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The Hudson River & PCBs

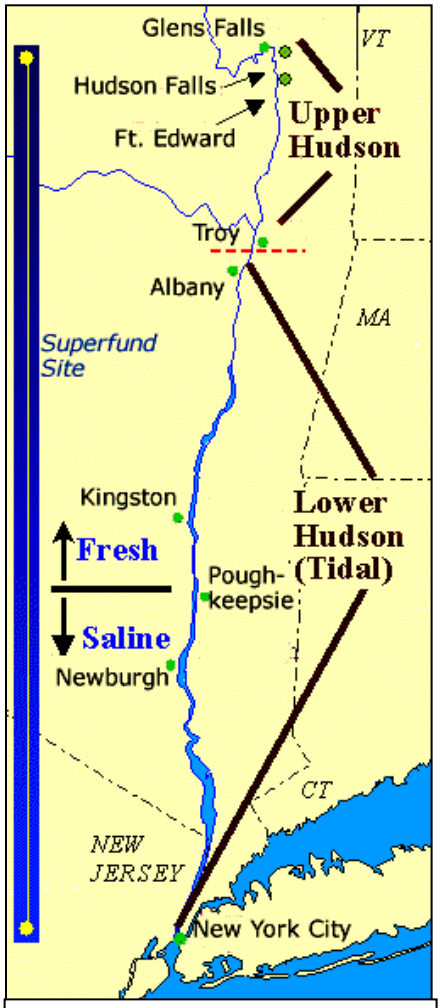

Figure 1: Map of the contaminated part of the Hudson River. *Map courtesy of NOAA.*

Polychlorinated biphenyls (PCBs) are a family of man-made chemicals. They were manufactured as a fire preventive and insulator in electrical equipment (like transformers and capacitors) from the 1940s until the 1970s. "PCBs are oily liquids that are chemically very stable and not very soluble in water. Instead, when released into the environment, they accumulate in sediments and especially in animal and plant fats" (Strayer, 2012). PCBs were used very widely, and are now found in many rivers around the world. Unfortunately, PCBs can cause cancer, neurological and developmental problems in humans, and have been shown to cause reproductive problems in fish and animals along the Hudson River (Strayer, 2012). The Environmental Protection Agency (EPA) banned the production of PCBs in 1977, but they estimate that 1.3 million pounds of PCBs had been discharged into the Hudson River prior to the ban (EPA, 2011).

PCBs in the Hudson

The Hudson River starts as a small stream in the Adirondack Mountains and flows south 315 miles to the ocean at New York City (see Figure 1, at left). PCBs entered the Hudson from several sources, but the largest sources are two (now decommissioned) capacitor manufacturing plants owned by General Electric in Fort Edward and Hudson Falls. These two plants are about 200 miles north of New York City and 50 miles north of Troy, where there is a large dam on the Hudson. Because of the movement of water and erosion, PCBs have moved downriver all the way to New York City.

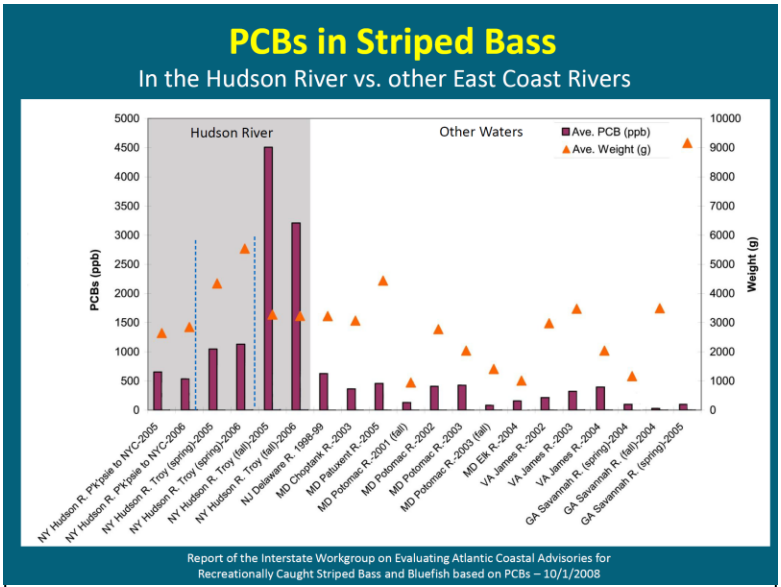

Figure 2. PCB levels in Striped Bass on the East Coast; part per trillion (ppt) = 1/1000 of a ppm

The Superfund Act was passed by Congress in 1980 to fund the cleanup of abandoned or uncontrolled hazardous waste sites. The Environmental Protection Agency (EPA) either cleans up the sites or tries to get the responsible party to pay for the cleanup of these sites. The EPA classified nearly 200 miles of the Hudson River as a Superfund site because of PCB contamination, and it is one of the largest Superfund sites in the country. You can see from the graph in Figure 2 that Hudson River fish had very high levels of PCBs compared to other rivers in the Northeast.

There are 209 individual molecules that are considered PCBs, and they have a variety of physical and biological properties. ”Polychlorinated” means the molecule has many chlorines, and chlorine plays a significant role in PCB toxicity. The specific location of the chlorine affects how toxic the molecule is, and PCBs with three or more chlorines are the most damaging to living organisms, so these are the PCBs that scientists focus on.

Starting in the 1980’s, the quantity of PCBs that entered the river declined as discharges from the plants decreased. Figure 3 shows levels of PCBs in striped bass from 1978 to 2003 near the city of

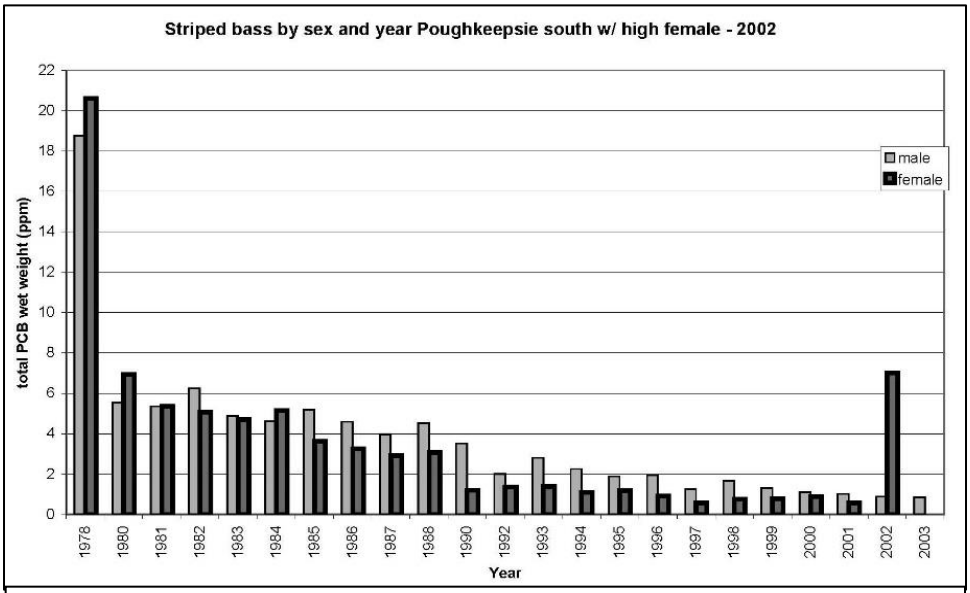

Figure 3. PCB concentrations in striped bass from Poughkeepsie to the George Washington Bridge near New York City. *NYSDEC Division of Fish, Wildlife and Marine Resources.*

Poughkeepsie, which is in the lower Hudson Valley, about 130 miles south of the plants in Hudson Falls. We can see that the PCB levels in fish near Poughkeepsie by 2003 were a lot less than they were in 1978!

PCBs and Living Things

PCBs become part of the food chain. They do not break down easily, can last for decades, and bind or "adsorb" to soil and sediment. Plankton (microscopic algae and animals) take up PCBs from the environment, but the molecules are not easily broken down or metabolized in them, so the PCBs just stay in their cells. When fish eat contaminated plankton, the same thing happens – the PCBs accumulate in their bodies, and especially in their fat cells.

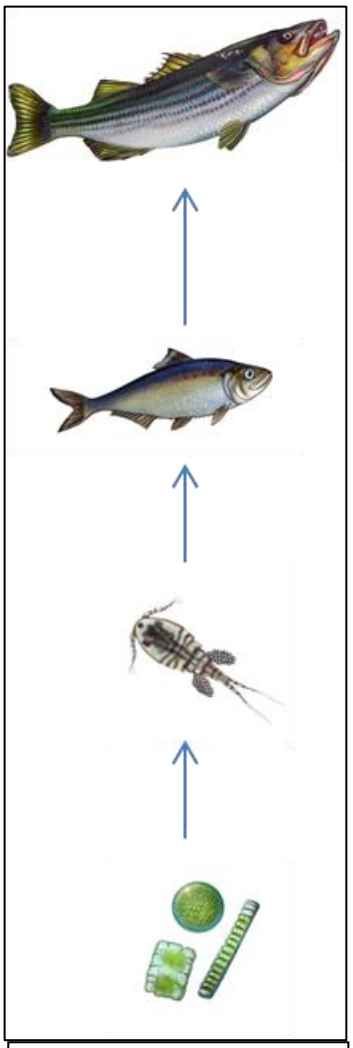

Figure 4. A simplified food

Let's look at the simplified food chain for the Hudson River (Figure 4). The phytoplankton is eaten by the copepod, which is eaten by the herring, which is eaten by the striped bass. If the plankton has PCBs, and the copepod eats a lot of contaminated plankton, the copepod will, over time, **bioaccumulate** PCBs in its own tissue as it continues to eat. **Primary consumers**, who only eat plants, generally contain less PCBs than **secondary consumers** that eat other animals. PCBs **biomagnify** throughout the food chain, with the higher order organisms, like striped bass, containing the highest levels of PCBs. Hudson River fish can have PCB levels that are thousands of times the level in the water.

Many things can affect the concentration of PCBs that may be in individual fish. What it eats is important, as well as where it lives and its age. PCBs build up in lipid or fat, so the amount of fatty tissue in a fish is related to its PCB level. Fat levels vary over time depending on whether there is a lot of food for the fish, so PCB levels might change in a fish from year to year. Age is a factor – a younger, smaller fish tends to have a lower concentration of PCBs than an older, larger fish of the same species.

However, where the fish spends time and eats is also important. Due to water action and the shape of the river, the PCBs in the sediment are not spread evenly. A fish who lives and eats in one area can have more PCBs than one who lives where the sediments have less PCBs.

Fish movement is complex and scientists are still studying it. Some fish have a small home range and do not travel far in their lifetime, and other fish are migratory or **anadromous**. Anadromous comes from a Greek word meaning "running upward". Anadromous fishes hatch in fresh water, then spend many years in marine waters until they migrate back to freshwater rivers to spawn. Examples of anadromous species in the Hudson River include striped bass, river herring, American shad, and Atlantic sturgeon.

Newly spawned bass, herring, shad, and sturgeon spend their first summer in the river before they migrate to the ocean to mature. However, some young striped bass males spend three to five summers in the very contaminated parts of the Hudson River near Albany, and have higher levels of PCBs. As you can see, there are a lot of factors that influence the PCB levels in Hudson River fish!

PCBs have a lot of effects throughout the ecosystem; on fish, reptiles and amphibians, birds, and other living things in contact with the Hudson. Another species of fish, the Atlantic tomcod, has evolved a tolerance to PCBs in their tissues, but their populations are declining in the Hudson River (Yuan et al., 2006). The concentrations of PCB measured in Hudson snapping turtles have been associated in some studies with juvenile mortality (Hudson River Trustees, 2002). The PCB concentrations found in mink near the Hudson River are high enough that they may cause problems with their reproduction (Hudson River Trustees, 2006). Almost one quarter of catbird eggs nesting near the Hudson River were found to have toxic levels of PCBs (Hudson River Trustees, 2018). Scientist are investigating these effects, and you can learn more from the references at the end of the document.

Gray catbird nest. *Photo courtesy of GardenPhotos.com*

PCBs and Your Health

In the early 1970s, people started to get worried about eating fish from the Hudson River. We now know that PCBs cause cancer in animals, and problems in people such as a reduced ability to fight infections, low birth weights, and learning problems (EPA, 2015). Contaminated fish consumption can be a large source of PCBs for people. The highest levels were found in fish near the plants, but elevated levels were found in the river south of Troy as well. In 1976, all commercial fishing in the Hudson River was suspended because of concerns about PCBs.

NYSDEC Fisheries Unit collecting striped bass from the Hudson River. *Photo courtesy of NYSDEC.*

The Food and Drug Administration (FDA) has a federal supermarket standard of 2 ppm for PCBs. Fish with more than 2 ppm PCBs can't be sold for human consumption. Some states use stricter guidelines for locally-caught fish consumption than the FDA limit. Studies found that people who eat fish they catch often eat more fish than other people, and sometimes they eat a lot of the same species of fish from the same place. Since 2014, Cornell Cooperative Extension in Columbia, Dutchess, Greene, Orange and Ulster counties in the Hudson Valley has asked 2,100 people in those counties if they go fishing and if they eat the fish they catch. Seventeen percent, or about one out of six people, say they eat fish that they catch from local water bodies, including the Hudson. New York State Department of Health (NYSDOH) provides "fish advisories", which give advice to the public about how much fish, if any, they should eat from water bodies that are contaminated, including the Hudson River. The advice is based upon data and analysis of fish that the New York State Department of Environmental Conservation (NYSDEC) collects.

Because PCBs can have a greater effect on the development of young children, there is stricter advice for women who might have babies and for children. PCBs, like many chemicals such as lead and mercury, are particularly bad for children and infants.

To Learn More about PCBs and Health, visit: http://www.atsdr.cdc.gov/toxfaqs/tfacts17.pdf

Monitoring the Fish in the Hudson

Each year NYSDEC scientists collect approximately 2,000 fish from more than 50 New York water bodies for NYSDOH fish advisories. Fish are collected annually from the Hudson and are analyzed for PCB concentrations. To collect data about Hudson River fish for the fish advisory, NYSDEC scientists follow a sampling plan that specifies the number, location and type of fish to collect in the Hudson each year. NYSDEC staff try to collect the same species in the same locations in the river over time to see trends, and to collect fish that people are most likely to catch and eat from the river. The scientists track the size and weight of the fish, its age, sex, and where and when it was caught.

Measuring and weighing Hudson River fish. *Photo, courtesy of DEC Hudson River Fisheries Unit.*

There is no obvious way to tell if a fish is contaminated with PCBs without sending it to a lab for analysis – it doesn't have a specific smell or a taste, and a contaminated fish doesn't look any different from a normal fish. Once the scientists catch a fish they want to test for PCBs, they send it to a lab which uses a written protocol on how to prepare the fish. They blend the skin (which contains a lot of fat, or lipid) and belly fat of the fish with the meat for the analysis. The New York State Department of Health develops the advisories by reviewing the data on PCBs in Hudson River fish and updating the fish advisory as needed.

The Future of the Hudson

To protect people who eat Hudson River fish, and all the creatures in the Hudson River affected by PCBs, the EPA required that areas with the most highly contaminated sediment in the Hudson River be dredged (dredging means removing the sediment that is contaminated). The dredging of the upper Hudson River removed almost 2.65 million cubic yards from a 40-mile stretch of river, and began in 2009 and was completed in 2015. The dredging project removed about 65% of the PCBs in the area north of the Troy dam, but none downriver. The dredged sediment was taken to a processing facility where the contaminated water was treated and

removed, and the sediment was then shipped out-of-state to a disposal facility. Clean sand and gravel were placed over the dredged areas, and plants were placed back in the river to recreate habitat.

Federal and state monitoring programs continue to review many aspects of the health of the environment in and around the dredging project, including PCB levels in the water, fish, and sediment. The EPA began a review of the effectiveness of the dredging work in 2016 and are considering whether dredging some sediment south of the Troy dam may be needed to meet the target levels for PCBs in fish. Scientists think the PCB levels in fish will slowly decline over time, but we will continue to have advisories against eating fish for many years to come.

Scientists preparing fish for analysis in the lab. *Photo courtesy of NYSDEC Hale Creek Station.*

The river is much cleaner than it was in the 1970's, and efforts to improve the river and all the creatures who depend upon it happen every day. Scientists and everyone in the public can help make the river better. Some options for how you can both enjoy and help out the Hudson River are listed below.

References:

Atlantic Sturgeon in the Hudson: https://www.dec.ny.gov/lands/5084.html

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Interstate Workgroup on Evaluating Atlantic Coastal Advisories for Recreationally Caught Striped Bass and Bluefish: https://www.maine.gov/dhhs/mecdc/environmental-health/eohp/fish/documents/9-08final.pdf

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Getting involved and learning more about the Hudson River

To Learn More about PCBs - PCB toxicology

http://www.atsdr.cdc.gov/toxfaqs/tfacts17.pdf

Community science volunteer opportunities in the Hudson River Estuary

https://www.dec.ny.gov/lands/72898.html

Amphibian Migrations and Road Crossings https://www.dec.ny.gov/lands/51925.html

American Eel Research https://www.dec.ny.gov/lands/49580.html

Hudson Estuary Trees for Tribs https://www.dec.ny.gov/lands/43668.html

The Great Hudson River Estuary Fish Count https://www.dec.ny.gov/lands/97891.html

Estuary educational programs https://www.dec.ny.gov/lands/5102.html