HUDSON RIVER PCBs: WHAT THE GE CLEAN-UP BRINGS TO LIFE

Simon Litten, Ph.D.

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PHOTO

General Electric Co. (GE) dredging
PCBs on Hudson River, 2012.

Peretz Partensky

When it comes to toxic pollution of our waters, this experience and others tell us that we need to worry far more about what we don't know about chemicals and their effects—and find a way to do something about it before, not after, crises develop.

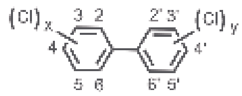
Polychlorinated biphenyls (PCBs) were first sold in 1929, almost a century ago. During the following four decades a great variety of industrial uses were found for this chemical. In New York's Upper Hudson River Valley, the General Electric Company (GE) relied heavily upon PCBs as a key element in electrical equipment it manufactured. Concerns about PCB toxicity, which were reported very early in its history, spread widely during the early 1970s and, as the environmental movement grew, attracted the critical attention of reformers and their allies in government. By 1977, domestic production of PCBs had ceased. State and Federal regulators entered into a multi-decade tug-of-war with GE over the spillage of PCBs into the Upper Hudson River from the company's two capacitor manufacturing plants at Hudson Falls and Ft. Edward, and the need to mitigate its effects. A consent decree between the federal government and GE stipulating a remediation project was signed in 2006 to be implemented in two phases separated by a year of study. By the end of 2016, General Electric had spent $1.7 billion on dredging and other projects[1] to remove PCBs from 40 miles of the Hudson River above Troy, NY.

At this writing, thirteen years after it entered into the consent decree, GE considers its role in the clean-up to have been completed. Though it cautioned that it might in the future require more remediation, including dredging, the federal Environmental Protection Agency (EPA) signaled a degree of agreement by issuing the company a certificate of completion on April 11, 2019. New York Governor Andrew Cuomo and Attorney General Letitia James, with the support of Scenic Hudson, Riverkeeper, and others announced an intention to sue. In short, the EPA notwithstanding, the matter is far from resolved.

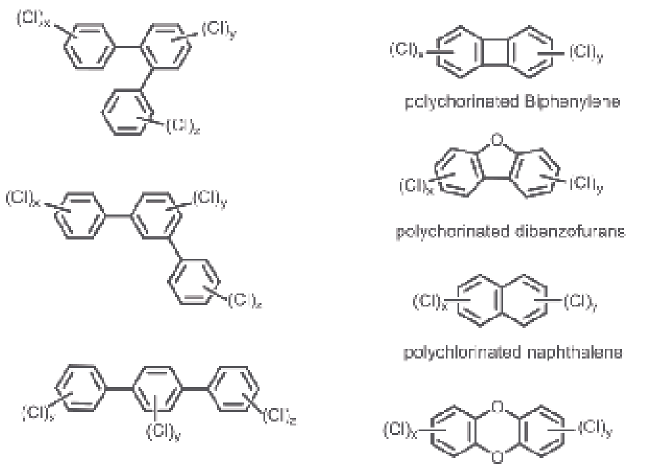
Here, we have a classic case study of the challenges—social, economic, and political—of dealing with toxicity to assure human and ecological well-being while balancing industrial and business requirements with public fears and expectations. When it comes to toxic pollution of our waters, this experience and others tell us that we need to worry far more about what we don't know about chemicals and their effects—and find a way to do something about it before, not after, crises develop. The alternative is endless repetition of our region's tortuous experience with GE's cleanup of PCBs from the Hudson. This is a matter on which all should be able to agree: prevention would be far better, and far cheaper than cleanup.

Moreover, the need for prevention and response increases apace. We can't seem to keep up. Right now there are more than 85,000 industrial chemicals listed on the EPA's inventory under the Toxic Substances Control Act (TSCA); not all are in use today but regulators understand of the toxicological properties of only a handful and those incompletely.

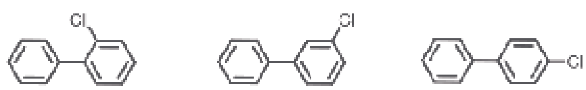
In the face of this massive challenge, we need to learn from experience. The story of PCBs in the Hudson River helps us do so.



Polychlorinated Biphenyls (PCB)



The numbers on the rings show the possible positions chlorine atom (designated as Cl) can be found in these compounds.



The three monochlorobiphenyl congeners

Structure of Polychlorinated Biphenyl. There are 209 ways to place one or more chlorine atoms on the biphenyl skeleton.

An Industrial Material

PCBs originated in response to a request the H. H. Richardson Company, a Pittsburgh manufacturer of roofing materials, made in 1929 to the Mellon Industrial Research Institute (later to be merged with Carnegie College to become Carnegie-Mellon University) for a fireproofing chemical that would be more persistent than the chlorinated naphthalenes (PCNs) then in use in a mix of tar and asbestos (now as much a pariah substance as PCBs).

Chemist Russell Jenkins at the Swann Company in Anniston, Alabama had, in 1920, devised a process for the commercial production of biphenyl. Jenkins reasoned that chlorinated biphenyl would satisfy H. H. Richardson. The Swann organization quickly realized the potential of the chlorinated biphenyl, which they marketed under the trademark Aroclor, for a wide range of applications such as plasticizers, flame retardants, water proofing, and as a dielectric for the rapidly expanding electrical industry.

In the 1920s, the "battle of the currents" of the late 19th century appeared to be decisively over, with alternating current the winner. But there were challenges. Long distance transmission of alternating current required dangerously high voltages. Transformers were needed to step up voltages at the point of generation and step down voltages for the user. Utility scale transformers generate heat that can be managed with non-conducting and chemically stable dielectric fluids. Most transformers, such as the cylinders on utility poles near houses, use carefully refined petroleum oils. However, mineral oil is less satisfactory for transformers inside buildings, vehicles, or underground where the consequences of fire are severe or where there are very high voltages. Arcing in transformers produces sludges that reduce functionality as well as flammable gases. As transmission voltages increased in the 1920s, transformer dielectrics became a limiting factor to the growth of the industry[2] PCBs when combined with chlorobenzenes and chloride scavengers filled an immediate need. High voltage electrical cables were insulated with PCBs in combination with PCNs.

The largest transformer in the United States in 1919 "can supply 1.5 million 40-watt Mazda lamps" (60,000-Kva), *G.E. Current News*, September, 1919

Source: https://ethw.org/Archives:Transformers_at_Pittsfield,_part_1

Also in the 1920s, varnishes were frequently made with celluloid (made up of nitrocellulose and camphor), a chemical originally made in the US, as a replacement for elephant ivory in the manufacture of billiard balls. It was later used as a replacement for black powder in fire-arms, as movie film stock, and in WWII, as rocket fuel. Nitrocellulose is highly flammable; several high-profile fires were partly due to its use in varnishes. Swann Company Chemist Russell Jenkins believed that PCBs could be a flame retardant in varnish but his process for making biphenyl, by bubbling crude benzene through a column of molten lead, generated colored by-products. Jenkins identified terphenyl and biphenylene as among the contaminants and devised distillation processes that would render a clear biphenyl and subsequently a clear PCB which could be incorporated in varnish. Apparently enough terphenyl was generated that Swann marketed polychlorinated terphenyl (PCT). PCT, marketed under the Aroclor tradename was sometimes blended with PCBs and sometimes used alone for many of the same purposes as PCBs. Biphenylene would be chlorinated as it passed into the product to make PCB.

Some of the polychlorinated biphenylenes have toxic effects identical to polychlorinated dibenzo-p-dioxins. Early runs of PCBs, used in combination with PCNs, were held responsible for several worker deaths from liver disease and disfigurements from an industrial disease called chloracne. Many years later industrial toxicologists at GE suspected that the early PCB runs were contaminated with polychlorinated dibenzo furans (PCDFs) but GE had destroyed their acceptance lots of Aroclor before more modern chemical analyses could be performed to test the idea.[3]

The Rise & Fall of PCBs

During the Depression, in 1935, the Swann conglomerate fell apart. Its employees including Russell Jenkins and assets, including Aroclors, and the phosphorous business, passed to the Monsanto Chemical Company in St. Louis. Monsanto operated the Anniston plant making PCBs, and continued to find new uses for them. Important

1956 Monsanto Chemical Company advertisement in *Chemical Engineering*

applications other than in the electrical industry included plasticizers for polyvinyl chloride and chlorinated rubber. Chlorinated rubber was, and still is, used for high durability paints for roads, trucks, ship hulls and concrete. Some PCB plasticized chlorinated rubber concrete sealant was mixed into wet concrete slurry. The PCBs are slowly released as the concrete crumbles.

The 1937 invention of the O-ring made high-pressure hydraulic systems possible. These were valuable on WWII aircraft and, after the war, in industrial machinery. Hydraulic fluids in aircraft must function under extreme conditions of varying temperature and atmospheric pressure. In aircraft and industrial applications where punctured hydraulic hoses could release a mist of oil, fire resistant fluids are highly desirable.[4] In 1948, Monsanto created lines of hydraulic fluids with PCBs as well as lubricants and other performance materials.

In 1954 National Cash Register marketed PCB microcapsules coated on office paper.[5] When broken under pressure the capsules released a dye precursor that, upon contact with another material coated on a contacting paper, produced a visible mark. This invention replaced carbon paper, resulted in contamination of the recycled paper stream, and added 113,000 kg of PCBs to the Fox River in Michigan.[6]

PCBs increased the toxicity and persistence of insecticides, were used as waxes, in building caulks, in pumps for

I offer here and now to walk into Binghamton or any part of that building and swallow an entire glass of PCBs ... You've got to take PCBs in quantities, deadly, over a long period of time and probably be pregnant, which I don't intend to become, and then you get PCB contamination."

—New York Governor Hugh Carey, 1981

natural gas, and as immersion oils in microscopy. Another important PCB application was for heat exchangers, sometimes replacing mercury. Usually non-reactive liquids, heat exchangers conduct heat from a source to a target material, avoiding directly heating the target. They therefore must be chemically stable at high temperatures.

However, PCBs are not perfectly immune to degradation by high temperatures. Scorching leads to the formation of PCDFs which in turn led to the downfall of PCBs. On February 5, 1981 PCB transformers in the basement of the New York State Office Building in Binghamton burned. The high temperatures caused the PCBs to pyrolize forming PCDFs. Chlorobenzenes in the transformer fluids formed polychlorinated dibenzo-p-dioxins.[7] Clean-up cost $53 million and New York Governor Hugh Cary offered to demonstrate the inconsequentiality of PCBs by drinking a glass. He was dissuaded by Health Commissioner David Axelrod.[8] Ten years later, on December 29, 1991 at SUNY New Paltz, five transformers exploded or overheated after an automobile struck a utility pole, causing an electrical surge. This released PCB's into three residence halls and two academic buildings, requiring a massive multiyear cleanup. PCB-askarel transformers in building and vaults leaked sending their fluids into city sewers, the lower Hudson River, and New York Harbor.

PCBs were a valuable industrial chemical for many years. But there were always available substitutes, including several phosphates, biphenyls, and phthalates. In 1979, with rising experience and concerns about toxicity, their manufacture was banned. In following years they became the target of lengthy and costly remediation projects. The responses to Hudson River PCBs are the outcome of evolving values concerning workplace safety, human health, and, to a lesser degree, the importance of non-human organisms.

Values—Worker Safety

Before there were environmental or off-site human health concerns there was some, although often not much, interest in the health of industrial workers. People exposed to industrial conditions or substances 10 hours a day, six days a week are more likely to feel their effects than people outside the factory or mine.

Greek mythology may reflect knowledge about heavy metal toxicity in the story of the lame smith-god Hephaestus. Roman writers observed the swift deaths of slaves working in mercury and lead mines. The early modern German mineralogist Georgius Agricola (1494–1555) noted the dangers of working mines and diseases peculiar to them. Bernardino Ramazzini (1633–1714) studied the conditions of a wide variety of Italian workers and documented the effects of heat, dust, dampness, noxious vapors, and cramped positions.[9]

Earlier observers took it for granted that there were inherent hazards of certain occupations. A sailor might drown or a builder may tumble from scaffolding just as a woman might die in childbirth. Such was human existence. Charles Turner Thackrah (1795–1833), who made highly numeric observations of Industrial Revolution workers in England, began to link workplace hazards to social conditions. He condemned the use of child chimney sweeps that Percivall Pott had shown in 1775 to be at high risk of developing scrotal cancer ("soot wart").[10] Thackrah's writing contributed to the 1833 *Factory Reform Act* which brought about enlightened regulations such as, "no child was to be employed in cotton, woolen, worsted, hemp, flax, tow, linen, or silk mills unless he produced a certificate stating that he was of the ordinary strength and appearance of a child aged nine years."[11]

A literate and numerate work force enabled Germany to become the leader in the Second Industrial Revolution technologies of organic chemistry and electricity.[12] The German model of limited political rights but strong worker protection regulations and institutions led to industrial accident rates an order of magnitude lower than those in America.[13] Alice Hamilton (1869–1970), a pioneer American industrial toxicologist, admired the German factory protections. She published detailed monographs on the toxicology of steel, lead, mercury, aniline, and munitions workplaces. Hamilton was also deeply involved in social issues of the working class through her Settlement House associations. American Progressives saw efforts to ameliorate industrial hazards as both a moral obligation and a way to reduce class conflict. However, manufacturers resisted constraints and state and federal laws gave only modest support for worker safety. The Worker Health Bureau (WHB), a private attempt to work with labor and toxicologists (including Alice Hamilton), briefly flourished in the 1920s. It collapsed as major unions feared association with the Socialist women behind the WHB in that era's repressive atmosphere.[14]

When PCBs were introduced, the Swann company evaluated the new chemical for safety: "Aroclor 1219 has a very distinctive, though not unpleasant odor; the other products [Aroclors] are practically ordorless, and tasteless as well. They have no noticeable action on the skin; the concentrated vapors are irritating to the nasal passages, and cause violent headaches to certain persons; but aside from this, no toxic action has been observed."[15] Industrial toxicologists in the 1920s, 30s, and 40s attempted to identify "certain persons" who were "susceptible" to toxic effects of chemicals on the basis of sex, race, or personal habits such as drinking alcohol or having dirty fingernails. The statement of Dr. J. D. Downing concerning cases of dermatitis from exposure to PCBs was typical, "An occupation should not be condemned because of a

Dr. Alice Hamilton, 1869-1970. Pioneer American industrial toxicologist. *Exploring the Dangerous Trades* 1942

Source: Smithsonian Institution from *Images from the History of Medicine*, B014009 PD-USGOV-HHS-NIH.

hypersensitive worker; transfer him, rather than abolish a process, thereby depriving other workers of their livelihood."[16] Dr. Hamilton herself advocated restricting the employment of females in certain industries.

Some workers coming in contact with PCNs (trademarked "Halowax"), and other newly-minted industrial chlorinated chemicals, sometimes well immersed in the stuff, came down with a fairly specific but usually temporary dermatitis called haloacne or chloracne. The first case of chloracne associated with PCBs was reported in 1936 in a 26 year old man who had worked distilling the chemical. He also complained of lassitude, loss of appetite, and loss of libido.[17] Chloracne became a particular problem among electricians stripping Halowax impregnated electrical cable in ship yards during World War II. Investigators discovered that some cable manufacturers had difficulty getting the insulating material to adhere and that it easily flaked off, getting into the men's clothing and on their skin. They brought it home and their wives and children also showed "cable-rash."

Academic toxicologists were beginning to use animal models as early as 1931. Mono-chlorinated PCB formulations were found to be acutely toxic (2.5 gm per kilo) to "small animals."[18] By 1936 General Electric and the Halowax Corporation commissioned an investigation by the Harvard School of Public Health into fatalities and injuries of workers exposed to PCNs, PCNs and PCBs, and PCBs alone. Despite the deaths and illnesses, government and industry representatives who heard the report determined to continue to use the chemicals. They agreed with the statement of GE's York Wireworks Manager F. M. Kaimer who said, "It is only 1½ years ago that we had in the neighborhood of 50 to 60 men afflicted with various degrees of this acne about which you all know. Eight or ten of them were very severely afflicted–horrible specimens as far as their skin condition was concerned. One man died and the diagnosis may have attributed his death to halowax vapors…The first reaction that several of our executives had was to throw it out—get it out of our plant. They didn't want anything like that for treating wire. But that was easily said but not so easily done. We might just have well have thrown our business to the four winds and said, 'we'll close up,' because there was no substitute and there is none today in spite of all the efforts we have made through our own research laboratories to find one."[19]

> For years I thought that what was good for our country was good for General Motors, and vice versa. The difference did not exist.
>
> —President Dwight Eisenhower's Secretary of Defense, Charles E. Wilson, a former General Motors CEO, 1953

Values—Environmentalism

Before WWII, concerns about the effects of chemicals were almost entirely confined to the workplace. A paradigm shift can be traced to the development of nuclear weapons. Since 1945, about 2,300 nuclear explosions have occurred worldwide. Of these, only two were detonated in war. One of the effects of atmospheric testing was the world-wide distribution of radioactive fallout. The major bomb isotopes are cesium 137, potassium 40, barium 140, iodine 131, and strontium 90. Strontium 90 is chemically similar to calcium and becomes concentrated in milk. Detonation of Bravo, a 15 megaton fusion blast at Bikini Atoll on February 28, 1954 resulted in fallout poisoning of Polynesians not properly evacuated, and 23 men on the Japanese fishing boat Daigo Fukuryu Maru. One of the men later died from radiation sickness.

During the early Cold War in the 1950s and early 1960s, many people, often individuals who had been part of the global leftist movement of the 1930s, became alarmed by the rapid proliferation of nuclear weapons and the development of ever more terrifying thermonuclear bombs. Also, Soviet propaganda, particularly prior to their own acquisition of nuclear weapons, may have influenced some Western leftists. Thus, in that era moral objections to nuclear weapons were sometimes seen as disloyalty and indications of Communist sympathies. Robert Oppenheimer, "father of the atomic bomb" lost his security clearance due to his objections to the development of the hydrogen bomb. Loyalty to the country was often conflated with support for big business. President Dwight Eisenhower's Secretary of Defense, Charles E. Wilson, a former General Motors CEO, famously said in 1953 "For years I thought that what was good for our country was good for General Motors, and vice versa. The difference did not exist."

Despite these political hurdles, it was nonetheless possible to investigate threats to American children. Strontium 90, an element that behaves chemically like calcium, was found to be accumulating in children's bones and teeth as a result of consuming vegetables and milk. In 1958 Herman M. Kalckar, a Danish medical researcher then at Johns Hopkins University, suggested collecting and analyzing baby teeth as a way to track Strontium 90 exposure of children from milk consumption. The project was first taken up by the Greater St. Louis Citizens' Committee for Nuclear Information. Participating children got a button that read "I gave my tooth to science." Rachael Carson relied heavily on the fallout *zeitgeist* in her seminal *Silent Spring* (1962). The first chemical she mentions in the book is strontium 90.[20]

> Pollution and the Vietnam war are symptoms of misplaced priorities and a warped conception of human values. To many of us it seems that individuals have lost control of their lives, that they are manipulated by a system with an inherent death wish rather than one in which enhancement of life is the primary goal. The major symbol of this death culture is the institutionalized violence perpetrated upon people and the land by corporations such as General Electric. —Denis Hayes, 1970

The public became aware of other environmental insults in the post-war era. Air pollution in Donora, Pennsylvania (1948) claimed 20 lives. London's Big Smoke of 1952 was estimated to have killed from eight to twelve thousand people. President Eisenhower saw environmental issues as local concerns outside the direct interest of the federal Government but Presidents John F. Kennedy and Lyndon Johnson, prompted by the urging of prominent Democratic thinkers Arthur Schlesinger Jr. and John Kenneth Galbraith, began to see environmentalism as a potentially politically valuable issue that went beyond the earlier New Deal package and was more relevant in the post-war age of abundance.

Prodigious quantities of oil washed up on Atlantic shores from the torpedoing of ships during WWII. The public became alarmed, however, only after oil spills on beaches at Santa Barbara, California in 1969 killed 3,500 seabirds. Local environmental issues became an avenue for women, often housewives, to find a voice in a time of patriarchal conformity. Students protesting the Vietnam War linked environmental degradation to the same "system" that prosecuted genocidal colonial wars. Denis Hayes, one of the founders of Earth Day wrote in 1970, "Pollution and the Vietnam war are symptoms of misplaced priorities and a warped conception of human values. To many of us it seems that individuals have lost control of their lives, that they are manipulated by a system with an inherent death wish rather than one in which enhancement of life is the primary goal. The major symbol of this death culture is the institutionalized violence perpetrated upon people and the land by corporations such as General Electric."[21]

The mobilization culminating in Earth Day (1970) was part of the landmark Nixon-era environmental initiatives—the National Environmental Policy Act (1969), creation of the Environmental Protection Agency (1970), establishment of the National Oceanic and Atmospheric Administration (1972), passage of the Clean Air Act and the Clean Water Act (1972), the Marine Protection, Research, and Sanctuaries Act (1973), the Endangered Species Act (1973). New York, in 1970, saw the creation of the state Department of Environmental Conservation. Also in 1970, activists spurred on by Silent Spring pressured New York State to ban DDT. The Federal Government banned the pesticide in 1972.

There was an accompanying idea that the federal government should play a dominant role in ensuring that workplaces be safe and healthful.[22] The Nixon era also saw passage of three revised or new worker safety laws. These

"All the News That's Fit to Print"

The New York Times

LATE CITY EDITION

Millions Join Earth Day Observances Across the Nation

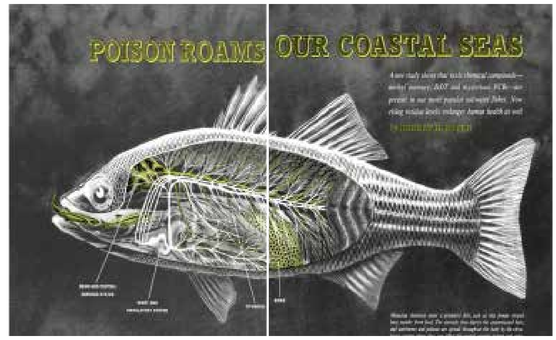
PRICES CLIMB 0.4%; BUT RATE OF RISE APPEARS TO SLOW

CAMBODIAN CRISIS GROWS AS TROOPS SEEN TO FALTER

On April 23, 1970, *The Times* published a front-page article, under a six-column headline, about the first Earth Day. The event drew millions of participants across the United States.

https://www.nytimes.com/times-insider/2014/04/22/april-22-1970-the-first-earth-day-draws-millions/

were the 1969 Coal Mine Health and Safety Act (which in 1977 was merged with the Metal and Non-Metallic Act to create the Mine Safety Act), the Railroad Safety Act of 1970, and the Occupational Health and Safety Act (OSHA), also of 1970. This legislation was inspired by reports of various appalling industrial accidents such as the 1968 West Farmington (West Virginia) coal mine explosion, from which 78 men were killed after ventilation fans had been intentionally disabled.



"A new study shows that toxic chemical compounds—methyl mercury, DDT and mysterious PCBs—are present in our most popular saltwater fishes. Now rising residue levels endanger human health as well." —Robert Boyle, *Sports Illustrated* October 26, 1970

PCB Toxicity Awareness

In 1966, Swedish chemist Soren Jensen published a report of his accidental discovery of wide-spread PCB presence. He had been looking for DDT, but found a hitherto unidentified substance in a dead eagle, the hair of his wife, and in the hair of his breast-fed infant daughter. Jensen analyzed a series of feathers from white-tailed eagles dating back to 1888. The presence of an unidentified toxic substance was found in feathers collected in 1942; chlorinated pesticides did not arrive in Sweden until 1945. Then very large amounts of the contaminant occurred in a dead eagle, which was sufficient for positive identification as PCB by the then insensitive mass-spectroscopy identification

The deleterious effects of PCBs on some species of wildlife are much more easily demonstrated than on people. In 1965, farmed mink fed salmon from the Great Lakes failed to reproduce and, by 1970, suspicion for this failure focused on PCBs. A NYSDEC study showed that mink above and within the area of Hudson River PCB contamination had markedly different population sizes. A DEC report suggested, on the basis of European work with otters, that PCBs interfered with hepatic vitamin A which increased susceptibility to infection.

Heat exchangers containing the Japanese PCB Kanechlor 400 were used for making edible rice oil in Japan and Taiwan. Pinhole leaks allowed PCBs to get into the food product. The Japanese incident, called Yusho ("oil disease"), affected more than 1,500 people in 1968. A similar incident in Taiwan in 1979, called Yu-cheng, injured 2,000. Shortly before the human Yusho outbreak, rice oil from the same facility was the cause of death to five hundred thousand chicks from chick edema disease.[23]

These reports, initially buried in the scientific literature, emerged into public consciousness in 1970. In July, the *New York Times* reported that Manhattan congressman William F. Ryan was urging the Department of Agriculture to reject pesticides containing PCBs. Ryan was unsuccessful in getting Monsanto to disclose which products contained PCBs. The company said that would "serve no nonpolitical purpose."[24] *Sports Illustrated* published an article in October by Robert Boyle showing that "mysterious PCBs" were showing up in Hudson River fish and that the suspected source was General Electric's capacitor plants in Fort Edward and Hudson Falls.[25]

The aforementioned Clean Water Act (1970) required that the EPA list toxic industrial chemicals that could degrade water quality. The EPA was unable to carry out this work because of its vast scope and a lack of knowledge about the toxicological properties of the thousands of industrial substances then in use. This Gordian knot was cut in 1976 as a result of a suit brought by a consortium of environmental organizations. They presented a somewhat arbitrary list of 129 chemicals, later reduced to 126. This approach was accepted by the hearing judge as a temporary expedient.[26] A reasonably short list allowed for the development of laboratory methods, inventories, targets for substitute chemicals, and establishment of standards or guidelines. These "Priority Pollutants" began the standard "usual suspects" list that is still in use. PCBs were included under the Monsanto trademark of Aroclors.

Measuring PCB's Presence—Chemistry

PCBs are a family of 209 different substances distinguished by how one to ten chlorine atoms are arranged on a biphenyl skeleton. The different individual chemicals are called congeners. Congeners can be grouped by the number of attached chlorines. For example there are three distinct ways for one chlorine atom to be attached. There are thus three monochlorobiphenyl congeners. These groups are called homologs. Each congener has slightly different physical-chemical and toxicological properties. Lighter ones are more prone to evaporation and heavier ones are more prone to attach to surfaces and to accumulate in biological tissues.

Laboratory methods attempted to identify and quantify Aroclors rather than individual congeners by looking at a forest of peaks of individual or groups of unresolved congeners and matching the pattern against reference batches. By 1998 a superior method[27] that utilized a large number of isotopically labelled PCB congeners permitted a much finer look at the composition of PCBs in a sample. Now PCBs could be expressed as homolog sums or sums of all congeners. The new method also revealed the wide-spread occurrence of non-Aroclor PCB congeners.

In 1983, the Chemical Manufacturer's Association informed EPA of seventy chemical processes having a high probability of PCB generation. Industry had known that some processes inadvertently generated PCBs.[28] For example, in 1978 General Electric informed EPA that its Waterford, NY silicone unit was inadvertently producing mono- and dichlorobiphenyls.[29]

In 1984, the EPA promulgated its final rule giving partial exemptions for the inadvertent production of PCBs from the 1979 ban. The published document estimated the total annual production of inadvertently generated PCBs to be 100,000 pounds. The Chemical Manufacturers Association, the Environmental Defense Fund, and the Natural Resources Defense Council agreed that fewer than 1,000 pounds of inadvertent PCBs were likely to have entered the environment. This production, they claimed, was only 0.0007 percent of the 180 million pounds estimated to have been released prior to PCB controls. And furthermore, approximately 110 million pounds of the total were mono- and dichlorobiphenyls, which were claimed to be less toxic. EPA wrote (possibly under industry influence) that, "from 1930 to 1978 no monochlorinated biphenyls and few if any dichlorinated biphenyls have been detected in humans or the environment."[30]

Recall that the first environmental measurements of PCBs occurred in 1966, in Sweden. Also recall that it was not until 1998 that an official analytical method was available to quantify mono- and dichlorinated biphenyls in the environment. The final rule allows a fifty-fold discount for monochlorobiphenyls and a five-fold discount for dichlorobiphenyls. Forty-nine manufacturers petitioned EPA for an exemption from the prohibition to manufacture, distribute, or sell products with more than fifty parts per million of PCBs. Among them were General Electric (probably due to their silicone caulk plant in Waterford, NY), and such pigment and printing concerns as the U.S Department of Treasury, Bureau of Printing & Engraving, and Binney & Smith, the manufacturer of Crayola crayons.

Most regulators and the environmental community were unaware of the availability of partial exemptions until 2002 when it was found that non-Aroclor PCBs in some parts of New York Harbor were overwhelmingly the largest component of PCBs. The source was the manufacture of certain organic pigments used in printing.

GE and PCBs in the Hudson River

Frank Clark, a chemist at General Electric's plant in Pittsfield, MA, very quickly saw the usefulness of PCBs as dielectric in high power transformers.[37] Transformer fluid dielectrics, called "askarel," were a mixture of PCBs (usually highly chlorinated PCBs like Aroclor 1260), tri- and tetrachlorobenzenes, and frequently an organo-tin chloride scavenger

Most of the focus on Hudson River PCB sources has centered on the two upriver General Electric factories that made capacitors. Capacitors are electrical devices capable of holding a charge and quickly releasing it. Capacitors are widely used as starters for motors and fluorescent lamps. They are also used by utilities in managing electric distribution. Capacitors consist of two conductive strips separated by a paper saturated with a non-conducting fluid. Over the years GE tried many fluids. In 1935 Frank Clark proposed xylenols but in 1938 selected light PCB oil.[38] In 1946 GE converted war-time factories at Hudson Falls and Ft. Edward, some 50 miles north of Albany, to making PCB-filled capacitors. The metal/paper/metal sandwich was rolled up and inserted into an open canister. The canisters were placed in a tray and flooded with PCB oil. The trays were then put into an autoclave to drive out any bubbles and thoroughly saturate the paper. When the autoclaves were opened a cloud of PCB vapor emerged and condensed on all surfaces in the workroom. Electrical leads were attached to a cover and the item was soldered shut. Floor drains led the condensate into the river. PCB was cheap and little effort was made to conserve it; EPA estimates that between 209,000 and 1,330,000 pounds of PCB entered the upper Hudson from the capacitor plants.

Since 1975, high concentrations of PCBs in fish led NYS to close various recreational fisheries and issue advisories constricting consumption

Photo: AP/Mike Groll

PCBs—Toxicology

Our word "toxic"[31] comes from the Greek "toxon" which means "bow" as in bow and arrow. In its original sense "toxic" agents killed quickly like an arrow shot from a bow. Our more modern concept of "toxic" embraces a widening range of sub-lethal effects including behavioral changes, endocrine disruption, and teratogenesis. Also included is mere persistence and initiation of somatic effects that can take years or decades before becoming manifest, such as cancer or population declines. Testing for acute lethality on laboratory animals fails to address many of these concerns.

During the 1930s and particularly after WWII, cancer, conceived as a single disease, began to get attention. A considerable cancer lobby grew to promote awareness of the disease and raise money for research to develop cures. While toxic effects associated with PCBs had been known for many years, it wasn't until 1975 that Center for Disease Control researcher Renate Kimbrough induced liver cancer in female (but not male) Sherman Strain rats with Aroclor 1260.[32] At this point PCBs (all 209 congeners) were designated (and are still designated) "Probable Human Carcinogens." However, as detailed below, initial epidemiological evidence from workers at the GE plants was equivocal.[33]

New York state establishes water quality standards based on risk, in conformity with procedures from the 1995 Great Lakes Initiative (GLI).[34] The most stringent standards are for the risk of cancer to humans from eating fish, calculated based on a risk tolerance of one in a million for eating one half pound of fish each week for seventy years. At the end of a very long chain of calculations the value for total PCBs (sum of all congeners) is one part per quadrillion in water. This level of contamination is not measurable by conventional methods. It is also less than the concentration of PCBs from atmospheric vapor at Sturgeon Point on the shore of Lake Erie.[35]

The state Department of Environmental Conservation developed a brute-force method for concentrating PCBs from very large volumes of water (up to thousands of liters) that, when coupled with advanced analytical detection, allows GLI risk-based standards to be measured.[36] No surface waters meet the standard for PCBs.

Thus even though PCBs were no longer being made or used by 1977, the Hudson River Basin already held a great deal of PCB that was getting into fish and being carried downstream. The problem bifurcated into two principal strands; above New York City the issues were primarily related to fish consumption and wildlife (mink, osprey, and eagle) reproduction, while in New York Harbor the driver became disposal of dredge spoil for the maintenance and deepening of shipping channels and berths in the Port of New York/New Jersey. EPA designated 200 miles of the Hudson River, from Bakers Falls to the New York City Battery, a Superfund Site in 1984. In 2002 EPA and GE reached an agreement and EPA issued a Record of Decision (ROD) for the remediation of the Upper Hudson north of the Waterford Dam. A decision about the Lower Hudson would be deferred until after completion of the Upper Hudson work.

General Electric

Between 1981 and 2001 General Electric was led by CEO Jack Welsh. Welsh, a chemical engineer by training, was famous for ruthlessly pruning underperforming businesses and people from the sprawling corporate conglomerate he ran. In 1976, as Hudson River PCBs became an issue for the company, he hired two researchers, Dr. Irwin Selikoff and Dr. Renate Kimbrough, to investigate cancer in those

> Over the years, this debate has gone from PCBs to a more fundamental crusade. Extremists have latched on to issues like PCBs to challenge the basic role of the corporation.
> —Jack Welsh, 2001

in the GE workforce who were handling PCBs at the capacitor plants at Hudson Falls and Fort Edward. Selikoff was a general practitioner in New Jersey who, in the 1950s, discovered that mesothelioma, a cancer of the tissue lining the lungs and chest wall, was associated with asbestos exposure. Kimbrough induced cancer in female rats fed Aroclor 1260, a highly chlorinated PCB.

Studies by these two very highly regarded scientists showed no cancer effect among the GE workers. This convinced Welsh that the public uproar and EPA's responses were essentially political and that the remedy of dredging the upper Hudson would be an environmental disaster. The company said that dredging would "stir up" PCBs that were safely buried in river bottom sediments. River bottom sediments are subject to remobilization during extreme storm events, engineering projects (like the 1973 removal of the Fort Edward Dam) and navigational dredging. While perhaps not an "environmental disaster," the Hudson River Natural Resource Damage Assessment trustees wrote, "Dredging and capping/backfilling activities in the Upper Hudson River are destroying mussel beds and mussel habitat, which are not being replaced as part of the remedy for the Hudson River PCBs Superfund Site."[39]

GE contended that their own experience, confirmed by the ultimate results of the Asian rice-oil contamination incidents which showed dioxin-like PCDFs to be the more probable source of the Yusho afflictions, was that PCBs were not toxic. Welsh wrote, "Over the years, this debate has gone from PCBs to a more fundamental crusade. Extremists have latched on to issues like PCBs to challenge the basic role of the corporation."[40]

Upper Hudson Remedial Superfund Timeline

1976

New York State Department of Environmental Conservation (DEC) closes the Upper Hudson to all fishing and closes the Lower Hudson to commercial fishing (except Atlantic sturgeon greater than four feet in length). Recreational fishing in the Lower Hudson is permitted except for American eel. Flooding mobilizes PCBs that had been trapped above the Ft. Edward dam before it was removed in 1973. General Electric ceases using PCBs at its capacitor plants.

1977

Monsanto ceases making PCBs.

1979

EPA bans manufacture and sale of PCBs.

1983

EPA lists the Upper Hudson on the Superfund National Priorities list.

1984

EPA's evaluation of the options for the Upper Hudson is "no action."

1995

DEC opens catch and release fishing in the Upper Hudson. Catching and possession of anadromous (born in freshwater, mostly live in the ocean, return to spawn) river herring is permitted. Recreational fishing is opened on the Lower Hudson but with consumption warnings. Fishing restrictions come about not only from concerns about contaminants. Fishery managers consider a variety of pressures on the stocks including ocean by-catch, climate change, habitat destruction, and competition with invasive or introduced species. Some historically important species, such as shad and American eel, are in significant peril of extirpation from the Hudson.

2000

EPA issues a new Record of Decision (ROD) calling for the removal of 2.65 million cubic yards of contaminated sediment from the 40 miles of river north of Waterford. GE CEO Jack Welsh believes the efforts by DEC and EPA to remediate PCBs are irrational and mounts a fierce ten million dollar public relations campaign against dredging. Many upriver communities and Congressman John Sweeney side with GE in opposing dredging.

2001

GE challenges the constitutionality of the Superfund law. GE Spokesman Mark Behan says, "Our lawsuit challenges a provision of Superfund which gives the EPA unlimited authority to order massive, long-term remediation projects in non-emergency situations, without any opportunity for the party that receives the order to have it reviewed by an impartial court." Lower courts reject the argument. The US Supreme Court refuses to intervene in the case General Electric v. EPA.[45]

Jack Welsh retires.

2002

GE begins testing PCB sediment "hotspots."

2005

GE and EPA sign a consent decree.

2006

GE and EPA finalize agreements on the conduct of the dredging, but details need to be worked out.

2009

Dredging begins. GE has built a de-watering facility and rail links. Dewatered spoil is taken to property near Eunice, New Mexico owned by Dallas billionaire Harold C. Simmons. Three New Mexico environmental officials resign in protest of the state granting the permit.[46]

2010

By prior agreement, dredging is halted while the results of the first year are evaluated.

2011 to 2015

Dredging is conducted and, GE believes, completed. GE disassembles the de-watering plant and rail links.

2019

April 11, 2019: EPA issues a certificate of completion with the proviso that, pending further testing, GE may be required to do more dredging.

The Noun Project: Otter: Marta Marinho; Trout: Michael Thompson; Mink: Anna Bearne; Falcon: Euka; Swallow: Olga

Neither Selikoff nor Kimbrough were epidemiologists. Moreover, their studies at the GE plants were never published. A 2006 study of a larger number of GE workers (14,458 individuals) showed statistically significant exposure-related incidences of cancer of the rectum, liver, intestine, stomach, breast, and prostate. There was some evidence for elevated melanoma and myeloma mortality as well as elevated rates of bronchitis and neurodegenerative diseases.[41]

Welsh's argument that the Yusho observation of co-contamination with PCDFs and the belief that the PCDFs were the major cause of the human illness is actually a difference of small distinction. PCBs were always contaminated with PCDFs at the point of manufacture[42] and many uses of PCBs resulted in increased PCDFs. PCBs occur at far higher concentrations, are easier to measure and thus can be a surrogate for PCDFs, which were never a commercial product.

GE's argument was that PCB toxicity is the same as PCDD/PCDF toxicity. Some PCB congeners lacking chlorination at the ortho position (closest to the bridge between the two benzene rings) have weak dioxin-like properties. Twelve such non-ortho congeners have toxic equivalency factors (equivalent to 2,3,7,8-TCDD) assigned by the World Health Organization. EPA considered including the 12 "toxic" PCB congeners in with the seven dioxin and ten furan congeners as defining "dioxin-like toxicity" but in the final rule-making, decided not to do so.[43] In spite of their relatively weak potency, in some environments PCBs account for the bulk of dioxin-type toxicity. Other non-ortho and mono-ortho PCB congeners may also have even weaker dioxin-like effects. Non-cancer dioxin-like toxicity may account for the reproductive impairment in Hudson River mink. And other PCB congeners may have other toxic effects such as hormone disruption and neurological dysfunction.[44]

After Welsh's retirement in 2001 GE relaxed its opposition to dredging as a remedy for PCB contamination and entered into negotiations with EPA. Dredging finally began in 2009.

> The Hudson River Superfund cleanup has not done the job it was meant to do—secure the health of the river, its wildlife and the people living along it. PCB contamination in the river remains a significant threat to public health and prosperity—as it has for nearly 80 years. —Scenic Hudson

Upper Hudson Remedial Superfund: The Ongoing Dispute

Are we done yet? 2.64 million cubic yards were dredged containing 155,800 kg of total PCB and 48,600 kg of PCBs having three or more chlorines (Tri+). These are more likely to accumulate in wildlife and to be attached to suspended particles.[47] The project ultimately removed much more PCB than the 70,000 kg that had been called for in the Record of Decision (ROD). Errors in preliminary sampling severely underestimated the amount of PCB in the river sediments. The ROD limited the amount of PCB escaping over the Troy Dam to one percent of PCB mass dredged. EPA believes that only 0.7% of the PCBs escaped.[48] Post-dredging, GE will continue to monitor PCBs in the river for the indefinite future.

EPA is evaluating the data and will decide if the terms of the ROD were met. The agency may take the position that the ROD defined the problem and the solution. That would mean that if the solution given by the ROD was achieved, the project achieved its goal. Some interested parties, taking a less legalistic view, are not so sure that the project is completed. Scenic Hudson, a non-governmental organization, writes, "The Hudson River Superfund cleanup has not done the job it was meant to do—secure the health of the river, its wildlife and the people living along it. PCB contamination in the river remains a significant threat to public health and prosperity—as it has for nearly 80 years."[49] High PCB concentrations in Champlain Canal sediments remain untouched by the Superfund remediation.

A panel of experts convened by the Hudson River Foundation evaluated the dredging project. Their report finds a preliminary indication of decreases in PCB concentrations in Upper Hudson fish following the completion of the dredging program. Decreases are most notable in Thompson Island Pool (a pool created by a dam about ten miles downstream from Hudson Falls that trapped contaminated sediment washed down after the removal of a dam in Ft. Edward) where post-dredging PCB concentrations in pumpkinseed fish (a small pelagic feeder) and small forage fish were three to six times lower than observed pre-dredging levels. This section of the Upper Hudson was the focus of much of the dredging operation.

However, post-dredging fish monitoring data show mixed results for sections of the Upper Hudson downstream of Thompson Island Pool. PCB concentrations in pumpkinseed were reduced by approximately a factor of two, and were closely linked to reductions in Tri+ PCB water column concentrations for low flow conditions (< 13,000 cubic feet/second). Little or no reduction however was observed for PCBs in small forage fish.

In this June 10, 2011 file photo, crews dredge the Hudson River in Fort Edward, N.Y. The work is part of a project on the upper-Hudson to clean up PCBs released by General Electric decades ago. The Environmental Protection Agency made an announcement Thursday, April 11, 2019, on GE's $1.7 billion Hudson River cleanup.
Photo: AP/Mike Groll

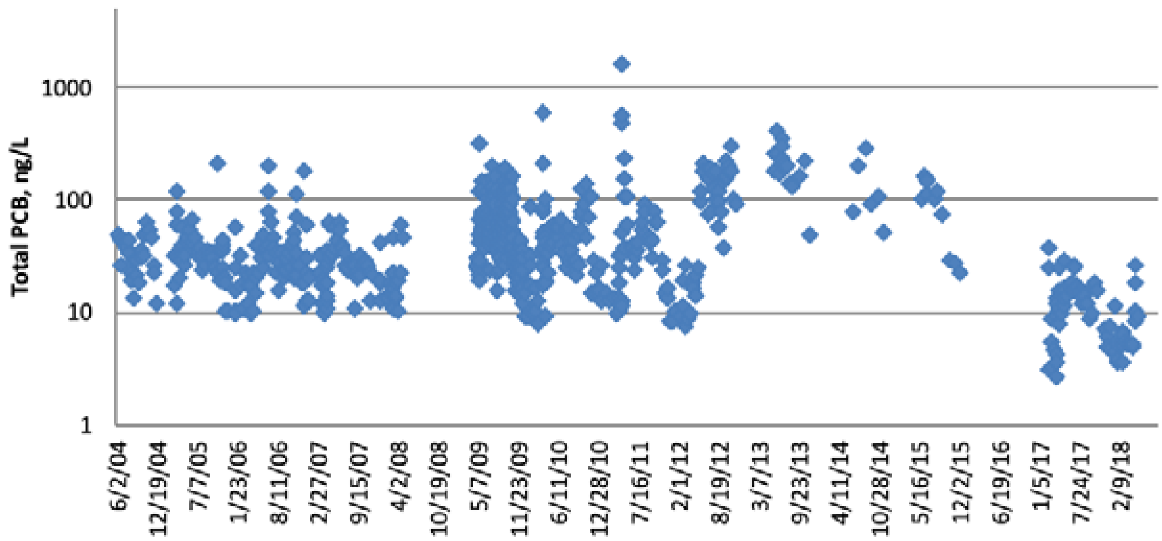
This result is consistent with the linkage between small forage fish and contaminant levels in localized sediments, and the limited amount of dredging that was performed in river sections downstream of Thompson Island Pool.

Post-dredging water column monitoring data show that Tri+ PCB water column concentrations at Waterford were reduced by approximately a factor of two for low flow conditions (< 13,000 cfs). However, based on limited post-dredging monitoring data, little or no reduction in Tri+ PCB water column concentrations was observed at Waterford for high flow conditions (> 13,000 cfs). This latter finding may indicate that Tri+ PCB water column concentrations during high flows are more likely derived from resuspension of localized sediments and not from sediments further upstream where dredging operations were more extensive.

Based on pre-dredging and 2016 post-dredging monitoring data, the panel estimated a 66% reduction in Tri+ PCB loads passing Waterford and entering the Lower Hudson. This large reduction, however, was in part due to the below-average flows in the Upper Hudson during 2016. If 2016 flows were more comparable to the 2004-2008 pre-dredging period, the Tri+ PCB loads would have been reduced by just 15-35 percent.

Tri+ PCB water column concentrations at Albany follow trends that are similar to the observed Tri+ PCB concentrations at Waterford. This is in contrast to observed Tri+ PCB concentrations 70 miles downstream at Poughkeepsie, which were very variable and not correlated to observed PCB concentrations at Albany. This discrepancy is believed to be related to the complexity of sediment transport in the Lower Hudson.

The panel said that sediment transport processes in the Lower Hudson will dampen PCB responses and greatly extend PCB response times to changes in Upper Hudson PCB loads. Based on previous sediment transport and contaminant transport modeling studies, it is expected to take a decade or more to see appreciable changes in PCB



Total PCB concentrations at Waterford, the downstream end of the remediation project, shows pre-dredging levels (average of 28 ng/L), increased levels during the 2009-2015 remediation project (53 ng/L), and a post-project decrease (10 ng/L). Data are from General Electric's monitoring.

water column, sediment and fish concentrations at many locations in the Lower Hudson.[50]

Down River

New York/New Jersey Harbor is estimated to sustain 124,000 directly related jobs with a combined payroll of $16.5 billion. Maintenance of the harbor requires periodic dredging. Dredged material had originally been dumped at sea but due to concerns about dioxin and PCB contamination, the majority of newly dredged material was to be banned from the dump site after 1997. With this background, the need to gain a better understanding of toxic substances in the harbor was apparent to the governors of both New York and New Jersey and to the Port Authority of New York/New Jersey. The Port Authority brought $130 million to the table and brokered the creation of the Contaminant Assessment and Reduction Project (CARP), an alliance among the state governments of New York and New Jersey, the relevant federal agencies, major dischargers and environmental groups. CARP sampled and analyzed mercury, cadmium, a list of polynuclear aromatic hydrocarbons (PAHs), legacy chlorinated pesticides like DDT, dioxins (principally as trace contaminants in trichlorophenoxy acetic acid, a component of Vietnam War era Agent Orange that had been made by Diamond Alkali on the Passaic River), and PCBs.

CARP did extensive field sampling (water, sediment, fish, benthic organisms) and used the latest laboratory methods followed by state-of-the-art mathematical modeling. It found that as of the year 2000, 74% of the PCBs in the harbor came from the Hudson River, mostly due to the GE capacitor plants, with the balance coming from sewage treatment plants (11.6%, much of which is probably from historic transformer leaks), 7% from combined sewer outfalls, 3.8% from storm water, 2.1% from atmospheric deposition, and 1.6 % from other (non-Hudson River) heads of tide. Sediments from modeled segments of Newark Bay and the Arthur Kill would be too contaminated for ocean disposal in 2040 without Upper Hudson Remediation, but most would be ocean disposable if the Superfund Project was continued.

It is unknown whether the expensive remediation work will have any observable impact on human health but it is also highly probable that it will have a large effect on mink and otters as well as other wildlife. That is no small thing.

Lessons Learned: Federal Action and Next Steps

An immediate reaction to the awareness of the PCB problem, and to the stream of revelations of environmental toxics (mercury, lead, asbestos, vinyl chloride, cadmium, chlorinated pesticides), was the 1976 passage of the Toxics Substances Control Act (TSCA). The TSCA provided for the phase-out of PCBs and sought to prevent toxic surprises from newly developed chemicals but was fundamentally flawed in that it did little to address problems arising from those that already existed.

The bill, first introduced in 1973 and passed in the waning days of the Ford Administration, directed the EPA to inventory all chemicals used in commerce during the preceding three years. These "old" substances were mostly left unregulated. The list, containing some 62,000 substances, was to be completed within 315 days of the Act's initiation. "New" chemicals or significantly new uses of "old" chemicals were to be evaluated by EPA within 90 days for the potential of "unreasonable risks."

The Act did not define "unreasonable risk" but the EPA was to consider economic and social impacts. The agency was to distinguish between substances that "may" or "will" present an unreasonable risk. Chemicals produced as byproducts or impurities were not to be considered as they were not "in commerce." Understaffed, and initially under-managed, EPA was unable to comply with its charge without simplifying the tasks and forming a close relationship with the Chemical Manufacturer's Association.[51]

The TSCA's weaknesses were made apparent in 1991 when the Fifth Circuit Appeals Court struck down a proposed ban on asbestos. In a victory for industry, the court found that the EPA had improperly rejected a less financially burdensome remedy such as labeling asbestos containing products.[52] In 2009 EPA Administrator Lisa Jackson said, "Not only has TSCA fallen behind the industry it's supposed to regulate, it's been proven an inadequate tool for providing the protection against chemical risks that the public rightly expects." By 2011 application of the TSCA had managed to control only nine chemicals.

In 2016, the TSCA was revisited and rebranded as the Lautenberg Chemical Safety for the 21st Century Act (LCSA). The LSCA revised the list of chemicals in use (now 85,000). It explicitly deals with mercury, looks to environmental as well as human health, and considers a list of toxic effects broader than cancer (reproductive, developmental, respiratory, immune, cardiovascular, and neurological). The LSCA strengthened the EPA's authority to require companies to give greater weight to risks to "health and safety" than to economic cost/benefit ratios in reporting on existing chemicals, and to prevent new toxic chemicals from entering the marketplace. In this way, the LSCA approaches (but does not go as far as) the European Union's regulatory rules, REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals), whose dictum "No data no market" assumes chemicals to be unsafe unless proven otherwise and places the burden of proof on the manufacturer, not the regulator.

In the present day, the LCSA seems a remarkable piece of bipartisan legislation. It even met with industry approval: In setting national regulatory standards, the Act quashed a trend toward state regulation that created a patchwork of rules that industry found burdensome and expensive. This preemption clause, Section 18, the "State-Federal Relationship," was opposed by the National Conference of State Legislatures and by Attorneys General in New York, California, Connecticut, Hawaii, Iowa, Maine, Maryland, Massachusetts, New Hampshire, New Mexico, Oregon, Vermont, and Washington. But, in reality, states can still act:

- States can require labelling on products so that informed consumers can influence the market, legislation that New York's Governor Cuomo has recently proposed in his Consumer Right to Know Act [53]
- States can act under the Safe Drinking Water Act (and Clean Air Act), as New York is poised to do in reaction to PFAS, a class of chemicals known to be carcinogenic for decades, found in public water supplies in Hoosick Falls and Newburgh. (This is a national problem.) The state has under consideration the most stringent guidelines in the country for the chemical's presence in drinking water (S 773).[54] New York's 2017–2018 enacted budget also required the Department of Health to identify "emerging contaminants" and require water systems to test for them.

- States can ban processes that might expose the public to toxic chemicals, as New York State did in 2014 when it banned fracking.
- States can ban the use of chemicals in certain products as New York state did when it was first in the nation to ban the flame retardant TCEP from children's' clothing (A 6195).

REACH, the European Union approach that changes the operating assumption for the regulation of potentially harmful chemicals—from safe until proven unsafe to unsafe until proven safe offers an aspirational ideal. By denying unproven chemicals a market, a REACH-reformed TSCA would minimize costly litigation on which the current system thrives and would eliminate the need for state work-arounds (and federal preemption) in response to the glacially slow progress of EPA regulation. Finally, we have seen the effect that an anti-regulation, industry-friendly administration can have on an already overburdened and underfunded EPA. (Asbestos is back on the table!) A REACH-inspired TSCA would minimize the consequences of elections on existing and proposed regulation.

In the absence of another sweeping TSCA reform act, and the status quo in Washington, the GE clean-up, ironically, models a way forward. In 2017, the New York state DEC sampled 1,700 Hudson River locations and took 230 fish samples in response to the EPA's five-year review of the clean-up. The EPA is working with the state to analyze the data. Dutchess County Executive Mark Molinaro, a former Republican gubernatorial candidate and avowed litigant in the event of the issuance of a certificate of completion, lauded the partnership as "a potential breakthrough in state-federal relations in addressing this issue, and bodes well for the future."[55]

There are alternative approaches that can be made to work. But we must end where we began. As earlier noted, as this brief was set to print, the EPA issued a certificate of completion to GE but left open the possibility of more dredging pending further testing. Lawsuits by a variety of interested governmental and non-governmental parties are certain. The now decade and a half long issue persists. This is not a model for good governance. We can do better.

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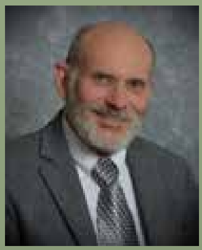

Dr. Simon Litten

History was Dr. Litten's first passion (B.A., University of Oregon) but unable to find a job in that field he became a research assistant in the Neurosurgery Department at Upstate Medical Center. He was invited to pursue studies in biostatistics (M.S. from Upstate Medical Center in Syracuse, NY) and then, wanting to spend more time working outdoors, he entered a Ph.D. program in limnology in the Civil Engineering Department at Syracuse University. While there he first became interested in PCBs. After getting his degree, Dr. Litten found his niche at the NYS Department of Environmental Conservation chasing toxic chemicals all around the state. After retiring from DEC in 2010 he began historical investigations into the technical, social, and legal histories of chlorinated pesticides, asbestos, dioxins, and PCBs. He is currently working part time for the Hudson River Foundation on PCBs and dioxins in New York/New Jersey Harbor.

Editorial staff
Janis Benincasa
Gerald Benjamin
Christine Wilkins

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Preety Dahr, Ph.D. and
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The Benjamin Center for Public Policy Initiatives
State University of New York at New Paltz
1 Hawk Drive
New Paltz, NY 12561-2443

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