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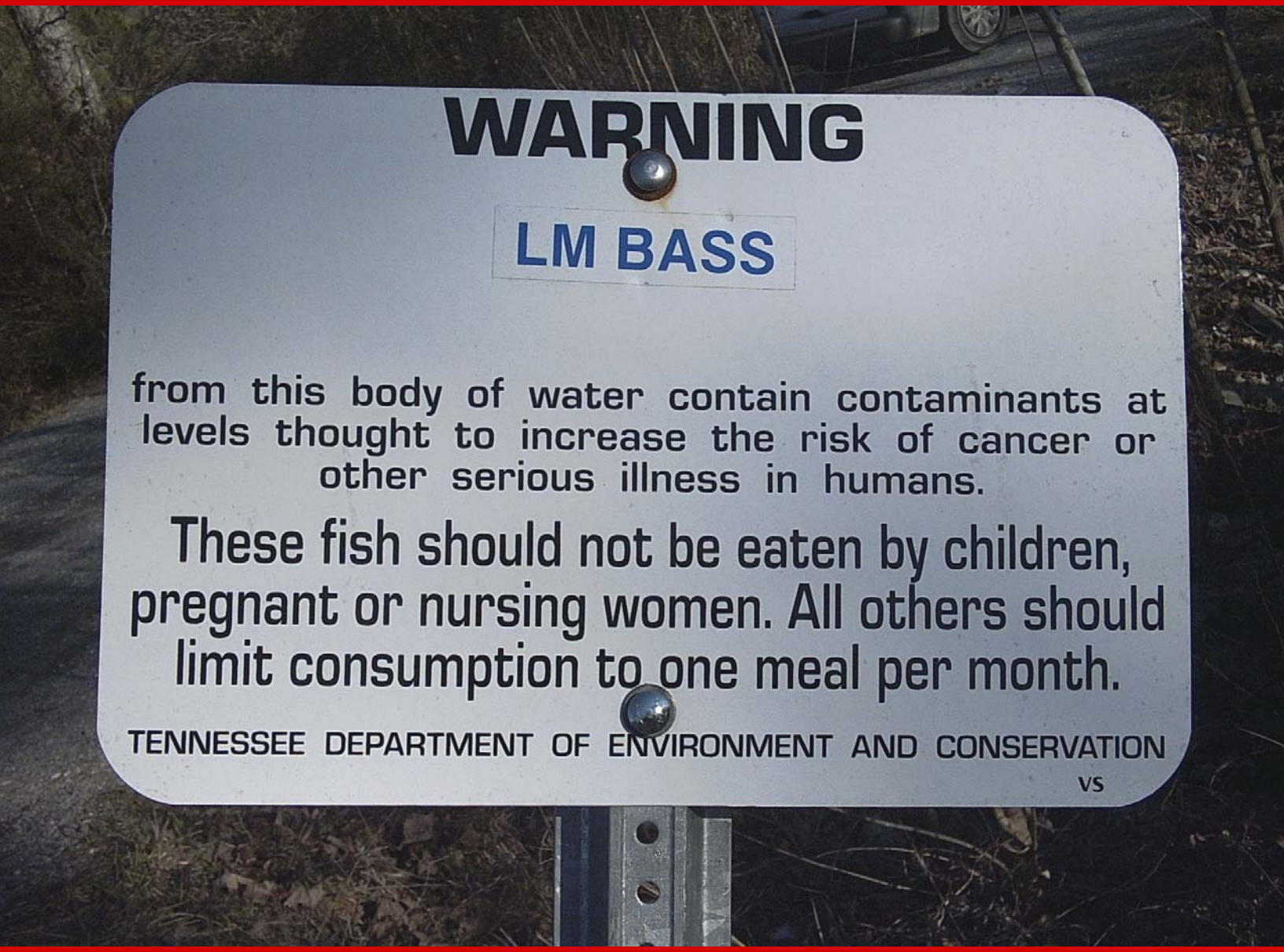
MERCURY ON THE HIWASSEE



SAMPLING OF FISH AND SEDIMENT PINPOINTS HIGH MERCURY LEVELS NEAR OLIN SITE

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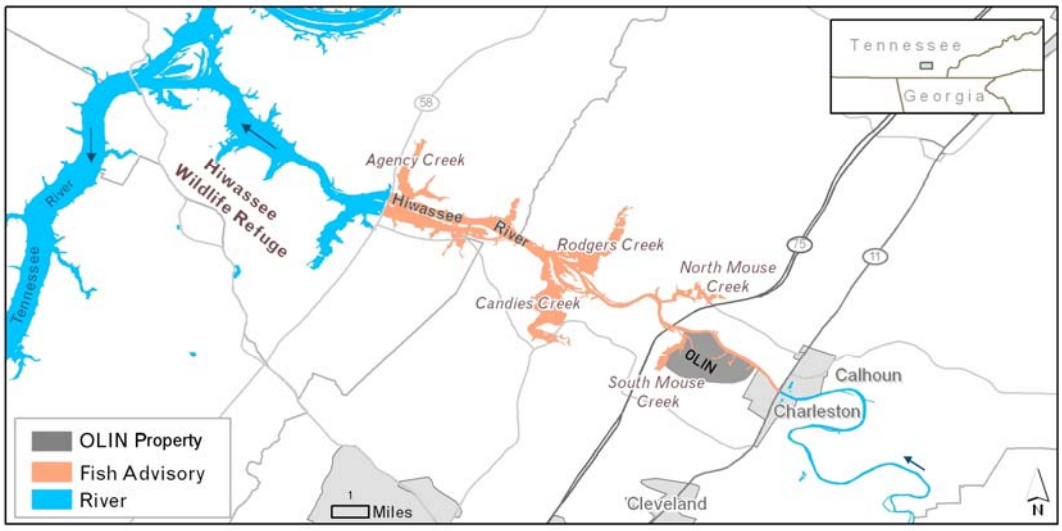
Executive Summary

Warning: Pregnant and nursing women and children should not eat largemouth bass from the Hiwassee River near Charleston, Tennessee due to mercury contamination. All others are warned to eat no more than 1 meal of largemouth bass a month.

This new fish consumption warning was issued by the Tennessee Department of Environment and Conservation (TDEC) in the spring of 2007 and covers a 7 mile stretch of the Hiwassee between the Highway 11 and Highway 58 bridges (See map below).[1] Mercury levels in largemouth bass in this section of the Hiwassee exceed the EPA standard (0.3 mg/kg,) which is the maximum level of mercury in game fish that EPA set as a threshold to protect human health.

Hiwassee River 2007 Largemouth Bass Precautionary Fish Consumption Advisory Area



Because of this mercury contamination in game fish, the state of Tennessee determined that this segment of the Hiwassee is no longer "fishable". This means that the mercury pollution prevents the river from fulfilling one of the uses (fishing) that the river must meet under the Clean Water Act. Such waterways are required to be included in a list of "impaired waters" in accordance with section 303(d) of the Clean Water Act. Since this segment of the Hiwassee is listed as impaired by mercury in Tennessee's 2008 draft "303d" report, the state is now required to identify the sources of mercury pollution to the river, and to determine how much mercury from all sources can be loaded into the river each day without causing fish contamination.[2] This amount of mercury, called the Total Maximum Daily Load, or TMDL, then provides an overall limit for all the mercury sources, and thus requires that pollution from those sources be reduced. In order to accomplish that, the source of mercury needs to be determined.

Mercury monitoring data presented in this report show that:

- Olin, Tennessee's largest mercury polluter has discharged far more mercury to the Hiwassee River than any other source.

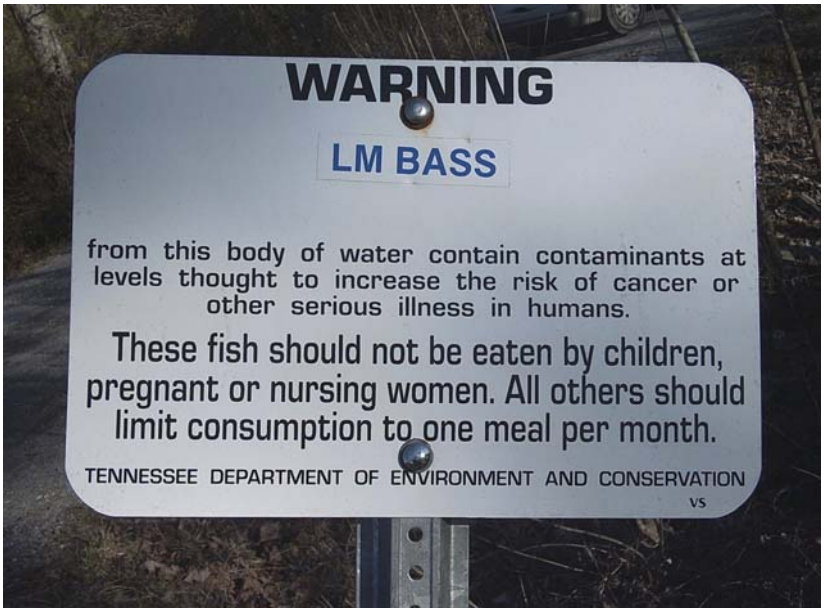
- Mercury levels in Hiwassee River sediments are highest directly below Olin's outfalls and remain elevated downstream compared to upstream sites.

- Sediment mercury levels near and downstream of Olin are so high that some sediment dwelling organisms are predicted to die within 10 days of exposure to them.

- Mercury levels in small prey fish are highest directly in front of the plant compared to upstream and farther downstream.

- Mercury levels in game-sized largemouth bass are highest at sites nearest the plant, where they exceed the EPA methylmercury safe level.

These data show that the contamination of the lower Hiwassee is a direct result of mercury discharges and emissions from the Olin Corporation chlorine plant in Charleston, Tennessee.



Tennessee Department of Environment and Conservation Sign on the banks of the Hiwassee River

Our research also strongly suggests that if Olin had not released so much mercury, it is highly unlikely that any fish advisories would exist in the lower Hiwassee River, due to the following findings:

- Soils in the watershed are much lower in mercury than corresponding river sediments, suggesting that runoff from the watershed is not the primary source of mercury contamination.

- The lower Hiwassee River system isn't an environment that promotes the production of methylmercury, the organic form of mercury that bioaccumulates in aquatic food webs, from inorganic mercury, the form released from Olin and other industrial sources.

- The methylmercury levels in sediments near the Olin Plant are high enough to contaminate fish only because of extremely high inorganic mercury levels, a direct result of Olin's discharges.

Nonetheless, even if atmospheric mercury contributes to mercury impairment of this watershed, controlling the largest emitter of mercury to the air in the state of Tennessee -- the Olin plant -- should address the problem.

Recommendations

To restore the health and full recreational uses of the Hiwassee River, Oceana recommends the following:

- Olin should cease needless mercury pollution of the Hiwassee River, by modernizing its plant and switching to readily available mercury-free technology

Should Olin refuse to update its facility voluntarily, then Tennessee should:

- Put a higher priority on developing the mercury TMDL for the Hiwassee River

- Strictly curtail Olin's mercury releases

- Consider corrective action to remediate contaminated river sediments

Background

The Hiwassee River is an important ecological and cultural resource. The river originates in Georgia and flows through North Carolina before crossing into the Tennessee Blue Ridge mountains. The lower Hiwassee then crosses into the Tennessee Valley and Ridge province and joins the Tennessee River's Chickamauga Lake, north of Chattanooga. The Hiwassee was the first river in Tennessee's Scenic River program.[3] This area of Tennessee is nationally recognized for its high diversity of freshwater fishes and mussels. The lower Hiwassee hosts over 90 species of fish and over 20 kinds of freshwater mussels, some of which are endangered upstream of the fish consumption advisory area.[4] Below the fish advisory area (downstream of Highway 58) is the Hiwassee Wildlife Refuge, which provides critical bird habitat for migrating Sandhill cranes and other waterfowl.[5] This area is also culturally important as the center of the ancestral Cherokee Nation.

The Olin Chlor-alkali Plant

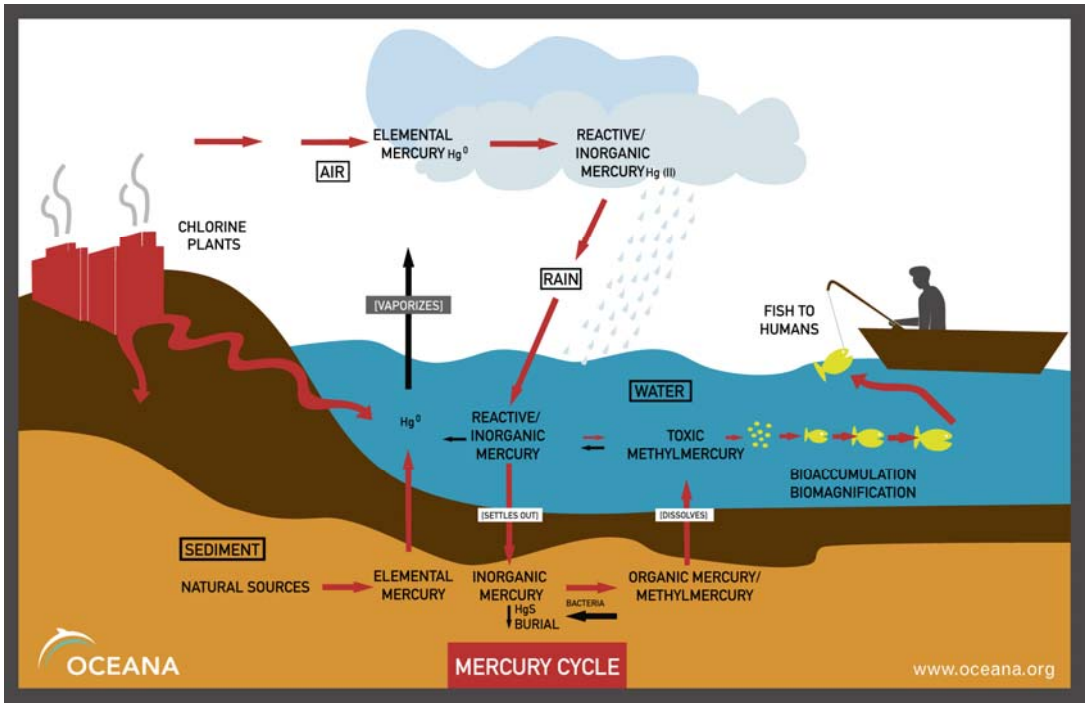
The Olin Corporation operates a mercury-based chlor-alkali plant in Charleston, Tennessee on the banks of the Hiwassee River, about 15-17 miles upstream of its confluence with the Tennessee River. Mercury-based chlor-alkali plants produce chlorine and caustic soda using an antiquated process rarely used by the rest of the U.S. chlorine industry. As a result, Olin's Charleston plant is the largest emitter of mercury to the air in all of Tennessee and the largest total mercury emitter of the four remaining mercury-based chlorine plants in the U.S.[6]

Mercury-based chlorine plants emit mercury to both the atmosphere and water. Because these plants emit much more mercury to the air than the water, their discharge of mercury into water has received less attention. However, mercury discharged directly into local waters may result in contamination of area fish, particularly if conditions in the river keep that mercury nearby.

How Mercury Gets into Fish

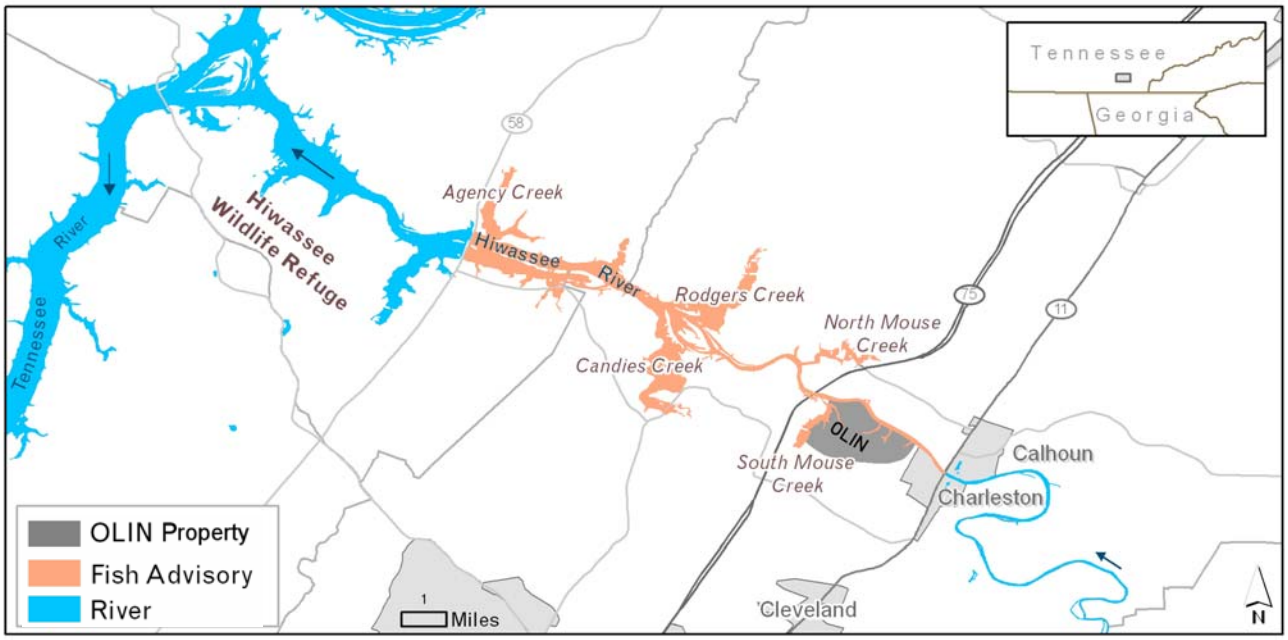
Mercury enters water bodies not only from direct discharges from industry, but also from mercury that has been released into the air. Part of this atmospheric mercury gets deposited either directly into water or onto land. Once on the land, the mercury may later enter rivers or other water bodies through runoff. Whatever the source, once mercury enters the water, it tends to attach to particles and sink to the bottom sediment. It is primarily in the underwater sediment where naturally occurring bacteria convert mercury to the more toxic form, methylmercury, which bioaccumulates in fish. As methylmercury makes its way up the food chain--through small plants, to small animals, to larger and larger fish--it gets more and more concentrated. It is not unusual for a top predator, like largemouth bass, to have a million times more mercury than does the water in which it swims.

The Mercury Cycle



Most people are exposed to mercury when they consume fish that contain methylmercury. Mercury is most toxic to the nervous and cardiovascular systems. Children are particularly vulnerable to mercury's toxic effects since their developing nervous systems are harmed by much lower levels of mercury than would affect adults. Mercury can also cross the placenta from a mother to her developing child. For these reasons, women of childbearing age and children are the primary targets of fish consumption advisories, like the one posted for the Hiwassee.

Hiwassee River 2007 Largemouth Bass Precautionary Fish Consumption Advisory Area



The Oceana Study

To explore the potential impact of the Olin, Charleston plant on the Hiwassee River, Oceana embarked on a scientific sampling program. Fish and sediments, the places where mercury is most likely to accumulate, were the target of the research presented here. The goal was to see whether the mercury discharged from the plant was causing mercury contamination in the Hiwassee River.

The area covered by the 2007 largemouth bass fish advisory for the Hiwassee River is shown on the map on the next page. This fish advisory area coincided with sites we sampled for mercury in the previous year.

In October of 2006, Oceana, in conjunction with the Biodiversity Research Institute, monitored mercury levels in small forage fish and mercury and methylmercury levels in sediments and soils upstream and downstream of the Olin plant. Recreational-sized largemouth bass were sampled along the Hiwassee fish advisory area in 2007. We compared our data to studies done by the Environmental Protection Agency (EPA) in 1998[7] and to data collected by Tennessee Department of Environment ad Conservation (TDEC) and published in 2007.[8] Oceana compiled a full analysis of these data and submitted them to TDEC in a technical report in conjunction with the state's Clean Water Act comment period for impaired waterway designations.[9]

High Mercury Levels Found in Fish and Sediments

The results of mercury monitoring conducted on the Hiwassee are plotted on maps, shown to the right. It is clear that mercury concentrations in the river sediment (top panel), the small fish that largemouth bass eat (middle panel), and in recreationally-sized largemouth bass (bottom panel) are all highest directly in front of the Olin plant, where Olin discharges its mercury to the river, or immediately downstream, while levels are lowest upstream of the plant.

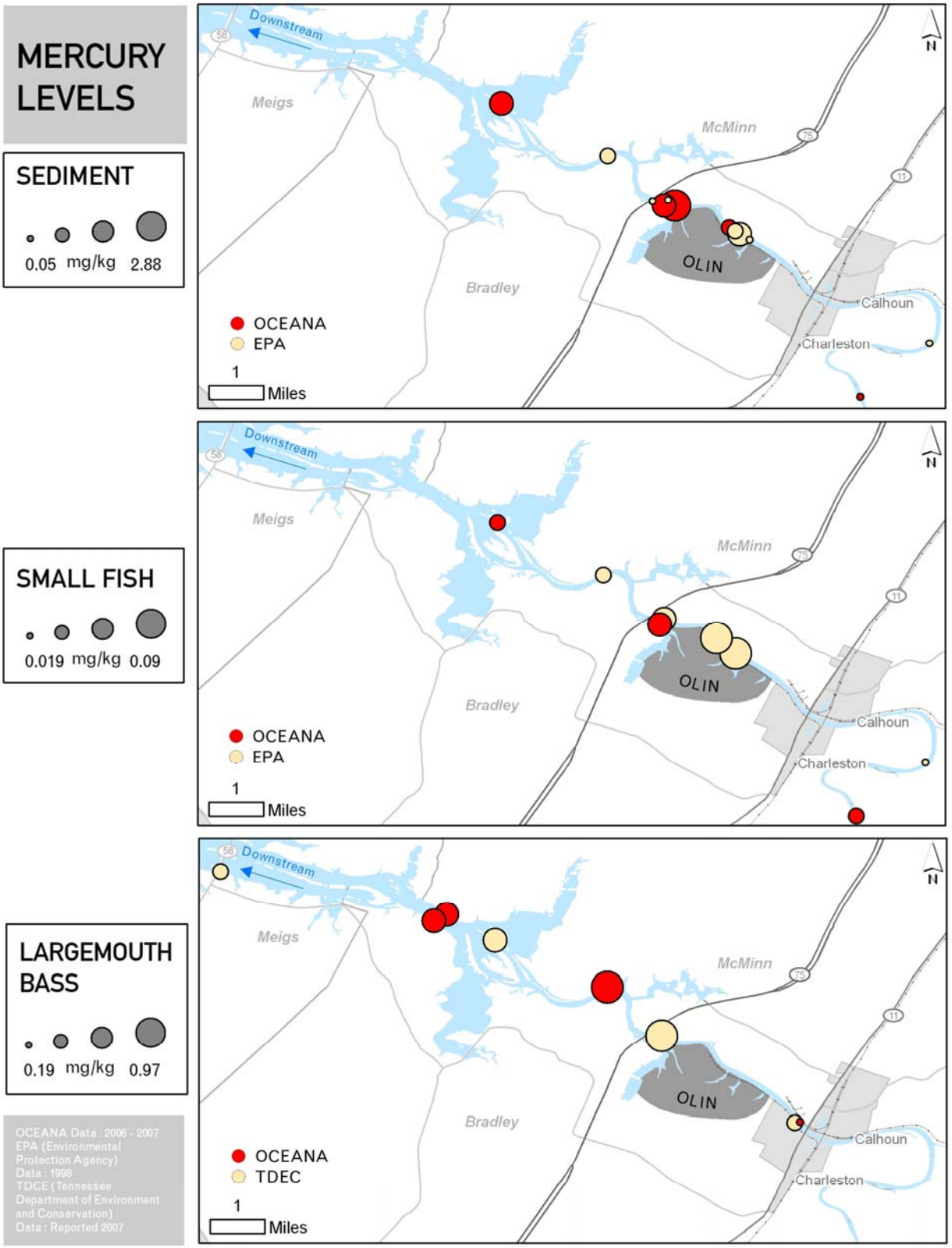
The mercury levels in sediment upstream of Olin are low and below levels associated with harm, while those levels near Olin's pipes and downstream are so high (more than 100 times higher than average) that some sediment dwelling organisms are predicted to die within 10 days of exposure to those toxic sediments.[10]

The mercury levels in small fish were highest in front of the plant, just below the threshold level for protecting wildlife from harm.[11] These small fish serve as food for larger fish, such as largemouth bass, and also waterfowl. In comparison, mercury levels are lower in small fish farther downstream and upstream of the Olin plant.

Largemouth bass mercury levels followed a pattern similar to the small prey fish. Largemouth bass mercury levels were highest in front of the plant and just downstream, and all of them were above the 0.3 mg/kg EPA safe level. The highest level of mercury (0.97 mg/kg) was found in a largemouth bass caught near the mouth of North Mouse creek. However, mercury concentrations in fish upstream of the plant were below the EPA health trigger level, as were those sampled further downstream.

Since the levels of mercury in fish often increase as the fish grow larger, we checked to see if the higher mercury levels in fish near the Olin plant may be due to catching larger fish at that location. However, statistical analysis showed that the higher mercury levels seen in largemouth bass near Olin were not due to fish size.[12]

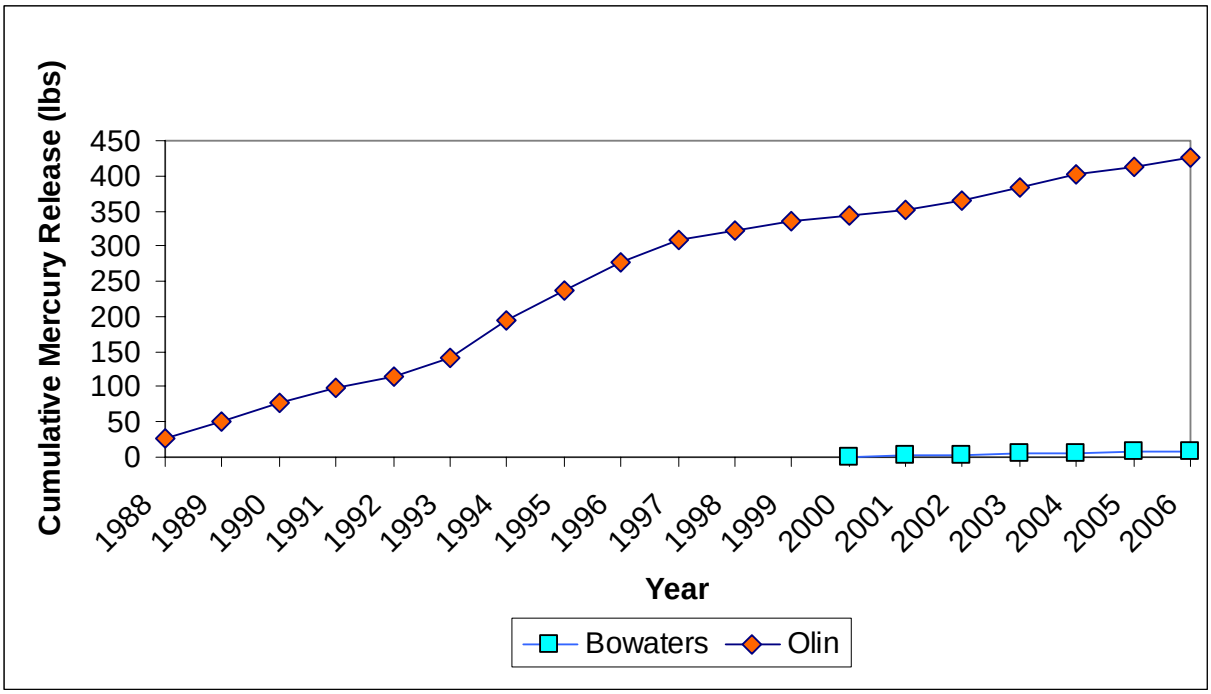
Hiwassee River Mercury Levels Highest Near Olin Plant



Olin Is the Source of the Mercury Problem on the Hiwassee

The only other facility that discharges mercury to the Hiwassee River is the Bowater Newsprint plant across the river from Olin in McMinn County. Bowater reported discharging 8 lbs of mercury since 2000, while Olin has discharged over 400 lbs since record keeping became public in 1988.[13] Furthermore, Olin emitted 87% more mercury before 1988 according to a newspaper quote from an Olin official.[14] Based on the lack of other significant mercury releases, combined with the high mercury levels at and downstream of the Olin plant, it is clear that the Olin facility is the predominant source of mercury contamination to this segment of the river.

Olin Mercury Releases Far Exceed All Other Sources



Cumulative mercury releases from all industries to the Lower Hiwassee since public reporting began in 1988

Remote Atmospheric Sources Unlikely to Cause the Hiwassee River Mercury Problem

Although the mercury monitoring data described above, especially when combined with EPA and TDEC data, point to the Olin plant as the main cause of fish contamination, we also wanted to rule out other possible sources of the contamination. Many pristine places without nearby industrial point sources also carry fish consumption advisories. This contamination can result from diffuse airborne sources of mercury falling directly onto the water or onto the land from which it can enter the river through runoff. Based on our analysis, however, this was not the case for the Hiwassee. This is evident from soil testing that shows that runoff was not a significant source of mercury to the river. Furthermore, our research shows that because the lower Hiwassee River basin is so poor at producing

methylmercury from inorganic mercury, it is highly unlikely that enough methylmercury would be made to contaminate fish in the absence of the very large point source inorganic mercury contribution from Olin.

Soil Levels Indicate That Remote Airborne Sources Did Not Cause Fish Contamination

Part of the evidence that argues against airborne sources of mercury being primarily responsible for fish contamination comes from looking at how much mercury is in the surrounding soil. If mercury were falling out of the sky onto the land and water, the soil particles that wash into rivers from the land and settle to the river sediment would have levels of mercury similar to the sediment. We compared mercury levels in soils near where we collected Hiwassee River sediment and found that those soils had much lower mercury and methylmercury levels than in the nearby river sediment.[15] This supports our contention that runoff of airborne mercury from the land to the water is not the major source of mercury to the area of the Hiwassee where the fish advisories have occurred.

The Hiwassee Is Not an Environment That Promotes the Production of Methylmercury

One way to determine how conducive an environment is to producing methylmercury is to measure how much methylmercury is in the sediment (where bacteria make it from inorganic mercury) and compare that level to how much total mercury is present. If the percentage of methylmercury is high, then that environment is considered a good environment for the formation of methylmercury and at greater risk for fish contamination.[16] There are several environmental factors--such as the presence of wetlands, newly created reservoirs, or acidic water[17]--that help promote production of methylmercury. In other words, some areas that have the same amount of mercury in their water can have higher levels of methylmercury in their fish simply because of these environmental conditions.

We measured the amount of methylmercury in Hiwassee River sediment and found that the average percentage of methylmercury in this system (0.55%) was lower than average of most other ecosystems (1% or above).[18] This means that the lower Hiwassee River system is not very good at producing methylmercury from small inputs of mercury. Thus we would not expect there to be fish consumption advisories upstream of Olin--and there are not. We also found that the only reason the sediments around and downstream of Olin had methylmercury levels high enough to contaminate fish and trigger fish consumption warnings was because of the very high levels of inorganic mercury in the sediments.[19]

The conclusion is inescapable: if Olin was not discharging such large amounts of inorganic mercury into the river over the years, it is extremely doubtful that high levels of methylmercury would be produced, and it is unlikely that fish advisories would exist on the Hiwassee.

Recommendations

Since the Hiwassee River is now impaired due to mercury contamination of fish, the law requires that Tennessee identify and control all sources of mercury to the Lower Hiwassee basin through the total maximum daily load (TMDL) process. The Tennessee Department of Environment and Conservation has listed an "industrial source" and "atmospheric deposition" as the pollutant sources to the Hiwassee River. Tennessee has given TMDL development a low priority, stating that it lacks the proper tools for including atmospheric deposition in developing the TMDL and needs EPA assistance.[20] Besides being unlikely to address the problem, waiting for EPA assistance is also likely to result in unnecessary delay. Because the TMDL has been given a low priority, the state estimates that it could take up to 12 years to begin to regulate and reduce mercury pollution in the Hiwassee. Since this study has shown that atmospheric sources are unlikely to be the source of the problem, a delay in controlling Olin's mercury emissions would not only be unfortunate, but also be unnecessary.

The data presented here clearly show that there is only one source that is responsible for the mercury contamination problem in the Hiwassee—the Olin plant. Our research also strongly suggests that if Olin had not released so much mercury, it is highly unlikely that any fish advisories would exist in the lower Hiwassee River. We contend that even if airborne mercury is ultimately found to contribute to the mercury impairment of this basin, controlling the largest emitter of mercury to the air in the region, which is also the largest emitter in Tennessee as a whole —the very same Olin plant—would address that part of the problem.

It is not often that the sources of mercury contamination of fish in any particular area are so easily identified. But here we have identified a simple solution to the mercury problem in the Hiwassee: strictly curtail Olin's mercury releases to the Hiwassee and have it clean up the river, either through regulation or voluntary action. The citizens of Tennessee deserve a restored Hiwassee River and should not have to wait 12 years to fix the source of the problem.

Based on these findings, Oceana recommends the following actions to restore the health and full recreational uses of the Hiwassee River:

- Olin should cease needless mercury pollution of the Hiwassee River, by modernizing its plant and switching to readily available mercury-free technology

Should Olin refuse to update its facility voluntarily, then Tennessee should:

- Put a higher priority on developing the mercury TMDL for the Hiwassee River
- Strictly curtail Olin's mercury releases
- Consider corrective action to remediate contaminated river sediments

[1] Tennessee fish advisory information available at: http://www.state.tn.us/environment/wpc/publications/advisories.pdf. Accessed 5/11/07
[2] Tennessee Department of Environment and Conservation. 2008 Year 2008 303d List: First Draft. Available at: http://www.state.tn.us/environment/wpc/publications/2008draft303dlist.pdf Accessed 2/15/08
[3] Information provided by Tennessee government: http://www.tennessee.gov/environment/parks/Hiwassee/
[4] Hampson, P.S., M.W. Treece, Jr, G.C. Johnson, S.A. Ahlstedt, and J.F. Connell. 2000. Water quality in the Upper Tennessee River Basin, Tennessee, North Carolina, Virginia, and Georgia, 1995-98. U.S. Geological Survey Circular 1205.
[5] Tennessee Important Bird Area program: http://www.tnbirds.org/IBA/SitePages/Hiwasee.htm
[6] Data compiled from US EPA, TRI Explorer 2006. Available at: http://www.epa.gov/triexplorer/ Accessed 2/15/08
[7] Berrang, B. and A. Keller. 1999. Ecological site investigation report for the Hiwassee River at Olin Chemical Corporation Charleston, TN: First draft. U.S. Environmental Protection Agency, EPA No. TND 003-337-292. Athens, Georgia.
[8] Denton, G. M. 2007. Mercury levels in Tennessee Fish. Tennessee Department of Environment and Conservation, Nashville, TN. Available at: http://www.state.tn.us/environment/wpc/publications/fishmercurylevels.pdf
[9] Warner, K.A. 2007. Environmental Mercury Levels Near a Chlor-alkali Plant on the Hiwassee River, Tennessee. Technical Report Submitted to Tennessee Department of Environment and Conservation in Support of the 2008 Draft 303(d) List Oceana, Washington, DC
[10] Field, L.J., D.D. MacDonald, S.B. Norton, C.G. Ingersoll, C.G. Severn, D. Smorong, and R. Lindskoog. 2002. Predicting amphipod toxicity from sediment chemistry using logistic regression models. Environ. Tox. Chem. 21: 1993-2005. See also note 9.
[11] Eisler, R. 1987. Mercury hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildlife Service Biological Report 85(1.10). 90 pp.
[12] See note 9
[13] U.S. EPA, 2006. See note 6
[14] Cleveland Daily Banner. 2008. “Hiwassee on state’s list for mercury contamination”. Accessed 3/31/08.
[15] See note 9
[16] Drott, A., L. Lambertsson, E. Bjorn, and U. Skyllberg. 2008. Do potential methylation rates reflect accumulated methylmercury in contaminated sediments? Envorn. Sci. Technol. 42:153-158
[17] Munthe, R.A. R.A. Bodaly, B.A. Branfireun, C.T. Driscoll, C.C. Gilmour, R. Harris, M. Horvat, M. Lucotte, and O. Malm.. 2007 Recovery of mercury-contaminated fisheries. Ambio 36:33-44;
Warner, K.A., J.C. Bonzongo, E.E. Roden, M.G. Ward, A.C. Green, I. Chaubey, W.B. Lyons, and D.A. Arrington. 2005. Effect of watershed parameters on mercury distributions in different environmental compartments in the Mobile Alabama River Basin, U.S.A., Sci. Tot. Environ. 347: 187-207.
[18] Benoit, J.M, C. Gilmour, A. Heyes, R.P. Mason, C. Miller. 2003. Geochemical and biological controls over methylmercury production and degradation in aquatic ecosystems. pp. 262-297 in Biogeochemistry of environmentally important trace elements, Chai and Braids eds. Washington DC. ACS symposium series no. 835.
[19] See note 10.
[20] See note 2