Fish: Concentrations of Key Contaminants

Background

Fish are an excellent source of protein, minerals and vitamins, are low in fat and cholesterol, and play an important role in maintaining a healthy, well-balanced diet. However, certain fish may absorb toxic chemicals, such as polychlorinated biphenyls (PCBs) and mercury, from the water they live in and the food they eat. Chemical contaminants such as dioxin and PCBs are classified by the U.S. Environmental Protection Agency as probable cancer-causing substances in humans, and elevated levels of mercury can pose serious health risks to the human nervous system, particularly to developing fetuses.

Since 1982, when research began to show elevated levels of these potentially harmful chemical contaminants in certain fish and crabs in some New Jersey waters, fish-consumption advisories have been issued to protect, inform and guide citizens on how to safely eat fish. The fish consumption advisories are developed through a scientific process that includes collecting samples of fish from waters throughout the state and analyzing them for various chemical contaminants. The contaminant levels in the fish are then evaluated using both state and federal guidelines for protecting human health. Based upon those findings, advice on fish consumption are then developed for the general public as well as that part of the population that may be at higher risk. In addition, since levels of contaminants may vary from one location to another and from one fish species to another, the consumption advisories are also issued for individual water bodies.

In 2002, to update and revise the State's fish consumption advisories, the Routine Monitoring Program for Toxics in Fish was developed and implemented by the DEP. This comprehensive program divides the State's waters into five regions that are sampled on a rotating basis for contaminants in fish and other species (e.g., crabs). The first round of this monitoring program containing five regions was completed in 2013 (i.e., Passaic River, Marine/Estuarine, Raritan River, Atlantic Coastal Plain, and Upper/Lower Delaware regions). Funding for continued monitoring has not been secured.

Overall a variety of contaminants of concern have been identified through the Routine Monitoring of Toxics in Fish. While levels of dioxins-furans and chlorinated pesticides (i.e., chlordane and dieldrin) have triggered a number of consumption advisories, mercury and polychlorinated biphenyls (PCBs) have been the two dominant contaminants responsible for the majority of New Jersey's fish consumption advisories.

Mercury

Mercury is a toxic metal that has been used in a number of products such as thermometers and electrical switches. There are many natural and man-made sources of mercury in the environment including the burning of fossil fuels such as coal, incineration of wastes, and metal processing and manufacturing. Mercury discharged to the environment can end up in local water bodies where it can be transformed into the more toxic methylmercury form. Methylmercury accumulates in fish tissue through the aquatic food chain. Above certain levels, methylmercury can damage the nervous system, particularly in unborn and young children, resulting in learning and developmental delays. With regular consumption, even low amounts of methylmercury may cause subtle effects on the central nervous system in both children and adults. In addition, long-term consumption of fish with elevated levels of methylmercury by adults and older children may result in adverse health effects, including neurological damage.

PCBs

PCBs were produced commercially for industrial application in heat transfer systems, hydraulic fluids and electrical equipment. They were later incorporated into other uses such as printing inks, paints, and pesticides. The manufacture of PCBs was stopped in 1979 as a result of evidence that PCBs build up in the environment and cause harmful effects to humans and wildlife. PCBs are organic compounds that once released into the environment tend to stay mostly in soil and sediment, but often these compounds can also be

found in both the air and water as well. These exposure routes make PCBs available to the food chains of a wide variety of aquatic and terrestrial organisms. Once PCBs enter the food chain, they have a tendency to absorb into lipid rich (fat) tissue and organs, building up to levels that are hundreds of thousands of times higher than the levels in the surrounding water. This bioaccumulation is then magnified, upward through the food web as, for example when smaller fish are consumed by larger fish. Ultimately, when people consume fish that already have accumulated and magnified levels of PCBs, the PCBs then accumulate in the organs and fatty tissues in their bodies. PCBs have been shown to cause cancer in animals, and there is evidence that PCBs may cause cancer in exposed humans. PCBs also have been shown to cause a number of other serious health effects, including effects on the nervous systems of developing fetuses, the immune system and the reproductive system. Numerous health studies have shown that unborn and young children are most at risk to PCB exposure so reducing everyone's exposure to PCBs is of primary importance.

Status and Trends

PCBs

Consistent declines in PCB concentrations for two important fish species, striped bass and bluefish, are documented in New Jersey's coastal waters. Both striped bass and bluefish are highly prized by anglers and consumers. They are both migratory fish species that are available seasonally along the coast. Their annual migration extends from North Carolina to Maine and both species spend extended periods of time in New Jersey estuarine and near-shore marine waters. While the PCB data for these species were collected within New Jersey coastal boundaries these data are representative of the general declining trend in PCBs along the east coast.

PCB contamination in rivers and streams is generally localized to the source making State-wide assessment of individual fish species more difficult.

Therefore, trend assessments of fish species in selected waterways were evaluated. Recent PCB fish concentration data were obtained from the Delaware River Basin Commission[1] from a number of sampling locations along the main stem of the Delaware River. These data were sorted by location, fish species, and year, and analyzed for trends with linear regressions. Two locations show some evidence of declining concentrations, while one site shows a very slight increase. Overall these results are consistent with a general observation that no marked trends in PCB levels are currently evident in the region for the recent past. The results are summarized in Table 1.

Table 1

Evidence of Trends in PCB Concentrations in Fish, Delaware River

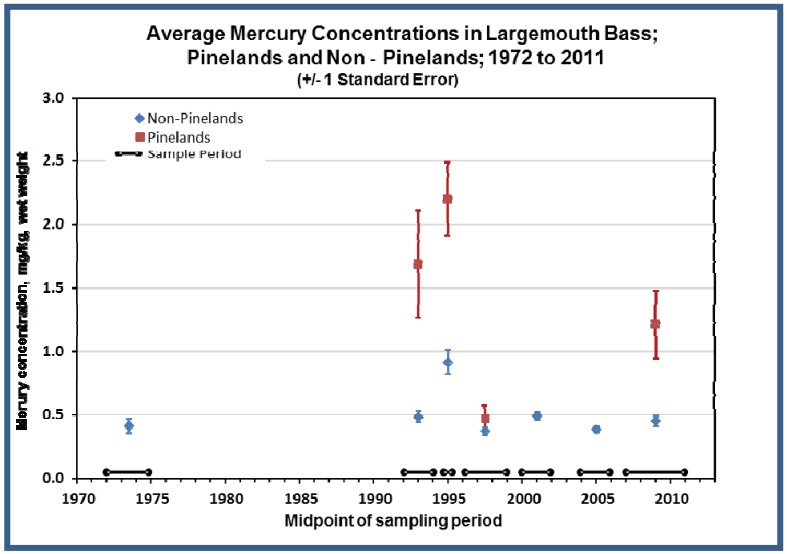
Site Name	Period	Species	Trend Present
Crosswicks Creek	2001 to 2010	Channel Catfish	No
Crosswicks Creek	2000 to 2010	White Perch	No
Easton	2004 to 2010	Smallmouth Bass	No
Easton	2004 to 2010	White Sucker	Decreasing
Lambertville	2004 to 2010	White Sucker	No
Lambertville	2004 to 2010	Smallmouth Bass	Decreasing
Milford	2004 to 2010	Smallmouth Bass	No
Milford	2004 to 2010	White Sucker	No
Raccoon Creek	2004 to 2010	Channel Catfish	No
Raccoon Creek	2004 to 2010	White Perch	No
Salem River	2004 to 2010	Channel Catfish	No
Salem River	2004 to 2010	White Perch	No
Tacony Palmyra	2001 to 2010	Channel Catfish	No
Tacony Palmyra	2001 to 2010	White Perch	No
Woodbury Creek	2004 to 2010	White Perch	No
Woodbury Creek	2004 to 2010	Channel Catfish	Increasing

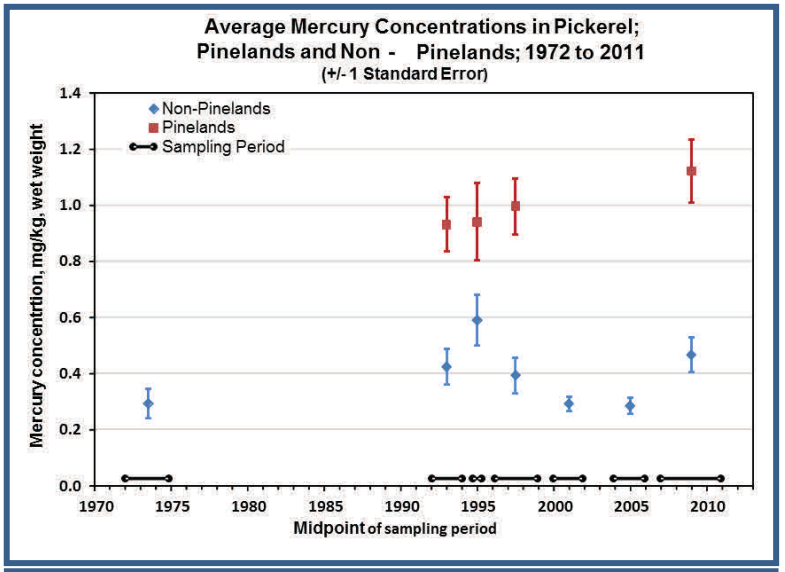
Mercury

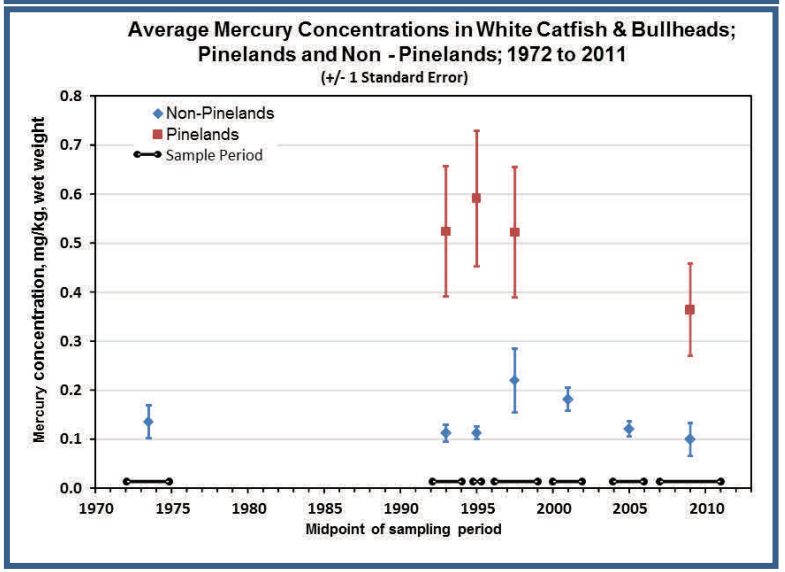
In New Jersey, the analysis of mercury in fish was initiated in the 1970s but it wasn't until early 1992 that a larger and more extensive sampling effort was initiated. That extensive sampling effort was continued by the Routine Monitoring Program.

The data provided below are on a variety of trophic levels of fish species collected from the freshwaters of New Jersey. For these data the highest trophic levels sampled are largemouth bass and chain pickerel. These species have the highest concentrations of mercury both statewide and by region. The data also provide the status and trends for other trophic levels species analyzed. Lower trophic level species (e.g., sunfish) and benthic omnivores (e.g., bullhead, white catfish) are also represented.

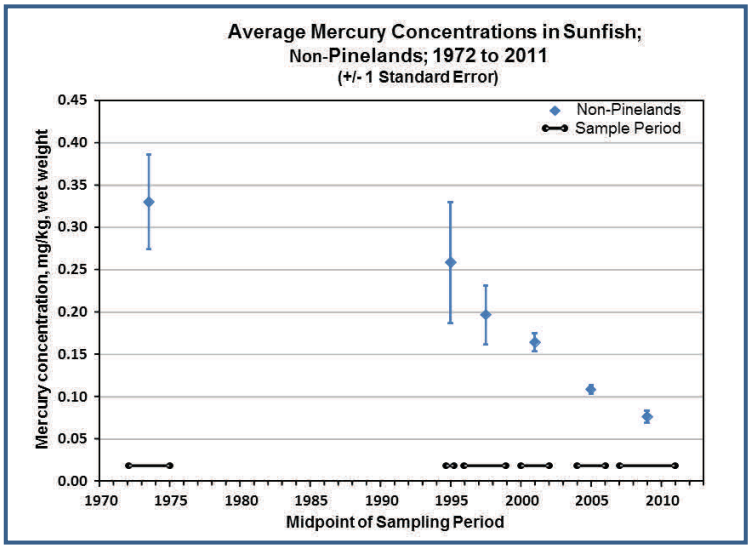
Overall there is no clear trend in mercury concentrations in a broad range of fish species. However, concentrations of mercury are markedly higher in Pinelands waters in several species analyzed: Largemouth Bass, Pickerel, and White Catfish and Bullheads (including both Yellow and Brown Bullhead). (See "Average Mercury Concentrations…" figures). It is believed that Pinelands water-quality characteristics such as low pH and generally higher dissolved organic carbon lead to increased methylmercury formation and bioaccumulation.







No trends are apparent in mercury concentrations in several other fish species and groups of species sampled in non-Pinelands waters. However, a decline in mercury concentrations appears to exist in sunfish, which includes Bluegills, Pumpkinseeds, and Redbreasts. The median concentration of mercury in sunfish sampled from the early 1970s through the 1990s was 0.18 mg/kg, and the median concentration of sunfish fish sampled from 2000 through 2010 was 0.11 mg/kg. This difference is significant according to a Mann-Whitney test, which showed a two-tailed *p*-value of less than 0.0001. A trend is apparent in the figure "Average Mercury Concentrations in Sunfish; non-Pinelands" below.



Mercury concentrations have also been measured at a number of sampling locations along the main stem of the Delaware River for the period 2000 through 2010 by the Delaware River Basin Commission. These data were sorted by location, fish species, and year, and analyzed for trends with linear regressions. Three locations show some evidence of declining concentrations. The results are summarized in Table 2.

Table 2

Evidence of Trends in Mercury Concentrations in Fish, Delaware River

Site Name	Period	Species	Trend Present
Crosswicks Creek	2001 to 2010	Channel Catfish	No
Crosswicks Creek	2000 to 2010	White Perch	No
Easton	2004 to 2010	White Sucker	Decreasing
Easton	2004 to 2010	Smallmouth Bass	No
Lambertville	2004 to 2010	Smallmouth Bass	No
Lambertville	2004 to 2010	White Sucker	No
Milford	2004 to 2010	White Sucker	Decreasing
Milford	2004 to 2010	Smallmouth Bass	No
Raccoon Creek	2004 to 2010	Channel Catfish	No
Raccoon Creek	2004 to 2010	White Perch	No
Salem River	2004 to 2010	Channel Catfish	Decreasing
Salem River	2004 to 2010	White Perch	No
Tacony Palmyra	2001 to 2010	Channel Catfish	No
Tacony Palmyra	2001 to 2010	White Perch	No
Woodbury Creek	2004 to 2010	Channel Catfish	No
Woodbury Creek	2004 to 2010	White Perch	No

Outlook and Implications

A number of steps have been taken by both the state and federal government to reduce levels of contaminants, such as PCBs, in the environment. In addition to the ban on PCB manufacturing, many hazardous waste sites have been cleaned up, proper disposal measures have been implemented, and sources continue to be identified for remediation. These steps should lead to the continued decline of contaminants such as PCBs in fish.

Numerous actions have been taken to curb mercury emissions in New Jersey, including reductions in mercury releases from solid and medical waste incinerators, coal-burning power plants, iron and steel manufacturing plants, wastewater discharges from dental offices, and other sources. See the *Mercury Emissions* chapter in this Trends Report series. These actions are reducing mercury loadings to the waters of the state. Reduction efforts

at the national level are reducing regional inputs as well. However, regional and global sources, especially coal-burning power plants, remain a significant source of mercury via atmospheric deposition.

Additional data are needed to determine long-term trends in mercury and other contaminant levels in fish. Continued monitoring is needed in order to determine the effectiveness of environmental management efforts to reduce contaminant levels in fish to acceptable levels and to review and revise fish consumption advisories.

More Information

www.state.nj.us/dep/dsr/njmainfish.htm

www.state.nj.us/dep/dsr/advisory_updates.htm

www.state.nj.us/dep/dsr/final-workplan.htm

www.epa.gov/ost/fish/

http://www.state.nj.us/drbc/quality/datum/fish/

References

[1]Data in this report was provided by the DEP Office of Science, April, 2013, and by the Delaware River Basin Commission, via: http://www.state.nj.us/drbc/quality/datum/fish/