

# Michael W. Murray

1419 Stovall St.  
Augusta, GA 30904

Ph: 734-657-1968  
michaelmurray1649@gmail.com  
mimurray@augusta.edu

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## Education

**Ph.D., Water Chemistry, 1996**

Minor: Atmospheric and Oceanic Sciences. University of Wisconsin, Madison, WI.

**M.S., Water Chemistry, 1987**

University of Wisconsin, Madison, WI.

**Graduate Program in Environmental Sciences**

University of Virginia, Charlottesville, VA, 1983-84.

**Diplôme, French Language and Civilization Program, 1983**

Université de Paris-IV, Paris, France.

**B.S., Geological Engineering, 1982**

Colorado School of Mines, Golden, CO.

## Experience

**Lecturer/Instructor, 2013 - present**

Department of Biological Sciences, Augusta University, Augusta, GA

- Teach Environmental Biology (Biol 1102), introductory environmental science course for non-science majors, with lab. Broad overview of environmental science, ranging across chemistry, geology, ecology and evolution, human population, air and water resources and pollution, climate change, approaches to conserving biodiversity, human health risks, and other topics.

**Instructor, 2016 - 2018**

Master of Public Health Program, Augusta University, Augusta, GA

- Taught Environmental Aquatic Sciences (MPHE 8904), one of core courses in former Environmental Health concentration in MPH program (entirely online). Significantly revamped course to include coverage across diverse topics including hydrology, overview of aquatic chemistry, physical-chemical properties of contaminants, inorganic and organic pollutants, water-related diseases, climate change and water resources, Great Lakes and Gulf of Mexico, policy/legal framework. Taught Fundamentals of Air Pollution (MPHE 8900) in summer 2017, drawing on additional materials regarding air pollutant sources, transport, exposures and effects, risk assessment, and other topics.

**Staff Scientist, 1997 – present (currently half-time)**

National Wildlife Federation, Great Lakes Regional Center, Ann Arbor, MI (currently working remotely from Augusta, GA)

- Have served as principal NWF scientist on issues involving toxic chemicals at state, regional, national and international levels; extensive involvement in numerous other environmental issues over past decade.
- Carry out and manage (including working with over 50 interns, research assistants and volunteers to date) scientific and science-policy research and education work on topics ranging across toxic chemical sources, fate and transport, exposures, impacts and policy/management options; aquatic invasive species; nutrient cycling and impacts; Great Lakes restoration prioritization; water levels; climate change mitigation and adaptation; and other topics.
- Coordinate/collaborate with multiple researchers on scientific and science/policy aspects of numerous Great Lakes and other issues (including synthesis efforts); serve on technical review, planning, and advisory committees, including over 30 to date (more recent committees identified below); carry out peer reviews of reports, manuscripts.

**Adjunct Associate Professor**, 2011 – present

University of Michigan School for Environment and Sustainability (formerly School of Natural Resources and Environment (SNRE)). Collaborate on projects with faculty, students as opportunities arise.

**Adjunct Lecturer**, 1998 – 2013; **Intermittent Lecturer**, 2011, 2013

University of Michigan School of Public Health (SPH), Department of Environmental Health Sciences (EHS), and University of Michigan SNRE, Ann Arbor, MI.

- Water Resource Policy course (SNRE).
- Coordinating, team-teaching, and guest lecturing in Water Quality Management, Environmental Chemistry, and Great Lakes Water Quality and Human Health courses (SPH); have also co-advised M.S. students (details below).

**Research Assistant/Student/Honorary Fellow**, 1984 – 1997

Water Chemistry Program, University of Wisconsin-Madison.

- Developed, evaluated and utilized a precipitation collector to measure polychlorinated biphenyls (PCBs) in precipitation.
- Utilized generator columns to assess dissolution behavior/aqueous solubilities of PCBs, gas purging systems for measuring PCB Henry's law constants in the laboratory and volatilization 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.

**Teaching/Advising**

- Environmental Biology (Biol 1102), Augusta University, Department of Biological Sciences (12 terms to date); Environmental Aquatic Sciences (MPHE 8904), Augusta University, MPH Program (2016-18). Fundamentals of Air Pollution (MPHE 8900), Augusta University, MPH Program (2017).

- Water Resource Policy (NRE 558), University of Michigan School of Natural Resources and Environment, instructor (winters 2011, 2013).
- Environmental Chemistry (EHS 574), University of Michigan School of Public Health, EHS, team taught with Dr. Jerome Nriagu (fall 2012 and multiple sessions in On Job/On Campus program (1998-2004)), and regular guest lecturer (2004-2011).
- Water Quality Management, University of Michigan SPH, EHS, co-coordinator (with Dr. Nriagu) and principal lecturer (fall 2005); co-coordinator (with Dr. Rolf Deininger) and principal lecturer (winter-spring 2005), regular guest lecturer after 2006 (under Dr. Chuangwu Xi).
- Great Lakes Water Quality and Human Health (EHS 615), University of Michigan SPH, EHS, regular guest lecturer (2010-11).
- Guest lecturer in NRE 558, other University of Michigan courses (including in SPH and Residential College), environmental science course at Henry Ford Community College, and water chemistry courses at University of Wisconsin.
- Advised through Augusta University MPH Capstone program: William Ealick (2016-17); also advised several MPH students on capstone projects, career options; currently serve as faculty advisor to Doctors Without Borders Student Chapter at AU.
- Advised as client organization (with SNRE Faculty members Dr. Gloria Helfand and Dr. Michael Moore) Kathleen Cardamone, Stephanie Cuttler and Nikole Reaksecker on SNRE M.S. mercury emissions reduction project (2001-02); have advised several SNRE and Public Policy students on projects, coursework, and/or career issues.
- Co-advised six University of Michigan EHS OJ/OC students on M.S. theses: John Rafterowski (2002), April Wendling (2002), Andrew Webster (2003), Pamela Pugh (2005), Nancy Bobola (2006), and Mazen Boughanem (2006).
- Have advised multiple student teams on client projects for Community Organizing class (HBHE 640, taught by Dr. Barbara Israel) at University of Michigan SPH, Department of Health Behavior and Health Education.
- Have spoken at several student career panels, and advised numerous NWF interns and students from UM and AU on career options.

### **Aquatic Sciences, Science-Policy Leadership**

- Member of International Joint Commission Science Advisory Board, Science Priority Committee (2012-present); Co-Chair of Fertilizer Application Work Group and Energy Transport and Water Quality Work Group; Current member of Great Lakes Early Warning System Work Group, Stressor Interactions Work Group, Harmonized Fish Consumption Advisory Framework Work Group, and Mining Work Group (the latter two jointly with Health Professionals Advisory Board); Previously involved in several environmental indicators work groups (including co-lead of three subgroups).
- Incoming Chair of Society of Environmental Toxicology and Chemistry Science Committee.

- Co-chair (with Dr. Don Scavia, University of Michigan) of Healing Our Waters (HOW) Great Lakes Coalition Technical Advisory Committee (2008-2015).
- Led effort of nearly two dozen scientists to examine potential for increased use of conceptual frameworks in Great Lakes restoration and protection efforts (2018-19).
- Organized/co-organized with other researchers five sessions (toxic chemicals policy, multiple stressors, restoration prioritization, Lake Erie nutrients/impacts) at conferences of the International Association for Great Lakes Research (1998, 2006, 2010, 2013, 2018).
- Have co-organized two restoration prioritization workshops for Great Lakes researchers (2006, 2009), and science/science-policy sessions at 2<sup>nd</sup>, 3<sup>rd</sup>, 5<sup>th</sup>, 6<sup>th</sup>, 7<sup>th</sup>, 10<sup>th</sup> and 11<sup>th</sup> Annual Healing Our Waters Great Lakes Coalition Restoration Conferences.
- Coordinated technical review of HOW Coalition restoration implementation proposals.
- Have been active in a number of literature synthesis efforts with other researchers, including regarding mercury cycling, exposures and effects in humans and wildlife; development of a mercury monitoring framework; understanding nutrient loads, impacts, climate implications, and abatement options in Lake Erie; implications of climate change on Great Lakes fisheries; assessing relative importance of commercial fertilizers and manures as phosphorus contributors to Lake Erie; and ecological implications of oil transport in the Great Lakes.
- Chair of Policy Coordination Committee of Great Lakes Panel on Aquatic Nuisance Species (2008 – 2012), with activities including coordinating development of committee work plans and priorities document, and several panel recommendation letters.
- One of lead nongovernmental organization participants in Canada-U.S. Binational Toxics Strategy (1997 - 2010), active in Mercury Work Group and Integration Work Group; current active member of Great Lakes Water Quality Agreement, Annex 3 (Chemicals of Mutual Concern), Extended Subcommittee; founding member of Great Lakes Wind Collaborative, Steering Committee (2008 – 2013), and co-organizer of workshop Offshore Wind Energy: Understanding Impacts on Great Lakes Fishery and Other Aquatic Resources (2012; GLWC formerly housed at Great Lakes Commission).

## Publications

### Technical Papers, Book Chapters (peer-reviewed)

- Collingsworth, P.D., Bunnell, D.B., **Murray, M.W.**, Kao, Y-C., Feiner, Z.S., Claramunt, R.M., Lofgren, B.M., Höök, T.O., Ludsın, S.A., 2017. Climate change as a long-term stressor for the fisheries of the Laurentian Great Lakes of North America, *Reviews in Fish Biology and Fisheries*, 27(2):363-391.
- Kalcic, M.M., Kirchhoff, C., Bosch, N., Muenich, R.L., **Murray, M.W.**, Gardner, J.G., Scavia, D., 2016. Engaging stakeholders to define feasible and desirable agricultural conservation in Western Lake Erie watersheds, *Environmental Science and Technology*, 50:8135-8145.

- Watson, S. B., Miller, C. J., Arhonditsis, G., Boyer, G.L., Carmichael, W., Charlton, M.N., Confessor, R., Depew, D.C., Höök, T.O., Ludsins, S.A., Matisoff, G., McElmurry, S. P., **Murray, M.W.**, Richards, R.P., Rao, Y.R., Steffen, M.M., Wilhelm, S.W. 2016. The re-eutrophication of Lake Erie: Harmful algal blooms and hypoxia, *Harmful Algae*, 56:44-66.
- Abbasi, G., Buser, A.M., Soehl, A., **Murray, M.W.**, Diamond, M.L. 2015. Stocks and flows of PBDEs in products from use to waste in the U.S. and Canada from 1970 to 2020, *Environmental Science and Technology*, 49:1521-1528.
- Mergler, D., Anderson, H.A., Chan, L.H.M., Mahaffey, K.R., **Murray, M.**, Sakamoto, M., Stern, A.H. 2007. Methylmercury exposure and health effects in humans: A worldwide concern, *Ambio*, 33(1):3-11.
- Scheuhammer, A., Meyer, M.W., Sandheinrich, M.B. **Murray, M.W.** 2007. Effects of environmental methylmercury on the health of wild birds, mammals, and fish, *Ambio*, 33(1):12-18.
- Harris, R., Krabbenhoft, D.P., Mason, R.F., **Murray, M.W.**, Reash, R.J., Saltman, T., 2007. Introduction, In: Harris, R., Krabbenhoft, D.P., Mason, R.F., Murray, M.W., Reash, R.J., Saltman, T. (Eds.), *Ecosystem Responses to Mercury Contamination: Indicators of Change*. Society of Environmental Toxicology and Chemistry, Pensacola, FL, and Taylor & Francis, New York, NY, pp. 1-11.
- Wolfe, M.F., Atkeson, T., Bowerman, W., Burger, J., Evers, D.C., **Murray, M.W.**, Zillioux, E., 2007. Wildlife indicators, In: Harris, R., Krabbenhoft, D.P., Mason, R.F., Murray, M.W., Reash, R.J., Saltman, T. (Eds.), *Ecosystem Responses to Mercury Contamination: Indicators of Change*, Society of Environmental Toxicology and Chemistry, Pensacola, FL, and Taylor & Francis, New York, NY, pp. 123-189.
- Saltman, T., Harris, R., **Murray, M.W.**, Reash, R.J., 2007. An integrated framework for ecological mercury assessments, In: Harris, R., Krabbenhoft, D.P., Mason, R.F., Murray, M.W., Reash, R.J., Saltman, T. (Eds.), *Ecosystem Responses to Mercury Contamination: Indicators of Change*, Society of Environmental Toxicology and Chemistry, Pensacola, FL, and Taylor & Francis, New York, NY, pp. 191-207.
- Mason, R.F., Abbott, M.L., Bodaly, R.A., Bullock, O.R., Driscoll, C.T., Evers, D., Lindberg, S.E., **Murray, M.**, Swain, E.B., 2005. Monitoring the response to changing mercury deposition, *Environmental Science & Technology*, 39(1):16A-22A.
- Murray, M.** and Holmes, S.A., 2004. Assessment of mercury emissions inventories for the Great Lakes states, *Environmental Research*, 95:282-297.
- Boethling, B., Buccini, J., Cowan-Ellsberry, C., Graham, D., Hansen, B., **Murray, M.**, Rampy, L., Rodan, B., Wahlstrom, B., 2000. Framework and criteria for evaluating persistent and long-range transport, In *Evaluation of Persistence and Long-range Transport of Organic Chemicals in the Environment*, Klecka, G., Boethling, B., Franklin, J., Grady, L., Graham, D., Howard, P.H., Kannan, K., Larson, R.J., Mackay, D., Muir, D., van de Meent, D. (Eds.), Society of Environmental Toxicology and Chemistry, Pensacola, FL, pp. 315-334.
- Murray, M. W.** and Andren, A. W., 1992. Evaluation of a precipitation collector for PCB analysis, *Atmospheric Environment*, 26A(6):1097-1101.

**Murray, M. W.** and Andren, A. W., 1992. Precipitation scavenging of polychlorinated biphenyl congeners in the Great Lakes Region, *Atmospheric Environment*, 26A(5):883-897.

**Murray, M. W.** and Andren, A. W., 1991. Preliminary evaluation of the potential of gas purging for investigating the air-water transfer of PCBs, *In Organic Substances and Sediments in Water*, Baker, R.A. (Ed.), Lewis Publishers, Inc., Chelsea, MI, pp. 3-13.

#### **Technical Papers – In Review/Revision**

**Murray, M.W.**, Norris, P.E., Wilcox, D.A., Steinman, A.D., Johnson, L.B., Allan, J.D., Danz, N.P., Scavia, D. 2019. Expert opinion to identify focus areas for restoration and protection in the Great Lakes, in revision for *Environmental Practice*.

#### **Technical Papers – In Preparation**

**Murray, M.W.**, Andren, A.W. Experimental determination of Henry's law constants for PCBs using Aroclor mixtures, in preparation.

**Murray, M.W.**, Andren, A.W. Field investigations of the water-air transfer of PCBs: Waukegan Harbor and Green Bay, Lake Michigan, in preparation.

#### **Committee/Workgroup/Other Reports (as lead author, co-author, or contributor)**

**Murray, M.W.**, and Salim, O. 2019. The science and policy of PFASs in the Great Lakes Region: A roadmap for local, state and federal action, National Wildlife Federation, Great Lakes Regional Center, Ann Arbor, MI.

**Murray, M.W.**, Steinman, A.D., Allan, J.D., Bratton, J.F., Johnson, L.B., Ciborowski, J.J.H., Stow, C.A. 2019. Conceptual frameworks and Great Lakes restoration and protection: A white paper. National Wildlife Federation, Great Lakes Regional Center, Ann Arbor, MI.

**Murray, M.W.**, Allan, J.D. and M. Child, 2018. Potential ecological impacts of crude oil transport in the Great Lakes Basin. Prepared by the Great Lakes Science Advisory Board for the International Joint Commission. Available at <https://www.ijc.org/en/sab/SAB-SPC-CrudeOil-Transport-GreatLakes-Report>.

International Joint Commission, 2018. Fertilizer application patterns and trends, and their implications for water quality in the western Lake Erie basin. Prepared by the Great Lakes Science Advisory Board for the International Joint Commission (Allan, J.D., **Murray, M.** and M. Child, co-authors). Available at <https://www.ijc.org/en/fertilizer-application-patterns-and-trends-and-their-implications-water-quality-western-lake-erie>.

**Murray, M.W.**, Kirchhoff, C., Kalcic, M.M., Steiner, A., Bosch, N., Lopez, F., Scavia, D., 2016. Guidance addressing Lake Erie eutrophication in a changing climate based on a case study with agricultural and coastal managers.

Great Lakes Science Advisory Board, Science Priority Committee, Communication Indicator Workgroup, An assessment of the communicability of the International Joint Commission

ecosystem indicators and metrics, June 2016 (contributor on PBTs in biota, and chemicals of mutual concern in water).

Pebbles, V., Braun, H., Leduc-Lapierre, M., **Murray, M.**, Koslow, M., Hoffman, J., 2014. Best practices for climate change adaptation: Spotlight on Michigan coastal wetlands. Great Lakes Commission and National Wildlife Federation. Available from <https://www.glc.org/library/2014-best-practices-for-climate-change-adaptation-mi-wetlands>.

Abbasi, G., Diamond, M., Soehl, A., **Murray, M.** 2014. Great Lakes PBDE reduction project, Summary paper no. 1, PBDE product inventory.

**Murray, M.**, Soehl, A., Abbasi, G., Diamond, M. 2014. Great Lakes PBDE reduction project, Summary paper no. 2, PBDE alternatives assessment.

Diamond, M., Abbasi, G., Soehl, A., **Murray, M.** 2014. Great Lakes PBDE reduction project, Summary paper no. 3, PBDE reduction metrics.

Koslow, M., Berrio, J., Glick, P., Hoffman, J., Inkley, D., Kane, A., **Murray, M.**, and Reeve, K. 2014. Restoring the Great Lakes' coastal future: Technical guidance for the design and implementation of climate-smart restoration projects with seven case studies. National Wildlife Federation, Reston, VA and National Oceanic and Atmospheric Administration, Silver Spring, MD.

Murray, M. 2013. Climate-smart habitat restoration in Muskegon Lake Area of Concern: A case study. National Wildlife Federation, Washington, D.C.

Murray, M. 2013. Climate-smart habitat restoration in Crow Island State Game Area: A case study. National Wildlife Federation, Washington, D.C.

Work Group Report to the International Joint Commission, Technical Report on Ecosystem Indicators: Assessment of Progress Towards Restoring the Great Lakes, Great Lakes Water Quality Agreement, 2012-2015 Priority Cycle, July 2013.

Murray, M. Lake Erie coastal wetlands and implications for nutrient loadings, draft report as part of International Joint Commission Lake Erie Ecosystem Priority Work Group, 2013.

Murray, M. Identifying restoration and protection focus areas for the Healing Our Waters – Great Lakes Coalition: A report to the Healing Our Waters – Great Lakes Coalition Steering Committee, March 2010.

U.S. Environmental Protection Agency (EPA) Federal Advisory Committee on Detection and Quantitation Approaches and Uses in Clean Water Act Programs, December 2007.

U.S. EPA Science Advisory Board, EPI Suite Review Panel report, September 2007.

Agreement Review Committee, 2006. Report to the Great Lakes Binational Executive Committee Volume 2. (Contributor to Review Working Group B and Special Issues Working Group Final Reports). December 2006.

Axler, R., Bails, J. Elliott, K., Fahnenstiel, G., Gannon, J., Krantzberg, G., Mackey, S., **Murray, M.**, Morrison, L., Ruetz, C., Savino, J., Scavia, D., Taylor, J., Todd, T. 2006. Future of the Great Lakes: Prioritizing prevention, protection, and restoration activities, July 2006.

Bails, J., Beeton, A., Bulkley, J., DePhilip, M., Gannon, J., **Murray, M.**, Regier, H., and Scavia, D. 2006. Prescription for Great Lakes ecosystem protection and restoration. (Also edited, and co-coordinated endorsement by initial group of 62 Great Lakes scientists in late fall 2005, then expanded to over 200 endorsements in 2006.)

Great Lakes Regional Collaboration Strategy, December 2005. (Contributor to Toxic Pollutant Strategy section.)

Michigan Mercury Electric Utility Workgroup, 2005. Michigan's Mercury Electric Utility Workgroup final report on mercury emissions from coal-fired power plants, June 20, 2005.

United Nations Environment Programme Chemicals, 2002. Global mercury assessment report, December 2002.

Eisenreich, S.J., Strachan, W.M.J. 1992. Estimating atmospheric deposition of toxic substances to the Great Lakes: An update, Workshop held at the Canada Centre for Inland Waters, Burlington, Ontario, January 31 – February 2, 1992.

### **Dissertation/Thesis**

Murray, M.W. Laboratory studies of physical-chemical properties and field measures of several parameters affecting the transport and fate of polychlorinated biphenyls in the environment, Ph.D. Dissertation, Water Chemistry Program, University of Wisconsin, Madison, WI, 1996.

Murray, M.W. Precipitation scavenging of PCBs: Collector evaluation and event analysis, M.S. Thesis, Water Chemistry Program, University of Wisconsin, Madison, WI, 1987.

### **Policy Papers/Other Publications**

**Murray, M.** 2010. Human health implications of the Gulf oil spill, *Therapeutics and Toxins News* (newsletter for the Therapeutic Drug Management and Toxicology Division of American Association for Clinical Chemistry), Summer 2010.

Stadler, F., **Murray, M.** 2001. Mercury rising, *Forum for Applied Research and Public Policy*, 16(3): 43-51.

**Murray, M.W.**, Lawther, J.H., DeFalco, T.S., Wolk, J.C., Cholewiak, D.M., Reyer, J.E. 1999. 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, Air & Waste Management Association, Mercury in the Environment, Proceedings of A Specialty Conference, September 15-17, 1999, Minneapolis, MN, pp. 63-74.

Billups, S., Eder, T., Jackson, J., Muldoon, P., **Murray, M.** 1998. Treading water: A review of government progress under the Great Lakes Water Quality Agreement, *The Toledo Journal of Great Lakes Law, Science & Policy*, Spring 1998, pp. 91-178.

### **Policy, Education, and Advocacy Reports/Fact Sheets**

(Project coordinator or co-lead on most reports)

Murray, M.W. Compilation of recent studies on pollinators and neonicotinoids, 2017.



- Inkley, D., Losoff, T., Rowland, J., Ellenberger, D., Glick, P., Murphy, J., **Murray, M.**, Ritter, J., Szollosi, F., Yancey, M. Wildlife in hot water: America's waterways and climate change, National Wildlife Federation, 2015.
- Lazaroff, C., Weinmann, A., **Murray, M.**, Goldman-Carter, J. Harmful algal bloom state survey: Summary of results and recommendations, Resource Media and National Wildlife Federation, 2014.
- Whitney, P., Heller, G., **Murray, M.**, Goldman-Carter, J., Watkins, G., Whelan, A. Toxic algae: Coming soon to a lake near you? Resource Media and National Wildlife Federation, 2013.
- Murray, M.W.**, Ruszaj, A., O'Shea, C., Radcliffe, C., Guadagnino, A. From the Great Lakes Water Quality Agreement to the Binational Toxics Strategy: An assessment of NGO perspectives on chemicals policies in the Great Lakes, National Wildlife Federation, 2011.
- Mida Hinderer, J., **Murray, M.W.**, and Becker, T. Feast and famine in the Great Lakes: How nutrients and invasive species interact to overwhelm the coasts and starve offshore waters, National Wildlife Federation, 2011.
- Murray, M.** The Enbridge oil spill, National Wildlife Federation, 2010. (annotated fact sheet)
- Reyer, J., Wolfe, C., and **Murray, M.W.** Protecting and restoring the kidneys of the Great Lakes: An assessment of wetlands programs in Michigan, Minnesota, Ohio and Wisconsin, National Wildlife Federation, 2009.
- Murray, M.W.** Putting the brakes on quicksilver: Removing mercury from vehicles in Ohio, National Wildlife Federation, 2007.
- Lory, Cameron S., Scott-Runnels, Amy E., and **Murray, M.W.** Environmentally preferable purchasing in the Great Lakes Region: A survey of state, municipal and institutional programs, National Wildlife Federation, 2007.
- Murray, M.** Recycling mercury thermostats in Ohio, 2007. (annotated fact sheet)
- Murray, M.W.** Five postings on Great Lakes issues as guest speaker on Great Lakes Town Hall (Web site), week of January 8, 2007.
- Murray, M.**, Lipman, Z., Stadler, F., Bowes, C., Swanson, M. Getting the job done: Affordable mercury control at coal-burning power plants, National Wildlife Federation, 2004.
- White, G., **Murray, M.**, Jackson, S.E. Ecosystem shock: The devastating impacts of invasive species on the Great Lakes food web, National Wildlife Federation, 2004.
- Baez, S., Greene, A., Welch, J., **Murray, M.**, McCamant, F., Mathrani, V. A woman's guide to eating fish safely, National Wildlife Federation, revised 2003. (brochure)
- Murray, M.**, Shetlar, M., McCamant, F., Mathrani, V. Toxic chemicals threatening our children, National Wildlife Federation, 2003. (Series of three annotated fact sheets for healthcare providers on risks from chemical contaminants in fish and approaches to reducing exposures.)
- St. Pierre, J., O'Brien, S., **Murray, M.** Getting serious about mercury: A guide for developing comprehensive mercury reduction programs, National Wildlife Federation, 2002.

Buchsbaum, A., Harmon, T., **Murray, M.**, Semion, J., Bonnardeaux, D., Richter, K., Gilbert, M. Clean the rain, clean the lakes II: Mercury in rain is contaminating New England's waterways, National Wildlife Federation, 2000.

Anderson, W., Buchsbaum, A., Dolan, K., Hess, M., **Murray, M.**, Semion, J., Steimke, A., Wolk, J., Box, B. Pollution paralysis II: Code red for watersheds, National Wildlife Federation, 2000.

Buchsbaum, A., DeFalco, T., Metty, J., **Murray, M.** Clean the rain, clean the lakes, National Wildlife Federation, 1999.

**Murray, M.** Linking air sources of toxic chemicals and water quality impairments: Potentially useful modeling tools and ongoing measurement initiatives, National Wildlife Federation, 1998.

**Murray, M.**, Eder, T., Kraemer, A. Ohio's mercury menace, National Wildlife Federation, 1997.

### **Group Policy Letters/Position Statements**

(Coordinator and/or contributor, since 2008)

Great Lakes Panel on Aquatic Nuisance Species: Letters/Statements to Aquatic Nuisance Species Task Force (ANSTF) on diverse topics (coordinator on all but third item), including:

- Comments on ANSTF draft Strategic Plan (2013-2017) (2012)
- Letter on need for additional federal action to address organisms in trade (2011)
- Position Statement on Professional Responsibility for Reporting of Aquatic Invasive Species (2010)
- Position Statement on Governance Issues Involving the Great Lakes Water Quality Agreement (2010)
- Position Statement on A National Ballast Water Discharge Standard (2009)

Healing Our Waters – Great Lakes Coalition comments on diverse topics:

- Letter to U.S. EPA and Environment Canada leads of Annex 3 process on draft Binational Summary Reports for individual chemicals of potential concern (2015)
- Letter to U.S. EPA on an independent science structure to advise the agency on the Great Lakes Restoration Initiative (2012)
- Letter on U.S. EPA draft 2011 – 2015 Strategic Plan (2010)
- Letter to U.S. EPA on Great Lakes Multi-year Restoration Action Plan (2009)

Great Lakes Water Quality Agreement, Annex 3, Chemicals of Mutual Concern: Policy and technical comment letters concerning binational strategies for mercury, PCBs and hexabromocyclododecane, polybrominated diphenyl ethers, mercury, and short-chain chlorinated paraffins.

National Wildlife Federation letters (principal author):

- Letters to U.S. EPA concerning development of groundwater cleanup standards for PFAS chemicals, and approaches to identifying harmful algal blooms of national significance (2019)
- Three letters to U.S. EPA regarding rules and guidance under the Toxic Substances Control Act, including concerning prioritization of chemicals for risk evaluation, procedures for chemical risk evaluation, and systematic review (2017-18)
- Three letters to U.S. EPA regarding ecological risk assessments for three neonicotinoid insecticides (2017-18)
- Letter to U.S. EPA on Science Advisory Board Panel for Review of Great Lakes Restoration Initiative Action Plan (2011)
- Letter to U.S. EPA on Great Lakes Restoration Initiative Action Plan, December 3, 2009 Draft (supplemental to Healing Our Waters Coalition comments) (2010)
- Letter to International Upper Great Lakes Study (IUGLS) Board, *Impacts on Upper Great Lakes Water Levels: St. Clair River* (2009)
- Letter to Agency for Toxic Substances and Disease Registry on Selected Information on Chemical Releases Within Great Lakes Counties Containing Areas of Concern (AOC) (Public Comment Draft 2008) (2008)
- Letter to International Joint Commission on Proposed new Order and regulation plan for managing water flows and levels of Lake Ontario and the St. Lawrence River (2008)
- Contributor to numerous other Great Lakes letters over past two decades.

### **Presentations**

(Over 55 oral conference and other meeting presentations; presentations since 2010 listed here)

Salim, O., and Murray, M.W., PFAS, PFAS everywhere: Problems and solutions, River Rally 2019, Cleveland, OH, June 21-24, 2019.

Murray, M.W., Revisiting the *Prescription*: Identifying a conceptual framework for approaches to restoring and protecting the Great Lakes, CIGLR All Partners Meeting, Ann Arbor, MI, September 21, 2018.

Murray, M.W. PBDEs and other PBTs in the Great Lakes: Breaking the cycle, PBDEs in the Great Lakes Workshop, Windsor, ON, February 22, 2017.

Murray, M.W. Harmful algal blooms in Lake Erie: A mini-review of recent science, 11<sup>th</sup> Annual Great Lakes Restoration Conference, Chicago, IL, September 29 – October 1, 2015.

Murray, M.W., Kirchhoff, C. Enhancing manager and stakeholder awareness of and responses to changing climatic conditions and their impacts on Lake Erie, poster presented at National Adaptation Forum, St. Louis, MO, May 11-14, 2015.

Murray, M., deBarros, C., Krantzberg, G., Ridal, J., Swackhamer, D. Re-evaluation of indicators of toxic chemicals in the Great Lakes, 57<sup>th</sup> Conference on Great Lakes Research, Hamilton, ON, May 26-30, 2014.

- Murray, M.W., Watson, S.B., Bejankiwar, R. Overview of binational approaches to address nutrients in Lake Erie, National Conference on Ecosystem Restoration, Schaumburg, IL, July 29 – August 2, 2013.
- Murray, M.W., Watson, S.B., Carpenter, D., Casselman, J., Miller, C. Lake Erie Ecosystem Priority: Taking Action on Lake Erie (TAcLE), 56<sup>th</sup> Conference on Great Lakes Research, West Lafayette, IN, June 2-6, 2013.
- Murray, M.W., Koslow, M. Guiding restoration in a changing Great Lakes climate: Steps and tools, 56<sup>th</sup> Conference on Great Lakes Research, West Lafayette, IN, June 2-6, 2013.
- Murray, M.W. Addressing climate, nutrients and interacting impacts in Lake Erie, Great Lakes, Great Challenges Conference, Rochester, MI, March 14, 2013.
- Murray, M.W. PBDEs in the Great Lakes: Filling in the picture, BIFMA Furniture Issues Summit, Ann Arbor, MI, October 16, 2012.
- Murray, M.W. Healing Our Waters – Great Lakes Coalition: Research, education and advocacy in support of restoration and protection, Society for Freshwater Sciences, 2012 Annual Meeting, Louisville, KY, May 21-24, 2012.
- Murray, M.W. Feast and famine in the Great Lakes: the interaction of nutrient pollution and invasive species, National Caucus of Environmental Legislators, Great Lakes/Midwest 10<sup>th</sup> Annual Meeting, Chicago, IL, December 8-10, 2011.
- Murray, M.W. Overview of offshore wind energy in the Great Lakes, 7<sup>th</sup> Annual Great Lakes Restoration Conference, Detroit, MI, October 12-14, 2011.
- Murray, M.W. Great Lakes wetland restoration and climate change: Vulnerability and adaptation considerations, Michigan Wetlands Association Annual Conference, Acme, MI, August 30 - September 2, 2011.
- Murray, M.W. Climate-smart restoration: An NGO perspective, presented at U.S. Areas of Concern Program Annual Meeting, Buffalo, NY, September 22-23, 2010.
- Murray, M.W. Offshore wind development in the Great Lakes: Potential aquatic/ecological issues, presented at Great Lakes Offshore Wind NGO Meeting, Chicago, IL, August 24, 2010.
- Murray, M.W. Identifying priority geographic areas in the Great Lakes for restoration and protection through an expert opinion process, presented at Evaluating US Army Corps of Engineer Protocols to Quantifying Aquatic Ecosystem Significance at Regional and National Scales, Review Workshop, Cambridge, MA, July 20-22, 2010.
- Murray, M.W. and Scavia, D. Identifying priority geographic areas for restoration and protection via an expert opinion process, presented at 53<sup>rd</sup> Annual Conference on Great Lakes Research, Toronto, ON, May 17-21, 2010.

### **Grants Received (as Principal Investigator (PI) or Co-PI)**

*Revisiting the Prescription: Assessing recent progress, understanding of stresses and responses, and needs concerning restoring and protecting the Great Lakes*, 2018. Awarded \$20,000 for expenses associated with organizing summit through Cooperative Institute for Great Lakes Research, University of Michigan, June 2018.

*Toxic Free Great Lakes Network*, 2017-18 (\$2,500, as part of larger grant from Freshwater Future to Canadian Environmental Law Association).

*Enhancing manager and stakeholder awareness of and responses to changing climatic conditions and their impacts on Lake Erie*, National Oceanic and Atmospheric Administration, 2013-2015 (\$296,709; Co-PI, with Dr. Christine Kirchhoff, Dr. Donald Scavia, Dr. Allison Steiner, Dr. Nate Bosch, Melinda Koslow, and Heather Elmer).

*Use of Environmental Management Systems to Address Chemicals of Concern in the Great Lakes Region*, U.S. Environmental Protection Agency, 2007 – 2009 (\$35,000); supplemental funding (\$15,000, through 2010) awarded in May 2009.

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

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

Also partner/collaborator on several other successfully funded proposals, including *A Self-Scaling Market Mechanism to Reduce Indirect Electricity Pollution* (WattTime *et al.*); *Real-Time Energy Impact Monitors for Residential, Industrial and Policy Use* (Dr. Carol Miller, Wayne State University, PI); *Forecasting Climate-Change Induced Effects on Recreational and Commercial Fish Populations in the Great Lakes* (Dr. David Bunnell, U.S. Geological Survey, PI); *Great Lakes PBDE Institutional Reduction project* (Anna Soehl, Great Lakes Commission, PI). Have also collaborated on numerous other successful NWF grant applications, including to the National Oceanic and Atmospheric Administration, U.S. EPA, the Wege Foundation, the Joyce Foundation, the Erb Family Foundation, the George Gund Foundation, the C.S. Mott Foundation, the Garfield Foundation, and the Great Lakes Fishery Trust.

### **Technical/Advisory/Review Committees**

International Joint Commission, Science Advisory Board/Science Priority Committee (2012 – present):

Fertilizer Application Work Group (Co-lead) (2015-2019)

Energy Transport and Water Quality Work Group (Co-lead) (2015-2018)

Member of Great Lakes Early Warning System Work Group and Stressor Interactions Work Group (2017-present), Harmonized Fish Consumption Advisory Framework Work Group (2018-present) and Mining Work Group (present)

Communication Indicators Work Group, including Co-lead on PBTs in biota indicator (2014-2016), and lead role in added indicator on chemicals of mutual concern in water (2016)

Taking Action on Lake Erie Work Group (Co-lead, Climate Change Implications for Total Phosphorus, Dissolved Reactive Phosphorus Inputs/Outputs and Excessive Algal Blooms in Lake Erie subgroup (2012-13))

Environmental Indicators Work Group, including lead on Chemicals of Mutual Concern in Water subgroup (2012-13)

Cooperative Institute for Great Lakes Research, Council of Fellows (2018 – present); review proposals for new organizational members, fellowship applications.

Society of Environmental Toxicology and Chemistry (SETAC) Technical Committee (1998 – present); Incoming Chair (2020); Member of Peer-Review Subcommittee (on wildlife toxicity assessments) (2017-2018)

Great Lakes Water Quality Agreement, Annex 3 (Chemicals of Mutual Concern), Extended Subcommittee (2013-present)

Augusta University Green Team (2015-present), with emphasis since 2015 on multi-organization Earth Day Planning Committee; assisted in organizing AU 2019 Earth Day event.

Ludington Pumped Storage Project, Technical Work Group (2017)

Healing Our Waters Great Lakes Coalition, Technical Advisory Committee, Co-chair (2008 – 2015)

Great Lakes Wind Collaborative, Advisory Committee/Steering Committee (2007-13); also member of Offshore Wind Workgroup, Finance and Fundraising Workgroup, and planning committee for 4<sup>th</sup> Annual Meeting.

Great Lakes Panel on Aquatic Nuisance Species, Chair of Policy Coordination Committee (2008-12); At-large member (2006-13)

Mercury Science in the Great Lakes Workshop, U.S. EPA and U.S. Geological Survey (2012-13)

Asian Carp Technical and Policy Workgroup (2011 – 2013)

Lake Michigan Biodiversity Conservation Strategy, Steering Committee (The Nature Conservancy-led project) (2011-12)

Lake Erie Biodiversity Conservation Strategy, Steering Committee (The Nature Conservancy-led project) (2011-12)

SETAC Gulf Oil Spill Focused Topic Meeting, Pensacola Beach, FL, Steering Committee (2010-11)

Cooperative Institute for Limnology and Ecosystems Research, External Review Panel for NOAA Great Lakes Environmental Research Laboratory, Great Lakes Restoration Initiative Projects (2011)

Evaluating US Army Corps of Engineer Protocols to Quantifying Aquatic Ecosystem Significance at Regional and National Scales, Review Workshop (2010)

International Joint Commission, Expert Consultation on Chemicals of Emerging Concern (2009)

Minnesota Pollution Control Agency, Minnesota Department of Agriculture, American Association of Pesticide Control Officials/State FIFRA Issues Research and Evaluation Group, and U.S. EPA Region V, Development of Community-Level Pesticide Aquatic Life and Plant Benchmarks Using Great Lakes Initiative Methodologies: A Pilot Project for AAPCO/SFIREG & EPA Region 5 (Phase 2 review group) (2009)

Canada – U.S. Binational Toxics Strategy, 10 Year Anniversary Workshop Planning Committee (2006-07)

Ecological team for research in support of economic analysis for Austin J.C., Anderson, S., Courant, P.N., Litan, R.E., America's North Coast: A Benefit-Cost Analysis of a Program to Protect and Restore the Great Lakes, September 2007 (2006-07)

Michigan Department of Environmental Quality, Michigan Mercury Rules Workgroup (2006-07)

Great Lakes Water Quality Agreement review, Governance and Institutions Working Group (2006-07)

Health Risks and Toxicological Effects of Methylmercury panel; findings presented at 2006 Conference on Mercury as a Global Pollutant in Madison, WI (2005-07)

U.S. EPA, Federal Advisory Committee on Detection and Quantitation for Uses in Clean Water Act Programs (2005-07)

SETAC/U.S. EPA Mercury Monitoring and Assessment Workshop, Pensacola, FL (with book development), Steering Committee (2003-07)

Great Lakes Water Quality Agreement review, Review Working Group B (Toxic Chemicals) (2006)

Great Lakes Water Quality Agreement review, Special Issues Working Group (2006)

U.S. EPA, Science Advisory Board, EPI Suite Review Panel (2006)

Michigan Department of Environmental Quality, Quantification Level Advisory Group (2004-06)

Michigan Department of Environmental Quality, Mercury Electric Utility Workgroup (2003-05)

United Nations Environment Programme Chemicals, Global Mercury Assessment Working Group (2002)

Michigan Department of Community Health, Michigan Biomonitoring Planning Grant, Advisory Committee (2002)

Michigan Great Lakes Protection Fund, Technical Advisory Board (2000-02)

U.S. EPA Workshop on the Fate, Transport and Transformation of Mercury in Aquatic and Terrestrial Environments, West Palm Beach, FL, Steering Committee, and co-chair of policy session (2001)

Ohio Environmental Protection Agency, Total Maximum Daily Load External Advisory Group (Mercury Workgroup) (1998-2000)

SETAC Pellston Workshop, Criteria for Persistence and Long-Range Transport of Chemicals in the Environment (with book development), Fairmont Hot Springs, British Columbia (1998-2000)

U.S. EPA Science to Achieve Results (STAR) program, Peer review panel, Mercury: Transport and Fate Through a Watershed, Washington, D.C. (1999)

Michigan Air Quality Division De Minimis Quantities Workgroup (1998)

Estimating Atmospheric Deposition of Toxic Substances to the Great Lakes: An Update, Burlington, ON (1992)

### **Additional Review Activities**

Have reviewed manuscripts for *Atmospheric Environment*, *Chemistry and Ecology*, *Environmental Engineering Science*, *Environmental Health Perspectives*, *Environmental Monitoring and Assessment*, *Environmental Pollution*, *Environmental Practice*, *Environmental Research*, and *Environmental Science and Technology*; have served as technical peer reviewer on grant proposals to U.S. EPA, Great Lakes Fishery Trust, and Great Lakes Protection Fund.

Have served as NWF staff commentator on resolutions for NWF annual meetings, including concerning moratorium on neonicotinoid insecticides (2017), and alternatives to single-use plastics (2018).

Have reviewed multiple external agency and NGO reports, including (since 2009) the following:

International Joint Commission, Atmospheric deposition of phosphorus to freshwater lakes (2012), Review of atmospheric deposition of mercury in the Great Lakes Basin (2015), and subsection of Triennial assessment of progress report (2017).

Great Lakes One Health, A Convening at the John G. Shedd Aquarium, May 20, 2011.

Commission for Environmental Cooperation, Taking stock: North American pollutant releases and transfers, 2006; and Taking stock: North American pollutant releases and transfers, Feature analysis: Pollutant releases to surface waters, 2011.

Great Lakes Regional Collaboration, 2010. Great Lakes mercury emission reduction strategy.

Canadian Environmental Law Association and Lowell Center for Sustainable Production, 2009. The challenge of substances of emerging concern in the Great Lakes Basin: A review of chemicals policies and programs in Canada and the United States, A report prepared for the International Joint Commission Multi-Board Work Group on Chemicals of Emerging Concern in the Great Lakes Basin.



Technical input (via comment letters) on numerous additional agency reports, rulemakings, and guidance, including to U.S. EPA, U.S. Coast Guard, IJC, and numerous state and provincial agencies, and served as expert witness (concerning mercury cycling and exposure and effects in fish and wildlife, for Environmental Law and Policy Center) before the Illinois Pollution Control Board on proposed rule addressing large combustion sources (mercury) (35 Ill. Adm. Code 225) (2006).

Reviews of over 50 additional reports and comment letters from NWF, Healing Our Waters – Great Lakes Coalition, and other nonprofit groups/coalitions.

### **Awards/Professional Societies**

Scheuhammer et al. 2007 paper cited as New Hot Paper by Thomson Reuters ScienceWatch.com in 2008; Scheuhammer et al. 2007 and Mergler et al. 2007 each have over 560 citations (Web of Science).

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)

#### **Society Memberships:**

- American Association of University Professors
- American Chemical Society
- Association for Environmental Studies and Sciences
- American Geophysical Union
- American Public Health Association
- International Association for Great Lakes Research
- Society of Environmental Toxicology and Chemistry

### **Languages, Other Activities**

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

Georgia-Carolina Toastmasters Club, Competent Communicator, President (2017-2018)

Augusta Choral Society, singer and Chorus Council member (2017-present)

Accomplished distance cyclist, including two-timer finisher of Paris-Brest-Paris; multiple other outdoor interests include running (5 km, 10 km), hiking, cross-country skiing, birding, stargazing, travel.