

Purdue Research on Impacts of "Forever Chemicals"

"Forever chemicals" is a catch-all term that refers to a family of over 4,000 types of chemicals designed to repel grease, water, and oil. They can take millennia to break down, and often degrade into smaller-chain chemicals. They appear in hundreds of common domestic products including stick-free cookware, water-proof treated fabrics, cleaning products, food packaging and fire-fighting foams. Also known by their more technical names, per- and polyfluoroalkyl substances (PFAS), they have been shown to increase the risk of cancer, increase cholesterol levels, impact the immune system as well as hormonal functioning in animals including humans. Having been widely used around the globe since the 1940s, they are found in tissues of most people. A key challenge is identifying potential risks and combining strategies of reduction and remediation.

Key issues our researchers on PFAS chemicals are working on include study of the toxicity of PFAS mixtures, effects of PFAS on the thyroid endocrine and central nervous systems, persistence of PFAS in soil, water and waste effluents, and ecological effects of PFAS on aquatic communities.

We're getting them in our foods through food packaging, in our homes from our furniture and carpet, and we get it from our drinking water.

Linda Lee

Linda Lee

Professor, Agronomy & Program Head for the Ecological Sciences and Engineering Interdisciplinary Graduate Program
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Linda Lee's research focuses on developing a mechanistic understanding of the processes that govern the environmental fate, and possible remediation, of contaminants. This information, in turn, can be used in decision tools and management guidelines for industrial and agricultural settings.

Over the last fifteen years, she has further focused on PFAS and other organic endocrine-disrupting chemicals of emerging concern. A recent breakthrough has been the creation of a reactive filter technology that can transform PFOS and associated compounds with the goal of capturing large diffuse PFOS-associated plumes in water and degrading them into harmless carbon and fluorine.

Lee is also working with wastewater treatment plants across the state on Indiana and, with support from the US EPA, developing strategies to decrease PFAS that exit the plants through effluent and sludge. In 2020, Lee was chosen to lead a \$3.2 million USEPA project to study impacts of biosolids with PFAS on surface and ground waters that feed rural drinking wells in Indiana, Pennsylvania and Virginia. Lee's study will evaluate the levels of PFAS in land-applied biosolids; the fate, transport and crop uptake of PFAS; the levels of PFAS in local rural water supplies; and the ways in which climate, landscape and hydrology affect PFAS movement and distribution.

Jason Hoverman

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Jason Hoverman's research program focuses on environmental stressors in freshwater ecosystems. He seeks to understand the effects of both man-made and natural stressors on animals and their environments. In collaboration with Drs. Sepulveda and Lee, he has worked on the development of toxicity reference values for amphibians exposed to perfluoroalkyl and polyfluoroalkyl substances, PFAS. Recently, his research team received funding from the Michigan Dept. of Natural Resources to assess the ecosystem-level effects of PFAS contamination on wetland food webs. This work will improve our understanding of the bioavailability, bioaccumulation, and biomagnification potential of PFAS within freshwater ecosystems.

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Basically these bonds are indestructible. They're the strongest bond in nature, carbon and fluorine. These chemicals are out there now, everywhere. We don't know how to get rid of them. We don't know how long they persist for. These are final products, so bacteria cannot get rid of them.

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Marisol Sepulveda

Marisol Sepulveda

Professor of Ecology and Natural Systems
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Marisol Sepulveda's interests in ecotoxicology include looking at the sublethal effect of contaminants and environmental stressors on the developmental and reproductive physiology of aquatic organisms. One such stressor of particular interest is animal exposure to, and effects of, environmental contaminants such as PFAS. She is leading a SERDP 5-year project that focuses on developing PFAS toxicity reference values (or TRVs) for amphibians. In collaboration with Drs. Hoverman and Lee, they have exposed different life stages of frogs, toads and salamanders to a range of PFAS and compared uptake and toxicity across different routes of exposure. In general, tadpoles concentrate and eliminate PFAS very quickly (within hours), with very short half-lives. Half-lives are likely longer in terrestrial forms, but those studies have not been conducted. Importantly, results of PFAS exposure include delayed development and metamorphosis, but these responses are species, PFAS, and life-stage dependent. The population-level consequences of these responses remain unclear. This work will increase our understanding of the ecotoxicity of PFAS at sites contaminated with PFAS.

Jason Cannon

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Jason Cannon performs mechanistic research on environmental exposures and neurological disease while also identifying and testing novel therapeutic strategies. He is interested in researching late-life neurological consequences of developmental PFAS exposures using nematode, amphibian, and rodent models. Current research is focused on how developmental PFAS exposures may increase risk for the development of neurodegenerative and psychiatric diseases. He is interested in integrating data across multiple model systems to increase the translational potential of his findings in order to better predict adverse outcomes in humans.

We have almost 90,000 chemicals in commerce, and of that number we have decent toxicology data for only a few hundred.

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Jennifer Freeman

Jennifer Freeman

Professor of Toxicology in the School of Health Sciences
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Jennifer Freeman looks to define the underlying genetic and epigenetic mechanisms of the toxicity of environmental stressors with a current focus on pesticides, metals, radiation, and emerging contaminants. She looks at adverse health outcomes throughout the lifespan as linked to various levels of exposure to harmful chemicals during different stages of development. More specifically, in relation to PFAS, Freeman has looked at how these chemicals impact the endocrine and central nervous systems as demonstrated using the zebrafish as a model system. Recently, she has focused on the neurotoxicity of PFAS mixtures in firefighting foams with funding from the US Centers for Disease Control and Prevention.

We don't want to see these biosolids wind up in landfills or incinerators. These approaches are not sustainable solutions and would eliminate an incredible source of carbon and nutrients that can improve soil and plant health. So, we need to do research to find ways to reduce their mobility from biosolids and remove them in the wastewater plants.

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Linda Lee