Mercury Rising

Written By Rodney Foushee

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In her conservation classic, *Silent Spring*, Rachel Carson predicted that we humans would eventually poison the Earth through our own industrial processes unless drastic changes were made to protect the environment. Though major strides have been made in some areas to reduce pollution since her book was first published nearly 40 years ago, Carson's dire predictions seem to be holding true when it comes to mercury. One need only look to the rivers and streams of eastern North Carolina for proof. In the past decade the state of North Carolina has issued a mounting number of advisories against eating certain fish tainted with the heavy metal. Last spring the state, along with several other southeastern states, issued a warning against eating large king mackerel from the Atlantic Ocean because of high mercury levels found in the fish.

These fish consumption advisories are not permanent—they can be lifted if lower levels of mercury are found. However, scientists and environmentalists agree that this will not likely happen unless we reduce the amount of mercury that's being released into the environment. Meanwhile, the elevated levels of mercury pose a health threat to North Carolina's fisheries, wildlife and humans.

One Toxic Metal

Mercury, most commonly seen as a shiny, silver white metal, is a naturally occurring element with many sources in the environment—both natural and man-made. It is also one of the most poisonous substances on Earth.

The toxic effects of this heavy metal on the nervous systems of humans and wildlife have been known for centuries. The phrase “mad as a hatter” originated during the 1800s in England, when mercury salts were commonly used to prepare felt for hat making. The hat makers, or hatters, often developed the shakes and other symptoms of brain damage after being exposed to high levels of mercury. Besides permanent brain damage, mercury can also cause lung and kidney damage and, at high levels, even death. At lower levels, mercury can cause serious neurodevelopmental problems in children. Though mercury is no longer used in the hat-making industry, it is still a product of many modern industrial processes. In fact, scientists estimate that human activities since the beginning of the industrial age have increased the amount of mercury in the atmosphere by a factor of three. Most of this mercury is being released from the burning of coal, waste incineration, mining, chlorine production and other industrial processes.

Mercury is particularly dangerous because once it is released, it doesn’t break down and cannot be destroyed. Instead, it accumulates in the environment over time, cycling through the environment in various chemical forms in air, land and water. Mercury vapor can stay airborne—circling the globe—for up to a year. And once mercury is deposited into water, it can be converted by bacteria into methylmercury, a mercury form that is readily absorbed by plants and fish and quickly moves up the aquatic food chain. As smaller fish are eaten by bigger

fish (see “The Mercury Connection” on page 9), the mercury is concentrated, or biomagnified, in the tissues of the largest, oldest top-predatory fish.

In the right water conditions, methylmercury makes for a potent poison. According to some estimates, just a drop of mercury in a 25-acre lake can make the fish unsafe to eat. Such mercury-sensitive conditions occur in eastern North Carolina’s blackwater rivers and streams, where mercury-converting bacteria flourish among decaying debris in the slow-moving, acidic waters. A relatively simple food web in our eastern waterways also helps concentrate methylmercury in the tissues of a few top predators that include largemouth bass, bowfin and chain pickerel.

“Mercury is so persistent in the environment,” explains Kent Nelson, coastal region fisheries supervisor for the N.C. Wildlife Resources Commission. “It takes a long time for mercury levels to decrease in many ecosystems. High levels of mercury can last in some fish for 20 or more years after the mercury source is removed. Eastern North Carolina is very sensitive to mercury. One of the reasons is the large number of wetlands we have. The more wetlands you have, the more bacteria there are to convert elemental mercury to methylmercury, and this is enhanced in the acidic waters of our coastal blackwater rivers. In these mercury-sensitive systems, it really doesn’t take much mercury at all to create big problems in fish.”

And the problems don’t end with fish. Fish-eating wildlife species, including eagles, loons, ducks, raccoons and otters, are susceptible to the effects

of mercury. Mercury can cause kidney and nervous system damage in wildlife as well as reproductive failure. A recent casualty—a bald eagle—was found weak and lethargic from mercury poisoning last spring near the North Carolina coastal town of Aurora. Treatment over several months successfully flushed much of the mercury from the bird's system, but it was too late to reverse the permanent damage caused by a lifetime of exposure to the toxic metal. The 2-year-old eagle was euthanized by wildlife rehabilitators in September.

Of course, at the very top of the food chain is man, and it is methylmercury in fish that poses the greatest threat from mercury to public health today. This is why 41 states, including North Carolina, have posted consumption advisories on waters where high levels of mercury have been detected in fish.

"The More We Look, the More We Find"

"Right now, in North Carolina we have 10 advisories for mercury in fresh water and one saltwater advisory on king mackerel," said Dr. Luanne Williams, a toxicologist with the N.C. Department of Health and Human Services. The freshwater advisories recommend limiting consumption of largemouth bass, bowfin and, in some cases, chain pickerel (see "Fish Consumption Advisories" on page 11). Advisories are posted when one part per million of mercury is detected in fish tissue. Children and women of childbearing age are advised not

to eat any of these fish from the posted waters. The consumption advisory on bowfin is statewide. As for king mackerel, small fish (under 33 inches) are safe to eat, but larger mackerel (over 39 inches) should not be eaten. Limited consumption is advised for king mackerel between 33 and 39 inches long. In addition to the state advisories, federal officials recommend people limit their consumption of two other saltwater fish found off the Tar Heel coast—swordfish and shark—because they have also been found to have high levels of mercury.

Though high levels of mercury have likely been in these fish populations for decades, if not longer, North Carolina posted its first fish consumption advisory for mercury in 1993 after elevated mercury levels were discovered in three isolated lakes in the Sandhills of Moore County. Additional testing of largemouth bass and bowfin revealed high mercury levels in these species throughout the Lumber River basin. Some of the highest mercury levels were found in fish from the Waccamaw River and Big Creek in southeastern North Carolina, prompting state health officials to take a closer look at the people living in the area.

"The Department of Health did test some people living along the Waccamaw River in Brunswick and Columbus counties when the original advisories were first issued," Williams said. The study revealed that people who ate few of the contaminated fish had only trace levels of mercury in their bodies. Conversely, those who ate large amounts of the fish from the river had higher levels of mercury. About 10 percent of the people exceeded the federal Food and

Drug Administration's maximum safe threshold for mercury of 10 parts per million. Two of the 70 people tested—both of whom had eaten bowfin often over their entire lives—had hair mercury levels above 30 ppm, believed to be the highest levels of mercury ever recorded in humans in the United States!

The lesson is painfully simple, according to Williams: "If you eat a lot fish with high levels of mercury, you will have higher blood and hair levels of mercury," she said. "This is why we advise people to limit their consumption of fish in these areas."

Though no more testing of humans for mercury has been carried out, the N.C. Division of Water Quality has since the mid-1990s routinely sampled and tested fish from state waters for mercury. Until this year, North Carolina's mercury advisories were confined to waters east of Interstate 95. However, the area was expanded when the state's latest freshwater advisory was issued in February, for the South and Black rivers. Wildlife Commission biologists recently finished putting up about a dozen large metal signs, including some in Harnett County, just a few miles from Raleigh, warning of the new consumption advisory.

It seems that the harder scientists look for mercury, the more serious the problem becomes. "The more we look, the more we find," Williams said.

Threat to a Fishery

Within minutes of putting the first cigar minnow overboard, the fluorescent green line is singing off the spool of one of the stout graphite reels. More than a hundred yards of line leaves the reel before the king finally ends its first run and is slowly coaxed back to the boat. The strong fish makes several more runs before it tires and is brought alongside.

“The king mackerel is just a great fish,” exclaims Capt. Charlie Watson, as he impales the 30-inch mackerel with the sharp steel gaff and brings it aboard his 22-foot catamaran. “A king hits hard, it is a great fighter and there are plenty of them out there. It is just a wonderful game fish.”

Watson, a Topsail Island charter captain, makes his living finding king mackerel and helping his clients put them in the boat. “I think the mercury advisory surprised everyone in the fishery when the news came out,” he said. “It caught us all off guard.”

The latest mercury warning hurts. “There is no doubt that this is bad publicity,” Watson said. “You’ve got to remember this area has been hit by hurricanes since 1996,” he says. “Couple that with this advisory and it does hurt.”

Watson says that every day he takes clients out, he has to deal with the specter of mercury. “You have to bring it up to the customer,” he said. “But I’d rather them hear it from me. I give them the information and then let them make up their minds about what they want to do when it comes to keeping a big fish.”

Subsistence fishermen, who eat large amounts of fish, are clearly at risk from the mercury threat. So is North Carolina's burgeoning recreational fishing industry, which accounts for nearly $1 billion per year. Wildly popular, king mackerel fishing alone represents millions of that total.

"This mercury situation is sad because the king mackerel has made such a comeback in the past few years," Watson said. "[Fisheries managers] have done so much work to protect the stock to get them back up; the impact of recreational fishing on the economy is huge. Go to Wilmington or Wrightsville Beach and look at the tackle stores now and look what was there five years ago. You'll see how they've grown—a lot of that is from king mackerel fishing. These fish are worth a huge amount to the sport fishery," in fiberglass, outboard motors, gasoline and tackle.

Nelson, the fisheries biologist, echoes the charter captain's concerns. "In addition to the potential health effects, there are also economic and social costs to these mercury advisories," he said. "As fishing, especially by those who want to keep fish, declines in areas with advisories, businesses related directly to fishing such as tackle and bait shops, or indirectly, like campgrounds and motels, are likely to suffer."

Also, advisories may affect subsistence anglers who depend on wild fish for food, Nelson explains. There are a significant number of these anglers in eastern North Carolina.

Though most North Carolina fish are perfectly safe to eat, advisories can have another negative impact on fisheries, Nelson added. “The perception that ‘some fish are unsafe to eat’ can lead to the perception that ‘no fish are safe to eat,’” he said.

In fact, the health benefits of eating fresh fish—an excellent source of low-fat protein—have been well documented for years. So, by choosing other foods to avoid fish, people may actually be hurting their health. Watson, the charter captain, puts it more plainly. “If you think eating fish—even with mercury—is bad for you, eat a bunch of fast food instead,” he said. “See where you are 30 years from now. I’ll take my chances eating king mackerel!”

Mercury Sources

The dangers of mercury in the environment are becoming quite clear, but where does it come from?

Most mercury, both worldwide and in North Carolina, is released as vapor into the air and falls back to Earth mixed with rain and snow and as dry particles through the process of atmospheric deposition, explains Jeff Hayward, a toxicologist with the N.C. Division of Air Quality. Mercury has many sources, and occurs naturally in the Earth’s crust. Nearly all soils and rock contain trace amounts, and about half of the releases of mercury worldwide come from natural sources, including volcanoes, forest fires and degassing of the Earth’s

crust deep below the oceans. Mercury cannot be created or destroyed; however, humans have accelerated the release of mercury into the environment through industrial processes, including the burning of fossil fuels that contain mercury, the burning of mercury-containing waste, certain manufacturing processes and smelting ore.

"It is clear that over the past 150 years, since the beginning of the Industrial Revolution, there has been an increased movement (mobilization) of mercury into the atmosphere," Hayward said. "We've seen a movement of mercury from sources locked up deep in the Earth's crust to living systems. Ultimately, it ends up in the fish."

In the United States, as well as in North Carolina, coal-fired power plants are the largest source of mercury emissions in the air, accounting for about one-third of the total man-made mercury emissions. Medical and municipal waste incinerators, which burn waste containing mercury, are also major sources, as well as certain chemical manufacturing plants that use mercury.

In 1998, according to state figures, 50 sources accounted for 97 percent of the mercury released in North Carolina, spewing about 11,000 pounds of the heavy metal into the air per year. Coal-fired plants operated by Carolina Power & Light Co. and Duke Energy represent the majority of the sources, holding 14 of the top 20 spots for North Carolina mercury emitters. At the top of the list is Carolina Power & Light Co.'s Roxboro plant—the nation's tenth largest power plant, providing electricity for more than 2 million customers in North Carolina.

The coal-burning plant, located in the northern Piedmont, releases 1,696 pounds of mercury into the air each year.

"Mercury is a global problem," explains Chuck Wakild, supervisor of CP&L's environmental air programs. "On a global basis, U.S. utilities contribute about 1 percent of total mercury emissions. On a global basis, this is pretty small, but on a regional basis, when you look at statewide, man-made sources, it becomes a major source."

Yet local sources of mercury may have an impact on sensitive environments such as those in eastern North Carolina. As evidence, consider the two stations that the state Division of Air Quality maintains in eastern North Carolina to monitor mercury levels in rainwater as part of a national mercury deposition network. The sites, which are very similar, are located in remote areas at Lake Waccamaw in Columbus County and Lake Phelps in Washington County. "What we see, year after year, is that the concentration of mercury in rainwater at Lake Waccamaw exceeds that at Lake Phelps," Hayward said. "As it turns out, the Waccamaw site has a greater density of mercury emission sources in its vicinity than Phelps. These data are consistent with a greater impact from local sources on rainwater concentrations of mercury in eastern North Carolina." This has serious implications when you consider that half of the major sources of mercury in North Carolina are located east of Interstate 95.

One of the potential local sources of the elevated mercury readings at the Waccamaw station was a chlor-alkali plant operated by Holtrachem, a

manufacturer of chlorine, in Riegelwood. In 1998, the plant ranked second among mercury sources in the state, emitting 1,276 pounds of mercury a year. After setting up very sensitive instruments that measure mercury in the air, state scientists discovered a strong plume of mercury vapor at the Lake Waccamaw site that pointed upwind in the direction of the plant some 18 miles away. More compelling, when Holtrachem voluntarily switched over to a non-mercury process in the spring of 1999, the mercury readings at the monitoring site immediately fell off. Most telling, the maximum readings, that once fluctuated widely, fell to just 1/10 of the level they had been when the plant was using mercury cells to make chlorine. “We’ve seen nearly baseline conditions ever since at Lake Waccamaw,” Hayward said. “It is very clear that this plant served as a major local source of mercury emissions in southeastern North Carolina. Whether or not you buy into the local or global theory of mercury deposition, removing all of this mercury and removing it in one of the most sensitive areas of the state is a wonderful thing for the environment. You’ve turned off a major source of mercury just like that.”

Wakild, the CP&L spokesman, dismisses the local deposition theory. “A power plant near low-pH waters doesn’t have anything to do with the deposition of mercury,” he said. “That’s more of an atmospheric process and it is coincidental. The linkage from a source to the mercury found in fish is hard to make. It is impossible to make.”

Fixing the Problem

The debate over local versus global sources of mercury can amount to fingerpointing and can be counterproductive. Reducing mercury emissions is clearly the solution to the problem.

“We could spend a lot of time studying and debating the local versus global impacts of mercury,” Hayward said. “We clearly have a problem—there is more compelling evidence in the case of mercury, when you look at the mercury we’ve already found in the fish and people in North Carolina, than of most any other pollutant. It is detrimental to argue about who is to blame. We need to move past that and try to encourage people to reduce their mercury emissions, especially in sensitive areas like eastern North Carolina.”

At the same time, people need to be informed about the dangers of mercury. One of the quickest ways is to tell fishermen about this problem, and advise them to keep smaller fish and avoid eating the posted species.

“We could remove all of the sources of mercury out there—all the power plants, trash burners—and there will still be a lot of mercury in the fish for five, 10 years or more,” Hayward said. “We have to be more proactive. It is one thing to put up signs, it is another to get out there with the people who fish these waters every day and tell them about the problem.”

As the widespread impacts of mercury have become clearer over the past decade, industries in the United States and other parts of the world have begun

to reduce their use of mercury. Alternative processes in the manufacturing of batteries and chlorine have reduced the use of mercury. And strict federal regulations passed in 1995 will reduce mercury emissions from medical waste and municipal waste incinerators by 90 percent.

However, the nation's top source of mercury—coal-fired power plants—remains essentially unregulated with no emission standards when it comes to mercury. Thirty years after the passage of the Clean Air Act, this may soon change.

At the constant prodding of environmental groups and state agencies, the federal Environmental Protection Agency is considering regulating utility companies for mercury emissions. After studying the problem for nearly a decade, the EPA must issue a decision by Dec. 15.

Many environmentalists and scientists believe the EPA will finally regulate mercury emissions from power plants. Meanwhile, a statewide Mercury Task Force, composed of environmental scientists and health officials, was established two years ago to study the impacts of mercury in North Carolina. The task force may make recommendations later this year on ways to further reduce mercury emissions in the state.

"This is a serious problem for our state," said Williams, the state health official and a member of the task force. "In order to protect our fishing resources and human health, measures should be taken to decrease the levels of mercury that are being released, especially from these major sources."

By reducing our emissions of mercury, hopefully someday the metal warning signs will finally come down from North Carolina's waters. And Rachel Carson will have been wrong, after all, about our destructive nature. You can bet she'd like to have been mistaken about this one.

Fish Consumption Advisories

Below is a list of the current consumption advisories for North Carolina waters that contain fish (species listed) with high mercury levels:

- Pages Lake, Pit Links and Watson Lake (Moore Co.)
- Ledbetter Lake (Richmond Co.)

  Largemouth bass— No consumption by women of childbearing age and children. No more than two meals per month for the general population.
- Big Creek (Columbus Co.)

- Waccamaw River (Columbus and Brunswick counties)

- Lumber River Basin (Moore, Hoke, Scotland, Richmond,

  Robeson, Bladen, Columbus and Brunswick counties)

- Phelps Lake (Washington and Tyrrell counties)

  Largemouth bass and bowfin (blackfish)— No consumption by women of childbearing age and children. No more than two meals per month for the general population.

- Black Lake (Bay Tree Lake) (Bladen Co.)

  Largemouth bass and bowfin (blackfish)— No consumption.

- South River (Harnett, Sampson, Cumberland and Bladen counties)

  and downsream of South River at the lower part of Black River (Sampson, Bladen and Pender counties)

  Largemouth bass and bowfin and chain pickerel— No consumption by women of childbearing age and children. No more than two meals per month for the general population.

- STATEWIDE

  Bowfin (blackfish) — No consumption by women of childbearing age, pregnant women and children. No more than two meals per month for the general population.

- STATEWIDE (Atlantic Ocean)

King mackerel — King mackerel larger than 39 inches should not be consumed. King mackerel less than 33 inches are safe to eat. People should limit their consumption of 33- to 39-inch fish. Children 12 and younger and women of childbearing age should eat no more than one 8-ounce portion per month. All other adults should eat no more than four 8-ounce portions per month.