where the pesticides are applied. Stopping the process there is the most direct and effective way to start recovering from the damage pesticides cause.

The U.S. Supreme Court is not making the task any easier. As Beyond Pesticides observed last June, President Biden said the Court's recent ruling in *Sackett v. Environmental Protection Agency (EPA)* "will take our country backwards" because it "dramatically limits the EPA's ability to protect critical wetland ecosystems," which are integral parts of continental watersheds. This means the burden of pesticides on waterways will increase, and, according to the Australian researchers, part of their active ingredients will traverse rivers all the way to the ocean.

Government agencies are not monolithic in their failure to press for improved regulation. Beyond Pesticides has covered the U.S. Geological Survey's critique of the EPA's regulation of pesticides in water. The USGS reported in 2020 that of its 110 National Water Quality Monitoring Network sampling sites, only 2.2 percent of the water samples were free of detectable pesticides. It is firmly established that humans are exposed to pesticides and their various related compounds through drinking water and carry body burdens of these chemicals that threaten their health.

SOURCE: F. Maggi, et al., Agricultural pesticide land budget and river discharge to oceans. *Nature* (2023), https://www.nature.com/articles/s41586-023-06296-x.

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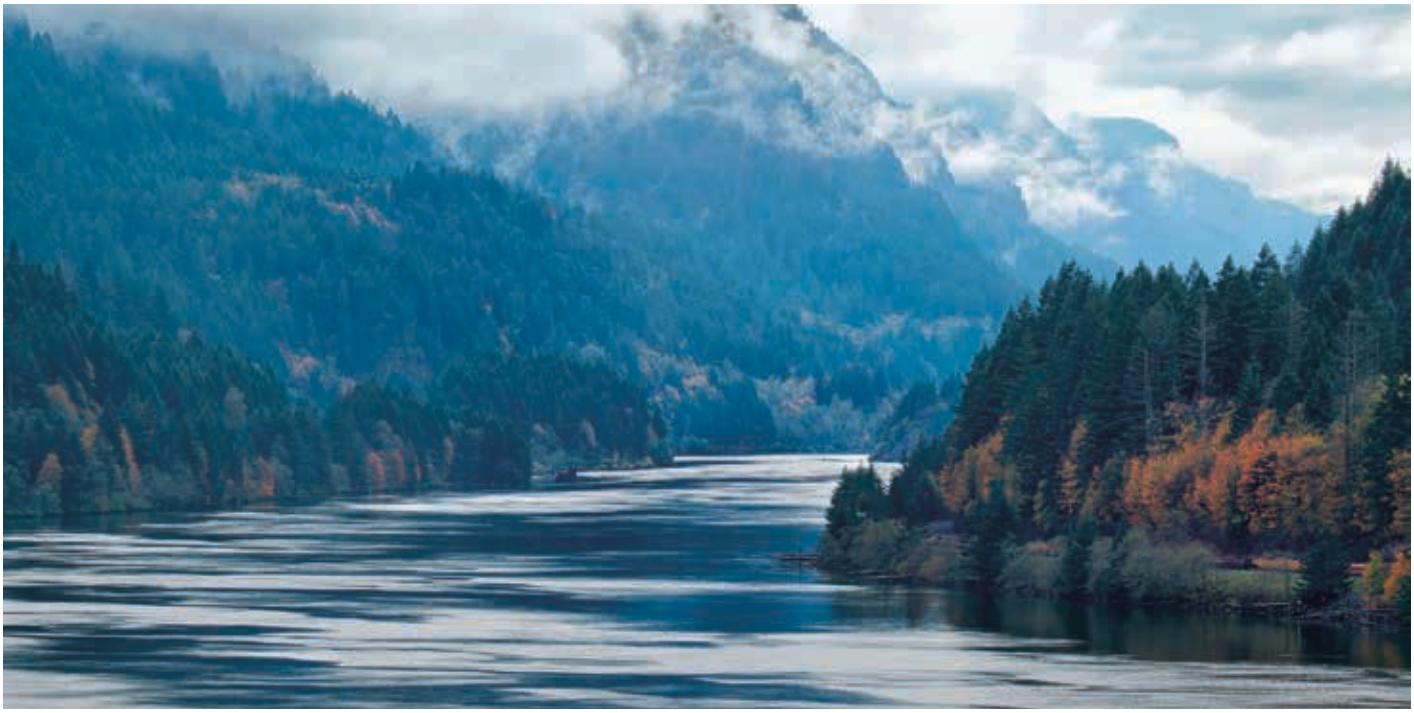

ENDANGERED SPECIES | APRIL 14, 2023

Two Pesticides Threaten Dozens of Endangered Species, EPA Proposes Failed Risk Mitigation Measures

In March, scientists at the National Marine Fisheries Service (NMFS) issued a draft Biological Opinion (BiOp) stating that carbaryl and methomyl—two commonly used carbamate insecticides—cause significant harm to dozens of already-endangered fish species in the Pacific Northwest's Columbia, Willamette, and Snake rivers. The BiOp indicates that these toxic compounds, in wide use on orchards and field vegetables throughout the Willamette Valley, the Columbia River Gorge, and southeastern Washington, will likely threaten scores of species on the Endangered Species list: 37 species at risk from carbaryl and 30 from methomyl. In addition, the BiOp says, "both are likely to harm or destroy many areas designated as critical habitat for endangered species." The mitigation measures proposed by NMFS and the U.S. Environmental Protection Agency (EPA), in light of this BiOp, are likely to be inadequate to the problem, given that both compounds can drift through air and/or migrate into groundwater and generate toxic runoff.

These two neurotoxic insecticides, carbaryl and methomyl, are very toxic to bees, birds, fish, and other aquatic organisms. In addition, carbaryl is a likely human carcinogen and an endocrine disruptor, and has harmful impacts on multiple bodily systems. Methomyl is also an endocrine disruptor and can cause renal and hepatic (liver) damage.

When EPA makes a determination that a pesticide product may so affect such species or habitats, the agency must initiate formal consultation with NMFS, the FWS, or both. Those agencies may then develop and issue their own BiOps on the jeopardy a pesticide presents to listed species and/or critical habitats.

NMFS and U.S. Fish and Wildlife Service (FWS) are the lead federal agencies tasked with implementing the Endangered Species Act (ESA). Under the law's requirements, EPA must evaluate any pesticide it registers to make sure it is not likely to result in jeopardy to the "continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat of such species."

When EPA makes a determination that a pesticide product may so affect such species or habitats, the agency must initiate formal consultation with NMFS, the FWS, or both. Those agencies may then develop and issue their own BiOps on the jeopardy a pesticide presents to listed species and/or critical habitats. The new NMFS draft BiOp is open to public comment until May 15; at some

point after that date, EPA will provide official comments to NMFS for consideration in developing its final opinion.

Beyond Pesticides has noted—in its 2020 comments on the draft ESA Biological Evaluations for carbaryl and methomyl—that the ESA embodies a more precautionary approach than does the *Federal Insecticide, Fungicide and Rodenticide Act* (FIFRA), federal pesticide law. The consultation requirement means that scientists at FWS and/or NMFS, who have greater expertise in evaluating harms to species and their habitats than do EPA scientists, have the chance to influence EPA pesticide regulation.

The EPA website indicates that it and NMFS are particularly interested in public comments relating to (1) additional risk reduction options beyond those described in the biological opinion; (2) the general feasibility of drift reduction measures based on wind direction; and (3) runoff and/or spray drift reduction technologies.

The draft BiOp suggests measures to "avoid jeopardy, including a flexible list of chemical-specific measures to reduce loading of pesticides into aquatic habitats to protect them from adverse effects of pesticide exposure. It also includes measures to minimize take and impacts to critical habitats, such as the development of ESA educational materials, reporting of label compliance monitoring, and inclusion of label information about ecological incident reporting." (Under ESA, "take" means unintentional harm or killing of an individual of a protected species.) According to *Oregon Public Broadcasting*, FWS "recommends either prohibiting the chemicals within 300 meters (about 325 yards) of species' habitat or implementing mitigation practices, like expanding vegetation ditches as buffers or using tools that reduce runoff."

The EPA website indicates that it and NMFS are particularly interested in public comments relating to (1) additional risk reduction options beyond those described in the biological opinion; (2) the general feasibility of drift reduction measures based on wind direction; and (3) runoff and/or spray drift reduction technologies. Clearly, EPA is aware that drift and runoff represent ongoing vectors for listed species' exposures to these two compounds; a between-the-lines read might reasonably conclude that EPA understands that current measures do not adequately protect the Northwest species at risk from carbaryl and methomyl.

As background: According to the EPA website, in March 2021, the agency completed its final biological evaluations for carbaryl and methomyl—resulting in determinations of "likely to adversely affect" (LAA) for 1,640 listed species and 736 designated critical habitats for carbaryl, and 1,098 listed species and 736 designated critical habitats for methomyl. Carbaryl continues to undergo the every-15-years registration review required by FIFRA, the federal statute governing all things "pesticide"). In October 2022, EPA announced revisions to the proposed interim registration decision on methomyl.

In late December 2022, EPA proposed new mitigations to attempt to curb some of the harms of carbaryl's use, including:

- Some use cancellations for residential dust formulations, residential granular formulations on turf, use on rice, and backpack applications to control tree boring beetles.
- Additional personal protective equipment for some uses.
- Longer restricted entry intervals for some uses.
- Mandatory spray drift language that prohibits application within 25 feet of aquatic habitats for ground applications and 150 feet for aerial applications.
- Mitigation to reduce runoff through protection statements and application restrictions during rain.
- Measures to protect pollinators from carbaryl exposure, including restrictions on applications during bloom.

EPA also proposed at the time a "pilot" set of measures for protection of four endangered species, one of which was—notably—steelhead trout in the upper Columbia River. It also offered a number of "reasonable alternative measures" intended to protect listed salmon and steelhead species in Washington, Oregon, Idaho, and California; those included vegetated filter strips, retention ponds, water control structures, no-till/reduced tillage practices, riparian hedgerow, and no-spray buffers. As of publication, no evidence of the enactment of these measures was publicly and readily available.

As for methomyl, EPA issued (in 2022) Proposed Revisions to the Methomyl Proposed Interim Registration Review Decision—on the heels of a successful lawsuit brought by the Center for Biological Diversity and Pesticide Action Network. EPA had made LAA determinations for 1,098 species and 281 designated critical habitats in its BiOp on the compound's impacts. In response, the agency proffered another set of mitigation measures (roughly analogous to those for carbaryl), including a three-species pilot. Remarkably, EPA concluded that the proposed FIFRA mitigation largely addresses the potential effects on Pacific salmon and steelhead species, of the use of methomyl.

In February 2023, Beyond Pesticides reported on other chemical pesticide assaults on Northwest salmonid species (which include steelhead trout); previously, Daily News covered the harms of three organophosphate pesticides (chlorpyrifos, malathion, and diazinon) on these same species. (The organophosphate insecticide malathion and methomyl have a similar mode of action—acetylcholinesterase inhibition.) These fish species are economically, culturally, and ecologically critical to the region.

The multiplicity of pesticides to which they are exposed, given intensive agricultural pesticide use in the region, contributes significantly to the well-documented decline of salmonid species. Subject simultaneously to impacts of pesticides, habitat loss, and climate change, these species are in trouble.

EPA has a history of continuing to allow use of pesticides that are demonstrably harmful, and taking relatively anemic measures to amend the compounds' use, in an attempt to reduce harms; examples fairly abound. In the current biodiversity crisis, for which pesticides bear some responsibility, the agency's lack of robust protective action is unacceptable.

In March 2022, EPA—succumbing to industry pressure—continued the registration of the organophosphate insecticide malathion, despite the agency's own findings that this class of insecticides has negative impacts on more than 1,000 endangered and threatened species, and that malathion, specifically, threatens 1,284 species. In 2021, EPA reregistered paraquat, the most acutely dangerous herbicide on the market, with some additional constraints on its use. (It subsequently went to a federal court in October 2022 to request permission to return and reconsider its decision to reapprove paraquat.)

In 2016, EPA registered sulfoxaflor, a so-called "novel," systemic, neurotoxic insecticide that, like neonicotinoids, acts on nACh (nicotinic acetylcholine) receptors, and is very toxic to bees. Beyond Pesticides wrote at the time, "This decision is the final result of a long-fought legal battle over the chemical's registration, spearheaded by beekeepers and public health organizations concerned with what has been identified as EPA's inadequate and flawed pesticide review processes. The agency claims that amendments made to the original registration . . . will protect pollinators. However, scientific studies have shown that there is no way to fully limit exposure to bees, especially native species that exist naturally in the environment, given that the chemical, being systemic, is found in pollen, nectar, and guttation droplets."

Sulfoxaflor is used to kill aphids and another sucking/piercing insects on many crops, including vegetables, fruits and tree fruits, and nuts. In 2019, EPA granted approvals for sulfoxaflor to be used extremely widely *on crops that are highly attractive to pollinators*—an astonishing move, given the toxicity to bees. Research suggests that beneficial insects are exposed to sulfoxaflor at relatively high concentrations in agricultural environments. In a late 2021 win for bees, a California Superior Court ruled that this "field legal but bee lethal" pesticide could no longer be used in the state.

In its comment to EPA on registration of sulfoxaflor, Beyond Pesticides wrote, "EPA is proposing to repeat missteps of the past by registering a pesticide known to be toxic to nontarget organisms without all required data to ensure its safety. As already seen with the neonicotinoid clothianidin, and the herbicide aminocyclopyrachlor, conditional registration without relevant ecological data can be detrimental to nontarget species." Indeed, according to *The Chicago Tribune*, attorneys general from Illinois and 12 other states have now called on EPA to restrict use of sufloxaflor because of its toxic impacts on bees and other pollinators.

Beyond Pesticides Executive Director Jay Feldman notes that, "EPA is consistently unrealistic and downright misleading about the real effects of the pesticide risk mitigation measures it enacts. They do not meet the agency's statutory mandate to protect health and the environment; what result are agency decisions that allow harm to those people and ecosystems EPA is charged with protecting."

Beyond Pesticides has repeatedly critiqued EPA for its abject lack of appropriate protective action on toxic pesticides—especially in the face of species on the brink of extinction, the unfolding pollinator and insect collapse, endemic human health impacts, and widespread contamination of natural resources and ecosystems. Many health and environmental advocates see EPA as an irresponsible federal agency falling far short of meeting its mission, as the nation (and world) face those extreme challenges.

"EPA is proposing risk mitigation measures that the agency knows do not work. It's shameful," said Mr. Feldman. He continued, "EPA knows that nothing short of cancellation is adequately protective, and the agency should know that we no longer need these toxic chemicals to produce food and manage landscapes."

Conventional, chemical-intensive U.S. agriculture—and the huge network of businesses, trade groups, and government agencies and programs that inform, support, and help fund it—is incredibly "dug in" to pesticide use as the way to do business.

Conventional, chemical-intensive U.S. agriculture—and the huge network of businesses, trade groups, and government agencies and programs that inform, support, and help fund it—is incredibly "dug in" to pesticide use as the way to do business. This grave and recklessness addiction to chemical pesticides in agriculture can be genuinely solved through a solution that is known, demonstrable, executable, and scalable: the transition to organic, regenerative agricultural practices. Organic agriculture can not only maintain productivity and profitability, but also increase societal resiliency, sustain living beings and Nature's functional integrity, and liberate everyone and everything from the toxic impacts of pesticides.

SOURCE: U.S. Environmental Protection Agency, EPA Posts Draft Biological Opinion for Carbaryl and Methomyl for Public Comment, March 16, 2023.

POLICY | APRIL 27, 2023

Nevada Assembly Votes Unanimously To Protect Pollinators, Recognizes Deficiencies of EPA Regulations

[Eds. Note: Subsequent to this article, the Nevada legislature passed the legislation that is the subject of this article.]

The Nevada Assembly, by unanimous vote, took the state one step closer to banning the use of neonicotinoid insecticides used on plants, with a waiver for commercial agricultural purposes. Despite dramatic declines in bee populations linked to neonicotinoid pesticides and other toxic pesticides, the U.S. Environmental Protection (EPA) and state regulatory authorities have for the most part ignored beekeepers and the independent scientific literature by allowing widespread toxic pesticide use—forcing elected officials to take protective action. Portions of the bill take effect upon passage or no later than January 1, 2024. Maine and New Jersey have adopted similar legislation.

The failure to adequately regulate pesticides under federal law, the *Federal Insecticide, Fungicide, and Rodenticide Act* (FIFRA), and EPA inaction is viewed by environmentalists as a shocking disregard for the importance of biodiversity to sustaining life. The inadequate restriction of pesticides and slower than necessary transition to organic land management practices are viewed as major contributors to the "insect apocalypse." The legislation (A.B. 162), led by Assemblywoman Michelle Gorelow and a group of nine other Assemblymembers, illustrates a growing trend of local and state legislative bodies asserting their authority to protect against health, biodiversity, and climate crises, linked to petrochemical pesticides and fertilizers, that are escalating out-of-control to devastating levels—with the U.S. Congress and federal agencies standing silent.

A systematic review of insect population studies worldwide in Biological Conservation magazine (2019) reports on "the dreadful state of insect biodiversity in the world, as almost half of the species are rapidly declining and a third are being threatened with extinction."

"We applaud the Nevada Assembly's initiative to protect pollinators and urge elected officials nationwide to see the pending biodiversity collapse as reason for broader action to eliminate petrochemical pesticides and fertilizers with organic systems that are effective and cost competitive," said Jay Feldman, executive director of Beyond Pesticides.

A systematic review of insect population studies worldwide in *Biological*

Conservation magazine (2019) reports on "the dreadful state of insect biodiversity in the world, as almost half of the species are rapidly declining and a third are being threatened with extinction." The study concludes with the dire prediction that insects as a whole will go extinct in the next few decades if patterns of pesticide use and other factors continue. Many systemic pesticides, like neonicotinoids, are taken up by the vascular system of the plant and expressed through pollen, nectar, and guttation droplets, causing indiscriminate poisoning and death to pollinating and foraging insects, including bees, butterflies, and birds. The chemicals also move through soil, killing terrestrial and aquatic organisms.

The complexity of pesticide hazards is captured in a statement by biology professor Matthew Forister, PhD, University of Nevada (Reno), who told the Natural Resources Nevada Assembly Committee: "[T]he extreme and prolonged droughts of recent decades are reducing the densities of beneficial insects in . . . open lands. This new reality elevates the importance of all decisions that we make about managed lands, and chief among these decisions is the use of pesticides."

As is typical, pesticides often cause a mixture of environmental and public health effects. According to Drew Toher, former community resource and policy director, Beyond Pesticides, "Emerging data shows neonicotinoids can act as hormone disruptors, increasing the risk of breast cancer; they can readily transfer from mother to fetus through the placenta, increasing risk of birth defects; they are associated with liver damage, and neurological impacts like memory loss."

The Toiyabe Chapter of the Sierra Club said, "The good news is that there are many safe alternatives to using neonicotinoid pesticides. If we switch to these safer methods, we could save the pollinators, other animals, and improve human health."

The New York State Assembly passed a similar bill (A03226), the *Birds and Bees Protection Act*. The Act bans neonicotinoid use on outdoor ornamental plants and turf, with a general exemption for agriculture except for treated seed. The bill, opposed by the New York Farm Bureau, contains a ban on seeds treated with neonicotinoids, but includes an "emergency" override by the State Commissioner of Agriculture, based on a written determination that (i) a valid environmental emergency exists; (ii) the pesticide would be effective in addressing the environmental emergency; and (iii) no other, less harmful pesticide or pest management practice would be effective in addressing the environmental emergency. The bill would immediately ban chlothianidin or dinotefuran, leaving the most widely used neonicotinoid imidachloprid, as well as thiamethoxam or acetamiprid, on the market until July 1, 2025.

SOURCE: Assemblywoman Michelle Gorelow, Assembly Bill No. 162, February 14, 2023.

POLICY | JUNE 15, 2023

Recent Supreme Court Ruling on Clean Water Act "Will Take Our Country Backwards"

The Supreme Court's recent ruling in *Sackett v. Environmental Protection Agency (EPA)* on the *Clean Water Act*'s jurisdiction dramatically limits EPA's ability to protect critical wetland ecosystems. On May 25, in a 5-4 majority decision, the Supreme Court ruled that EPA has authority to protect only "wetlands with a continuous surface connection to bodies that are 'waters of the United States' in their own right." Wetlands must appear "indistinguishable" from larger waterways at a surface-level perspective. Wetlands next to a large waterway are no longer protected if they are separated by a manmade or terrestrial barrier. Water flows underground from upstream to downstream sources and exits the confines of its customary boundaries during periods of flooding, so to declare waterways distinct based merely on a surface-level perspective defies scientific understanding of ecosystem health.

Critical Nature of Wetland Ecology

The conservation of wetland ecology is critical to the health of the environment. The United States Geological Survey (USGS) states, "Wetlands are among the most productive habitats on earth" given their role in flood resilience, improvement in water quality, and coastal erosion control. Wetlands are essential nursery grounds for many species of fish and oases for migratory birds en route to their final destinations.

Not only are wetlands one of the most crucial ecosystems on the planet, but they are also particularly vulnerable to stressors such as habitat loss, pollution, and climate change. Both sea level rise and rapid human development are quickening the pace of their disappearance. Upstream runoff can carry destructive chemical pesticides and fertilizers that wreak havoc on downstream ecosystems. Many wetlands are brackish, meaning they are a mixture of fresh- and saltwater. When sea levels rise, coastal wetlands are inundated with massive amounts of seawater, throwing off their careful salt concentrations and spelling out death for organisms reliant on a narrow range of water chemistry.

History of Clean Water Act and Court Cases

The *Clean Water Act* (CWA) has played an integral role in the preservation of environmental health over the last few decades. Prior to the passing of CWA, jurisdiction of the nation's waterways was left in the hands of the states and very few regulations were imposed. The federal government finally took action after Ohio's Cuyahoga River spontaneously caught fire in 1969 due to a substantial amount of pollution in the waters. Passed in 1972, CWA "aimed to restore and maintain the chemical, physical, and biological integrity of the nation's waters." The law forbids "unpermitted discharges of pollutants to 'navigable waters,'" which are defined as "the waters of the United States." A few years later, authority was broadened to encompass waters "adjacent" to navigable waterways. CWA sets industrial wastewater standards, requires a strict permitting process regarding wetland development, and outlines safety limits for contaminant concentrations in drinking water. EPA and the Army Corps of Engineers are tasked with the protection of wetlands and enforcement of CWA regulations to defend water quality against polluting industries.

Despite the success of CWA in improving the quality of waterways, decades-long debates have pitted politicians against each other over the ambiguity of exactly which "waters of the United States" fall under EPA jurisdiction. Under constitutional law, the legislative branch is granted the power to regulate interstate commerce. This detail found in Article I, Section 8, allows a federal agency (e.g., EPA) to impose waterway regulations within states since "navigable waters" play an important role in interstate commerce. Historically, wetlands neighboring a large waterway, despite an interrupted surface connection, were under EPA's jurisdiction. Even the smallest creeks, however, run downstream to larger lakes and rivers, so many believe the original wording of CWA does not clearly portray the extent of the EPA's authority. EPA and the Army Corps of Engineers often consider potential regulatory infractions on a case-by-case basis, but court cases in years since have attempted to clarify these uncertainties.

One such landmark case brought before the Supreme Court in 2006, *Rapanos v. United States,* highlighted key issues related to CWA's scope in a case brought by a land developer. Half of the Court supported a broad interpretation of "waters of the United States" that includes smaller tributaries that eventually flow into larger bodies of water. The opposing justices, led by Justice Antonin Scalia, favored more limited EPA authority, arguing for the protection of what they referred to as only "traditionally navigable waters" or those "indistinguishable" from such. To qualify, neighboring tributaries would have to be "relatively permanent" bodies of water with a "continuous surface connection" or uninterrupted by any terrestrial barriers. A contentious case, the ruling concluded with a 4-1-4 plurality. The court finally decided on a resolution by Justice Anthony Kennedy, the concurring vote, in which he deemed EPA jurisdiction extending to "traditionally navigable waters," as well as any U.S. waters serving as a "significant nexus," meaning wetlands that "either alone or in combination with similarly situated lands in the region, significantly affect the chemical, physical, and biological integrity" of the navigable waters. Ambiguity, however, remained, as one could endlessly debate what qualifies as "significant."

In 2015, the Obama administration took a position on the not fully defined language of the amended

CWA. The administration's stance, known as WOTUS (waters of the United States), and later the Clean Water Rule, asserts that any waterway active for at least part of the year (implying seasonally flowing or ephemeral streams) qualifies as a protected wetland and is therefore under EPA jurisdiction. EPA had spent years studying the effects of upstream pollutants on downstream waters and, based on its in-depth scientific reports, found that protecting all tributaries and wetlands is necessary to the preservation of the quality and health of larger waterways. This position generated immediate backlash, as the industrial, mining, and agricultural sectors, as well as property rights activists, fought the protection of seasonally active waterways. The rule was stayed in federal court as lawsuits began piling up in states around the country, and the administration looked to adjust the rule in response.

EPA had spent years studying the effects of upstream pollutants on downstream waters and, based on its reports, found that protecting all tributaries and wetlands is necessary to the preservation of the quality and health of larger waterways.

The statutory intent of CWA was then entirely turned upside down with the Trump administration. In a 2019 reversal of Obama-era protections, the Trump administration maintained that justices led by Scalia in the *Rapanos* case had gotten it right, limiting protections to tributaries with a direct surface connection to larger waterways.

In an attempt to compromise, the Biden administration set standards similar to those prior to 2015, falling between the broad protections of the Obama administration and the extremely limited protections of the Trump administration. This approach meshes "traditional navigable waters" with adjacent waterways, including "inter-state waterways and upstream water sources that influence the health and quality of those waterways." With this interpretation, a small land divide does not render two nearby wetlands separate. Environmentalists generally support this effort and affirm that this rule is "central to efforts to restore the health of impaired waterways and fragile wildlife habitats because it gives federal and state governments powers to limit the flow of pollutants, including livestock waste, construction runoff and industrial effluent."

Present-Day Supreme Court Case

So now for the case at hand: Chantell and Michael Sackett, a couple beginning construction of a house on an area of wetlands near Priest Lake in Idaho, were alerted by EPA that their land fell under the protection of CWA. The Sacketts disagreed with the EPA's stance and took the issue to court. After the case made its way to the Supreme Court, the justices concluded that the Sacketts' land did not fall under the protections granted by CWA and then curtailed the reach of the law by limiting CWA to larger bodies of water, such as lakes and oceans.

Objecting to the perspective of the majority, Justice Elena Kagan, joined by Justices Sonia Sotomayor, Ketanji Brown Jackson, and Brett M. Kavanaugh, compares this case to one last year limiting EPA's authority to limit greenhouse gas emissions under the *Clean Air Act*. In both cases, the Court voted to vastly limit the EPA's jurisdiction, with dangerous implications for the future health and safety of people and the planet.

Consequences of the Ruling

The dissenting justices highlight the destructive effects this ruling will have on nationwide water quality and flood control, as EPA is now drastically limited in its "ability to extend protections to upstream waters in order to protect downstream water quality for drinking and wildlife." Wetlands are a filtration system, trapping many pollutants and preventing them from traveling downstream into major waterways. Environmental advocates say that this will cause broad adverse effects, from the Everglades to maintenance on the levee systems along the Mississippi River to cleanup projects along the Chesapeake Bay. According to some estimates, about 50 percent of wetlands will lose federal protection. The environmental law firm Earthjustice estimates that federal protections will be withheld from 118 million acres of wetlands.

President Biden has warned that the Supreme Court decision "will take our country backwards," and assured the public he will continue to fight for clean water. In his statement, the President continued, "Today's decision upends the legal framework that has protected America's water for decades. It also defies the science that confirms the critical role of wetlands in safeguarding our nation's stream, rivers, and lakes from chemicals and pollutants that harm the health and wellbeing of children, families, and communities." EPA Administrator Michael Regan said that the ruling has "ripped the heart out of the law." The Natural Resources Defense Council cited the "incalculable harm" that will come of the decision.

Multiple legal observers predict that the two court rulings in the past year regarding the EPA's authority under the *Clean Water* and *Clean Air Acts* may be the start of a pattern of restrictions on federal authority in the environmental sector. At a time when an immediate response to climate change and chemical pollution is more urgent than ever, these decisions are seen by environmentalists and public health advocates as undermining action necessary for a sustainable future by opening the door to widespread and unrestricted contamination of wetlands and waterways necessary to support life.

SOURCE: U.S. Supreme Court, Sackett v. Environmental Protection Agency, Docket No. 210-454, May 25, 2023.

POLICY | OCTOBER 20, 2023

Take Action Today: Tell EPA To End Pesticide Dependency, Endangered Species Plan Is Inadequate

The U.S. Environmental Protection Agency's (EPA) plan to "protect" endangered species, its *Draft Herbicide Strategy Framework*, continues a legacy of failed risk assessment and mitigation measures that do not meet the moment of looming biodiversity collapse. This is a critical time for the agency to embrace real fundamental change in how it regulates pesticides, recognizing that land management strategies, including in agriculture, exist that are no longer reliant on pesticides. This is not a time to tinker with strategies that EPA admits fall short.

Recognizing that its Pesticide Program has failed to meet its obligation to protect endangered species from registered pesticides, EPA has come up with a strategy to redefine its responsibilities to protect endangered species in its pesticide registration and registration review program. According to EPA, "The proposed Strategy is structured to provide flexibility to growers to choose mitigations that work best for their situation. Additionally, the draft Strategy may require more or less mitigation for growers/pesticide applicators depending on their location."

Understandably, EPA has taken this approach, finding it virtually impossible to meet the statutory obligations of the *Endangered Species Act* (ESA)—given the fact that the agency itself admits, "EPA's Pesticide Program has been unable to keep pace with its ESA workload, resulting not only in inadequate protections for listed species but also successful litigation against the Agency." And, "Even if EPA completed this work for all of the pesticides that are currently subject to court decisions and/or ongoing litigation, that work would take until the 2040s, and even then, would represent only 5% of EPA's ESA obligations."

EPA starts with the position that farmers must use toxic chemicals, an assumption that clouds and undermines the regulatory process and keeps farmers on the pesticide treadmill. EPA says, "Without certain pesticide products, farmers could have trouble growing crops that feed Americans and public health agencies could lack the tools needed to combat insect-borne diseases." This is not true. Organic farmers are not reliant on these pesticides.

EPA recognizes that it needs to fundamentally change. But to EPA, the "fundamental change" means risk mitigation measures that have failed miserably over its history—drift mitigation being one of many key failures. In fact, the fundamental change that is needed is change of agricultural practices that have kept farmers dependent on chemical-intensive practices. Fundamental change requires EPA in every pesticide registration and registration review to ask whether there are practices that can eliminate the harm, not reduce risk with high degrees of uncertainty.

The planet faces an existential biodiversity crisis, with a rising number

of species on the brink of extinction. The goal of ESA is to address the broader issue of biodiversity loss by protecting habitats of species most at risk, or, as stated in ESA, to "Provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth. . ." in the law.

On the contrary, EPA's language about its proposed changes includes phrases like "draft Strategy may require more or less mitigation for growers/pesticide applicators depending on their location." That is not a plan to avoid biodiversity collapse.

Pesticide use is a major cause of declining biodiversity, which is manifested in extinctions, endangered species, and species vulnerable to environmental disturbances—including climate change, habitat fragmentation, and toxic chemicals. If EPA is serious about protecting biodiversity, it must look first to the ways it has created the crisis in the first place. Yet EPA admits the limitations of its own proposal, saying, "The scope of this document is limited to spray drift, aqueous runoff, and runoff of sediment-bound residues (erosion)." Moreover, EPA fails to recognize that the agency does not have toxicological data for key endpoints or health outcomes like endocrine disruption, an effect that can wipe out a species by undermining its ability to reproduce.

Pesticides are a major contributor to the loss of insect biomass and diversity known as the "insect apocalypse," posing a threat to life on Earth. EPA's registration of insecticides has always endangered insects, but herbicides destroy the food and habitat of insects. Similarly, pesticides threaten food webs in aquatic and marine environments.

Pesticides threaten frogs and other amphibians in a way that demonstrates the potential to warp the growth and reproduction of all animals. Agricultural intensification, in particular pesticide and fertilizer use, is the leading factor driving declines in bird populations. Industrial agriculture eliminates habitat—either through outright destruction or through toxic contamination. In much of the U.S., agricultural fields are bare for half the year and support a single plant species for the other half. As opposed to industrial agriculture, organic producers are required to conserve—protect and increase—biodiversity.

In other words, a major reason that species are endangered is that EPA has registered pesticides that harm them. If EPA is to really protect endangered species, it must eliminate the use of toxic pesticides and encourage organic production.

SOURCE: U.S. Supreme Court, *Sackett v. Environmental Protection Agency,* May 25, 2023.

POLICY | NOVEMBER 3, 2023

States Step In To Restrict Bee-Toxic Pesticides, California the Latest in Absence of EPA Action

California joined 10 other states that have laws partially restricting use of bee-toxic neonicotinoid (neonic) insecticides with the enactment of CA AB 363 into law in October, 2023. California's new law will ban over-the-counter sales of lawn and garden neonics by 2025, limiting their use to licensed pesticide applicators. The legislation gives the state's Department of Pesticide Regulation (CA EPA) until June 30, 2029 to take broader action on neonics, if it determines restrictions are necessary. CA 363 will take neonics out of the hands of homeowners, while allowing lawn care companies to continue use. The California law falls short of the strongest state laws in Nevada, New Jersey, and Maine that eliminate all outdoor (nonagricultural) uses of these chemicals, even by lawn care companies. In June 2023, Nevada became the third state to ban lawn and garden uses of neonics, while Colorado prohibited homeowner use of land and garden neonic products, similar to laws in Maryland, New York, Massachusetts, Rhode Island, and Vermont. Minnesota recently banned neonic use on state lands and granted its home rule subdivisions the authority to ban "pollinator-lethal pesticides" (those with bee warning labels) under its state law preempting local authority to restrict pesticides. All of these state-level restrictions pale in comparison to the robust protections currently implemented in the European Union (EU), where the EU has banned neonicotinoid pesticide use on all outdoor areas, allowing use only in enclosed greenhouses.

The actions of the 11 states acting on neonics and asserting their authority in the absence of action by the U.S. Environmental Protection Agency (EPA) are positive steps, but fall short of meeting escalating and devastating health, biodiversity, and climate crises that are linked to neonicotinoids and other petrochemical pesticides and fertilizers. Evaluating individual hazardous pesticides has been dubbed a process of the "whack-a-mole." Professor and author David Goulson, PhD, who studies the enormity of the pollinator and biodiversity crisis, author of Silent Earth: Averting the Insect Apocalypse (2021),

and speaker at Beyond Pesticides' September National Forum Series (2023), urges a rejection of this "whack a mole" approach in favor of a systemic change to stop all pesticide and synthetic chemical use. The solution, he said, can be found in a systems approach like organic land management; it is effective and will safeguard pollinators, food production, wildlife, water quality, and the environment, while reducing risks to human health.

Beyond Pesticides advocates for the transition from chemical dependency to organic land management in food production, and in parks, playing fields, and all recreational and public spaces. "We urge elected officials nationwide to see the looming biodiversity collapse as reason for broader action to eliminate petrochemical pesticides and fertilizers with organic systems that are effective and cost competitive," said Jay Feldman, executive director of Beyond Pesticides. "Each ban or partial regulation of a particular pesticide, each bit of research demonstrating harms—these represent small, incremental advances on a pesticide problem that is vast in scope and requires a shift to organic," says Mr. Feldman.

Neonics more toxic than DDT

Dr. Goulson said, "One of the properties of neonicotinoids is that they are phenomenally toxic . . . you certainly heard of DDT. Imidacloprid . . . is much, much more toxic than other insecticides that went before. It takes just four nanograms . . . to kill a bee," making imidacloprid and this new generation of insecticides about 7,000 times more poisonous to a honey bee than DDT. "That means that a teaspoon of imidacloprid would be enough to kill one and a quarter billion honey bees. So the fact that we are applying hundreds of tons of these chemicals to the landscape is quite concerning."

Treated seeds loophole remains (CA 1042 and NY Birds and Bees Protection Act)

California Governor Gavin Newsom declined to sign into law AB 1042, which could have taken a modest step toward addressing the neonic-treated seeds loophole that allows neonic-coated seed to go unregulated by either EPA or state regulatory agencies, despite proven deadly effects and well documented harm to biodiversity, human health, and widespread contamination of groundwater and surface waters. The New York State Assembly passed a similar bill (A03226), the *Birds and Bees Protection Act*, that awaits NY Governor Kathy Hochul's signature. [The bill was amended and signed by the Governor at the end of 2023.] The NY bill would ban neonicotinoid use on outdoor ornamental plants and turf, with a general exemption for agriculture, except for treated seeds [to be regulated by 2029]. The coated seed provision of the act would be suspended if the Commissioner of Agriculture determines that neonic-free seeds are not commercially available. With chemical companies controlling the seed market, the effectiveness of this provision remains to be seen. A phaseout of treated seeds would incentive and help grow the neonic-free seed market. The bill would leave the most widely used neonicotinoid, imidacloprid, as well as thiamethoxam or acetamiprid, on the market until July 1, 2025. [For update on final bill, see Bill to Protect Birds and Bees in New York Raises Political Challenges to Addressing Ecosystem Collapse.]

Meanwhile, the intensive use of neonics as seed treatments continues despite a stark lack of efficacy. EPA itself (in 2014) reported that "seed treatments with neonicotinoid insecticides provide little or no overall benefit in controlling insects or improving yield

or quality in soybean production." (See the detailed EPA letter on the underlying research here.) Research in 2019, as reported by Beyond Pesticides, found that neonic-treated soybeans provide negligible benefits to farmers in terms of yield and overall economic benefit. EPA ought, in its neonic registrations and reregistration, to evaluate whether pesticide compounds—especially those with such demonstrated harms as neonics cause—are necessary and effective before introducing them into the environment or allowing their continued deployment.

Minnesota took a small step in regulating pesticide-treated seeds, including neonicotinoid coated seeds, and their disposal, after treated seeds were used in ethanol production, creating toxic waste with disastrous consequences. Because of a regulatory loophole, EPA does not monitor or otherwise regulate treated seed use and disposal. In the absence of any federal regulation, Minnesota laws HF1317/ SF1339 will now direct state officials to develop rules and consumer guidelines for the proper use and disposal of "waste" pesticide-treated seeds.

Because the use of neonics is widespread, from agriculture to parks, playing fields, to lawns, public exposure is dramatically high. As reported in January, the Centers for Disease Control and Prevention (CDC) cites half the U.S. population encountering at least one type of neonic daily, with children ages three to five having the highest exposure risk. Health impacts of exposure to neonics can include neurotoxicity, reproductive anomalies, hepatic and renal damage, and an increase in gene expression linked to hormone-dependent breast cancer . . . mounting evidence over the past years shows that chronic exposure to sublethal (low) levels of pesticides can cause neurotoxic effects or exacerbate preexisting chemical damage to the nervous system. The impacts of pesticides on the nervous system, including the brain, are hazardous, especially for chronically exposed individuals (e.g., farmworkers) or during critical windows of vulnerability and development (e.g., childhood, pregnancy).

Pollinator losses have broad implications for reducing the global production of nuts, fruits, and vegetables by 3–5 percent, and this loss of healthy, nutrient-dense food is resulting in over 425,000 excess deaths each year, according to research published in December 2022 in Environmental Health Perspectives. According to researchers, "Today's estimated health impacts of insufficient pollination would be comparable to other major global risk factors: those attributable to substance use disorders, interpersonal violence, or prostate cancer." The availability of nontoxic alternative materials and practices, as are used in organic management, raises questions about EPA's determination that neonic use is "reasonable" for registered crops under federal pesticide law, given competitive productivity and profitability without it. Beyond Pesticides advocates for organic land and agriculture management as precautionary approach to pest prevention and management.

SOURCE: American Bird Conservancy, Failing to come to grips with a predictable environmental disaster, June 2023.

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