



“Hazardous 100+” Chemicals Detected in the Great Lakes

The Great Lakes, the largest freshwater resource in the world and a national treasure, is polluted by historical and ongoing releases of hazardous chemicals.

The worst areas of contamination have been designated as “Areas of Concern¹” under the Great Lakes Water Quality Agreement. These areas have been prioritized for action due to the presence of critical pollutants.² Some critical pollutants were banned or phased-out of production, however many chemicals still used in commercial products today pose hazards to the Great Lakes. The map on page 2 shows the locations of Areas of Concern in the Great Lakes and highlights those that are contaminated with one or more Hazardous 100+ chemicals.

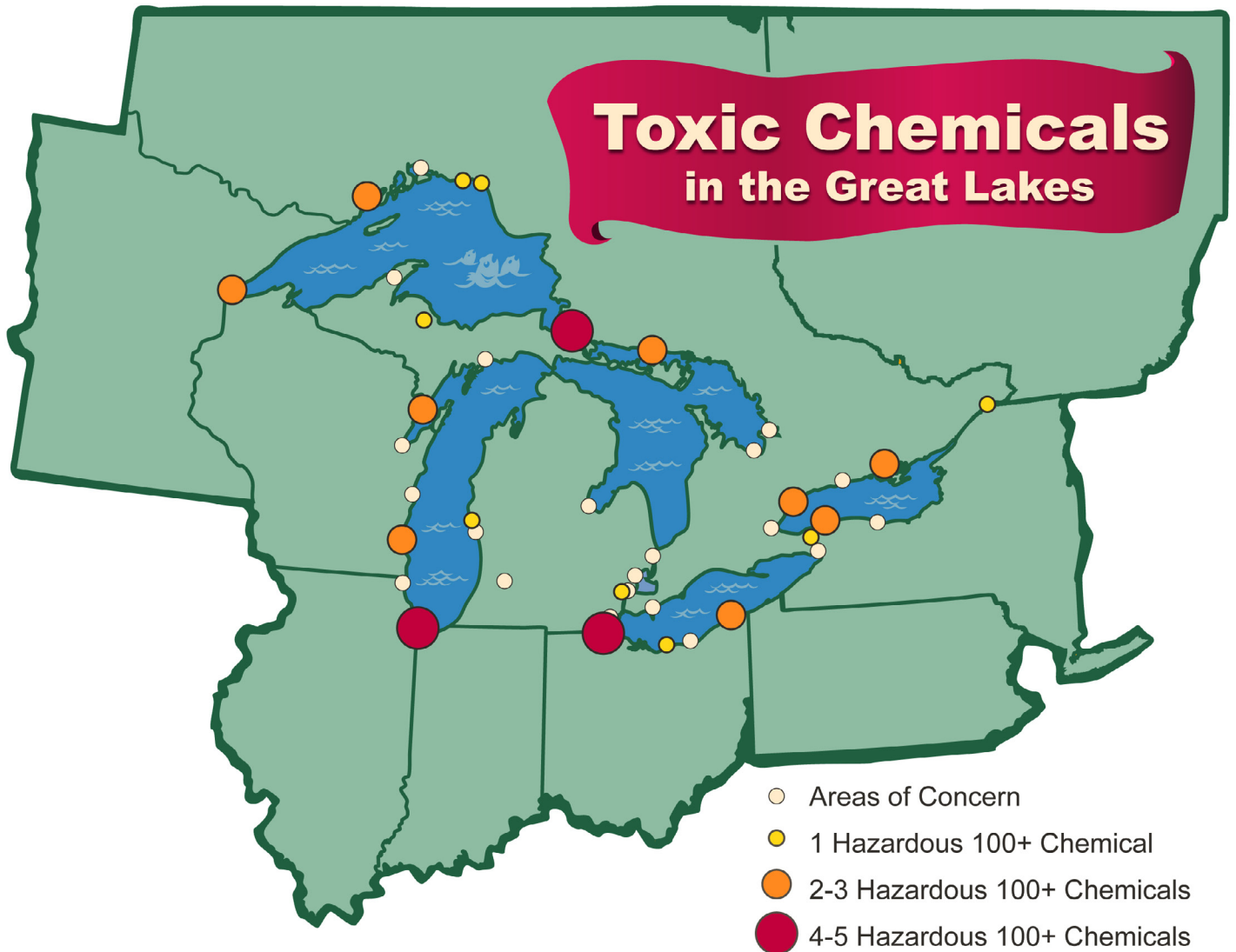


Photo credit: Jennifer Canvasser

A 2009 report on *Chemicals of Emerging Concern*,³ identifies a list of emerging chemicals that pose a threat to the Great Lakes. Most of the chemicals identified by the scientific panel are on the Hazardous 100+ list. These include fluorinated surfactants, brominated diphenyl ethers and other flame retardants, alkylphenol ethoxylates, chlorinated paraffins, phthalates and some compounds in personal care products. These chemicals are widely used in consumer products and are not entirely captured in wastewater treatment plants.

- 1 The U.S.-Canada Great Lakes Water Quality Agreement (Annex 2 of the 1987 Protocol) defines AOCs as “geographic areas that fail to meet the general or specific objectives of the agreement where such failure has caused or is likely to cause impairment of beneficial use of the area’s ability to support aquatic life.”
- 2 As designated by the International Joint Commission. They include PCBs, dioxins, furans, hexachlorobenzene, benzo(a)pyrene (one of many polycyclic aromatic hydrocarbons or PAHs), lead and mercury compounds and pesticides (toxaphene, mirex, aldrin/dieldrin, DDT).
- 3 Great Lakes Water Quality Agreement Work Group Report on Chemicals of Emerging Concern, August 2009.

Toxic Chemicals in the Great Lakes



These chemicals are showing up in the air, water, sediment, and in the food web of the Great Lakes. The following is a short list of **recent** research.

PBDE's, flame retardants commonly used in electronics, polyurethane foam and other products, are now being voluntarily removed from the market. However, previous widespread use has resulted in their dissemination throughout the food web and in sediment in the Great Lakes. Based on analysis of stored fish samples from the Great Lakes, researchers determined that levels of PBDEs in fish rose rapidly during the 1980s and 1990s. PBDE levels doubled in Great Lakes fish in less than three years. In contrast, levels of PCBs (which have been banned for many years) fell in Great Lakes fish during the same time frame.^{4,5} PBDEs have been detected in commonly con-

sumed fish, such as salmon, mackerel, swordfish, herring, and catfish.

TBB and TBPH-- two flame retardant chemicals included in commercial mixtures introduced in recent years to replace polybrominated diphenyl ethers -- have been found in air samples throughout the region, and their levels are rising very rapidly.⁶ Additional PBDE replacement chemicals, TBBP-A-dbpe and TBBP-A-ae⁷ are present in herring gull

flame retardants in the North American environment. *Environment International* 29:6. pp 771-779.

6 Emerging Brominated Flame Retardants in the Sediment of the Great Lakes. Ruiqiang YangHua Wei, Jie-hong Guo. An Li. *Environmental Science & Technology*. 3/20/2012, Vol. 46 Issue 6, p3119-3126.

7 Letcher, Robert J., and Shaogang Chu. "High-Sensitivity Method for Determination of Tetrabromobisphenol-S and Tetrabromobisphenol-A Derivative Flame Retardants in Great Lakes Herring Gull Eggs by Liquid Chromatography-Atmospheric Pressure Photoionization-Tandem Mass Spectrometry." *Environmental Science and Technology*. 44.22 (2010): Web. 30 Jul. 2013.

4 See for instance: Polybrominated Diphenyl Ethers in the Sediments of the Great Lakes: Influencing Factors, Trends, and Implications. *Environmental Science & Technology*. 12/15/2006, Vol. 40 Issue 24, p7528-7534.

5 Hale R Alae M Manchester-Neesvig J Stapleton H Ikonomou M. 2003. Polybrominated diphenyl ether

eggs in the Great Lakes, bioaccumulate in the herring gull food chain, and are transferred from gull to egg.

Tetrabromobisphenol-A-bis (2,3-dibromopylether) and tetrabromobisphenol-A-bis (allyl ether)⁸ are present in herring gull eggs in the Great Lakes, bioaccumulate in the herring gull food chain, and are transferred from gull to egg.

Triclosan, an antimicrobial used in hand sanitizer and a growing list of other consumer products, was recently detected in Minnesota lake sediments, including those of Lake Superior.⁹ The Canadian government has declared that Triclosan is toxic to the environment. It is an aquatic toxicant and can lead to antibiotic resistant organisms. There is also evidence that Triclosan in wastewater effluent contributes to the formation of toxic dioxin compounds.

Bisphenol A, a component of polycarbonate plastic and an additive in other plastics, may be disrupting kidney and liver function in lake trout according to an article in *General and Comparative Endocrinology*.¹⁰

Short- and medium-chain chlorinated paraffins are used in a wide range of industrial applications, such as flame retardants, [plasticizers](#), sealants, adhesives, coatings and additives in metal working fluids. The bioaccumulation and trophic magnification of chlorinated paraffins in food webs from Lake Ontario and Lake Michigan have been demonstrated.¹¹

Alkylphenol and alkylphenol ethoxylates, used as surfactants in industrial detergents and processes, are present in fish from throughout the Great Lakes basin. Carp are excellent accumulators of APEs. Carp from the North Branch of the Chicago River had the highest average level of APEs (16 mg/kg fresh wt.), and walleye collected from the St. Paul metropolitan outfall had the next highest average level of APEs (6.1 mg/kg fresh wt.).¹²

Phthalates are plasticizers used in plastics and are also ingredients in personal care and cleaning products among other uses. Phthalates have been detected in the air, suspended particulates and surface water in the Great Lakes.¹³ DEHP, a common phthalate, was measured at high levels in Lake Ontario sediments.¹⁴

Perfluorochemical surfactants¹⁵ have been detected throughout the Great Lakes including in Lake Trout. Perfluorochemicals are used in a variety of industrial applications and consumer products, such as food packaging, nonstick cookware and textiles.

Mercury is a ubiquitous contaminant in the Great Lakes region. Every inland lake in Michigan has a fish advisory due to mercury contamination, for example. Mercury fish advisories are common throughout the region and pose a public health threat, particularly for subsistence anglers.

8 Letcher, R. et al. High-Sensitivity Method for Determination of Tetrabromobisphenol-S and Tetrabromobisphenol-A Derivative Flame Retardants in Great Lakes Herring Gull Eggs by Liquid Chromatography–Atmospheric Pressure Photoionization–Tandem Mass Spectrometry. *Environ. Sci. Technol.*, 2010, 44 (22), pp 8615–862

9 Anger CT, Sueper C, Blumentritt DJ, McNeill K et al. Quantification of Triclosan, Chlorinated Triclosan Derivatives, and their Dioxin Photoproducts in Lacustrine Sediment Cores. *Environ. Sci. Technol.* 2013; 47(4):1833–1843.

10 Jurgella, G. et al. Effects of xenobiotics and steroids on renal and hepatic estrogen metabolism in lake trout. *General and Comparative Endocrinology*. [Volume 148, Issue 2](#), 1 September 2006, Pages 273–281

11 [Houde M](#), [Muir DC](#), [Tomy GT](#), [Whittle DM](#), [Teixeira C](#), [Moore S](#). Bioaccumulation and trophic magnification of short- and medium-chain chlorinated paraffins in food webs from Lake Ontario and Lake Michigan. [Environ Sci Technol.](#) 2008 May 15;42(10):3893-9.

12 Rice, Clifford, et al. Survey of Alkylphenol and alkylphenol ethoxylates in fish from the Great Lakes and from contaminated US rivers near the Great Lakes. *Society of Environmental Toxicology and Chemistry Abstracts*. Submitted November 20, 2002. [USDA website](#)

13 See for example: [Health Canada report on dibutyl phthalate](#)

14 McDowell DC, Metcalfe CD. Phthalate Esters in Sediments Near a Sewage Treatment Plant Outflow in Hamilton Harbour, Ontario: SFE Extraction and Environmental Distribution. *Journal of Great Lakes Research*, 2002; 27(1): 3-9.

15 See for example: [John P. Giesy](#) and [Kurunthachalam Kannan](#). Perfluorochemical Surfactants in the Environment: These bioaccumulative compounds occur globally, warranting further study. *Environ. Sci. Technol.*, 2002, 36 (7), pp 146A–152A, and [Vasile I. Furdui](#), et al. Spatial Distribution of Perfluoroalkyl Contaminants in Lake Trout from the Great Lakes, *Environ. Sci. Technol.*, 2007, 41 (5), pp 1554–1559