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PFOA, PFOS, and Other Perfluoroalkyl Substances: What we Know

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This list is in no way exhaustive. Rather, it attempts to provide a set of primary references that offer key pieces of information in building a clear understanding of the issue. Thus, it is subjective in its completeness. Annotations attempt to identify unique or defining characteristics of each entry.

Comprehensive Reviews

Polyfluorinated Compounds: Past, Present, and Future (2011) Lindstrom, et al. *Environmental Science & Technology*
https://doi.org/10.1021/es2011622

- provides a history of PFAS production and usage; an overview of present knowledge of toxicity, environmental occurrence, and human exposure; and some conjecture on the future of policy surrounding the regulation of these chemicals

Contamination, bioaccumulation and toxic effects of perfluorinated chemicals (PFCs) in the water environment: a review paper (2009) Suja, et al, *Water Science and Technology*
https://doi.org/10.2166/wst.2009.504

- explores the presence of PFOX in global waters and provides a concise overview of different aspects of these chemicals including sources of contamination and toxicology

Fact Sheets

Emerging Contaminants – Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA) (2014) EPA
http://www.townofhoosick.org/pdf2015/factsheet_contaminant_pfos_pfoa_march2014.pdf

Perfluorooctanoic Acid (PFOA) in Drinking Water, Hoosick Falls, New York (2015) NYS Department of Health
http://www.villageofhoosickfalls.com/Media/PDF/NYS-DOH-PFOA%20Fact%20Sheet-1215.pdf

Sources of PFOA/S Contamination

Detection of Poly- and Perfluoroalkyl Substances (PFASs) in U.S. Drinking Water Linked to Industrial Sites, Military Fire Training Areas, and Wastewater Treatment Plants (2016) Hu, et al, *Environmental Science & Technology Letters*
https://doi.org/10.1021/acs.estlett.6b00260

- discusses the presence of known sources of PFASs and detection of PFASs in public drinking water. Notes that more data needs to be collected from private drinking water sources

National Estimate of Per and Polyfluoroalkyl Substance (PFAS) Release to U.S. Municipal Landfill Leachate (2017)Lang, et al, *Environmental Science & Technology*
https://doi.org/10.1021/acs.est.6b05005

- using samples from 18 different landfills across the United States, calculates an estimate of PFAS concentration in leachate sent to wastewater treatment plants

Perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) in surface waters, sediments, soils and wastewater - A review on concentrations and distribution coefficients (2013) Zareitalabad, et al, *Chemosphere*
https://doi.org/10.1016/j.chemosphere.2013.02.024

- compares lab-developed distribution coefficients to actual field conditions and concludes that the use of these coefficients may lead to an underestimation of PFOX residence time in soils

Source attribution of poly- and perfluoroalkyl substances (PFASs) in surface waters from Rhode Island and the New York metropolitan area (2016) Zhang, et al, *Environmental Science and Technology Letters*
https://doi.org/10.1021/acs.estlett.6b00255

- analyzes watersheds and their spatial relationship to known sources of PFASs to determine three main contributors of PFASs in surface water in the northeastern United States.

Routes of PFOA/S Exposure

Perfluorinated Substances in Human Food and Other Sources of Human Exposure (2010) D'Hollander, et al, *Reviews of Environmental Contamination and Toxicology Volume 208* (pp. 179–215)
https://doi.org/10.1007/978-1-4419-6880-7_4

- reviews existing literature to determine different exposure pathways of PFCs, emphasis on PFOX in fish, but also discusses drinking water and dust as potential sources

Per- and Polyfluoroalkyl Substances (PFASs) in Food and Human Dietary Intake: A Review of the Recent Scientific Literature (2017) Domingo, et al, *Journal of Agricultural and Food Chemistry*
https://doi.org/10.1021/acs.jafc.6b04683

- reviews global studies on PFASs in food, but highlights a need for more information from "reputable" food agencies on dietary habits to determine possible health effects

Toxicological studies

A critical review of perfluorooctanoate and perfluorooctanesulfonate exposure and cancer risk in humans (2014) Chang, et al, *Critical Reviews in Toxicology*
https://doi.org/10.3109/10408444.2014.905767

- assesses the probability of a causal relationship between PFOX and cancer and provides a thorough overview of 24 epidemiologic studies that focus on cancer risk in both occupationally and non-occupationally exposed communities

A critical review of perfluorooctanoate and perfluorooctanesulfonate exposure and immunological health conditions in humans (2016) Chang, et al, *Critical Reviews in Toxicology*
https://doi.org/10.3109/10408444.2015.1122573

- reviews evidence from both animal and human studies on the effect of PFOX on various immune conditions. Concludes that more information and improved study design are necessary to establish a causal effect between PFOX and any immunological condition

The Navigation Guide—Evidence-Based Medicine Meets Environmental Health: Integration of Animal and Human Evidence for PFOA Effects on Fetal Growth (2014) Lam, et al, NIEHS
https://ehp.niehs.nih.gov/1307923/

- using the results from 18 human studies and 21 animal studies, determined that PFOX exposure can lead to lower birth weights in both humans and other mammals

Degradation/Removal

Treatment technologies for aqueous perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA): A critical review with an emphasis on field testing (2015) Espana, et al, *Environmental Technology & Innovation*
https://doi.org/10.1016/j.eti.2015.06.001

- summarizes the pros and cons of 5 existing removal technologies; adsorption using activated carbon considered the most successful. Note that aside from adsorption the methods discussed are still at the lab scale

Occurrence of perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) in N.E. Spanish surface waters and their removal in a drinking water treatment plant that combines tsconventional and advanced treatments in parallel lines (2013) Flores, et al, *Science of the Total Environment*
https://doi.org/10.1016/j.scitotenv.2013.05.026

- real world example testing different technologies for removal of PFOX in a drinking water treatment plant. Reverse osmosis and granular activated carbon proved to be the most effective methods

Investigating the biodegradability of perfluorooctanoic acid (2010) Liou, et al, *Chemosphere*
https://doi.org/10.1016/j.chemosphere.2010.03.009

- documents attempts to degrade PFOA using a variety of microbial communities but ultimately concludes that PFOA does not biodegrade which explains its persistence in the environment

Removal of emerging perfluorooctanoic acid and perfluorooctane sulfonate contaminants from lake water (2016) Pramanik, et al, *Environmental Technology (United Kingdom)*
https://doi.org/10.1080/09593330.2016.1240716

- compares removal of PFOX from lake water using three different technologies: granular activated carbon, ultrafiltration, and nanofiltration. Also looked at the effects of pH and organic matter on removal efficiency

Legal Info/Gov't Guidance

In 2016, the EPA issued lifetime drinking water Health Advisories of 0.07 micrograms per liter (µg/L) for both PFOA and PFOS. Along with more information on the advisories, both documents contain extensive overviews of their respective chemicals.

EPA Health Advisory for PFOA
https://www.epa.gov/sites/production/files/2016-05/documents/pfoa_health_advisory_final_508.pdf

EPA Health Advisory for PFOS
https://www.epa.gov/sites/production/files/2016-05/documents/pfos_health_advisory_final_508.pdf

Risk Management for Per- and Polyfluoroalkyl Substances (PFASs) under TSCA (2017) EPA
https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/risk-management-and-polyfluoroalkyl-substances-pfass

- provides a thorough background on PFASs and updates on regulatory actions the EPA is taking to control these emerging contaminants

Misc.

Biological Monitoring of Polyfluoroalkyl Substances: A Review (2006) Houde, et al, *Environmental Science & Technology*
https://doi.org/10.1021/es052580b

- reviews the presence of PFASs in humans and wildlife and how location and species affect contamination profiles

A North American and global survey of perfluoroalkyl substances in surface soils: Distribution patterns and mode of occurrence (2016) Rankin, et al, *Chemosphere*
https://doi.org/10.1016/j.chemosphere.2016.06.109

- assesses the distribution of PFASs in the surface soils of all seven continents with quantifiable levels in all 62 locations tested

Perfluoroalkyl acids in Lake Superior water: Trends and sources (2010) Scott, et al, *Journal of Great Lakes Research*
https://doi.org/10.1016/j.jglr.2010.03.003

- reviews concentrations and distributions of PFASs in Lake Superior, indicates tributaries and WWTP effluents as main sources of contamination

Toxic Fluorinated Chemicals in Tap Water and at Industrial or Military Sites (2017) Environmental Working Group
http://www.ewg.org/interactive-maps/2017_pfa/index.php

- An interactive map developed by EWG and Northeastern University that shows PFAS contamination sites in the U.S. and provides more detailed information for each site including concentrations and probable sources