

## GENERAL PROFESSIONAL BIOGRAPHY

MITCHELL J. SMALL

Professor

Civil & Environmental Engineering/Engineering & Public Policy

Carnegie Mellon University

Pittsburgh, PA 15213

### *Vital Statistics*

Born June 11, 1953, Pittsburgh, Pennsylvania

### *Education*

1975 BS in Civil Engineering/Engineering and Public Affairs, Carnegie-Mellon University

1979 MS in Environmental and Water Resources Engineering, University of Michigan

1982 Ph.D. in Environmental and Water Resources Engineering, University of Michigan

### *Current and Previous Positions*

Carnegie Mellon University

Departments of Civil & Environmental Engineering and Engineering & Public Policy

- H. John Heinz III Professor of Environmental Engineering, 2001 - present
- Professor, 1991 - present
- Associate Professor, 1987-1991
- Assistant Professor, 1982-1987
  
- Associate Department Head for Graduate Education,  
Engineering & Public Policy, 1992 - present.
  
- Acting Department Head,  
Engineering & Public Policy, January 1997 - July 1997.

University of Pittsburgh

Department of Environmental and Occupational Health, Graduate School of Public Health

- Adjunct Professor, 1995 - present.

Teaching and Research Assistantships, University of Michigan, 1979-1982.

Engineer, Hydrosience, Inc., 1975-1978.

Research Intern, Allegheny County Health Department, Division of Water Quality, Summer 1974.

*Professional and Honorary Society Memberships*

American Geophysical Union  
 American Society of Civil Engineers  
 Association of Environmental Engineering & Science Professors  
 Chi Epsilon (Civil Engineering Honor Society)  
 International Society of Exposure Analysis  
 International Society for Industrial Ecology  
 Sigma Xi (Research Honorary Society)  
 Society for Risk Analysis

*Recent Professional Activities*

US EPA Science Advisory Board (SAB)

Member, Environmental Engineering Committee, 1985- 1991  
 Consultant to SAB, 1991-present  
 Chair of SAB Environmental Models Subcommittee, 1999-2003.  
 Recent SAB Panels:

- Member of SAB Expert Elicitation Advisory Panel, 2009.
- Member of SAB Dioxin Review Panel, 2010-2011

US EPA ORD Board of Scientific Counselors (BOSC), 1996 – 2002

US EPA External Review Panel for ORD National Exposure Research Laboratory, Ecological Research Division, 2007.

Member of National Research Council Committees:

- Hazardous Wastes in Highway Rights-of-Way, 1990-1993
- Remediation Priorities for Hazardous Waste Sites, 1991-1994
- USGS Water Resources Research, 1993-1996.
- Risk Characterization, 1994-1996.
- Environmental Remediation at Naval Facilities, 2000-2002.
- Changes in New Source Review Programs for Stationary Sources of Air Pollutants, 2004-2006.
- Review of Department of Homeland Security's Approach to Risk Analysis, 2008-

Associate Editor, *Environmental Science & Technology*, 1995-2011.

Elected Councilor, Society for Risk Analysis (SRA), 1999-2002.

Planning Committee for First World Congress on Risk, Brussels, Belgium, June 2003.

Elected Secretary, 2005-2009.

Chair of DOE Independent Peer Review Committee for Multimedia Models for Use in Programmatic Environmental Impact Statement Risk Assessment, 1994.

Panelist for EPA Risk Assessment Forum review on Selecting Input Distributions for Exposure Assessment, 1997, 1998.

Review Panel Member for NIEHS Superfund Basic Research Program, 1999.

Scientific Advisory Committee, Harvard EPA Center on Ambient Particle Health Effects, 2000-2003.

EPA Peer Review Committee review of draft *Risk Assessment Guidance for Superfund (RAGS) Volume 3A*, 2000.

Member of EPA Science Advisory Board Review Panel for selection of EPA employees to receive Scientific and Technological Achievement Awards (STAA), 2001.

Member of Review Panel for EPA Superfund Minority Institutions Program on Hazardous Substance Research, 2002.

Member of Jury Panel for the Annual Heinz Award in Technology, the Economy and Employment, 2001 - 2003.

Member of External Peer Review Panel for Evaluation of US Army Corps of Engineers (COE) Risk-Informed Decision Framework for the Louisiana Coastal Protection and Restoration Project (LaCPR), 2006 - .

Independent Third Party Administrator for Peer Consultation Panel on EPA-DuPont PFOA Site Related Environmental Assessment Program, 2008-2009.

Appointed Expert Scientist to advise US EPA Ecological Research Program (ERP) on methods for Decision Support. Application to coral reefs management in US coastal waters, 2009 - .

Member of Allegheny County Health Department (ACHD) Air Toxics Advisory Committee reviewing revisions of the ACHD air toxics program, 2010 - .

Academic Advisory Panels:

University of North Carolina, Department of Environmental Science & Engineering, Graduate Program Review, April 2000.

Member of Review Panel for Helmholtz Gemeinschaft Research Programme in Earth and Environment: Sustainable Use of Landscapes, Leipzig-Halle, Federal Republic of Germany, June 2003.

Chair of Advisory Board for Cranfield University (UK) Research Council/Defra Collaborative Centre of Excellence in Understanding and Managing Natural and Environmental Risks, 2009-2011.

*Awards and Fellowships*

Appointed as board-certified member of the American Academy of Environmental Engineers (AAEE) by eminence, December 2006.

Elected Fellow of the Society for Risk Analysis (SRA), December 2003.

2003 American Water Works Association (AWWA) Award for the Best Paper in the Small Systems Division, and the 2003 AWWA Publications Award (selected from the divisional winners), for the *Journal of the American Water Works Association* paper, "Point-of-use treatment and the revised arsenic MCL."

Frank Wilcoxon Prize, 1992, American Society for Quality Control – for best practical

applications paper in the journal *Technometrics*, "Modeling lake-chemistry distributions: Bayesian methods for estimating a finite-mixture model."

National Science Foundation Presidential Young Investigator Award, 1986-1991.

The Universities Council on Water Resources, Inc., 1982 Award for the Outstanding Water Resources Thesis in the Field of Environmental and Water Resource Engineering.

Horner Award, 1980, American Society of Civil Engineers – for outstanding urban hydrology paper, "Stormwater interception and storage."

College of Engineering Fellowship, University of Michigan, 1978-1979.

Rackham Pre-Doctoral Fellowship, University of Michigan, 1980-1981.

### *Research Interests*

Mathematical modeling of environmental quality; statistical methods and uncertainty analysis; human exposure modeling; human risk perception and decision making; integrated assessment models for human-environmental systems; ground water and soil pollution monitoring, site remediation, drinking water regulation and risk communication. Recent applications include design and analysis of leak detection monitoring systems at geologic CO<sub>2</sub> capture and storage sites, and decision support for protecting coral reefs.

## **PUBLICATIONS**

### **Books**

McDaniels, T.L. and M.J. Small (eds). 2004. *Risk Analysis and Society: An Interdisciplinary Characterization of the Field*. Cambridge University Press, Cambridge, UK.

Ramaswami, A., J.A. Milford and M.J. Small. 2005. *Integrated Environmental Modeling: Pollutant Transport, Fate and Risk in the Environment*. John Wiley & Sons, New York.

### **Journal Articles with Peer Review**

Small, M.J. and W.P. Darby. 1976. Evaluating water quality impacts of small streams on major urban rivers. *J. Boston Society of Civil Eng., ASCE*, 63: 101-122.

Darby, W.P. and M.J. Small. 1976. Identifying urban flash flooding problems. *J. Wat. Res. Planning Mgt. Div., ASCE*, 102: 349-363.

Di Toro, D.M. and M.J. Small. 1977. Discussion of "Theory of storage and treatment plant overflows". *J. Env. Eng. Div., ASCE*, 103: 517-520.

Di Toro, D.M. and M.J. Small. 1979. Stormwater interception and storage. *J. Env. Eng. Div., ASCE*, 105: 43-54.

- Small, M.J. and D.M. Di Toro. 1979. Stormwater treatment systems. *J. Env. Eng. Div., ASCE*, 105: 557-569.
- Small, M.J. and P.J. Samson. 1983. Stochastic simulation of atmospheric trajectories. *J. Clim. & Appl. Meteor.*, 22: 266-277.
- Rhue, L.G. and M.J. Small. 1986. Application of a low-flow assessment model for the Monongahela River Basin. *Water Resources Bulletin*, 22: 121-127.
- Small, M.J. and M.C. Sutton. 1986. A regional pH-alkalinity relationship. *Water Research*, 20: 335-343.
- Small, M.J. and D.J. Morgan. 1986. The relationship between a continuous time renewal model and a discrete Markov chain model of precipitation occurrence. *Water Resources Research*, 22: 1422-1430.
- Small, M.J. and M.C. Sutton. 1986. A direct distribution model for regional aquatic acidification. *Water Resources Research*, 22: 1749-1758.
- Small, M.J. and J.R. Mular. 1987. Long-term pollutant degradation in the unsaturated zone with stochastic rainfall-infiltration. *Water Resources Research*, 23: 2246-2256.
- Small, M.J., M.C. Sutton and M.W. Milke. 1988. Parametric distributions of regional lake chemistry: Fitted and derived. *Environmental Science and Technology*, 22: 196-204.
- Small, M.J. and C.A. Peters. 1988. Public policy model for the indoor radon problem. *Mathematical Computer Modelling*, 10: 349-358.
- Davidson, C.I., J.R. Harrington, M.J. Stephenson, M.J. Small, F.P. Boscoe and R.E. Gandley, 1989. Seasonal variations in sulfate, nitrate and chloride in the Greenland ice sheet: Relation to atmospheric concentrations. *Atmospheric Environment*, 23: 2483-2493.
- Small, M.J. and P.J. Samson. 1989. Stochastic simulation of meteorological variability for long-range atmospheric transport: 1. Dynamic Lagrangian models. *Atmospheric Environment*, 23: 2813-2824.
- Small, M.J., C. Boyd, G. Keeler and R.J. Marnicio. 1989. Stochastic simulation of meteorological variability for long-range atmospheric transport: 2. Long-term statistical models. *Atmospheric Environment*, 23: 2825-2840.
- Luthy, R.G. and M.J. Small. 1990. Environmental research: A clearer focus over a broader horizon. *Environmental Science & Technology*, 24(11): 1620-1623.
- Sullivan, T.J., D.L. Kugler, M.J. Small, C.B. Johnson, D.H. Landers, B.J. Rosenbaum, W.S. Overton, W.A. Kretser, J. Gallagher. 1990. Variation in Adirondack, New York, lakewater chemistry a function of surface area. *Water Resources Bulletin*, 26: 167-176.
- Rubin, E.S., M.J. Small, C.N. Boyd and M. Henrion. 1992. An integrated assessment of acid deposition effects on lake acidification. *Journal of Environmental Engineering, ASCE*, 118: 120-134.

- Borrazzo, J.E., C.I. Davidson and M.J. Small. 1992. A stochastic model for diurnal variations of CO, NO, and NO<sub>2</sub> concentrations in occupied residences. *Atmospheric Environment* 26B: 369-377.
- Crawford, S.L., M.H. DeGroot, J.B. Kadane and M.J. Small. 1992. Modeling lake chemistry distributions: Bayesian methods for estimating a finite-mixture model. *Technometrics*, 34: 441-453.
- Levy, K.O. and M.J. Small. 1992. Radon risk assessment: The effect of voluntary sampling distributions and bias. *Environmental Monitoring and Assessment*, 22: 153-168.
- Patwardhan, A. and M.J. Small. 1992. Bayesian methods for model uncertainty with application to future sea level rise. *Risk Analysis*, 12: 513-523.
- Julien, B., S.J. Fenves and M.J. Small. 1992. Knowledge acquisition methods for environmental evaluation. *AI Applications*, 6: 1-20.
- Julien, B., S.J. Fenves and M.J. Small, 1992. An environmental impact identification system. *Journal of Environmental Management*, 36: 167-184.
- Wilkes, C.R., M.J. Small, J.B. Andelman, N.J. Giardino and J. Marshall. 1992. Inhalation exposure model for volatile chemicals from indoor uses of water. *Atmospheric Environment*, 26A: 2227-2236.
- Giardino, N.J., E. Gumerman, N.A. Esmen, J.B. Andelman, C.R. Wilkes, C.I. Davidson and M.J. Small. 1992. Shower volatilization exposures in homes using tap water contaminated with trichloroethylene. *Journal of Exposure Analysis and Environmental Epidemiology*, Suppl. 1, 147-158.
- Merz, J., M.J. Small and P. Fischbeck. 1992. Measuring decision sensitivity: A combined Monte Carlo-logistic regression approach. *Medical Decision Making*, 12: 189-196.
- Ramaswami, A. and M.J. Small. 1994. Modeling the spatial variability of natural trace element concentrations in groundwater. *Water Resources Research*, 30: 269-282.
- Dakins, M.E., J.E. Toll and M.J. Small. 1994. Risk-based environmental remediation: Decision framework and role of uncertainty. *Environmental Toxicology & Chemistry*, 13: 1907-1915.
- Small, M.J., B.J. Cosby, R.J. Marnicio and M. Henrion. 1995. Joint application of an empirical and mechanistic model for regional lake acidification. *Environmental Monitoring & Assessment*, 35: 113-136.
- Small, M.J., A.B. Nunn, III, B.L. Forslund and D.A. Daily. 1995. Source attribution of elevated residential soil lead near a battery recycling site. *Environmental Science & Technology*, 24(4): 883-895.
- Siegel, E., H. Dowlatabadi and M.J. Small. 1995. Sensitivity and uncertainty analysis of an individual plant model and performance of its reduced form versions: A case study of TREGRO. *Journal of Biogeography*, 22: 689-694.
- Siegel, E., H. Dowlatabadi and M.J. Small. 1995. A probabilistic model of ecosystem prevalence. *Journal of Biogeography*, 22: 875-879.
- Brand, K.P. and M.J. Small. 1995. Updating uncertainty in an integrated risk assessment: Conceptual framework and methods. *Risk Analysis*, 15(6): 719-731.

- Dakins, M.E., J.E. Toll, M.J. Small and K.P. Brand. 1996. Risk-based environmental remediation: Bayesian Monte Carlo analysis and the expected value of sample information. *Risk Analysis*, 16(1): 67-79.
- Wolfson, L.J., J.B. Kadane and M.J. Small. 1996. Bayesian environmental policy decisions: Two case studies. *Ecological Applications*, 6(4): 1056-1066.
- Wilkes, C.R., M.J. Small, C.I. Davidson and J.B. Andelman. 1996. Modeling the effects of water usage and co-behavior on inhalation exposures to contaminants volatilized from household water. *Journal of Exposure Analysis and Environmental Epidemiology*, 6(4): 393-412.
- Kovacs, D.C., M.J. Small, C.I. Davidson and B. Fischhoff. 1997. Behavioral factors affecting exposure potential for household cleaning products. *Journal of Exposure Analysis and Environmental Epidemiology*, 7(4): 505-520.
- Small, M.J. 1997. Groundwater detection monitoring using combined information from multiple constituents. *Water Resources Research*, 33(5): 957-969.
- Small, M.J. 1997. Show me the data. *Journal of Industrial Ecology*, 1(4), 9-12. Invited column on Systems Modeling and the Environment.
- Amekudzi, A., P. Fischbeck, J. Garrett, Jr., H. Koutsopoulos, S. McNeil and M. Small. 1998. Computer tools to facilitate brownfield development. *Public Works Management & Policy*, 2(3): 231-242.
- Gross, L.J. and Small, M.J. 1998. River and floodplain process simulation for subsurface characterization. *Water Resources Research*, 34(9): 2365-2376.
- Sinha, R., M.J. Small, P.F. Ryan, T.J. Sullivan and B.J. Cosby. 1998. Reduced-form modelling of surface water and soil chemistry for the tracking and analysis framework. *Water, Air and Soil Pollution*, 105: 617-642.
- Stiber, N.A., M.J. Small and P.S. Fischbeck. 1998. The relationship between historic industrial site use and environmental contamination. *J. Air & Waste Management Association*, 48: 809-818.
- Fischhoff, B., D. Riley, D.C. Kovacs and M. Small. 1998. What information belongs in a warning? *Psychology and Marketing*, 15(7): 663-686.
- Diwekar, U. and M.J. Small. 1998. Industrial ecology and process optimization. *Journal of Industrial Ecology*, 2(3), 11-13. Invited column on Systems Modeling and the Environment.
- Sohn, M.D. and M.J. Small. 1999. Parameter estimation of unknown air exchange rates and effective mixing volumes from tracer gas measurements for complex multi-zone indoor air models. *Building and Environment*, 34: 293-303.
- Small, M.J. and P.S. Fischbeck. 1999. False precision in Bayesian updating with incomplete models. *Human and Ecological Risk Assessment*, 5(2): 291-304.
- Stiber, N.A., M. Pantazidou and M.J. Small. 1999. Expert system methodology for evaluating reductive dechlorination at TCE sites. *Environmental Science & Technology*, 33(17): 3012-3020.

Farrow, R.S., C.B. Goldberg and M.J. Small. 2000. Economic valuation and the environment: A special issue. *Environmental Science & Technology*, 34(8): 1381-1383.

Fischhoff, B. and M.J. Small. 2000. Human behavior in industrial ecology modeling. *Journal of Industrial Ecology*, 3(2&3): 4-7. Invited column on Systems Modeling and the Environment.

Casman, E.A., B. Fischhoff, C. Palmgren, M.J. Small and F. Wu. 2000. An integrated risk model of a drinking-water-borne cryptosporidiosis outbreak. *Risk Analysis*, 20(4): 495-511.

Sohn, M.D., M.J. Small and M. Pantazidou. 2000. Reducing uncertainty in groundwater site characterization using Bayes Monte Carlo methods. *Journal of Environmental Engineering*, 126(10): 893-902.

Riley, D.M., M.J. Small and B. Fischhoff. 2000. Modeling methylene chloride exposure-reduction options for home paint-stripper users. *Journal of Exposure Analysis and Environmental Epidemiology*, 10 (3): 240-250.

West, J.J., M.J. Small and H. Dowlatabadi. 2001. Storms, investor decisions, and the economic impacts of sea level rise. *Climatic Change*, 48: 317-342.

Matthews, H.S. and M.J. Small. 2001. Extending the boundaries of life-cycle assessment through environmental economic input-output models. *Journal of Industrial Ecology*, 4(3): 7-10. Invited column on Systems Modeling and the Environment.

Riley, D.M., B. Fischhoff, M.J. Small and P. Fischbeck. 2001. Evaluating the effectiveness of risk-reduction strategies for consumer chemical products. *Risk Analysis*, 21, 357-369.

Casman, E., B. Fischhoff, M. Small, H. Dowlatabadi, J. Rose and M. G. Morgan. 2001. Climate change and cryptosporidiosis: A qualitative analysis. *Climatic Change*, 50: 219-249.

Kovacs, D.C., B. Fischhoff and M.J. Small. 2001. Perceptions of PCE use by dry cleaners and dry cleaning customers. *Journal of Risk Research*, 4(4): 353-375.

Gurian, P.L., M.J. Small, J.R. Lockwood III and M.J. Schervish. 2001. Benefit-cost estimation for alternative drinking water maximum contaminant levels. *Water Resources Research*, 37(9): 2213-2226.

Gurian, P.L., M.J. Small, J.R. Lockwood III and M.J. Schervish. 2001. Addressing uncertainty and conflicting cost estimates in revising the arsenic MCL. *Environmental Science & Technology*, 35(22): 4414-4420.

Lockwood, J.R., M.J. Schervish, P. Gurian and M.J. Small. 2001. Characterization of arsenic occurrence in source waters of US community water systems. *Journal of the American Statistical Association*, 96(456): 1184-1193.

Gurian, P.L. and M.J. Small. 2002. Point-of-use treatment and the revised arsenic MCL. *Journal American Water Works Association*, 94(3): 101-108.

Reichert, P., M. Schervish and M.J. Small. 2002. An efficient sampling technique for Bayesian inference with computationally demanding models. *Technometrics*, 44(4): 318-327.

Axtell, R.L., C.J. Andrews and M.J. Small. 2002. Agent-based modeling and industrial ecology. *Journal of Industrial Ecology*, 5(4): 10-13. Invited column on Systems Modeling and the Environment.

DeKay, M.L., M.J. Small, P.S. Fischbeck, R.S. Farrow, A. Cullen, J.B. Kadane, L. Lave, M.G. Morgan and K. Takemura. 2002. Risk-based decision analysis in support of precautionary policies. *Journal of Risk Research*, 5(4): 391-417.

Yeh, S. and M.J. Small. 2002. Incorporating exposure models in probabilistic assessment of the risks of premature mortality from particulate matter. *Journal of Exposure Analysis and Environmental Epidemiology*, 12(6): 389-403.

Mihelcic, J.R., J.C. Crittenden, M.J. Small, D.R. Shonnard, D.R. Hokanson, Q. Zhang, H. Chen, S.A. Sorby, V.U. James, J.W. Sutherland and J.L. Schnoor. 2003. Sustainability science and engineering: The emergence of a new metadiscipline. *Environmental Science & Technology*, 37(23): 5314-5324.

Frey, H.C. and M.J. Small. 2003. Integrated environmental assessment, Part 1: Estimating emissions. *Journal of Industrial Ecology*, 7(1): 9-11.

Ailamaki, A., C Faloutsos, P.S. Fischbeck, M.J. Small, J. VanBriesen. 2003. An environmental sensor network to determine drinking water quality and security. *SIGMOD Record*, 32(4): 47-52.

Schultz, M.T., M.J. Small, R.S. Farrow and P.S. Fischbeck. 2004 State water pollution control policy insights from a reduced-form model. *Journal of Water Resources Planning and Management*, 130(2): 150-159.

Stiber, N.A., M. Pantazidou and M.J. Small. 2004. Embedding expert knowledge in a decision model: Evaluating natural attenuation at TCE sites. *Journal of Hazardous Materials*, 110(1-3): 151-160.

Gurian, P.L, M.J. Small, J.R. Lockwood and M.J. Schervish. 2004. Benefit-cost implications of multicontaminant drinking water standards. *Journal American Water Works Association*, 96(3): 70-83.

Lockwood, J.R., M.J. Schervish, P. Gurian and M.J. Small. 2004. Analysis of contaminant co-occurrence in community water systems. *Journal of the American Statistical Association*, 99(465): 45-56.

Boccelli, D.L., M.J. Small and U.M. Diwekar. 2004. Treatment plant design for particulate removal: Effects of flow rate and particle characteristics. *Journal of American Water Works Association*, 96(11): 77-90.

Karcher, S.C., M.J. Small and J.M. VanBriesen. 2004. Statistical method to evaluate the occurrence of PCB transformations in river sediments with application to Hudson River data. *Environmental Science & Technology*, 38(24): 6760 -6766.

Krayer von Krauss, M.P., E.A. Casman and M.J. Small. 2004. Elicitation of expert judgments of uncertainty in the risk assessment of herbicide tolerant oilseed crops. *Risk Analysis*, 24(6): 1515-1527.

Stiber, N.A., M.J. Small and M. Pantazidou. 2004. Site-specific updating and aggregation of Bayesian Belief Network models for multiple experts. *Risk Analysis*, 24(6): 1529-1538.

Ramaswami, A., J.B. Milford and M.J. Small. 2004. Integrated environmental assessment, Part II: Modeling fate and transport. *Journal of Industrial Ecology*, 8(3): 11-13.

- Goyal, A., M.J. Small, K. von Stackelberg, D. Burmistrov and N. Jones. 2005. Estimation of fugitive lead emission rates from secondary lead facilities using hierarchical Bayesian models. *Environmental Science & Technology*, 39(13): 4929-4937.
- Boccelli, D. L.; Small, M. J.; Dzombak, D. A. 2005. Enhanced coagulation for satisfying the arsenic maximum contaminant level under variable and uncertain conditions. *Environmental Science & Technology*, 39(17): 6501-6507.
- MacDonald, J. and M.J. Small. 2005. Assessing sites contaminated with unexploded ordnance: Statistical modeling of ordnance spatial distribution. *Environmental Science & Technology*, 40(3): 931-938.
- Weber, C.L., J.M. VanBriesen and M.J. Small. 2006. A stochastic regression approach to analyzing thermodynamic uncertainty in chemical speciation models. *Environmental Science & Technology*, 40(12): 3872-3878.
- Boccelli, D., M.J. Small and D.A. Dzombak. 2006. Effects of water quality and model structure on arsenic removal simulation: An optimization study. *Environmental Engineering Science*, 23(5): 835-850.
- Schultz, M.T., M.J. Small, P.S. Fischbeck and R.S. Farrow. 2006. Evaluating response surface designs for uncertainty analysis and prescriptive applications of a large-scale water quality model. *Environmental Modeling and Assessment*, 11(4):345-359.
- Bushey, J.T., M.J. Small, D.A. Dzombak and S.D. Ebbs. 2006. Parameter estimation of a plant uptake model for cyanide: Application to hydroponic data. *International Journal of Phytoremediation*. 8(1): 45-62.
- McKone, T.E. and M.J. Small. 2007. Integrated environmental assessment, Part III: Exposure assessment. *Journal of Industrial Ecology*, 11(1): 4-7.
- Karcher, S.C., J.M. VanBriesen and M.J. Small. 2007. Numerical method to elucidate likely target positions of chlorine removal in anaerobic sediments undergoing polychlorinated biphenyl dechlorination. *Journal of Environmental Engineering*. 133(3): 278-286.
- Boccelli, D., M.J. Small and U. Diwekar. 2007. Drinking water treatment plant design incorporating variability and uncertainty. *Journal of Environmental Engineering*, 133(3): 303-312.
- Higgins, C.J., H.S. Matthews, C.T. Hendrickson and M.J. Small. 2007. Lead demand of future vehicle technologies. *Transportation Research Part D: Transport and Environment*, 12(2): 103-114.
- Gilau, A.M., R. Van Buskirk and M.J. Small. 2007. Enabling optimal energy options under the Clean Development Mechanism. *Energy Policy*, 35(11): 5526-5534.
- Gilau, A.M. and M.J. Small. 2008. Designing cost-effective seawater reverse osmosis under optimal energy options. *Renewable Energy*. 33(4): 617-630.
- Xu, J., P.S. Fischbeck, M.J. Small, J.M. VanBriesen and E. Casman. 2008. Identifying sets of key nodes for placing sensors in dynamic water distribution networks. *Journal of Water Resources Planning and Management*, 134(4): 378-385.

- Ryker, S.J. and M.J. Small. 2008. Combining occurrence and toxicity information to identify priorities for drinking-water mixture research. *Risk Analysis*, 28(3): 653-666.
- Choi, T., M. J. Schervish, K. A. Schmitt and M. J. Small. 2008. A Bayesian approach to a logistic regression model with incomplete information. *Biometrics*, 64(2): 424-430.
- Brusick, D., M.J. Small, E.L. Cavalieri, D. Chakravarti, X. Ding, D.G. Longfellow, J. Nakamura, E.C. Rogan and J.A. Swenberg. 2008. Possible genotoxic modes of action for naphthalene. *Regulatory Toxicology and Pharmacology*, 51(2), Supplement 1(Naphthalene State of Science Symposium): 43-50.
- MacDonald, J., M.J. Small and M.G. Morgan. 2008. Explosion probability of unexploded ordnance: Expert beliefs. *Risk Analysis*, 28(4): 825-841.
- Small, M.J. 2008. Methods for assessing uncertainty in fundamental assumptions and associated models for cancer risk assessment. *Risk Analysis*, 28(5): 1289-1307.
- Ostfeld, A., J.G. Uber, E. Salomons, J.W. Berry, W.E. Hart, C.A. Phillips, J-P. Watson, G. Dorini, P. Jonkergouw, Z. Kapelan, F. di Pierro, S-T. Khu, D. Savic, D. Eliades, M. Polycarpou, S.R. Ghimire, B.D. Barkdoll, R. Gueli; J.J. Huang, E.A. McBean, W. James; A. Krause, J. Leskovec, S. Isovitsch, J. Xu, C. Guestrin, J. VanBriesen, M. Small, P. Fischbeck, A. Preis, M. Propato, O. Piller, G.B. Trachtman, Z.Y. Wu and T. Walski. 2008. The Battle of the Water Sensor Networks (BWSN): A design challenge for engineers and algorithms. *Journal of Water Resources Planning and Management*, 134(6): 556-568.
- MacDonald, J. and M.J. Small. 2009. Statistical analysis of metallic anomaly patterns at former Air Force bombing ranges. *Stochastic Environmental Research and Risk Assessment*, 23(2): 203-214.
- MacDonald, J., M.J. Small and M.G. Morgan. 2009. Quantifying the risks of unexploded ordnance at closed military bases. *Environmental Science & Technology*, 43(2): 259-265.
- Green, S.T., M.J. Small and E.A. Casman. 2009. Determinants of national diarrheal disease burden. *Environmental Science & Technology*, 43(4): 993-999.
- Attari, S., M. Schoen, C. Davidson, M.L. DeKay, W. Bruine de Bruin, R. Dawes, and M. Small. 2009. Preferences for change: Do individuals prefer voluntary actions, soft regulations, or hard regulations to decrease fossil fuel consumption? *Ecological Economics*, 68: 1701-1710.
- Francis, R.A., M.J. Small and J.M. VanBriesen. 2009. Multivariate distributions of disinfection by-products in chlorinated drinking water. *Water Research*, 43(14): 3453-3468.
- Xu, J., M.P. Johnson, P.S. Fischbeck, M.J. Small and J.M. VanBriesen. 2009. Robust placement of sensors in dynamic water distribution systems. *European Journal of Operational Research*, 202(2010): 707-716.
- Logue, J.M., M.J. Small and A.L. Robinson. 2009. Identifying priority pollutant sources: Apportioning air toxics risks using positive matrix factorization. *Environmental Science & Technology*, 43(24): 9439-9444.

- Francis, R.A., J.M. VanBriesen and M.J. Small. 2010. Bayesian statistical modeling of disinfection byproduct (DBP) bromine incorporation in the Information Collection Rule (ICR) database. *Environmental Science and Technology*, 44(4): 1232–1239.
- Schoen, M.E., M.J. Small and J.M. VanBriesen. 2010. Bayesian model for flow-class dependent distribution of fecal-indicator bacterial concentrations in surface waters. *Water Research*, 44(3): 1006–1016.
- Logue, J.M., M.J. Small, D. Stern, J. Maranche and A.L. Robinson. 2010. Spatial variation in ambient air toxics concentrations and health risks between industrial-influenced, urban, and rural sites. *Journal of the Air & Waste Management Association*, 60(3): 271–286.
- Hughes, A., J.M. VanBriesen and M.J. Small. 2010. Identification of structural properties associated with polychlorinated biphenyl dechlorination processes. *Environmental Science & Technology*, 4(8): 2842–2848.
- Rehr, A.P., M.J. Small, H.S. Matthews and C.T. Hendrickson. 2010. Economic sources and spatial distribution of airborne chromium risks in the U.S. *Environmental Science & Technology*, 44(6): 2131–2137.
- Jolliet, O., M.J. Small. 2010. Integrated environmental assessment, Part IV: Human health risk assessment. *Journal of Industrial Ecology*, 14(2): 188–191.
- Xu, J., M. Small, P. Fischbeck and J. VanBriesen. 2010. Integrating location models with Bayesian analysis to inform decision making. *Journal of Water Resources Planning and Management*, 136(2): 209–216.
- Choi, T., M. J. Schervish, K. A. Schmitt and M. J. Small. 2010. Bayesian hierarchical analysis for multiple health endpoints in a toxicity study. *Journal of Agricultural, Biological, and Environmental Statistics*, 15(3): 290–307.
- Logue, J.M., M.J. Small and A.L. Robinson. 2011. Evaluating the national air toxics assessment (NATA): Comparison of predicted and measured air toxics concentrations, risks, and sources in Pittsburgh, Pennsylvania. *Atmospheric Environment*, 45: 476–484.
- Yang, Y-M., M.J. Small, B. Junker, G.S. Bromhal, B. Strazisar, A. Wells. 2011. Bayesian hierarchical models for soil CO<sub>2</sub> flux and leak detection at geologic sequestration sites. *Environmental Earth Sciences*, 64(3): 787–798.
- Shao, K. and M.J. Small. 2011. Potential uncertainty reduction in model-averaged benchmark dose estimates informed by an additional dose study. *Risk Analysis*, 31(10): 1561–1575.
- Goodman A., A. Hakala, G. Bromhal, D. Deel, T. Rodosta, S. Frailey, M. Small, D. Allen, V. Romanov, J. Fazio, N. Huerta, D. McIntyre, B. Kutchko, G. Guthrie. 2011. U.S. DOE methodology for development of geologic storage potential for carbon dioxide at the national and regional scale. *International Journal of Greenhouse Gas Control*, 5(4): 952–965.
- Yang Y-M., M.J. Small, E.O., Ogretim, D.O. Gray, G.S. Bromhal, B.R. Strazisar, A.W. Wells. 2011. Probabilistic design of a near-surface CO<sub>2</sub> leak detection system. *Environmental Science & Technology*, 45(15): 6380–6387.

Tokdar, S., I. Grossmann, J. Kadane, A. Charest and M. Small. 2011. Impact of beliefs about Atlantic tropical cyclone detection on conclusions about trends in tropical cyclone numbers. *Bayesian Analysis*, 6(4): 1-22. (<http://ba.stat.cmu.edu/journal/forthcoming/tokdar.pdf>)

Bakshi, B. and M.J. Small. 2011. Incorporating ecosystem services into life cycle assessment. *Journal of Industrial Ecology*, 15: 477–478.

**Current Submissions:**

Shao, K. and M.J. Small. 2011. A statistical evaluation of toxicological experiment design for the Bayesian model averaged benchmark dose estimation in dichotomous data. *Human and Ecological Risk Assessment*, accepted for publication.

Rose, S., P. Jaramillo, M.J. Small, I. Grossmann and J. Apt. 2011. Quantifying the hurricane risk to offshore wind turbines. *Proceedings of the National Academy of Sciences*, accepted for publication.

**Edited or Reviewed Conference Proceedings and Book Chapters**

Small, M.J. and P.J. Samson. 1982. Mathematical simulation of Lagrangian precipitation and associated sulfur wet deposition. Proceedings of Specialty Conference on Atmospheric Deposition, Detroit, MI, November 7-10, 1982, *Air Pollution Control Association*, Pittsburgh, PA., pp. 273-285.

Samson, P.J. and M.J. Small. 1984. Atmospheric trajectory models for diagnosing the sources of acid precipitation. *Acid Precipitation, Vol. 9: Modeling of Total Acid Precipitation Impacts*, Ed. J.L. Schnoor, Ann Arbor Science, Butterworth Publishers, Boston, 1-23.

Keeler, G.J., P.J. Samson and M.J. Small. 1984. Representativeness of precipitation data in regional-scale acid deposition modeling. Proceedings of Specialty Conference on Meteorology of Acid Deposition, Hartford, CT, *Air Pollution Control Association*, Pittsburgh, PA, 225-240.

Small, M.J., M.C. Sutton and P.A. Labieniec. 1987. Modelling distributions of aquatic chemistry in regions impacted by acid deposition. *Systems Analysis in Water Quality* Ed. M.B. Beck, Pergamon Press, Oxford, England, 161-172.

"Probability Distributions and Statistical Evaluation," Chapter by M.J. Small and M. Henrion in *UNCERTAINTY: A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis*, by M.G. Morgan and M. Henrion, Cambridge University Press, 1990.

Labieniec, P.A., M.J. Small and B.J. Cosby. 1989. Regional distributions of lake chemistry predicted by mechanistic and empirical lake acidification models in *Regional Acidification Models: Geographic Extent and Time Development*, eds. J. Kamari, D.F. Brakke, A. Jenkins, S.A. Norton, R.F. Wright. Springer-Verlag, Berlin, 185-201.

Small, M.J., 1989. Regional distributions of water quality derived as averages of spatial random processes. In *Regional Characterization of Water Quality*, ed. S. Ragone. IAHS Publ. No. 182, International Association of Hydrologic Sciences, Wallingford, Oxfordshire, England, 3-10.

- Milke, M.W. and M.J. Small, 1989. A Modelling approach for estimating long-term and seasonal CaCO<sub>3</sub> dissolution rates. In *Water-Rock Interaction*, WRI-6, ed. D.L. Miles, Balkema, Rotterdam, Netherlands, 487-490.
- Small, M.J., P.A. Labieniec and M.C. Sutton. 1990. Identification of a direct distribution model from a regionalized mechanistic model of aquatic acidification. *Impact Models to Assess Regional Acidification*, Ed. J. Kamari, Kluwer Academic, Dordrecht, The Netherlands, 167-181.
- Rubin, E.S., M.J. Small, C.N. Boyd, R.J. Marnicio and M. Henrion, 1990. Atmospheric Deposition Assessment Model: Applications to regional aquatic acidification in eastern North America. *Impact Models to Assess Regional Acidification*, Ed. J. Kamari, Kluwer Academic, Dordrecht, The Netherlands, 253-284.
- Patwardhan, A. and M.J. Small. 1990. Bayesian framework for model structure uncertainty: Application to sea-level response to changing global CO<sub>2</sub> in *Risk Based Decision Making in Water Resources III*, ed. Y. Haimes, Engineering Foundation and ASCE.
- Small, M.J., 1990. "Parametric Distributions," Two sections of *Historical Changes in Surface Water Acid-Base Chemistry in Response to Acidic Deposition*, NAPAP State of Science/Technology Report No. 11, T.J. Sullivan, National Acid Precipitation Assessment Program, Washington, D.C., 77-81, 102-107.
- Small, M.J., 1992. Integrated assessment of environmental risk and human response. *Proceedings of Risk Based Decision Making in Water Resources V*. Y. Haimes and E. Stakhiv (eds), Engineering Foundation and ASCE, New York, 78-91.
- Small, M.J. and M.D. Escobar. 1993. Discussion of "Bayesian decision support using environment transport-and-fate models," by Wolpert et.al., in *Case Studies in Bayesian Statistics*, Gatsonis et al., eds., Springer-Verlag, New York, 271-286.
- National Research Council. 1994. *Ranking Hazardous-Waste Sites for Remedial Action*. Committee on Remedial Action Priorities for Hazardous Waste Sites. National Academy Press, Washington, DC. (Principal author for Ch 4, EPA's Priority Setting, Contributor Chs 2 &3)
- Small, M.J. 1994. Invariably uncertain about variability? Try the normal-gamma conjugate! *Proceedings of Air & Waste Management Association 87th Annual Meeting & Exhibition*, June 19-24, Cincinnati, Ohio, Paper 94-TP55.05.
- Wolfson, L.J., J.B. Kadane and M.J. Small. 1996. Expected utility as a policy-making tool: An environmental health example. in *Bayesian Biostatistics*, D.A. Berry and D.K. Stangl, eds., Marcel Dekker, Inc., New York, pp. 261-277.
- National Research Council. 1996. *Hazardous Materials in the Hydrologic Environment*. Committee on U.S. Geological Survey Water Resources Research. National Academy Press, Washington, DC. (Principal co-author for Ch 5, Mathematical Models and Decision Support)
- Stern, P.C. and H.V. Fineberg, eds. (also National Research Council). 1996. *Understanding Risk: Informing Decisions in a Democratic Society*. Committee on Risk Characterization. National Academy Press, Washington, DC. (Principal author of section on The Analysis of Uncertainty in Ch 3, Analysis, co-author for other sections of Ch 3, and principal author for Appendix A Case

Study on Approval of the Waste Technologies, Inc. Incinerator at East Liverpool, Ohio.)

- Wolfson, L.J., J.B. Kadane and M.J. Small. 1997. A subjective Bayesian approach to environmental sampling. in *Case Studies in Bayesian Statistics, Volume III*, C. Gatsonis, J.S. Hodges, R.E. Kass, R. McCulloch, P. Rossi, N.D. Singpurwalla, eds., Springer-Verlag (Lecture Notes in Statistics, 121), New York, pp. 457-468.
- Stiber, N.A., M. Pantazidou, M.J. Small. 1998. An expert system to evaluate TCE sites for natural attenuation. In *Natural Attenuation, Chlorinated and Recalcitrant Compounds*, Proceedings of The First International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, California, May 18-21, 1998, G.B. Wickramanayake and R.E. Hinchee, eds., Battelle Press, Columbus, Ohio, pp. 199-204.
- Schultz, M.S. and M.J. Small. 2001. Integrating performance in design of a water pollution trading program, in *Improving Regulation: Cases in Environment, Health, and Safety*. P. Fischbeck and S. Farrow (eds.), Resources for the Future (RFF) Press, Washington, DC. pp. 380-404.
- Riley, D.M. , B. Fischhoff, M.J. Small and P.S. Fischbeck. 2001. Behaviorally realistic regulation. in *Improving Regulation: Cases in Environment, Health, and Safety*. P. Fischbeck and S. Farrow eds.), Resources for the Future (RFF) Press, Washington, DC. pp. 145-165.
- Diwekar U. and M.J. Small. 2002. Process analysis approach to industrial ecology, Chapter 11 in *A Handbook of Industrial Ecology*, R.U. Ayres and L.W. Ayres, eds., Edward Elgar Ltd, Cheltenham, UK, pp. 114-137.
- Stiber, N.A., M. Pantazidou, M.J. Small. 2002. Developing an expert-knowledge scoring system for evaluating reductive dechlorination at TCE sites. Proceedings of the 4<sup>th</sup> International Congress on Environmental Geotechnics, Volume 1. eds. L Guilherme de Mello, M. Almeida. Rio de Janeiro, Brazil, Balkema Publishers, Lisse.
- Cullen, A. and M.J. Small. 2004. Uncertain risks: The role and limits of quantitative analysis. In *Risk Analysis and Society: An Interdisciplinary Characterization of the Field*, eds. T. McDaniels and M. Small, Cambridge University Press, Cambridge, UK.
- Bier, V.M., Y.Y. Haimes, J.H. Lambert, S. Ferson and M.J. Small. 2004. Quantifying risk of extreme/rare events: Lessons from a selection of approaches. In *Risk Analysis and Society: An Interdisciplinary Characterization of the Field*, eds. T. McDaniels and M. Small, Cambridge University Press, Cambridge, UK.
- Small, M.J. 2004. The value of information for conflict resolution. in Linkov, I. and Ramadan, A. eds., *Comparative Risk Assessment and Environmental Decision Making*. Kluwer Academic Publishers, Dordrecht, pp. 171-194.
- Yeh, S. and M.J. Small. 2006. Statistical models for distributions of ambient fine particulate matter. In B. Morel and I. Linkov, eds., *Environmental Security and Environmental Management: Role of Risk Assessment*. Springer, Netherlands, pp. 127-150.

Xu, J., J.M. VanBriesen, M.J. Small, P.S. Fischbeck. 2009. Decision making under information constraints. *World Environmental and Water Resources Congress 2009*, American Society of Civil Engineers.

CCSP. 2009. *Best Practice Approaches for Characterizing, Communicating, and Incorporating Scientific Uncertainty in Decisionmaking*. M.G. Morgan (lead author), H. Dowlatabadi, M. Henrion, D. Keith, R. Lempert, S. McBride, M. Small and T. Wilbanks (contributing authors). A Report by the Climate Change Science program and the Subcommittee on Global Change Research. National Oceanic and Atmospheric Administration, Washington, DC, 96 pp.

### **Other Papers, Reports and Conference Proceedings**

Small, M.J. 1974. Land use control as means of flash flood protection, *Carnegie Technical*, 39: No.1.

Small, M.J. and W.P. Darby. 1974. Management of urban watersheds: The potential impact of regulatory action, Allegheny County Health Department, Division of Water Quality, Pittsburgh, PA, 172 pp.

Hydroscience, Inc. 1976. 208 Areawide assessment procedures manual, vol. 1, Ch. 2-5, U.S. Environmental Protection Agency, EPA-600/9-76-014.

Hydroscience, Inc. 1976. Water quality management planning methodology for urban and industrial stormwater needs, Texas Water Quality Board, Arlington, TX.

Hydroscience, Inc. 1976. Water quality management planning methodology for hydrographic modification activities, Texas Water Quality Board, Arlington, TX.

Hydroscience, Inc. 1978. Rainfall-runoff and statistical receiving water models. New York City 208 Task Report (PCP Task 225), 271 pp.

Driscoll, E.D., M.J. Small, J. Heany and W. Huber. 1978. Review of "An assessment of urban stormwater in the Delaware Valley". U.S. Environmental Protection Agency, Region III, Philadelphia, PA, 22 pp.

Small, M.J. 1978. Nationwide estimate of wind induced reaeration. Hydroscience, Inc. Research and Development Report 78-125, HYDRTB-21, Westwood, N.J.

Hydroscience, Inc. 1979. A statistical method for assessment of urban stormwater loads-impacts-controls. U.S. Environmental Protection Agency, EPA-440/3-79-023, 377 pp.

Samson P.J., B.T. Berlyand, M.J. Small, and L. Husain. 1982. Comparison of daily SO<sub>2</sub> concentrations at Whiteface Mountain with estimated upwind SO<sub>2</sub> emissions. Preprints of 2nd Symposium on Composition of the Nonurban Troposphere, Williamsburg, VA, May 25-28, 1982, *Amer. Meteor. Soc.*, Boston, 222-225.

- Carnegie-Mellon University. 1984. A conceptual framework for integrated assessments of the acid deposition problem. C-MU Center for Energy and Environmental Studies for the U.S. Environmental Protection Agency, 231 pp.
- Rhue, L.G. and M.J. Small. 1984. Low-flow assessment model for the Monongahela River Basin. Final Report to the Pennsylvania Department of Environmental Resources, Bureau of Water Resources Management, Department of Civil Engineering, C-MU, 150 pp.
- Small, M.J. and J.R. Mular. 1984. Methodology for assessing the persistence of groundwater contamination in the unsaturated zone. Final Report to Pennsylvania Office of Hazardous and Toxic Waste Management, Department of Civil Engineering, C-MU, 129 pp.
- Small, M.J. and J.R. Mular. 1984. Groundwater aquifer protection with meteorological and geochemical uncertainty. Proceedings of the Annual Meeting of the Society for Risk Analysis, Knoxville, TN.
- Gilman, W.P. and M.J. Small. 1985. Storm sewer computer aided design and uncertainty. Proceedings of ASCE Conference on Computer Applications in Water Resources, Buffalo, NY, 845-854.
- Small, M.J. and J.R. Mular. 1985. Uncertainty in unsaturated zone pollutant transport. Proceedings of ASCE Annual Conference on Environmental Engineering, Boston, MA, 911-918.
- Small, M.J. and E.S. Rubin. 1985. Integrated assessment of the acid deposition problem. Proceedings of ASCE Annual Conference on Environmental Engineering, Boston, MA, 825-831.
- Marnicio, R.J., E.S. Rubin, M. Henrion, M.J. Small, G. J. McRae and L.B. Lave. 1985. A comprehensive modeling framework for integrated assessments of acid deposition. Proceedings of 78th Annual meeting of the Air Pollution Control Association, Paper 85-1B.2, Detroit, MI.
- Rubin, E.S., R.J. Marnicio, M.J. Small and M. Henrion. 1985. Integrated assessments of acid deposition in the U.S.A. Proceedings of International Workshop on Regional Resource Management, Albena, Bulgaria.
- Marnicio, R.J., E.S. Rubin, M.J. Small and M. Henrion. 1986. The Acid Deposition Assessment Model: An integrated framework for benefit and cost analysis. Proceedings of the 7th World Clean Air Congress and Exhibition, Sydney, Australia. August, 1986.
- Small, M.J. and N.L. Chicowicz. 1986. Risk-based design of inspection programs for detecting leaky underground storage tanks. Proceedings of ASCE Annual Conference on Environmental Engineering, Cincinnati, OH, 372-379.
- Ayres, R.U., L.W. Ayres, J. McCurley, M.J. Small, J.A. Tarr and R.C. Widgery. 1985. An historical reconstruction of major pollutant levels in the Hudson-Raritan Basin 1880-1980, Vol. I-III. Variflex Corp. for Martin Marietta Environmental Systems and National Oceanic and Atmospheric Administration, Variflex, Pittsburgh, PA.

- Small, M.J. 1985. Predictions for a variable environment. CIT Engineering News, 5(1): 18-19.
- Small, M.J. and B.A. Kravitz. 1986. Relationship between historical air pollution and tree growth in Pittsburgh, PA. Final Report to Charles A. Lindbergh Fund, Inc., 13 pp. & figures.
- Barton, D.J., Jr. and M.J. Small. 1986. Low flow analysis and conditional operating rule analysis for the Monongahela River Basin. Final Report to the Pennsylvania Department of Environmental Resources, Bureau of Water Resources Management, Department of Civil Engineering, CMU, 135 pp.+.
- Small, M.J. 1986. Ground water: protecting the hidden resource. Accent on Research, Carnegie Mellon University, October, 1986, 22.
- Small, M.J. and C.A. Peters. 1987. Quantitative framework for assessing indoor radon policy. Proceedings of ASCE Annual Conference on Environmental Engineering, Lake Buena Vista, Florida, 300-307.
- Bloyd, C.N., M.J. Small, M. Henrion and E.S. Rubin. 1988. The effects of uncertainty on the analysis of acid deposition. Proceedings of Annual Meeting of the Air Pollution Control Association, Paper 88-104.3, Dallas, TX.
- Environmental Engineering Committee, Science Advisory Board, U.S. Environmental Protection Agency. 1989. Resolution on the use of mathematical models by EPA for regulatory assessment and decision-making, SAB-EEC-89-012, January, 1989.
- Small, M.J. 1989. Decision making in the environment: Discussion of the paper by Talbot Page, In Fundamental Research Directions in Environmental Engineering, eds. R.G. Luthy and M.J. Small, Association of Environmental Engineering Professors, 152-154.
- Luthy, R.G. and M.J. Small, eds. 1989. Fundamental Research Directions in *Environmental Engineering*, Association of Environmental Engineering Professors, 164 pp.
- Milke, M.W. and M.J. Small, eds. Evaluation of the application of geochemical equilibrium programs to regulatory assessment. Submitted as EPA report, August, 1988.
- Andelman, J.B., N.J. Giardino, J. Marshall, J.E. Borrazzo, C.I. Davidson, M.J. Small and C. Wilkes. 1989. Exposure to volatile chemicals from indoor use of water. Proceedings of Symposium on Total Exposure Assessment Methodology, U.S. EPA and Air and Waste Management Association, Las Vegas, Nevada.
- Small, M.J., C.R. Wilkes, J.B. Andelman, N.J. Giardino and J. Marshall. 1990. Inhalation exposure from contaminated water uses: A behavioral model for people and pollutants. Proceedings of ASCE Annual Conference on Environmental Engineering, Washington, D.C., 764-771.
- Giardino, N.J., E. Gumerman, J.B. Andelman, C.R. Wilkes., and M.J. Small. 1990. Real-time air measurements of trichloroethylene in domestic bathrooms using contaminated water. Proceedings of 5th International Conference on Indoor Air Quality and Climate: Indoor Air '90, Toronto, Canada, Volume 2, 707-712.

- Levy, K.O. and M.J. Small. 1990. Characterization of indoor radon concentrations: Sampling bias and implications for risk assessment. Proceedings of 5th International Conference on Indoor Air Quality and Climate: Indoor Air '90, Toronto, Canada, Volume 3, 71-75.
- Wilkes, C.R., M.J. Small, J.B. Andelman, N.J. Giardino and J. Marshall. 1990. Air quality model of volatile constituents from indoor uses of water. Proceedings of 5th International Conference on Indoor Air Quality and climate: Indoor Air '90, Toronto, Canada, Volume 2, 783-788.
- Environmental Engineering Committee, U.S. EPA Science Advisory Board, Usage of computer models in the hazardous waste and Superfund programs, EPA-SAB-EEC-91-016, September, 1991. (Chair of Committee and principal author of report.)
- Shott, D. J., S.K. Gupta and M.J. Small. 1992. Impacts of a heterogeneous waste matrix on remediation technology evaluation. IT Technology Exchange Symposium, Scottsdale, Arizona, IT Corporation, Monroeville, Pennsylvania.
- Wilkes, C.R., M.J. Small, C.I. Davidson, J.B. Andelman and M.D. Pandian. 1993. A Human Activity - Indoor Air Quality Model for Predicting Inhalation Exposures to VOCs. Proceedings - The Sixth International Conference on Indoor Air Quality and Climate, Helsinki, Finland, Vol. 3, 409-414.
- Report of the Peer Review Committee for Multimedia Models for Use in the DOE Programmatic Environmental Impact Statement Risk Assessment. 1994. Prepared for the Department of Energy Office of Environmental Restoration and Waste Management, Oak Ridge, TN, April 4, 1994. (Chair of Committee and principal author of report.)
- Environmental Engineering Committee, U.S. EPA Science Advisory Board, Review of EPA's Composite Model for Leachate Migration with Transformation Products - EPACMTP, EPA-SAB-EEC-95-0xx, July, 1995. (Committee member and contributor to report)
- Radiation Advisory Committee, U.S. EPA Science Advisory Board, Review of radionuclide cleanup levels for soil, EPA-SAB-RAC-95-023, September, 1995. (Committee member and contributor to report)
- Sohn, M.D., G.S. Bromhal, M. Pantazidou, M.J. Small, A.P. Sanil and W.F. Eddy. 1997. Updating Uncertainty in Groundwater Contamination. Proceedings - The 24<sup>th</sup> Annual Water Resources Planning and Management Conference: American Society of Civil Engineers, Houston, TX, 346-351.
- Program Review of the National Center for Environmental Research and Quality Assurance (NCERQA), U.S. EPA Board of Scientific Counselors (BOSC), April 1998 (Chair of Committee and principal author of report).
- An SAB Advisory on the TRIM.FaTE Module of the Total Risk Integrated Methodology (TRIM), US EPA Science Advisory Board, Environmental Models Subcommittee, December 1998, EPA-SAB-EC-ADV-99-003 (Member of Committee, author of portions of report, assisted with final editing).
- Review of ORD/OSW Integrated Research and Development Plan for the Hazardous Waste Identification Rule (HWIR), M.J. Small, Submitted to EPA Office of Research and Development, December 3, 1998, (Signed individual report) 5 pp.

- Small, M., B. Fischhoff, E. Casman, C. Palmgren, and F. W. Morris, *Protocol for Cryptosporidium Risk Communication for Drinking Water Utilities*, Final Project Report, AWWA Research Foundation and American Water Works Association, 140 pp + Appendices.
- US EPA Science Advisory Board, *Advisory on the Agency's "Total Risk Integrated Methodology" (TRIM)*, SAB Environmental Model's Subcommittee, EPA-SAB-EC-ADV-00-004, May 2000. see <http://www.epa.gov/science1/ecadv04.pdf>. (Chair of committee and principal author of report)
- US EPA Board of Scientific Counselors, *Management Review of the EPA ORD Particulate Matter Research Program*, Draft Report, November 2000. (Chair of Atmospheric Sciences Subcommittee and author of this section of the report).
- Report on the Peer Review of the Risk Assessment Guidance for Superfund (RAGS) Volume 3A: Process for Conducting Probabilistic Assessment*, Eastern Research Group, Inc. for US EPA Office of Emergency and Remedial Response, EPA Contract, No. 68-C-98-148, Task Order No. 2001-01. January 12, 2000. (Participated in review and wrote sections of the report).
- U.S. EPA Science Advisory Board. 2001. *Recommendations on the FY2000 Scientific and Technological Achievement Award (STAA) Nominations: An SAB Report*. EPA-SAB-EC-01-007. (Participated in review and wrote sections of report).
- U.S. EPA Science Advisory Board. 2001. *NATA- Evaluating the National-Scale Air Toxics Assessment 1996 Data – An SAB Advisory*, U.S. EPA Science Advisory Board, EPA-SAB-EC-ADV-02-001, see: <http://www.epa.gov/sab/pdf/ecadv02001.pdf> (Chair of committee and principal author of report).
- U.S. EPA Board of Scientific Counselors. April, 2002. *BOSC Review of the ORD National Risk Management Research Laboratory (NRMRL)*. (Co-chair of committee and co-author of report).
- NRC. 2003. *Environmental Cleanup at Navy Facilities: Adaptive Site Management*. Report of Committee on Environmental Remediation at Naval Facilities, National Research Council, National Academies Press, Washington, DC. (Committee member and author of portions of report)
- Small, M.J. 2005. Values can alter views of science findings. One of four "The Forum" columns on "What is 'Sound Science'?" *The Environmental Forum*, 22(1): 42-43.
- Gilau, A.M. and M. J. Small. 2006. Designing Cost-Effective Sea Water Reverse Osmosis System under Optimal Energy Options for Developing Countries. Proceedings of International Conference on Renewable Energy for Developing Countries, ICREDC-06, April 6-7, 2006, Washington, DC, Session T2: Sustainable Renewable Energy Models, Evaluation and Analysis, Paper 1, 18 pp.
- U.S. EPA Science Advisory Board. 2006. *Review of the Agency's Draft Guidance on the Development, Evaluation, and Application of Regulatory Environmental Models and Models Knowledge Base*, Report of the Committee on Regulatory Environmental Modeling, U.S. EPA Science Advisory

Board, EPA-SAB-06-009, available at: [http://www.epa.gov/sab/pdf/sab\\_06\\_009.pdf](http://www.epa.gov/sab/pdf/sab_06_009.pdf) , (Member of committee and author of portions of the report).

NRC. 2006. *New Source Review for Stationary Sources of Air Pollution*. Report of Committee on Changes in New Source Review Programs for Stationary Sources of Air Pollutants, National Research Council, National Academies Press, Washington, DC (Committee member and author of portions of report).

Shortle, J., B. Nagle, eds. 2006. *Final Report of the Consortium for Atlantic Regional Assessment (CARA)*, Submitted to the US Environmental Protection Agency, Office of Research and Development, Cooperative Agreement # R-83053301, December 31, 2006.

This report was written by the multidisciplinary CARA team composed of faculty and students from the Pennsylvania State University, Carnegie Mellon University, the University of Rhode Island, Virginia Institute for Marine Sciences, Prescott College, and the University of Dayton, Cape May County Cooperative Extension, and the Wildlife Conservation Society's Adirondack Program. The CMU contribution was extracted from the CMU final report:

Casman, E., M. DeKay, P. Fischbeck, A. Gilau, A. Rehr, M. Schoen, M. Schultz, N. Shorr and M.J. Small. 2006. *Decision Tools and Tutorials for the Consortium for Atlantic Regional Assessment (CARA): Anticipating and Planning for Changes in Land Cover and Climate Regionally and Locally*, Final Report submitted by CMU study team to Penn State University for inclusion in main report.

The CMU report provides information and decision tools designed to enable citizens and decision makers to better understand the linkage between climate change, land-use change, and specific resources that they are concerned about and manage. The resource domains where significant research and tool development were achieved include: water resources; ecological resources; energy use; human health; and coastal storm impacts. CMU contributions are included as part of the principal deliverable from the CARA project, the CARA web site: <http://www.cara.psu.edu/> . See especially: <http://www.cara.psu.edu/tools/tools.asp> .

Brusick, D., E. Cavalieri, D. Chakravarti, X. Ding, D. Longfellow, J. Nakamura, E. Rogan, M. Small and J. Swenberg. 2007. *Module D: Key Questions and Studies Needed to Better Understand Possible Genotoxic Modes of Action for Naphthalene*. Summary of deliberations conducted as part of Module D at the Naphthalene State-of-the-Science Symposium (NS<sup>3</sup>), Monterey, CA, October 9-12, 2006 (Facilitator for group and editor of final report).

Small, M.J., A. Krupnick, D. Bain, R. Clark, S. Farrow, W. Freudenburg, C. Harris, R. Kasperson, T. Prudhomme and C. Shelly Norman. 2007. *Integrating Social Science Research into the WATERS Network*. Report of the WATERS Network Project Office Social Science Committee: <http://www.watersnet.org/docs/SocialSciencePlan.pdf> .

*Peer Consultation Panel Report on the DuPont – EPA Site Related Environmental Assessment Program for Perfluorooctanoic Acid and its Salts (PFOA)*. 2009. M.J. Small (Independent Third Party Administrator and Editor), J. Baker, K. Kurunthachalam, L.S. Lee, P. J. Lioy, S. A. Mabury, M. McLachlan, R.A. Schoof and T.B. Watson (contributing authors). Carnegie Mellon University, <http://itp-pfoa.ce.cmu.edu/> .

- U.S. EPA Science Advisory Board. 2010. *Review of EPA's Draft Expert Elicitation Task Force White Paper*, Report of the Expert Elicitation Advisory Panel, U.S. EPA Science Advisory Board, EPA-SAB-10-003, available at: [http://yosemite.epa.gov/sab/sabproduct.nsf/fedrgstr\\_activites/061D0E0A700B6D4F852576B20074C2E2/\\$File/EPA-SAB-10-003-unsigned.pdf](http://yosemite.epa.gov/sab/sabproduct.nsf/fedrgstr_activites/061D0E0A700B6D4F852576B20074C2E2/$File/EPA-SAB-10-003-unsigned.pdf) , (Member of committee and author of portions of the report).
- NRC. 2010. *Review of the Department of Homeland Security's Approach to Risk Analysis*. Report of Committee to Review the Department of Homeland Security's Approach to Risk Analysis, National Research Council, National Academies Press, Washington, DC (Committee member and author of portions of report).
- Rocks, S.A., S.J.T. Pollard, A. Angus, M.J. Small, P. Howsam and D. Goodman. 2010. Risk and responsibility: impact on policy making. Report of the Cranfield University Risk Centre to the UK Department for Business, Innovation and Skills (BIS), Cranfield, UK.