



National Parks Conservation Association®
Protecting Our National Parks for Future Generations®

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November 3, 2006

Quincy Styke
State of Tennessee
Department of Environment and Conservation
Nashville, Tennessee 37243-0435

Re: Recommendations for a Smokies Mercury Study

Dear Mr. Styke:

On behalf of the National Parks Conservation Association (NPCA) please accept the following recommendations for a mercury study at Great Smoky Mountains National Park. As stated in Deputy Commissioner Sloan's August 24, 2006 letter, TDEC is seeking to learn whether the federal clean air mercury rule (CAMR) goes "far enough or fast enough" in reducing power plant mercury to address potential mercury deposition problems in the Smokies. In order to make that determination, three questions need to be answered.

1. What is the amount and rate of atmospheric deposition of mercury in the Smokies?
2. How much atmospheric mercury deposition in the Smokies is from power plants versus other sources?
3. Is atmospheric mercury deposition in the Smokies harming protected resources?

Answering these three questions will help TDEC determine whether greater reductions in power plant mercury emissions than those called for under CAMR will benefit the Smokies. Our letter outlines three areas of study needed to answer these questions (part A), and then elaborates on the need for a source attribution component of the study (part B).

A. Key Elements of a Smokies Mercury Study

The Smokies mercury study should consist of three fully integrated components: **monitoring**, **source apportionment**, and **impacts analysis**. It should be designed around each of these components from the beginning to ensure that monitoring is done in a way that is useful for determining source apportionment and impacts.



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The study should begin as soon as possible so that a baseline can be established prior to mercury reductions that are expected under CAMR. Monitoring and impacts analysis should commence at the outset of the study, while source apportionment can be done after two or three years of data collection (but again, monitoring must be implemented from the beginning in a way that results can be used in source apportionment).

A three-year study will provide enough data for TDEC to determine whether additional power plant mercury reductions are warranted. Monitoring and impacts analysis should continue beyond three years to help determine the effectiveness of TDEC's regulatory response.

In addition, NPCA recommends that the principal researchers in the Steubenville mercury deposition study be consulted in the design and execution of the Smokies study – EPA scientist Matthew S. Landis and University of Michigan professor Gerald J. Keeler.

1. Mercury Deposition Monitoring.

NPCA recommends that monitoring begin as soon as possible in order to establish a baseline prior to the installation and operation of emissions controls at TVA plants. In particular, it would be helpful to have as much data as possible before scrubbers go on line at TVA's Kingston plant. Monitoring should be designed to support the source-receptor analysis addressed in 2 below.

- a. **Continue existing mercury monitoring** of elemental and methyl mercury currently being done through the Mercury Deposition Network at the Clingman's Dome and Elkmont sites in the Smokies.
- b. **Conduct event-based wet deposition mercury monitoring** at two locations, the Smokies and possibly Oak Ridge. Since event-based monitoring will require near-daily staffing, the sites should be readily accessible. Event-based depositing monitoring is necessary in order to perform the source-receptor analysis.
- c. **Operate an acid cloud deposition monitor** to collect elemental and methyl mercury samples. As NPS noted at the October 3 meeting, a significant portion of mercury deposition in the park may occur through cloud moisture, so this monitoring is needed to get a complete picture of mercury deposition in the park.



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2. Mercury Deposition Source Attribution Analysis.

A source-receptor study of atmospheric mercury deposition will help TDEC determine the extent to which mercury deposition in the Smokies is from coal-fired power plants versus other sources, and the geographic range of mercury-emitting sources impacting the Smokies. A source-receptor study should include the following components:

- a. At least three years of **event-based mercury deposition monitoring** and sampling data at a minimum of two locations (noted in 1b above);
- b. **Meteorological and trajectory analysis** to determine the probable geographic sources of mercury deposition in the park;
- c. **Apportionment of mercury sources** using statistical approaches such as Unmix and positive matrix factorization (PMF).

3. Mercury Deposition Biological Effects.

Recent research in the eastern United States shows significant bioaccumulation of methylmercury in salamanders, Peregrine falcons and forest songbirds. In recent decades, the number of wood thrushes in the southeast region has declined 45 percent, and researchers now suspect that accumulation of mercury in forest ecosystems could be part of the cause. Many of these species are found in the Smokies, and are therefore likely to be similarly impacted. To determine if park natural resources are being harmed by mercury the Smokies study should examine the following topics.

- a. **Establish mercury levels in park soil and water**, establish a current baseline and trends over the course of CAMR implementation.
- b. **Determine mercury levels in park wildlife**, including key indicator animal and plant species, with special focus on threatened and endangered species.
- c. **Review scientific literature on mercury wildlife impacts** to determine if harm occurs at the levels found in Smokies wildlife.



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B. The Need for a Source-Receptor Analysis

Existing evidence supports a strong inference that coal-fired electric utilities are likely the major source of the atmospheric mercury deposition presently occurring in the Smokies. In particular:

§ Coal-fired power plants are the largest uncontrolled sources of mercury in the U.S., emitting approximately 45 tons of mercury into the air every year and accounting for 30 to 40 percent of total domestic mercury emissions.¹

§ In Tennessee, power plants are responsible for more than 60 percent of mercury emissions, far above the national average.

§ According to data provided by the Tennessee Valley Authority to EPA, seven TVA power plants emit 2023 pounds of mercury into the air each year. TVA ranks fourth among the nation's major electric utilities in emissions of mercury.²

§ EPA's Regional Modeling System for Aerosols and Deposition (REMSAD) indicates that "[m]ost states have [mercury 'hot spot'] areas that are *significantly influenced* by sources within their boundaries."³

§ The Smokies already experience a well-demonstrated high degree of atmospheric deposition of other air contaminants from coal-fired power plants, including sulfates and nitrates.

§ In a May 15, 2006, report the EPA Inspector General found that flawed models underlay CAMR's assumption that mercury trading would not cause hot spots. The IG's report said recent studies show high levels of mercury deposition from local coal-burning facilities that are a major source of airborne mercury pollution.⁴

§ And, as detailed below, a substantial body of scientific evidence demonstrates that mercury emitted from coal-fired power plants and other air emission sources deposits and accumulates close to the source (so-called "hot spots").

On the basis of already existing evidence such as this, seven states have adopted laws or regulations requiring greater mercury reductions from coal-fired electric power plants than required under CAMR, while another 13 states are in various stages of adopting stronger policies.⁵

In spite of these facts, TVA maintains that U.S. electric utilities are responsible for only a few percent of the total pool of global mercury air emissions, and from this TVA infers that its contribution to mercury deposition within the U.S. is proportionally small.⁶



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This emphasis on global emissions wholly misses the point. The issue is not the amount of mercury emitted globally, but the amount – and the source – of mercury *deposited* within the United States.

TVA's inference that local and regional coal-combustion sources are not a significant source of atmospheric mercury deposition within Tennessee is increasingly at odds with the facts established in numerous scientific studies. These studies, some of which are summarized below, have found that 70% of mercury atmospheric deposition is traceable to regional coal combustion sources, and that mercury contamination of waterways and soils dropped dramatically following the cleanup of local mercury air emission sources.

What Steubenville and these other studies show is that we have the tools to determine the likely origin of atmospheric mercury deposition in the Smokies. By using these tools and conducting a source attribution analysis, TDEC will be able to determine with a high degree of certainty, how much of the Smokies mercury deposition is attributable to coal-fired power plants. This in turn will give the agency the confidence it needs to answer Deputy Commissioner Sloan's query whether CAMR goes "far enough or fast enough" to protect the Smokies.

Numerous recent studies establish that a substantial portion of atmospheric mercury deposition comes from local and regional sources.

(1) University of Michigan (Keeler) & US EPA (Landis)
– Steubenville Ohio (2006)

A study published in September 2006 by University of Michigan professor Gerald Keeler and EPA scientist Matthew Landis found that most of the mercury in rain collected at a Steubenville, Ohio monitoring site originated from coal-burning plants no more than 400 miles away and had been emitted no longer than three days earlier.⁷ This study is the most comprehensive work ever undertaken on the transport of mercury emissions, and is the first in which scientists used rain samples and meteorological data to track mercury from smokestacks to monitors.

Precipitation sampling for the study began in October 2002 and will



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continue through December 2006. Results reported in September 2006 are for samples collected in 2003-2004. Using two new EPA-implemented multivariate statistical models (positive matrix factorization and Unmix), the researchers found that “the dominant contributor to the mercury wet deposition was found by both models to be coal combustion (approximately 70%).” Their meteorological analysis also “indicated that a majority of the mercury deposition found at the Steubenville site was due to local and regional sources.”⁸

Minimum or baseline mercury concentrations observed at Steubenville are about four times higher than baseline concentrations recorded during the same period at rural sites in Michigan and Vermont that are not directly downwind of coal-fired power plants. The researchers’ model looked at all of the potential mercury sources in the region, and found that “the source identified as coal combustion was clearly dominant in terms of explaining the Hg deposition.” They concluded that “the results of the multivariate statistical analysis (~70% of the Hg in the wet deposition at Steubenville coal combustion sources), and meteorological analysis (highlighting the importance of local regional sources), consistently point toward the dominant influence by local and regional coal-burning sources.”⁹

EPA has recognized that the Steubenville results “would appear to contradict” claims about a global pool of mercury from the Electric Power Research Institute – an industry trade group. EPA staff even warned that its research had “implications for potentially vulnerable areas (i.e., ‘hot spots’).” EPA noted that mercury pollution was worse than the models predicted because the models lacked “event-based empirical deposition data.” In fact, EPA observed that there was “emerging but limited empirical evidence of very high Hg concentrations/deposition in urban areas.” Without this evidence, models would “potential[ly] underestimate” the level of “predicted deposition.”¹⁰

(2) University of Wisconsin, US Geological Survey, et al.
– Voyageurs National Park (2006)

Monitoring has shown that concentrations of methylmercury in game fish from many interior lakes in Voyageurs National Park in northern Minnesota substantially exceeds criteria for the protection of human health. Studying geologic sediments, researchers recently concluded



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that nearly all of the mercury in fish in this seemingly pristine environment was derived from atmospheric deposition, and that most of this bioaccumulated mercury was from anthropogenic sources.¹¹

The Voyageurs study is buttressed by an earlier peer-reviewed, published report on Wisconsin mercury concentrations, which finds “that remote lake waters might respond quickly to reductions in atmospheric pollutants.”¹² This observation was based on a finding that “[r]egional changes in the emission of SO₂ [sulfur dioxide] and Hg [mercury] have apparently had a significant and immediate impact on Hg cycling and levels of fish contamination” in northern Wisconsin.¹³

(3) Pennsylvania State University & PA DEP – Cambria & Tioga County (2006)

Sample results from Pennsylvania’s two longest-running mercury deposition collection sites reinforce other state and national studies that show the neurotoxin tends to concentrate around local emission sources, creating “hot spots” of contamination. Data collected over eight years by Penn State University for the Department of Environmental Protection show mercury levels 47 percent higher in areas closer to power plants.

The data were collected at two sites -- Cresson in Cambria County and Wellsboro in Tioga County -- between 1997 and 2004. The sites were selected because of their significantly different profile relative to locations to nearby coal-fired electric generating stations.

The Cresson site, which is fairly close to and downwind of a number of large coal-fired electric utilities in southwestern Pennsylvania, reported an average wet deposition rate of mercury that was 47 percent higher than results collected at the northern tier monitoring site. Wellsboro is at a much greater distance from any coal-fired utilities.¹⁴

(4) National Oceanographic and Atmospheric Administration – Great Lakes & Chesapeake Bay (2004)

Two studies conducted by the National Oceanic and Atmospheric Administration (NOAA) – one on the Great Lakes region and the other



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on the Chesapeake Bay – have determined that sources within sixty miles of a particular water body are responsible for the majority of mercury contamination in the water, despite the level of emissions from the distant sources.¹⁵ Local emissions of mercury can account for 50% to 80% of mercury deposition in “hot spots.”¹⁶ The Chesapeake Bay study, for example, noted that sources more than 1550 miles (2500 kilometers) from the Bay emit more than five times as much mercury as local sources within 62 miles (100 kilometers). *Despite this disparity, the local sources accounted for nearly thirty times as much of the mercury directly deposited in Bay waters.*¹⁷

The Great Lakes report, which resulted in a published, peer-reviewed article in the journal *Environmental Research*, concluded, “Overall, coal combustion in the United States was found to be the most significant source category contributing mercury through atmospheric deposition to the Great Lakes.”¹⁸ “For Lake Michigan,” the NOAA researchers explained, “the contribution from the Chicago region stands out, due to its significant emissions *and proximity to the lake*... For Lakes Erie and Ontario, contributions from the Ohio River Valley appear to be very significant, again, due to the high emissions in this region *and the comparative proximity to these lakes.*”¹⁹

(5) Massachusetts DEP – Fish Tissue Study (2006)

Seven years after Massachusetts enacted the nation's toughest mercury emission laws for incinerators, amounts of the toxic metal in a signature freshwater fish caught near some of those facilities have declined by 32 percent.²⁰ The 32 percent average decrease in mercury occurred in nine lakes in the northeast corner of Massachusetts, home to a cluster of incinerators. Yellow perch from lakes elsewhere in the state recorded a 15 percent drop on average.²¹

Since 1999, the Massachusetts Department of Environmental Protection has been testing the same subset of 17 lakes. The data reveal substantial reductions of mercury in fish tissue statewide, and the most significant reductions in the fish tissue were found in an area where the greatest reduction in mercury emissions occurred - the northeast region of Massachusetts.²²



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- (6) Florida DEP et al.
– Fish & Bird Tissue Study (2003)

A 2003 study found that concentrations of mercury in fish and wading birds in the Everglades dropped about 75 percent after Florida imposed stringent controls on incinerators and other local sources of mercury emissions in the 1990s.²³ A comprehensive, multi-agency study²⁴ on mercury pollution in the Everglades also focused on this precise issue, asking: “Is the source of mercury contributing to deposition into the Everglades predominantly coming from emissions sources within South Florida, or is it coming from long distance transport from sources around the globe?”²⁵ They found that “*several lines of evidence suggest that local sources were the predominant contributor to mercury deposition in south Florida.*”²⁶

In Florida, in-state reductions of mercury emissions resulted in a 75% reduction in mercury levels in largemouth bass and great egret birds from the mid-1990s to the year 2002.²⁷ Based on these results, the Florida Electric Power Coordinating Group conceded that “*it is clear that the fundamental hypothesis that changes in local emissions of mercury [in Southeast Florida] have been the primary agent for recent biota changes in mercury contaminations in the Everglades cannot be rejected.*”²⁸

Conclusion

NPCA thanks you for the opportunity to provide input on your efforts to protect Great Smoky Mountains National Park from mercury deposition and its impacts. My colleagues and I look forward to working with you and the other stakeholders as we work toward solutions.

Sincerely,

Mark Wenzler
Clean Air Program Director

Don Barger
Southeast Regional Senior Director



Endnotes

¹ See EPA, Final 1999 Point Source National Emissions Inventory for Hazardous Air Pollutants (July 9, 2003); 65 Fed. Reg. 79825, 79827 (Dec. 20, 2000). In addition, coal-burning plants annually emit 56 tons of arsenic, 62 tons of lead compounds, 62 tons of chromium compounds, 23,000 tons of hydrogen fluoride, and 134,000 tons of hydrochloric acid. U.S. EPA, Study of Hazardous Air Pollutant Emissions from Electric Steam Generating Units: Final Report to Congress, EPA-453/R-98-004A, at ES-5, Table ES-1 (“Utility Report to Congress”).

² NRDC, “Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the United States – 2004,” <http://www.nrdc.org/air/pollution/benchmarking/default.asp>.

³ R. Dwight Atkinson, Ph.D., EPA, “Air Deposition Modeling and the TMDL Program: Mercury Loadings to States and Regions,” available at <http://www.northstar.sierraclub.org/campaigns/air/mercury/epaMercuryDepositionReport2003.pdf> (Draft 2003) (emphasis added).

⁴ *BNA Daily Environment Report*, “Inspector General Questions EPA Position That Mercury Rule Will Not Cause ‘Hotspots,’” May 16, 2006.

⁵ National Wildlife Federation, “States Tackling Mercury Pollution from Coal Fired Power Plants,” <http://www.nwf.org/wildlife/pdfs/StatesCoalBurningPowerPlants.pdf>.

⁶ TVA, *On the Air: Mercury Emissions*: “Mercury is a global problem, with much of the mercury in the environment today coming from outside the United States and from the re-circulation of past emissions from both natural and human-made sources. U.S. power plants, overall, are responsible for about 1 percent of current global emissions.” http://www.tva.gov/environment/air/ontheair/merc_emis.htm.

⁷ Gerald J. Keeler, M.S. Landis, G.A. Norris, E.M. Christianson, and J.T. Dvonch, “Sources of Mercury Wet Deposition in Eastern Ohio, USA,” *Environmental Science and Technology* (American Chemical Society), Vol. xx, No. xx, xxx (published online September 8, 2006).

⁸ *Id.*

⁹ *Id.*

¹⁰ Tim Watkins, et al., EPA National Exposure Research Laboratory, *Preliminary Results From Steubenville Hg Deposition Source Apportionment Study* (April 27, 2005).

¹¹ J.G. Wiener, B.C. Knights, M.B. Sandheinrich, J.D. Jeremianson, M.E. Brigham, D.R. Engstrom, L.G. Woodruff, W.F. Cannon, and S.J. Balough, “Mercury in Soils, Lakes and Fish in Voyageurs National Park (Minnesota): Importance of Atmospheric Deposition and Ecosystem Factors,” *Environmental Science and Technology* (American Chemical Society), vol. 40, no. 20 (September 6, 2006).

¹² T.R. Hrabik, C.J. Watras, “Recent Declines in Mercury Concentration in a Freshwater Fishery: Isolating the Effects of De-acidification and Decreased Atmospheric Mercury Deposition in Little Rock lake,” *The Science of the Total Environment*, at 2 (2002).

¹³ *Id.* at 8.

¹⁴ Pennsylvania Department of Environmental Protection, *Daily Update* (May 31, 2006): “Data Collected Over Eight Years Show Mercury Levels 47% Higher in Areas Near Power Plants,” <http://www.depweb.state.pa.us/news/cwp/view.asp?a=3&q=507034>

¹⁵ M. Cohen *et al.*, “Modeling the Atmospheric Transport and Deposition of Mercury to the Great Lakes,” 95 *Env’tl Res.* 247, 262-63 & fig. 14 (2004) (power plant contribution to Great Lakes mercury



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“hot spots”); M. Cohen, NOAA, Modeling the Fate and Transport of Atmospheric Mercury in the Chesapeake Bay Region (May 17, 2004) (“NOAA Chesapeake Bay”) available online at http://www.arl.noaa.gov/data/web/reports/cohen/20_Ches_Bay_talk.pdf.

¹⁶ *Id.*

¹⁷ NOAA Chesapeake Bay, at 34 (graph showing “Emissions and Direct Deposition Contributions from Different Distance Ranges Away From the Chesapeake Bay”)(attached).

¹⁸ M. Cohen, *et al*, 95 *Env’tl Res.* 247, 262-63 (emphasis added).

¹⁹ *Id.* at 261 (emphasis added).

²⁰ *Boston Globe*, “Mercury down 32% in fish near Mass. Incinerators; Progress tied to emissions laws,” By Beth Daley, April 3, 2006.

²¹ Massachusetts Department of Environmental Protection, “Freshwater Fish in Mass. Lakes Show Reductions in Mercury,” <http://www.mass.gov/dep/public/publications/mercury.htm>.

²² Massachusetts Department of Environmental Protection, Office of Research and Standards, “Massachusetts Fish Tissue Mercury Studies: Long-Term Monitoring Results, 1999 – 2004,” <http://www.mass.gov/dep/toxics/stypes/hgtrend.pdf#search=%22Massachusetts%20incinerators%20mercury%20yellow%20perch%22> (2006).

²³ Florida Department of Environmental Protection, *Integrating Atmospheric Mercury Deposition With Aquatic Cycling in South Florida*, revised November 2003, available at [ftp://ftp.dep.state.fl.us/pub/labs/assessment/mercury/tmdlreport03.pdf], visited April 5, 2005. See especially, pp. 56-59.

²⁴ Florida Department of Environmental Protection, et al., *Integrating atmospheric Mercury Deposition with Aquatic Cycling in South Florida: An Approach for Conducting a Total Maximum Daily Load Analysis for an Atmospherically Derived Pollutant* (2003). The project was undertaken by the Florida Department of Environmental Protection, the United States EPA, the United States Geological Survey, The Florida Electric Power Coordinating Group, Florida State University, and the University of Florida, among others.

²⁵ *Id.* at 2.

²⁶ *Id.* at *iv.*(emphasis added); *id.* at 57 (“[T]he dominant source term signal contributing to total mercury deposition in south Florida are local emissions).

²⁷ *Id.* at 56. Prior to the implementation of controls, the principal sources of mercury in Florida were municipal and medical waste incinerators, not coal-fired power plants. We recognize that incinerators emit more oxidized mercury than most coal-fired units, and as a result, the two source categories might have slightly different percentages of mercury emissions deposit locally. This distinction, however, does not alter or affect the most critical finding of the Florida study – that reducing local mercury emissions reduces the local deposition of mercury to watersheds, with the result that levels of mercury in fish and animals decline.

²⁸ *Id.* at 57 (alteration and emphasis in original).