BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
PROPOSED NEW 35 ILL. ADM. CODE 225	)	R06-25
CONTROL OF EMISSIONS FROM	)	(Rulemaking – Air)
LARGE COMBUSTION SOURCES (MERCURY)	)	

NOTICE OF FILING

PLEASE TAKE NOTICE that the Environmental Law and Policy Center has filed the attached TESTIMONY OF MICHAEL MURRAY. We respectfully request that the live testimony of Michael Murray at the second hearing in Chicago, Illinois take place on either Monday, August 14, 2006 or Tuesday, August 15.

Faith E Bugel

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DATED: July 24, 2006

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TESTIMONY OF MICHAEL W. MURRAY, Ph.D.

Qualifications

My name is Michael Murray. I joined the Great Lakes office of the National Wildlife Federation (NWF) as Staff Scientist in 1997. While I am an environmental chemist by training, my work with NWF has ranged broadly across diverse scientific and policy aspects of toxic chemicals, in particular in the Great Lakes region but also more broadly. This work has included scientific and policy research and education related to mercury sources, fate and transport, ecological and human health effects, and control options; other toxic chemicals of concern; water quality criteria and total maximum daily load plans; and development and communication of fish consumption advisories. I have also more recently become involved in work on invasive species, food webs and broader issues associated with Great Lakes restoration.

I received M.S. and Ph.D. degrees in Water Chemistry from the University of Wisconsin-Madison, where my research addressed several aspects of the environmental chemistry of polychlorinated biphenyls. I have authored or co-authored one-half dozen peer-reviewed technical publications (with others in press, review, or preparation), as well as numerous policy and advocacy papers and reports. I have served on over one dozen conference planning, proposal review, and technical committees, including currently the Federal Advisory Committee on Detection and Quantitation and a U.S. Environmental Protection Agency (EPA) Science Advisory Board panel on chemical screening. In addition to current duties with NWF, I have served as an adjunct lecturer in Environmental Health Sciences at the University of Michigan's School of Public Health, where I have team-taught courses in environmental chemistry and water quality management.

In the past several years I have had the opportunity to explore in more detail issues associated with ecological effects of mercury. A September 2003 workshop of 33 mercury researchers organized by the Society of Environmental Toxicology and Chemistry (SETAC) addressed issues associated with the development of a national mercury monitoring network, and I have been involved with the group identifying indicators of mercury contamination in wildlife. (The book resulting from the workshop (of which I am also a co-editor) is forthcoming). In addition, I was invited to take part in the July 2005 International Workshop on Mercury Pollution in Madison, WI, which in part served as a planning meeting for the International Conference on Mercury as a Global Pollutant (ICMGP) meeting to take place August 6-11, 2006 in Madison. I have been involved with researchers specializing in mercury exposure and effects in humans, fish, and wildlife, through the Heath Risks and Toxicological Effects of Methylmercury workgroup. Two synthesis papers resulting from this workgroup's activities will be presented at the ICMGP meeting, and will be submitted for publication in *Ambio* following the meeting.

Testimonial Statement

My testimony largely concerns the potential effects of mercury in fish and wildlife. Mercury cycling in the environment is complex; after a very brief review of sources, deposition and transformation within water bodies, this testimony will focus on recent research related to exposure and effects of mercury in fish and wildlife. Many other relevant components of this problem (e.g., emissions, atmospheric transport and deposition, control options) have been addressed by others providing testimony in this rulemaking process.

Mercury is a naturally occurring element, but human activities (in particular over the past two centuries) have greatly increased its mobility on the Earth's surface. Studies on sediment, ice and peat cores have found increased mercury levels in more recent deposition (compared to pre-industrial) that typically range from about 3-fold to over 10-

fold, and in some cases with modern maxima over 100 times pre-industrial values.[1] While a number of these studies have shown declines in deposition in the past several decades (at least in some sediment cores), contemporary deposition rates are still thought to be well above pre-industrial values, indicating the importance of ongoing human activities.[2]

Human contributions to the global mercury cycle are generally grouped into two categories: purposeful uses of mercury and subsequent release (e.g., mining of mercury ore, processing, use in products such as thermometers and blood pressure units and subsequent disposal), and incidental mercury releases (e.g., release of mercury found naturally in coal during fuel combustion at coal-fired power plants). An analysis of U.S. EPA National Emissions Inventory data for 1999 indicated that coal-fired power plants in Illinois were responsible for over 47 percent of the state's mercury emissions, slightly lower than the value for the eight Great Lakes states combined.[3]

As discussed in other testimony, mercury emissions from coal-fired power plants are typically divided into three categories (elemental, reactive gaseous mercury, and particulate mercury). The latter two forms more readily (but not exclusively) can deposit closer to the source, either on land or plant surfaces in watersheds or directly on water bodies. Once in water, inorganic mercury can be transformed (typically in sediments) via bacterial action to methylmercury. This form of mercury has a greater tendency to bioaccumulate and biomagnify in food webs. For example, methylmercury in sediments can diffuse into the overlying water, be taken up by phytoplankton (algae), which can be consumed by zooplankton, which can then themselves be consumed by forage fish (such as smelt or alewives), which can then be consumed by predator fish (e.g. northern pike, walleye).[4] Methylmercury concentration in fish can exceed the surrounding water concentration by a factor of one million to 10 million, and methylmercury generally

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[1] See for example Jackson 1997; Fitzgerald et al., 1998; Kamman and Enstrom, 2002; Schuster et al., 2002; Bindler 2003; Givelet et al., 2003.
[2] See for example Kamman and Enstrom, 2002; Schuster et al., 2002; Givelet et al., 2003; Fitzgerald et al., 2005.
[3] Murray and Holmes, 2004.
[4] See for example review in Wiener et al., 2003.

accounts for the large majority of mercury in fish.[5] A number of factors can influence the production of methylmercury in water bodies, including the amount of bioavailable inorganic mercury, pH, level of dissolved organic carbon, the forms and levels of sulfur, and the activity and type of the bacterial community.[6] It has been well established that wetlands often present conditions which lead to elevated production of methylmercury; dissolved organic matter from wetlands can also contribute to transport of inorganic mercury to water bodies.[7]

The effects of mercury (both inorganic and methylmercury) on wildlife have been investigated for over four decades, with both an early and more recent emphasis on research in birds and mammals. Methylmercury has been considered to be one of the more harmful contaminants to birds, and controlled studies have shown that methylmercury can affect cell development, reproductive success, behavior, and adult survival, and can also cause teratogenic effects.[8] While methylmercury can be excreted via feces and feather growth, it can also be passed on to eggs from the mother. The young can be particular vulnerable to methylmercury exposure, with laboratory studies showing effects including decreased embryo weights, developmental abnormalities and embryo death.[9]

Early research found that organic mercury-containing fungicidal seed dressings were responsible for bird mortality, with, for example, die-offs of species including ring-necked pheasants and rooks associated with mercury poisoning in Sweden. Similarly, high levels of mercury were observed in kestrels, buzzards and a long-eared owl showing signs of mercury poisoning in the Netherlands.[10] More recent studies have emphasized piscivorous birds that would generally be exposed to methylmercury largely via consumption of contaminated fish, and there has been increased emphasis on controlled studies using methylmercury doses at ecologically relevant levels.

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[5] *Ibid.*
[6] See for example Ullrich et al., 2001; Wiener et al., 2003.
[7] See for example Grigal 2002.
[8] See for example review in Wiener et al., 2003.
[9] See for example reviews in Wolfe et al., 1998; Wiener et al., 2003.
[10] See reviews in Heinz 1996 and Thompson 1996.

Though its breeding range does not formally include Illinois (although they may migrate through the state), the common loon has been subject to a number of studies on mercury exposure and effects. An earlier study in northwestern Ontario reported reductions in egg laying and general reproductive success in areas with elevated methylmercury concentrations in eggs and prey fish.[11] A more recent study on loons in New England found that loons with blood methylmercury levels over 3.0 parts per million (ppm) produced 40 percent fewer young than loon pairs with methlymercury levels below 1.0 ppm (their no observed adverse effect level). Adult loons spent less time attending the nest areas termed "high risk" for methylmercury exposures compared to those identified as "low risk" (14 % vs. 1% of time unattended, respectively).[12] These studies on a bird species at risk for elevated mercury exposures (and effects) may have implications for other species more commonly found in Illinois.

Mercury exposure (and in some cases effects) has been studied in a number of other species. Researchers in the southeastern U.S. have studied mercury contamination in various species of waterbirds, including wood storks, white ibises, and snowy and great egrets. In studies in southern Florida, mercury contamination has been identified as an additional stress that could potentially be delaying recovery of populations of egrets and other waterbirds significantly impacted by other factors.[13] Laboratory studies on mallard ducks found embryo deformities from eggs containing 1 ppm methylmercury, and a wide range in sensitivity of embryos to mercury toxicity.[14] Several studies have examined mercury levels in great blue herons, and a recent study reported increasing levels of mercury exposure in belted kingfishers in lake habitats in Maine compared to marine habitats.[15] In addition, while most research on mercury exposure and effects in birds has focused on fish-eating birds, several studies have examined exposure in insectivorous passerines. A recent study on methylmercury in Bicknell's thrush in northeastern North America reported some mercury bioaccumulation, and generally higher uptake in

[11] Barr 1986; also reviewed in Wiener et al., 2003.
[12] Evers et al., 2004.
[13] See for example Sundlof et al., 1994; Spalding et al., 2000.
[14] Heinz and Hoffman, 2003.
[15] Wolfe and Norman, 1998; Evers et al., 2005.

wintering than in breeding areas, and higher mercury levels in adults than young-of-the-year.[16] Though concentrations were lower than those generally seen in piscivorous wildlife (and lower than laboratory-derived effects levels), the findings warrant further research to indicate whether other passerine species may be at risk for increased methylmercury exposure (and potentially effects).

Mammals are the other wildlife group for which a relatively large amount of data exists on mercury exposure and effects, including for species more common in Illinois, including river otter and mink. As with birds, most research on mercury toxicity in mammalian wildlife has focused on fish-eating species. In mammals, a principal target of methylmercury toxicity is the central nervous system; methylmercury readily crosses the blood-brain barrier, as well as the placenta. Effects of higher exposures can include anorexia, loss of weight, loss of coordination, and tremors and convulsions.[17]

An earlier controlled study of mink indicated that elevated mercury levels (e.g. 5 ppm in the diet) resulted in death to mink within one month, with effects on the heart, lungs, liver, and kidneys, and another study reported extensive death of brain cells at high levels of methylmercury.[18] Other studies using lower doses have reported anorexia and uncoordinated muscle function, kidney and brain lesions, reproductive impairment or behavioral changes.[19] Recent studies have reported an association between methylmercury in wild mink and otter and neurochemical receptors in the brain, changes similar to those seen in the laboratory dosing studies of mink with methylmercury. These types of biochemical changes can be associated with clinical (e.g. neurobehavioral) effects that can be observed and can have significant impacts on the viability of individuals.[20]

In addition to the longstanding concern about fish serving as a vehicle for mercury exposure in humans and fish-eating wildlife, there has been increasing research on the

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[16] Rimmer et al., 2005.
[17] See reviews in Heinz 1996; Thompson 1996; Wolfe et al., 1998; Wiener et al., 2003.
[18] Reviewed in Heinz 1996.
[19] Reviewed in Wolfe et al., 1998; also Dansereau et al., 1999.
[20] Basu et al., 2005a,b; Basu et al., 2006.

potential for mercury to harm fish directly.[21] Very high mercury exposures (e.g. at sites contaminated by direct discharges) can cause brain lesions, affect fish growth, behavior and mobility, and lead to mortality.[22] More recent research has investigated methylmercury effects on fish at more typical environmental exposures. For example, one study found that low to moderate methylmercury exposures inhibited gonadal development in females, reduced reproductive success, and altered sex hormones in male and female fathead minnows.[23] Another study similarly found decreased reproduction in fathead minnows at methlymercury exposures typical of mercury-contaminated waters.[24] Other species that have been studied include grayling and walleye; one study reported decreased hatching success and embryo heart rate in walleyes exposed to waterborne methylmercury at environmentally relevant concentrations.[25]

Conclusions

In summary, research has shown that mercury contamination can cause significant effects in certain wildlife (in particular fish-eating species). While earlier research documented acute effects from high level exposures, ongoing research is documenting the potential for more subtle but important neurobehavioral and reproductive effects at more typical exposure levels. These findings have implications for ongoing mercury contamination in Illinois and other states in the U.S., in particular for certain fish-consuming species (e.g., great egrets, belted kingfishers, river otters and mink). In addition, it is possible that some fish species in Illinois are at risk for subtle reproductive problems due to mercury contamination. While research will continue, given that there is no known biological value of mercury, it is prudent to take additional measures to reduce anthropogenic releases, in order to more aggressively work towards environmental mercury levels that do not pose risks to Illinois fish and wildlife.

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[21] See Wiener and Spry, 1996, for earlier review.
[22] Ibid.
[23] Drevnick and Sandheinrich, 2003.
[24] Hammerschmidt et al., 2002.
[25] See review in Wiener et al., 2003.

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Attachment 1

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Experience

Staff Scientist, May 1997 - Present
National Wildlife Federation, Great Lakes Natural Resource Center, Ann Arbor, MI
Serve as principal NWF scientist on issues of toxic chemical contamination, at state, regional national and international levels. Involved in preparation and review of scientific and policy papers, reports, fact sheets, comment letters, and other projects. Duties have included:

- Overseeing NWF technical work on source characterization, fate and transport, human health and ecological effects of mercury and other toxic chemicals.
- Supervising or co-supervising over 30 interns on diverse scientific and policy research and public education projects.
- Taking part in over one dozen planning, advisory, and technical review committees.
- Preparing scientific/technical comments on over 30 national and state policy documents and regulatory proposals (with topics including federal hazardous air pollutant standards, water quality standards, land disposal restrictions, and human exposure assessments), and serving on a number of technical committees.
- Chairing session *Policy Initiatives to Reduce Loadings of Persistent Toxic Substances in the Great Lakes Basin*, at 41st Annual Conference on Great Lakes Research at McMaster University, Hamilton, Ont., May 1998; Co-chair of session on management aspects of multiple stressors at 49th Conference on Great Lakes Research, Windsor, Ont., May 2006.

Adjunct Lecturer, September 1998 – present.
University of Michigan School of Public Health, Department of Environmental Health Sciences, Ann Arbor, MI.

Team-teach environmental chemistry and water quality management courses, through On Job/On Campus (OJ/OC) program for working professionals pursuing M.S./M.P.H. degrees. Also co-coordinated and taught majority of water quality management course in residential program in fall 2005, and lecture periodically in residential program environmental chemistry course. Have also advised students on thesis projects, including co-supervising three theses.

Research Assistant/ Student/Honorary Fellow, September 1984 - May 1997
Water Chemistry Program, University of Wisconsin-Madison.

- Developed, evaluated and utilized a precipitation collector to measure polychlorinated biphenyls (PCBs) in precipitation.

- Utilized generator column to assess dissolution behavior of PCBs and measure aqueous solubilities, a gas purging system for measuring PCB Henry's law constants in the laboratory and volatilization potential in the field, and a Hi-Vol sampling system for measuring PCBs in atmospheric samples. Developed techniques to minimize blank contamination in trace analysis of PCBs in several environmental matrices, and conducted detection level assessment.

Education

Ph.D., Water Chemistry, December 1996
University of Wisconsin-Madison. Thesis Advisor: Professor Anders W. Andren
Dissertation: "Laboratory Investigation of Physical-Chemical Properties and Field Measures of Several Parameters Affecting the Transport and Fate of Polychlorinated Biphenyls in the Environment."
Minor: Atmospheric and Oceanic Sciences

M.S., Water Chemistry, December 1987
University of Wisconsin-Madison. Thesis Advisor: Professor Anders W. Andren
Thesis: "Precipitation Scavenging of PCBs: Event Analysis and Collector Evaluation."

Graduate Program in Environmental Sciences
University of Virginia, Charlottesville, VA, September 1983 - May 1984.

Diplome, French Language and Civilization Program
Université de Paris-IV, Paris, France, October 1982 - June 1983.

B.S., Geological Engineering, May 1982
Colorado School of Mines, Golden, CO.

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National Wildlife Federation, Toxic chemicals threatening our children, revised 2003 (series of three annotated fact sheets for healthcare providers on risks from chemical contaminants in fish and approaches to reducing exposures). (Co-author)

National Wildlife Federation, Getting serious about mercury: A guide for developing comprehensive mercury reduction programs, May 2002. (Co-author)

National Wildlife Federation, Rain check – Milwaukee: Conservation groups monitor mercury levels Milwaukee's rain, September 2001. (Co-author)

National Wildlife Federation, Clean the rain, clean the lakes II: Mercury in rain is contaminating New England's waterways, September 2000. (Co-author)

National Wildlife Federation, Pollution paralysis II: Code red for watersheds, April 2000. (Project coordinator and co-author)

National Wildlife Federation, Clean the rain, clean the lakes, September 1999. (Co-author).

National Wildlife Federation, Linking air sources of toxic chemicals and water quality impairments: Potentially useful modeling tools and ongoing measurement initiatives, May 1998. (Author).

National Wildlife Federation, Ohio's mercury menace, December 1997. (Principal author).

Presentations (Selected)

Murray, M.W., Abbott, M.L., Bodaly, R.A., Driscoll, ,C.T., Evers, D.C., Harris, R.H., Krabbenhoft, D.P., Lindberg, S.E., Mason, R.P., Saltman, T., Swain, E.B., Wiener, J.G., Wolfe, M.F., A Framework for Monitoring the Response to Changing Mercury Releases, presented at Fith National Monitoring Conference, San Jose, CA, May 7-11, 2006.

Murray, M.W., Ohio Auto Salvage Yard Survey, Environmentally Preferable Purchasing Guide, and 2005 Compendium of State's Mercury Activities. Presented at Ohio Mercury Reduction Group meeting, Columbus, OH, February 7, 2006.

Murray, M.W., 2005 Compendium of State's Mercury Activities. Presented at Canada – U.S. Binational Toxics Strategy, Mercury Workgroup Meeting, Chicago, IL, December 6, 2005.

Murray, M.W., Value of state actions to reduce mercury emissions from coal-fired power plants. Presented at Canada – U.S. Binational Toxics Strategy, Mercury Workgroup Meeting, Chicago, IL, November 30, 2004.

Murray, M.W., Approaches to reducing mercury emissions from coal-fired power plants. Presented at American Public Health Association Annual Meeting, Washington, D.C., November 8-11, 2004.

Murray, M.W., Addressing the mercury problem: Challenges and approaches for coal-fired utilities. Presented at Resources for the Future workshop, Addressing the Mercury Problem: Global Challenge and Local Impact, Washington, D.C., June 15, 2004.

Murray, M.W., Mathrani, V., Risks from chemical contaminants in fish, and approaches to reducing exposures. Presented at 18th Annual Minority Health Conference, Ann Arbor, MI, March 12-13, 2004.

Murray, M.W., Mathrani, V., Fish consumption advisories and approaches to reducing exposures. Presented to Detroit Health Department healthcare providers, Detroit, MI, January 15, 2004.

Murray, M.W., Additional thoughts on mercury release inventories in the U.S. Presented at Commission for Environmental Cooperation, "Environment-First Approach" to Mercury in the Great Lakes Region, Chicago, IL, December 17, 2003.

Murray, M.W., Getting to the source: Promoting statewide mercury phase-out plans. Presented at American Public Health Association Annual Meeting, San Francisco, CA, November 15-19, 2003.

Murray, M.W., Mercury phaseouts: An alternative to mercury TMDLs. Presented at Quicksilver Caucus 2003 Mercury Workshop, St. Louis, MO, October 29-30, 2003.

Murray, M.W., Progress and challenges in reaching the virtual elimination goals for toxic chemicals in the Great Lakes. Presented at Great Lakes Experiences and Global Applications meeting (in conjunction with 46th Conference on Great Lakes Research), Chicago, IL, June 24, 2003.

Murray, M.W., Clean the rain campaign: Raising public awareness of the mercury deposition issue. Presented at Michigan Department of Environmental Quality workshop, Measuring Atmospheric Mercury: Goals, Methods and Results, Lansing, MI, March 26-27, 2003.

Murray, M.W., Mercury sources and cycling: Some additional thoughts. Presented at International Joint Commission workshop, An Ecosystem Approach to the Health Effects of Mercury in the Great Lakes Basin, Windsor, Ont., February 26-27, 2003.

Murray, M.W., Pollutants and health of communities in the Great Lakes Basin: A response. Presented at Great Lakes Symposium: Our Challenging Future, Ann Arbor, MI, November 5-6, 2002.

Murray, M.W., Tackling mercury TMDLs: Are we there yet? Presented at River Network River Rally, Asheville, NC, May 17-22, 2002.

Murray, M.W., Harmon, T., Keith, K., Kenzie, J., Environmental cycling and fish and wildlife impacts of mercury: An overview. Presented at Methylmercury: Impacts on Wildlife and Human Health meeting, Charleston, SC, April 9-10, 2001.

Murray, M.W., An NGO perspective on federal and state policies on mercury in the U.S. Presented at Environmental Council of the States Mercury Workshop, St. Louis, MO, October 18-20, 2000.

Murray, M.W., Lawther, J.H., DeFalco, T.S., Wolk, J.C., Cholewiak, D.M., Reyer, J.E., Technical and policy issues related to the development of a total maximum daily load plan for mercury in the St. Louis River, MN: Development of a case study. Presented at Air & Waste Management Association, Mercury in the Environment conference, Minneapolis, MN, September 15-17, 1999.

Murray, M.W., Pascual, D. L., A mercury emissions inventory in Ohio. Presented at 41st Annual Conference on Great Lakes Research, McMaster University, Hamilton, Ont., May 18-22, 1998.

Murray, M.W., Investigation of the air/water transfer of PCBs using gas purging. Presented at Dissertations Symposium on Chemical Oceanography, Honolulu, HI, November 6-11, 1994. (Symposium sponsored by National Science Foundation, Office of Naval Research, and National Oceanic and Atmospheric Administration).

Murray, M.W., Andren, A.W., The water/air transfer of PCBs in Green Bay as determined by gas purging. Presented at 36th Conference on Great Lakes Research, DePere, Wisconsin, June 4-10, 1993.

Murray, M.W., Andren, A.W., Investigation of water/air distribution of PCBs in Green Bay using gas purging. Presented at 15th Annual Midwest Environmental Chemistry Workshop, Madison, WI, October 16-17, 1992.

Murray, M.W., Andren, A.W., Henry's law constants of PCBs as determined by gas purging. Presented at 35th Conference on Great Lakes Research, Waterloo, Ontario, Canada, May 31-June 4, 1992.

Murray, M.W., Andren, A.W., PCB fugacities in natural waters as determined by gas purging. Presented at 11th Annual Meeting of the Society of Environmental Toxicology and Chemistry, Washington, D.C., November 11-15, 1990.

Murray, M.W., Andren, A.W., Field evaluation of gas purging for PCB fugacity determinations. Presented at 33rd Conference on Great Lakes Research, Windsor, Ontario, Canada, May 28-June 1, 1990.

Murray, M.W., Andren, A.W., Preliminary evaluation of the potential of gas purging for investigating the air-water transfer of PCBs. Presented at 199th American Chemical Society National Meeting, Boston, MA, April 22-27, 1990.

Murray, M.W., Andren, A.W., Laboratory and field evaluation of gas purging for aqueous trace organic determinations. Presented at 32nd Conference on Great Lakes Research, Madison, WI, May 30-June 2, 1989.

Grants Awarded

U.S. Environmental Protection Agency: Enhancing Reduction of Mercury and Other PBT Chemicals in the Great Lakes Region, October 2005 – September 2006 ($35,000).

U.S. Environmental Protection Agency: Addressing Mercury Reductions in the Great Lakes, October 2004 – September 2005 ($35,000).

Have collaborated in proposal writing on numerous other successful grant applications.

Technical/Advisory Committees, Panels, and Other Service Activities

- Michigan Department of Environmental Quality, Michigan Mercury Rules Workgroup, June 2006 – present.
- U.S. EPA, Science Advisory Board, EPI Suite Review Panel, February 2006 – present.
- Health Risks and Toxicological Effects of Mercury panel, to present findings at 2006 Conference on Mercury as a Global Pollutant, July 2005 – present.
- U.S. EPA Federal Advisory Committee on Detection and Quantitation for Uses in Clean Water Act Programs, June 2005 – present.
- Society of Environmental Toxicology and Chemistry (SETAC) Technical Committee, 1998 – present. (Review proposals for technical workshops).
- Michigan Department of Environmental Quality Quantification Level Advisory Group, March 2004 – February 2006.
- Michigan Department of Environmental Quality Mercury Electric Utility Workgroup, August 2003 – June 2005.
- Steering Committee of SETAC workshop on environmental responses to reduced mercury loadings, September 14-17, 2003.
- Global Mercury Assessment Working Group, United Nations Environment Programme Chemicals, Global Mercury Assessment, July – December 2002.
- Advisory Committee to Michigan Department of Community Health, Michigan Biomonitoring Planning Grant process, September – December 2002.
- Peer reviewer for Michigan Department of Environmental Quality document, The Development of an Air Toxics Monitoring Strategy for Michigan, 2002.
- Michigan Great Lakes Protection Fund, Technical Advisory Board, 2000 – 2002.
- Steering Committee, and co-chair of policy session, for U.S. EPA Workshop on the Fate, Transport and Transformation of Mercury in Aquatic and Terrestrial Environments, West Palm Beach, FL, May 8-10, 2001.
- Total Maximum Daily Load External Advisory Group (Mercury Workgroup), Ohio Environmental Protection Agency, 1998 – 2000.
- Peer reviewer for U.S. EPA report, Deposition of Air Pollutants to the Great Waters: Third Report to Congress, 2000.
- Peer review panel, Mercury: Transport and Fate Through a Watershed, EPA Science to Achieve Results (STAR) program, Washington, D.C., May 5-6, 1999.
- SETAC Pellston Workshop, Criteria for Persistence and Long-Range Transport of Chemicals in the Environment, Fairmont Hot Springs, British Columbia, July 14-19, 1998.
- Michigan Air Quality Division De Minimis Quantities Workgroup, 1998.
- Estimating Atmospheric Deposition of Toxic Substances to the Great Lakes: An Update, Meeting in Burlington, Ont., January 31 – February 2, 1992.
- Have reviewed manuscripts for *Atmospheric Environment, Environmental Science and Technology, Environmental Health Perspectives*, and *Environmental Engineering Science*, a grant proposal to U.S. EPA, and have reviewed over 25 reports and comment letters from other nonprofit groups.

Awards/ Professional Societies

Runner-up for the **HydroLab Best Student Paper** award at the 33rd Conference on Great Lakes Research (1990).
Selected for membership in Sigma Xi, 1993
American Chemical Society, since 1990
American Geophysical Union, since 1995
American Public Health Association, since 2003
International Association for Great Lakes Research, since 1990
Society of Environmental Toxicology and Chemistry, since 1993

Languages

Speaking/reading/writing proficiency in French; limited proficiency in Spanish.

CERTIFICATE OF SERVICE

I, Faith Bugel, certify that on July 24, 2006, I filed the attached TESTIMONY OF MICHAEL MURRAY. An original and 9 copies were filed, on recycled paper, with the Illinois Pollution Control Board, James R. Thompson Center, 100 West Randolph, Suite 11-500, Chicago, IL 60601, and copies were served via United States Mail to those individuals on the included service list.

Faith E Bugel

Faith Bugel (Reg. No. 6255685)
Counsel for Environmental Law and Policy Center

DATED: July 24, 2006

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