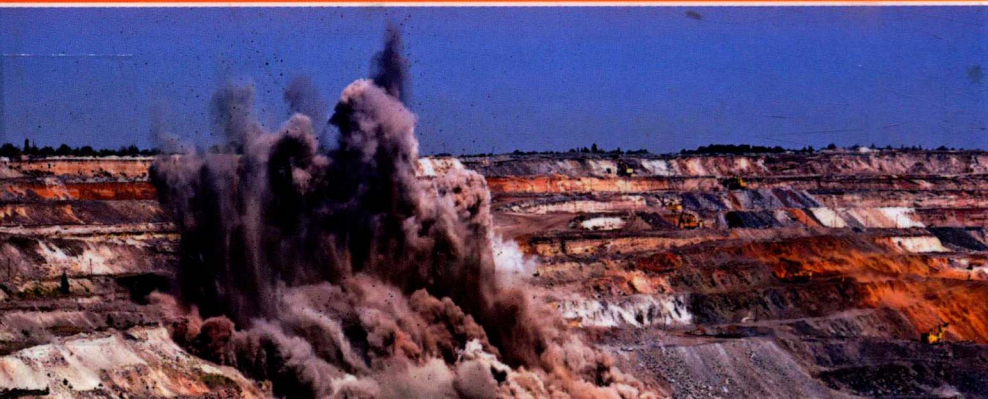


Wildlife Toxicity Assessments for Chemicals of Military Concern



Edited by Marc A. Williams, Gunda Reddy,
Michael J. Quinn, Jr., and Mark S. Johnson



WILDLIFE TOXICITY ASSESSMENTS FOR CHEMICALS OF MILITARY CONCERN

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EDITOR BIOGRAPHIES

Mark S. Johnson, PhD, DABT, is the Director of the Toxicology Portfolio, U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD. Dr. Johnson has worked extensively in the evaluation of the toxicity of military unique compounds and development and evaluation of sensitive indicators of stress (e.g., immunotoxicity) for use in field applications and toxicity testing. He has extensive experience in risk assessment and has developed and tested new methods in improving exposure/effects relationships. Current work involves the development of a phased approach to the gathering toxicity data for new compounds under development (ASTM E-2552). Other work has included the development of a process to derive toxicity reference values for terrestrial wildlife. He has authored over 50 peer-reviewed publications, book chapters, and technical reports. He has been a member of SETAC since 1997 and a member of SOT since 2009. Within SETAC, Dr. Johnson is a Steering Group Member of the Wildlife Toxicology World Advisory Group, Vice Chair of Ecological Risk Assessment World Advisory Group, and a member of the Science Committee for SETAC North America. He is also Chair of the Tri-Service Toxicology Consortium (TSTC); Steering Committee Chair of the Joint Army-Navy-NASA-Air Force (JANNAF) Propulsion Committee, Subcommittee on Safety and Environmental Protection; and the past Chair of the Terrestrial Toxicity Subcommittee of the Biological Fate and Effects Committee of the American Society for Testing and Materials (ASTM). He is the current Vice President of the American Board of Toxicology (ABT).



Michael J. Quinn, Jr., PhD, is the Program Manager of the Health Effects Research Program – Toxicology Portfolio, U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD. His early education at Fairleigh Dickinson University in Madison, NJ focused on Marine Biology, where he studied ichthyological and marine invertebrate behavior and physiology. Upon graduation, he completed an internship at the U.S. Geological Survey where he developed a Master's thesis at Shippensburg University, PA, on the effects of polychlorinated biphenyls on the development of falcon plumage. Dr. Quinn received a PhD in Animal Science at the University of Maryland, College Park, MD where he studied the effects of estrogen- and androgen-active endocrine disruptors on the functional development of the reproductive and immune systems in Japanese quail. In addition to contributing to many toxicology studies at the PHC with explosives and propellants in a variety of taxa (e.g., mammals, birds, reptiles, and amphibians), Dr. Quinn's primary passion is method development. His most recent research has centered on developing an avian two-generation toxicity test for the U.S. Environmental Protection Agency's Endocrine Disruptor Screening Program's Tier 2 battery of tests.



Gunda Reddy, PhD, DABT, is a Senior Toxicologist with the Toxicology Portfolio, U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD. He received his PhD from Osmania University, Hyderabad, India. After postdoctoral work, Dr. Reddy joined the U.S. Army Biomedical Research and Development Laboratory at Fort Detrick, MD as a Pharmacologist, and then the U.S. Army's Aberdeen Proving Ground, where he focuses on toxicity of munitions compounds and chemicals, toxic metabolites, and degradation products of chemical warfare agents using *in vivo* and *in vitro* model systems. He conducts in-house research, and manages extramural research projects with universities, government agencies, and private institutions. He reviews toxicity



data and performs risk assessments of Army-related chemicals. Dr. Reddy has published over 100 peer-reviewed publications and book chapters and has presented his work at national and international meetings. Dr. Reddy serves as an Associate Editor of *Drug and Chemical Toxicology Journal* and as a regular editor with the editorial boards of *International Journal of Toxicology*, *Journal of Toxicology and Environmental Health*, and *Toxicology Mechanisms and Methods*. He is recognized by the Army as a Master Consultant in his specialized field. Dr. Reddy is a member of the Society of Toxicology, the American College of Toxicology, the Association of Government Toxicologists, the Association of Scientists of Indian Origin in America, and the Indian Science Congress.

Marc A. Williams, PhD, FAAAAI, is a Biologist with the Toxicology Portfolio – Health Effects Research Program, U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD. Dr. Williams was previously a Research Biologist with the U.S. Environmental Protection Agency (U.S. EPA), with research interests in allergic asthma, and exposure to respirable ambient airborne particulate matter, and nanoparticulate pollutants that he showed were both pro-inflammatory and pro-oxidative instigators of allergic immunity. Prior to joining the U.S. EPA, Dr. Williams was an Assistant Professor of Medicine and Environmental Medicine at the University of Rochester School of Medicine and Dentistry, NY and an Instructor of Medicine at the Johns Hopkins University School of Medicine where he led research programs in human immunology, immunotoxicology, and disease pathways. Dr. Williams holds a PhD in Hematological Oncology and Immunobiology from Queen Mary – University of London, UK, where his group was one of the first to combine successfully adoptive dendritic and T cell-mediated immunotherapy in the treatment of a hematological malignancy. Dr. Williams did postdoctoral training in infectious disease and HIV-1 immunology at the University of California San Diego, La Jolla, CA, and in autoimmunity and immunological gene therapy at Johns Hopkins University, Baltimore, MD. He is a Fellow of the American Academy of Allergy, Asthma, and Immunology, and a nominated member of the Faculty of 1000 (Immunology Section) post-publication review panel with emphasis on allergy and immunotoxicology,



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AUTHOR BIOGRAPHIES

Valerie H. Adams, MS, PhD, is a Biologist in the Toxicology Portfolio – Health Effects Research Program, U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD. As an undergraduate at California State University Fresno she majored in Biology, minored in Chemistry, and worked as an intern at an agricultural research facility. During her master's program at University of Guam, she studied a predation-induced plant defense response, participated in coral reef field studies, and completed coursework in aquatic toxicology and environmental contaminants. Dr. Adams received a PhD in Cellular and Structural Biology from the University of Texas Health Sciences Center, San Antonio, TX where she studied the immune response to chlamydial infection using a mouse model. Dr. Adams completed postdoctoral research at Colorado State University in the field of chromatin biology and protein biochemistry. A prior recipient of NIH predoctoral and postdoctoral training grants, Dr. Adams has published over 30 peer-reviewed articles, abstracts, and technical reports. She is a member of the Society of Toxicology and has previously served as chair of the Triservice Environmental Risk Assessment Workgroup. She volunteers annually for the U.S. Army e-Cybermission as a science project judge and was selected as a 2014 National Junior Science and Humanities Symposium Judge. In her current position, Dr. Adams is the principle investigator for *in vivo* and *in vitro* toxicity studies and explores novel approaches for *in vitro* toxicity assessment.

Christine Ann Arenal, MS, is a Biologist and Ecological Risk Assessor with CH2M HILL, Inc. She earned her BA in Biology at Occidental College in Los Angeles, CA, where she was an instructor for the Classroom at Sea program aboard the college's research vessel R/V Vantuna. Following this teaching program, Ms. Arenal spent time tracking and studying grizzly bears with the Interagency Grizzly Bear Study Team, in Billings, MT. Ms. Arenal received an MS in Zoology at Southern Illinois University in Carbondale, where she conducted field studies to evaluate the reproductive and behavioral effects of polychlorinated biphenyls and metals on avian species. She also studied liver enzyme activity in nesting birds exposed to metals. As a postgraduate fellow at the Oak Ridge National Laboratory (ORNL), TN, Ms. Arenal developed models of wildlife risk assessment, and methods

for interspecies extrapolation of avian and mammalian toxicity data. She also performed risk analyses for the endangered gray bat, and completed a regulatory analysis of the Marine Mammal Protection Act of 1972 as it applies to underwater explosions in military sea range activities. Immediately following this fellowship in 2000, she joined CH2M HILL and currently specializes in ecological risk assessment, wildlife toxicology, ecology, and wildlife biology. As a project scientist, Ms. Arenal has continued to develop methods and tools for ecological risk assessment, including avian and mammalian toxicity reference values for a wide range of chemicals such as petroleum hydrocarbons and military relevant chemicals. She also developed and parameterized an exposure model for incorporation into the Army Risk Assessment Modeling System (ARAMS). Ms. Arenal has given over 20 oral or poster presentations at national and regional professional conferences, authored or coauthored 10 peer-reviewed publications, and has been a member of the Society of Environmental Toxicology and Chemistry (SETAC) since 1995. She currently lives and works in Sacramento, CA, with her husband and four children.

Desmond I. Bannon, PhD, DABT, is a *Toxicologist in the Toxicology Portfolio – Health Effects Research Program, U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD*. Dr. Bannon previously spent 10 years at the Kennedy Krieger Institute Lead Poisoning Program in Baltimore, MD. In addition to his PhD from the Department of Environmental Health Sciences at Johns Hopkins University School of Public Health (2002), Dr. Bannon has been a Diplomate of the American Board of Toxicology since 2006. With a focus on toxicology and human health, his interests include metal toxicology (tungsten alloys and lead) bioinformatics/genomics, mechanisms of toxicology, and toxicology studies in support of risk assessment. He recently led a U.S. Army Public Health Command effort to propose new blood lead guidelines for lead exposure and medical management in the Department of Defense. His range of journal publications includes, among others, Biomarkers, Clinical Chemistry, Chemical Research in Toxicology, Environmental Health Perspectives, Environmental Science and Toxicology, Toxicology and Applied Pharmacology, and Nature Communications, indicating broad interests and strong interdisciplinary collaborations. Dr. Bannon currently serves as the Contracting Officer's Representative for an ongoing Department of Defense contract with the U.S. National Academy of Sciences in Washington, DC.

Adam T. Deck, BS, is an Environmental Scientist and Health Risk Assessor with the Environmental in the Health Risk Management Portfolio – Health Risk Assessment Program, U.S. Army Institute for Public Health (AIPH). Throughout his tenure at the AIPH, his work has focused on ecological and human health risk assessments in both garrison and deployed settings. Mr. Deck currently serves on the AIPH Institutional Animal Care and Use Committee and the administrative team for the chairperson of the Joint Environmental Surveillance Working Group. Mr. Deck's primary passion is conducting field studies and serving as the primary investigator and team lead for the Comprehensive Reproductive Assessment for Wild Rodents at Contaminated Army Properties. Mr. Deck holds a BS in Biology from the University of Mary Washington with a focus in ecology and zoology.

William S. Eck, PhD, is a Biologist (Chemist/Toxicologist) in the Toxicology Portfolio – Health Effects Research Program, U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD. His principle efforts at the U.S. Army Institute of Public Health have been directed toward support of the U.S. Army's Ordnance Environmental Program as Team Leader for preparation of Toxicology Assessments. Dr. Eck is also responsible for QSAR modeling of newly developed explosive, propellant, and pyrotechnic compounds, and is a Subject Matter Expert on perchlorates. Dr. Eck has also served as a Study Director and regularly participates in the general toxicology effort within the Directorate. Prior to joining the Directorate of Toxicology in 2008, Dr. Eck was a university professor, Senior Intelligence Analyst with the Defense Intelligence Agency, and a serving Army officer in the Medical Service and Chemical Corps. Dr. Eck is the primary or coauthor of numerous publications relating to compounds of military interest. He received his PhD in Chemistry (Biochemistry) from the University of Maryland, College Park, MD and a BS in Chemistry, from the College of William and Mary, Williamsburg, VA.

Rachel M. Hebert, BS, is a Biological Science Technician with the Oak Ridge Institute for Science and Education, positioned with the Toxicology Portfolio – Health Effects Research Program, U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD. Ms. Hebert received a BS in Biology, with a concentration in Organismal Biology and Ecology and a minor in Geographic Information Systems from Towson University in Towson, MD. While

at Towson University, she studied the reproductive biology and behavior of Mountain Bluebirds in the Bighorn Mountains of Wyoming. Ms. Hebert also conducted the first systematic mammal species survey at Eden Mill Park in Pylesville, MD as her departmental honors thesis and spent two years studying plant–mammal interactions in wetlands using exclosures.

Allison M. Jackovitz, BS, is a Biologist with the Toxicology Portfolio – Toxicity Evaluation Program, U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD. Upon graduating from Pennsylvania State University, Ms. Jackovitz arrived at the U.S. Army U.S. Army Institute of Public Health to work under Dr. Michael Quinn, Jr., in the development of an avian two-generation toxicity test for the U.S. Environmental Protection Agency's Endocrine Disruptor Screening Program's Tier 2 battery of tests. Ms. Jackovitz attends the University of Maryland School of Medicine and is working on a PhD in Toxicology. Her most recent research focuses on the endocrine disrupting potential of insensitive munitions.

Glenn J. Leach, PhD, DABT, is a former Senior Toxicologist and Program Manager in the Toxicology Portfolio, U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD. He retired in 2011 and returned to work part-time as a consultant in the same organization. Dr. Leach received a PhD in Biological Sciences from the University of Delaware and had postdoctoral training at the Louisiana State University Medical Center. He became a Diplomate of the American Board of Toxicology in 1982 and is a member of the Society of Toxicology. He served for over 10 years on the Acute Exposure Guidelines Committee. His interests include evaluating the toxicity of munitions compounds and risk assessment. Dr. Leach has authored or coauthored more than 50 peer-reviewed papers, book chapters, and technical reports.

Sang Ho Lee, PhD, DVM, is an Officer in the U.S. Army Veterinary Corp., U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD, currently serving as the Executive Officer in the Toxicology portfolio at the U.S. Army Public Health Command. His work contributes to the collaborative data sharing in the field of toxicology, cooperation between toxicology and veterinary medicine, and issuing toxicity clearances for chemicals and platforms of

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Emily May Lent, PhD, is a Toxicologist with the Toxicology Portfolio – Toxicity Evaluation Program, U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD. Previously, Dr. Lent was a Research Assistant at the New England Aquarium Edgerton Research Lab where her research interests included effects of habitat degradation on species assemblages, by-catch survivability, and effects of nutrient loading on eelgrass beds. Dr. Lent received a Master's degree in Natural Resources – Wildlife Management from the University of New Hampshire where she studied the effects of multiple stressors on phenotypic plasticity in larval anurans. Dr. Lent holds a PhD in Natural Resources and Environmental Studies from the University of New Hampshire. As a U.S. Environmental Protection Agency (EPA) Science to Achieve Results (STAR) Fellow, Dr. Lent studied the effects of endocrine-disrupting contaminants on gonadal histology and reproductive steroidogenesis in anurans. Prior to joining the U.S. Army Institute of Public Health, Dr. Lent was a National Research Council (NRC) Postdoctoral Research Associate with the U.S. Army Edgewood Chemical and Biological Center where she conducted investigations on the effects of nerve agents on gene expression patterns. Dr. Lent has authored over 20 peer-reviewed publications and technical reports. She received the Federal Executive Board Award for Excellence in Federal Career in 2007. Current work includes investigations on the reproductive toxicity and genotoxicity of militarily relevant compounds. Her primary interests are in endocrine disruption, reproductive toxicology, and genotoxicology.

Matthew J. McAtee, BA, is the Section Chief, Strategic Risk Assessment in the Environmental Health Risk Assessment Program, U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD. He provides 19 years of subject matter expertise in environmental health risk assessment. He is responsible for directing a staff of risk assessment subject matter experts from several science and engineering disciplines. Their mission is to support Army Public Health

by identifying and executing initiatives to develop methods, guidance, and information to improve the value of Army health risk assessments, with special emphasis on chemical and microbiological hazards. Mr. McAtee and his section are currently focused on designing risk assessment methods, information databases, and military exposure guidelines (MEGs) for chemical and biological hazards. He is personally interested in expanding collaboration opportunities across risk assessment disciplines, supporting risk managers' decision-making processes, training junior risk analysts, facilitating proper risk assessment design and risk characterization, and integrating risk assessment concepts throughout the Army Public Health enterprise and its collaboration with chemical, biological, radiologic, and nuclear defense (CBRND) planning and response operations. He has authored numerous technical reports, technical guidance documents, and peer-reviewed publications. His risk assessment experience also includes the development of health risk assessments for hazardous waste sites, military training ranges, deployment locations, and combustion activities, including facilities designed to destroy the US chemical-warfare agent stockpile. He developed the ecological risk assessment methodology for Army combustion facility permitting decisions before guidance was available from the Environmental Protection Agency. He codeveloped the Army's first process to derive toxicity reference values for terrestrial wildlife. Mr. McAtee holds a BA in Biology from the University of Colorado, Boulder and a Risk Sciences and Public Policy Certificate and training in Epidemiology at the Johns Hopkins Bloomberg School of Public Health.

Wilfred C. McCain, PhD, is a Toxicologist with the Toxicology Portfolio – Health Effects Research Program, U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD, and works on a variety of toxicological issues affecting global military operations. He is involved in all phases of toxicology including risk characterization, risk assessment, and risk management. He represents the Army at public forums and meetings with various regulatory agencies. Dr. McCain's primary function is to conduct toxicological research for regulatory and safety purposes under GLP guidelines. Dr. McCain has a strong background in general and neurotoxicology with extensive experience in physiological, pharmacological, and statistical evaluation of cardiovascular, neuromuscular, and pulmonary function both *in vivo* and *in vitro*. He has more than 30 years of technical experience in academic, industrial, and government laboratories including supervisory and management positions.

Concurrent with his present position, Dr. McCain is adjunct associate professor of veterinary bioscience at the VA MD Regional College of Veterinary Medicine, VA Tech, where he has both teaching and advisory duties. He also teaches toxicology in the Public Health graduate program at the Uniformed Services University of the Health Sciences.

Emily N. Reinke, PhD, is a Biologist with the Toxicology Portfolio – Health Effects Research Program, U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD, where she evaluates the toxicity of Army-relevant compounds. She holds a PhD in Pathology from the University of Illinois at Chicago and an MS in Animal Sciences from Washington State University. During her PhD studies, Dr. Reinke received the Science, Mathematics, and Research for Transformation (SMART) Scholarship from the Department of Defense. She is also a postdoctoral member of the Society of Toxicology. Dr. Reinke has authored or coauthored more than six peer-reviewed journal articles or book chapters, and several toxicological technical reports. Her primary interests are in the development and adoption of alternative methods of assessing toxicology and in the mechanisms of carcinogenesis and cancer treatment efficacy.

Stephen W. Rice, BS, is an Intern with the Toxicology Portfolio – Health Effects Research Program, U.S. Army Institute of Public Health, Aberdeen Proving Ground, MD. Mr. Rice graduated from Salisbury University in 2014 with a BS in Biology and a minor in Chemistry. During his time at Salisbury University and the U.S. Army Institute of Public Health, he has dedicated much of his time preparing for a career in medicine by volunteering and shadowing physicians at Peninsula Regional Medical Center and Kirk U.S. Army Health Clinic respectively. Working with the U.S. Army Institute of Public Health, he focuses on analyzing dose-response data and the derivation of threshold reference values using the benchmark dose approach.

Christopher Salice, PhD, is the current Director of the Environmental Science and Studies Program at Towson University, MD. His research interests have previously focused on understanding the ecological and evolutionary consequences of anthropogenic and natural stressors. Examples of recent research projects include studies to better understand long-term exposures to stressors (multigeneration); transgenerational effects of stress, ecology, and pesticide resistance in mosquitoes; and the ecotoxicology and risk of perfluorinated compounds to aquatic species. Dr. Salice received a BS in

Environmental Science with an emphasis in ecology from Drexel University, and a PhD in environmental toxicology from the University of Maryland, Baltimore. He conducted his doctoral research at the University of Maryland's Chesapeake Biological Laboratory. Previously, Dr. Salice joined the U.S. Army Center for Health Promotion and Preventive Medicine where he conducted laboratory studies and developed tools for ecological risk assessment. Dr. Salice was then appointed to conduct research with the U.S. Environmental Protection Agency as an ecological risk assessor. From 2008 to 2014, Dr. Salice was an Assistant Professor at Texas Tech University before being appointed as the Director of the Environmental Science and Studies Program at Towson University.

Bradley E. Sample, PhD, is an Ecotoxicologist/Ecological Risk Assessor with Ecological Risk, Inc., with over 20 years of experience designing and leading large-scale risk assessments for both private and public-sector clients. His work includes evaluation of exposure and effects to wildlife, aquatic, sediment, and soil biota from radionuclides, metals, munitions, chlorinated organics, and petroleum compounds. He is the author of more than 100 peer-reviewed publications and presentations. Dr. Sample served on the steering committee and developed the wildlife exposure model for the USEPA's Ecological Soil Screening Levels (Eco-SSLs), and developed the wildlife modeling component for the U.S. Army's Adaptive Risk Assessment Modeling System (ARAMS). He has twice served on peer-review committees for the ecological risk assessment and bioaccumulation modeling components of the USEPA's Hazardous Waste Rule. In 2004, he served on an independent peer-review committee evaluating the EPA's ecological risk assessment for the General Electric Housatonic River site. Also in 2004, he served as a peer-review committee member for the development of USEPA's national metals risk assessment framework. In 2008, Dr. Sample served on the USEPA Science Advisory Panel reviewing the Office of Pesticide Programs Preliminary Notice of Intent to Cancel the pesticide Carbofuran. Dr. Sample is coauthor of a book on ecological risk assessment at contaminated sites, and has served as Editor for Hazard/Risk Assessment for the Society of Environmental Toxicology and Chemistry (SETAC) since 2006.

Joseph P. Sullivan, PhD, is a Certified Wildlife Biologist and owner of Ardea Consulting, Woodland, CA. Dr. Sullivan established Ardea Consulting in 1997 in Morrisville, PA. Before that, Dr. Sullivan conducted field studies to evaluate