



PCBs in Green Bay

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The Fox River Valley in northeastern Wisconsin is home to the largest paper production industry in the world. Before they were banned in 1979, PCBs were used by paper mills here and elsewhere as a vehicle for holding and delivering ink in carbonless copy paper. Much of this copy paper was recycled and reprocessed, releasing an estimated 50,000 kilograms (110,000 lbs.) of PCBs to the Fox River and Green Bay via the mills' wastewater discharges.

PCB contamination of the Fox-Green Bay system has been the subject of many studies over the last 25 years, but the Green Bay PCB Mass Balance Study (GBMBS) stands as the most comprehensive and scientifically validated. This landmark five-year study involved dozens of scientists from six federal agencies, two state agencies and 13 universities. Completed in 1990, the GBMBS produced the first complete model of the sources, movement and fate of PCBs in an aquatic ecosystem.

GBMBS estimates of the amount and rate of burial of PCBs in Green Bay sediments have been questioned in the lingering controversy over how best to clean up the system. To resolve this issue, the University of Wisconsin Sea Grant Institute in 1998 sponsored a follow-up study. Completed in 2000, the UW Sea Grant study confirmed the GBMBS' original estimate of the amount of PCBs in the bay, but found that the concentration of PCB in the bay's surface sediments—where it is most readily bioconcentrated by aquatic organisms and fish—was declining at a much slower rate than projected by the GBMBS and remained virtually unchanged a decade later.

About PCBs

PCBs (polychlorinated biphenyls) are colorless, odorless chemical compounds with low electrical conductivity that were widely used in electrical equipment and a variety of commercial applications, including adhesives, paints and carbonless copy paper, for five decades.

Although PCB use was restricted and its production banned in the U.S. more than 25 years ago, large environmental reservoirs of these chemicals still exist. Of the estimated 1.4 billion pounds of PCBs produced

ISSUES

- **The Fox River-Green Bay system is contaminated with an estimated 50,000 kilograms (110,000 lbs.) of PCBs. About 80 percent of this mass of PCBs resides in the Fox River.**
- **More than 1,000 kilograms (2,200 lbs.) of PCBs were transferred from the Fox River to Green Bay during the 1990s. As a result, PCB concentrations in the bay's surface sediments—where they are most bioavailable—have not improved and remain unacceptably high.**
- **The Green Bay ecosystem will continue to be contaminated by PCBs indefinitely until the input of PCB-contaminated sediment from the Fox River is halted.**
- **The Wisconsin Sea Grant program has supported research, education and outreach on the sources, movement, fate and health risks of PCBs in the Fox River-Green Bay system for more than three decades.**

between 1929 and 1979, about half has been released into the environment. PCB is an oily substance that does not dissolve easily in water, so most of the PCBs in natural waters adsorb to sediment particles. The sediments at the bottom of many natural bodies of water thus contain high levels of PCBs. When sediment particles move, the PCBs attached to them are also transported.

Because they are highly stable chemicals, PCBs are extremely persistent and readily bioconcentrate over time. Long-term, low-level exposure to PCBs is suspected of contributing to a variety of health problems, including liver damage and developmental problems in children, and high doses can cause cancer.

The U.S. Food and Drug Administration has determined that fish containing PCBs at levels over 2 parts per million pose a health risk to people who eat them. Based on this standard, Wisconsin annually issues health advisories concerning PCB contamination of certain sport-caught fish. This advisory still lists more than a dozen species of fish in the Lower Fox River-Green Bay system today, including a "do not eat" warning for eight species—the highest number for any body of water in the state.

The Green Bay PCB Mass Balance Study

GBMBS scientists estimated the total amount of PCBs in Fox River sediments at 42,500 kilograms (93,500 lbs.)—about five times the amount in bay sediments at the time. They also created a very detailed map of PCB deposits in Green Bay that clearly showed that the Fox River was essentially the only source of the PCBs in Green Bay.

Besides horizontal distribution, the map also showed how the distribution of PCBs changed with depth in bay sediments. Deeper sediments are generally older than sediments near the surface. Analysis of changes in PCB concentrations at different depths—called PCB/depth profiles—enabled the researchers to reconstruct the history of PCB input to Green Bay.

The GBMBS produced 64 of these PCB/depth profiles, covering almost every part of Green Bay where PCB contamination occurs. Viewed as a complete set, these sediment profiles show that PCBs began entering the bay in large amounts in the mid-1960s and reached peak amounts around 1980 (roughly coinciding with the ban on PCB use), after which PCB concentrations declined rapidly. While PCB levels at the bay's sediment surface were still unacceptably high in 1990, the rate of decline suggested that surface sediments might be free of PCBs within a few decades.

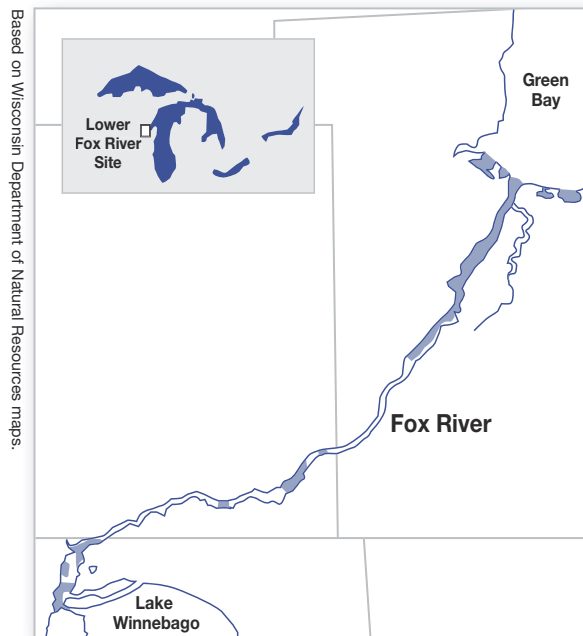
Ten Years Later...

In 1998, the UW Sea Grant Institute funded a second study of Green Bay to determine whether the projected disappearance of PCBs in surface sediments suggested by the GBMBS had, in fact, occurred. The new study developed PCB/depth profiles for eight representative locations in the bay sampled during the GBMBS a decade earlier. The new PCB/depth profiles were then combined with those from the GBMBS to create a profile of PCB contamination of Green Bay sediments for the preceding 70 years.

First and foremost, the new study confirmed the original GBMBS estimate of the total amount of PCBs in Green Bay sediments in 1990 (8,500 kg/18,700 lbs.). This closely agrees with the estimated mass of PCBs in the bay now accepted by the Wisconsin Department of Natural Resources. Three other important findings were:

- The amount of PCBs in Green Bay sediments has increased about 15 percent since 1990 as a result of PCB-contaminated sediments entering the bay from the Fox River.
- Permanent burial of PCBs occurs more slowly than projected by the GBMBS because of resuspension, dispersal and redeposition of bay sediments by currents and storms.
- The combination of new PCB-contaminated sediments from the Fox River and resuspension of bay sediments are keeping PCB concentrations in the bay's surface sediments similar to what they were in the late 1980s.

Lower Fox River PCB-Contaminated Sediment Deposits



Cleaning Up Green Bay

The solution to ending PCB contamination of Green Bay seems clear: the flow of PCB-contaminated sediments from the Fox River must be halted. Green Bay clearly has the capacity to clean itself through the gradual natural burial of contaminated sediments. About 75 percent of the PCBs in the bay are already permanently buried. But as long as additional PCBs continue to enter the bay from the river, an accurate prediction of how long it will take for the bay to clean itself cannot be made.

The sediments of the Fox River contain almost five times the amount of PCBs as the sediments of Green Bay. Most of the time, the transport of river sediments is slow and only relatively small amounts of PCBs are transported to the bay—on the order of 100 kilograms (220 lbs.) a year—but it is enough to keep PCB concentrations in bay surface sediment near present levels for decades, perhaps centuries. A greater and more immediate concern is that a major flood of the Fox River could rapidly move a large amount of contaminated sediment into Green Bay and greatly increase PCB concentrations in the bay's surface sediments, causing higher PCB levels in Green Bay fish for decades afterward.

PCB contamination of the Fox-Green Bay system must be addressed while the PCBs are still largely confined to the river. Removing PCBs from the bay is impractical. Once PCB-contaminated sediments enter the bay, they spread over a vast area, and huge volumes of sediment—millions of dump-truck loads—would need to be dredged to remove even a small percentage of the PCBs from the bay.