



Michael Bock, PhD

Managing Director

Expertise	<ul style="list-style-type: none">• Chemical forensics• Statistics and data analysis• Data visualization• Fate and transport modeling• Risk assessment
Summary	<p>Dr. Bock is a Managing Director with over 25 years of experience in environmental science and consulting. He specializes in the investigation and assessment of contaminated marine and freshwater sediments, including statistical analysis, forensic analysis and source allocation, fate and transport modeling, species sensitivity toxicity evaluations, and ecological and human health risk assessment. His expertise includes using multivariate statistical data analysis such as multicriteria analysis and receptor modeling/source unmixing (e.g., principal components analysis, hierarchical cluster analysis, ratio analysis, least-squares mixing models, cosine-theta analysis, and polytopic vector analysis), to determine fingerprint patterns and allocate sources in environmental samples.</p> <p>His environmental forensic work has focused extensively on discerning sources and the fate of polychlorinated biphenyls (PCBs), dioxins and furans (PCDD/Fs), Per- and polyfluoroalkyl substances (PFAS), polycyclic aromatic hydrocarbons (PAHs), and metals in rivers, lakes, ports, harbors, groundwater, and soils. He has developed multimedia fate and transport models that are used to model organic chemicals in the environment, during wastewater treatment, and in land applied biosolids. These models have been used to assess the concentration, persistence, treatability, bioaccumulation, and weathering of chemicals in the environment. His experience also includes exploratory data analysis and visualization; conventional, probabilistic, and Bayesian statistical analysis; simulation studies; mathematical modeling; computer programming and automation; database design and management; the critique of chemical analysis methods; data quality; and usability evaluations.</p>
Professional Experience	<p>Environmental Forensics and Data Analysis</p> <ul style="list-style-type: none">• Forensic analysis of PFAS in groundwater and soils: The work involved exploring the distribution of PFAS in the environment and using multivariate statistical methods to compare the PFAS chemical profiles to possible sources. The project was conducted to define the extent of potential liabilities associated with a manufacturing facility. The work included a weight-of-evidence evaluation of PFAS profiles, concentration gradients, and groundwater and air transport pathways.• Forensics analysis of PCDD/Fs in a complex estuary system with numerous potential sources: The work involved the evaluation and defense against legal claims that a single facility in a large industrial area is the only significant source of dioxins to the estuary system. The analysis focused on an evaluation of PCDD/F fingerprints in the sediments and associated with various chemical processes. An additional component of the work included the analysis of sediment fate and transport, sediment dating, and the presence of unique chemical tracers.• Litigation over the alleged impacts of dioxins associated with a copper smelter: The work included a forensics analysis of the PCDD/Fs in house dust and tree bark alleged to have originated from Cerro operations. The case has progressed past the submission of expert reports and depositions,



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and a settlement was reached with the first set of plaintiffs during trial in January 2020. Additional cases are pending.

- Forensic analysis of PCB sources in soils in Toronto, CA defending a manufacturing company from claims related to the potential offsite migration of PCBs: The work involved the assessment of the mixture of Aroclors at the two properties and the potential for migration and weathering the link PCBs from one property to the other. The case has progressed past the submission of expert reports and is currently in mediation.
- Forensics analysis of PFAS and other chemicals related to a warehouse fire: The work included a forensic analysis of various PFAS related compounds and other chemicals to a small urban waterway with the goal of delineating the area of impacts. The analysis was able to narrowly define the area of impacts and limit the remedial footprint.
- Forensic analysis of PAHs in sediments of a canal system: The analysis includes delineation of manufactured gas plant (MGP) related impacts in an urban canal system impacted by both point sources and non-point sources. The work focused on the multivariate analysis of alkylated PAHs and other potentially MGP related compounds.
- Forensic analysis of PAHs in soils associated with a Brownfields redevelopment site: The analysis focused on the delineation of MGP related impacts and association with remnant facility infrastructure. Negotiations of liability have reached settlement between the PRPs.
- Forensics analysis of PCDD/Fs and PCBs alleged to have migrated from disposal impoundments into complex river system: During the first phase of the work, supported the successful legal defense against claims regarding the primary waste impoundment. The second phase of the work involves legal claims associated with two waste impoundments and residential properties and is ongoing. The analysis includes multivariate analysis of congener profiles and source identification and source unmixing.
- Forensic analysis of PCBs alleged to have migrated downgradient from a water drainage conveyance to a river system: The analysis included multivariate analysis of congener profiles and source identification, source unmixing, and the analysis of transport pathways. The project moved into litigation in 2018 and is ongoing.
- Allocation support of PCB impacts to marine mammals in an estuary system: The work included the identification of PCB profiles and the relative abundance of background and non-background PCB profiles in tissue.
- Evaluation of the spatial distribution of PCB congener profiles and the relative potency of these profiles: The work included the evaluation of sediments, birds, fish, and mammals.
- Forensics analysis of PCDD/Fs alleged to have migrated from an agricultural chemical mixing area to harbor sediments: Successfully negotiated with the Navy and the Justice Department to remove PCDD/Fs from the site allocation and remedy design phase of the work.
- PCB weathering study to characterize the alteration of the congener fingerprint due to physical processes: The analyses were used to examine the potential for the misidentification of PCB sources.
- Statistical analysis of fish fillet tissue: This work included conducting a detailed statistical analysis of fish fillet tissue and otolith for concentrations of mercury and selenium.

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- Multivariate analyses of large environmental sampling datasets: These datasets contained multiple classes of organic chemicals in an estuary system to investigate the likely age and source of a pesticide hotspot and allocate the remedial action and costs among multiple parties.
- Evaluation of historical MGP processes: This work focused on reaction conditions, the formation of chemical by-products, and waste management.
- PCDD/F fingerprinting evaluation to ascertain the sources of dioxins and furans to a waste disposal pit: The focus of the analysis was the identification of the waste streams most likely responsible for the dioxins in the waste oil.
- PCB fingerprinting analysis: This work analyzed the sources and distributions of PCBs in a west coast harbor. The analyses were used to examine remedial allocations among potentially responsible parties.
- Forensic analyses of historical operations at two Ohio steel manufacturing facilities: The analyses included principal components analysis, bootstrapping and other advanced statistical fingerprinting analyses, and a critique of PCB analytical methods for Aroclors, congeners, and homologues. Data analysis included the description of chemical concentrations and their relationship to geographic area, matrix, sediment depth, and soil depth.
- Analysis of arsenic effluent loadings: Implemented a sampling program and statistical simulation study used to determine the most appropriate sampling interval and duration to characterize arsenic effluent loadings from a large European manufacturing facility.
- Analysis of trends in composition of metals: Used a weight-of-evidence approach involving multivariate statistical analyses, environmental sampling, and fate modeling to examine trends in the composition of metals in lichens. The composition of metals and their weathering in soils were found to be influenced by three factors—proximity to coal fired power plants, year, and season.
- Probabilistic analysis of failure rates of methane detectors installed in multiple residences: This work was conducted to optimize the frequency of replacement of the detectors prior to anticipated failure: Implemented bootstrap techniques in numerous projects in order to generate the most defensible upper confidence limits for use as exposure point concentrations in risk assessments.
- Temporal trends in contaminant concentrations in groundwater: Designed and executed the statistical approach to determine temporal trends in contaminant concentrations in groundwater as part of the five-year review process at a National Priority List (NPL) Superfund site in Louisiana. The results of the analysis, which indicated declining trends in the levels and spatial extent of the contamination, was accepted by the U.S. Environmental Protection Agency (EPA) with negligible comments.
- Temporal trend analyses of groundwater monitoring data: The data were collected from a Massachusetts site impacted by several chlorinated organic compounds in a bedrock aquifer. The results were used to refine the monitoring program and improve performance of the groundwater extraction system.

Assessment of Sediments

- Investigation of the distribution of furans and other chemicals in the Tittabawassee and Saginaw Rivers in Michigan: Managed the project team responsible for the project databases, statistical analysis, geographic information system (GIS), and exploratory data analysis of the watershed. Responsible for the management of the project library and the development of a searchable



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document database. Designed and managed the development of a client web site for interactive mapping and information exchange. Performed geospatial and forensic chemical analyses.

- Ecological risk assessment: Provided ecological risk assessment services on a major northeastern river where PCBs are the primary chemical of interest. Activities have included multivariate statistical analyses, food web modeling, critique of opposing parties' studies, and development of ecotoxicologically based remediation goals.
- Chemical exposures calculations due to sediment contaminants in a geographically and hydrodynamically diverse harbor complex: Exposures were calculated based on geographic relationships, water depths, and sediment depths. Created tables and figures to describe the distribution of chemicals, characterized exposure, and described the relationship between sediment contaminates and sediment type. Evaluated the effectiveness of multiple remedial alternatives.
- Field investigation of surface water and sediment sampling of a pond: Led the field investigation. Aided in the design of the sampling plan and coordinated with the laboratory for sample analysis requirements. Evaluated the results of the sediment and surface water investigation and helped formulate recommendations to the client.
- Characterization of digestive environments of marine benthic invertebrates: Designed and executed a study of the digestive environments and how digestive chemistry relates to the bioavailability of nutrients and chemicals in sediments. Investigated the influence of the speciation of metals *in vivo* enzyme activity and digestive uptake.
- Sediment transport on an intertidal sandflat: Designed and implemented a study to predict and measure sediment transport on an intertidal sandflat under a variety of weather conditions. Techniques used included dye tracer studies, sediment traps, suspended load profiles, and mathematical modeling.
- Interaction between clay minerals and organic matter: Designed and executed a study to examine the association between clay minerals and organic matter and how that interaction relates to the preservation of organic matter and chemicals. Techniques used included heavy liquid floatation, X-ray diffraction, enzymatic analysis, chemical analysis, and visible and electron microscopy.
- Benthic surveying in Delaware: Designed and implemented surveys of Delaware Inland Bays for benthic infauna. Conducted a benthic survey of Bethany Beach, Delaware. Samples were collected using grab samples and sediment cores and were preserved and processed in the laboratory for taxonomic classification.

Fate and Transport Modeling

- Evaluation of the environmental impacts of an industrial chemical: Designed and implemented a sub-watershed scale multimedia fugacity model combined with a flow network to predict concentration of bisphenol A (BPA). The model predicted the aquatic concentrations in watersheds throughout Germany.
- Probabilistic evaluation of the environmental impacts of an industrial chemical: Designed and implemented a watershed and sub-watershed scale multimedia fugacity model to predict risks to aquatic receptors. The model followed the fate and transport of the chemical via multiple release pathways, during wastewater treatment, and in the aquatic environment. The model predicted the range of exposures in watersheds throughout the continental U.S.



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- Bioaccumulation models development: Developed multiple bioaccumulation models and bioaccumulation factors for metals and organic chemicals. The models have been used to support risk assessment and remedial design in soils and sediments.
- Probabilistic evaluation of the environmental impacts of a consumer chemical: Designed and implemented a coupled fugacity food web model to predict risks to ecological receptors due to the release of a consumer chemical. The model followed the fate and transport of a consumer chemical from release to wastewater treatment plants then to wildlife receptors. The model predicted the range of exposures and effects expected in watersheds throughout the continental U.S.
- Bioavailability of arsenic in soil: Designed and executed a study of the bioavailability in soil at a site in Oregon. Employed specialized laboratory analyses to quantify the fraction of arsenic present in soil that is available for uptake in the event of incidental soil ingestion by humans. Evaluated data quality, managed project database, and completed associated statistical and risk analyses.
- Development of soil cleanup goals for lead and arsenic: Used a weight-of-evidence approach involving statistical analyses, environmental sampling, and fate modeling to develop site-specific solubility constants for the development of soil cleanup goals for lead and arsenic at a site in Georgia. The complexity of the site required a consideration of site-specific chemistry and a careful examination of the data for outliers and anomalies.

Oil and Gas

- Comparative Risk Assessment (CRA) Results Tool: Developed CRA Results Tool for evaluating response options for the API Subsea Dispersant Injection Program Committee. The tool integrates environmental exposures, population exposures, and population recovery for valued ecosystem components potentially exposure to oil released from a hypothetical deepwater blowout to evaluate response options such as subsea dispersant.
- Arctic Response Consequence Analysis Support Tables (ARCASTs): Developed ARCASTs, a pan-Arctic NEBA Support Tool developed for the International Association of Oil & Gas Producers (IOGP) Arctic Response Technology's Joint Industry Programme (JIP).
- Information management system: Assisted in developing a web-based information management system that compiles, evaluates, and facilitates access to publicly available data, reports, articles, and geospatial information related to baseline ecological and human use services provided within a large waterbody.
- Analysis of stressors to ecological resources in a large marine water body: The purpose of the analysis was to characterize the relative importance of unusual and infrequent events such as a large oil spill relative to other stressors.
- PAH weathering study to characterize the alteration of PAH profiles due to physical processes: The analyses were used to evaluate the potential for the misidentification of sources.

Risk Assessment

- Re-evaluation of mercury toxicity to birds and fish: Assisted in the detailed re-evaluation of mercury toxicity. The analysis was based on a detailed review and reanalysis of the toxicity literature and has resulted in numerous presentations at scientific meetings and two peer reviewed publications.
- Dynamic population-based model: Updated and enhanced a dynamic population-based model designed to track consumer behavior, assess the risk associated with different behaviors, and



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predict mortality. The model is being used to assess the relative risks associated with certain legacy products and new alternative products.

- Information management system: Assisted in developing a web-based information management system that compiles, evaluates, and facilitates access to publicly available data, reports, articles, and geospatial information related to baseline ecological and human use services provided within a large waterbody.
- Statistical evaluation of the EPA attenuation factors database: The results of the analysis were used to develop scientifically valid recommendations for default attenuation factors for vapor intrusion into buildings as an alternative to the values proposed by EPA.
- Human health and ecological screening analyses: Designed and managed a customized database that automated human health and ecological screening analyses for 14 administrative orders on consent (AOCs) and five environmental media at a Department of Defense (DOD) site. Managed the verification and importation of a large quantity of DOD analytical data into the database. Facilitated negotiations between DOD and Ohio Environmental Protection Agency related to the screening values and format of the risk analyses. Managed production of over 200 data tables and reviewed those tables for clarity and accuracy. Developed export routines to provide data for the production of over 150 figures.
- Chemical reclassification: Assisted in the development of a proposal to reclassify chemicals under federal hazardous discharge regulations. Participated as a member of project team involved in the critical evaluation of the carcinogenic potential of 1,4-dioxane.
- Background screening levels: Developed background screening levels for trichloroethylene (TCE) in indoor air for one of the largest TCE-contaminated sites in the U.S. Assisted in negotiations with the state of Colorado to finalize methods and application of results for the purposes of determining levels above background.
- Hazardous Ranking System calculations: Assisted in the calculation of Hazardous Ranking System scores for several contaminated sites in New Jersey and Oregon.
- Risk-based site-specific criteria and remediation goals calculations: Calculated risk-based site-specific criteria and remediation goals for several contaminated sites located in Ohio, Oregon, Kentucky, and Massachusetts. Depending upon the needs and conditions of a given site, such goals were designed to ensure the health of residents, anglers, swimmers/waders and trespassers. In other cases, remediation goals were calculated to ensure the viability of populations and communities of ecological receptors, including ospreys, bald eagles, belted kingfishers, American robins, mink, fish, benthic invertebrates, raccoons, and muskrats.
- Environmental risk assessment (ERA) in Massachusetts: Assisted with the preparation of an ERA at an AOC located at Fort Devens, Massachusetts, in which TCE and daughter products were the primary chemicals of interest in groundwater. Aerobic biodegradation of those chlorinated compounds mobilized naturally occurring arsenic and magnesium in subsurface soils, creating potentially hazardous conditions at the downgradient groundwater-surface water interface.
- ERAs in Georgia: Member of the project team involved in preparation of several ERAs at AOCs located at Fort Gordon, Georgia. Participated in environmental investigations of soil, surface water, and sediment.
- Vapor intrusion analysis: Assisted with analyzing potential risks associated with vapor intrusion of tetrachloroethene (PCE), TCE, vinyl chloride, benzene, and other volatile organic compounds (VOCs) in subsurface soil and groundwater at sites across the country: Managed extensive



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datasets containing soil gas, subsurface soil, groundwater, indoor air, and ambient air data. Evaluated data to allow discrimination among background contributions, surface infiltration, and vapor intrusion. Executed screening and advanced versions of Johnson and Ettinger's vapor intrusion model.

- Human health risk assessments analyses: Completed the data evaluation, management, database design, statistical analysis, dose estimation, risk calculations, and uncertainty analyses for human health risk assessments conducted under Superfund, Resource Conservation and Recovery Act (RCRA), and state cleanup programs throughout the Northeast and Midwestern U.S. Developed and implemented a standardized database and spreadsheet format optimized for risk assessment purposes. For example, examined potential risks posed by PAH contamination at an apartment complex in Wisconsin, as well as recreational and trespassing risks associated with PAHs at two MGP sites in New York.

Academic Qualifications	PhD in Oceanography, University of Delaware, 1995 MS in Marine Studies, University of Delaware, 1992 BS in Marine Studies, University of South Carolina, 1989
Professional Training	40-Hour OSHA Hazardous Waste Operations (HAZWOPER) Safety Training
Publications	Bock, M.J., Brown, L.E., Wenning, R.J. and Bell, J.L. 2021. Sources of 2,3,7,8-tetrachlorodibenzo-p-dioxin and other dioxins in Lower Passaic River, NJ, Sediments. Environ Toxicol Chem. 40(5), pp. 1499-1519. https://doi.org/10.1002/etc.4974 . Reash, R., Friedrich, L., Bock, M., Halden, N. and Palace, V., 2019. Selenium and mercury in freshwater fish muscle tissue and otoliths: a comparative analysis. Environmental toxicology and chemistry. 38:1467-1475. French-McCay, D., D. Crowley, J. Rowe, M. Bock, H. Robinson, R. Wenning, A. H. Walker, J. Joeckel, and T. Parkerton. 2018. Comparative risk assessment of spill response options for a deepwater oil well blowout: Oil spill modeling. Marine Pollution Bulletin. 133:1001-1015. Bock, M., H. Robinson, R. Wenning, D. French McCay, J. Rowe, A. H. Walker. 2018. Comparative risk assessment of spill response options for a deepwater oil well blowout: Relative risk methodology. Marine Pollution Bulletin. 133:984-1000. Walker, A.H., M. McPeek, J. Joeckel, D. Scholz, D. French-McCay, J. Rowe, M. Bock, H. Robinson, and R. Wenning. 2018. Comparative risk assessment of spill response options for a deepwater oil well blowout: Stakeholder engagement. Marine Pollution Bulletin. 133:970-983. Wenning, R.J., Robinson, H., Bock, M., Rempel-Hester, M.A. and Gardiner, W., 2018. Current practices and knowledge supporting oil spill risk assessment in the Arctic. Marine environmental research, 141, pp.289-304.



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- Yost, L.J., Barber, T.R., Gentry, P.R., Bock, M.J., Lyndall, J.L., Capdevielle, M.C. and Slezak, B.P., 2017. Evaluation of triclosan in Minnesota lakes and rivers: Part II—human health risk assessment. *Ecotoxicology and environmental safety*, 142, pp.588-596.
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Presentations	Bock, M., Robinson, H., Wenning, R., French-McCay, D., Rowe, J., and A.H. Walker. 2021. A tool for comparing relative risks to ecological components associated with different oil spill response options. IOSC 2021.
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Bock, M., and L. Brown. 2019. The importance of validating source identification results and validating alternative hypotheses in a forensic investigation. Battelle Sediments Conference. February 11-14. New Orleans, LA.

Bock, M., Robinson, H., Wenning, R., French-McCay, D., Rowe, J., and A.H. Walker. 2018. Comparing relative risks to ecological components when SSDI is included in oil spill response. Clean Gulf 2018 Meeting. November 13-15, New Orleans, LA.

Bock, M., and L. Brown. 2018. Emerging statistical methods for source apportionment. INEF Annual Meeting. June 25-27. Salt Lake City, UT.

French-McCay, D., Rowe, J., Bock, M., Wenning, R., Robinson, H., and A.H. Walker. 2017. Oil spill modeling for a comparative risk assessment (CRA) of response options for a deepwater oil release. Society for Environmental Toxicology and Chemistry (SETAC) North America 38th Annual Meeting. November 12-16, Minneapolis, MN.

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Bock, M., Richard, R., Backus, J., Heise, L., and R. Baranek. 2017. Use of a weight-of-evidence approach to assess sulphide effects on wild rice in Minnesota. Society for Environmental Toxicology and Chemistry (SETAC) North America 38th Annual Meeting. November 12-16, Minneapolis, MN.

Bock, M., Fuchsman, P., O'Conner, A., Capdevielle, M., Fried, K. 2017. Chlorinated triclosan derivatives and dioxin transformation products: pathways, ecological significance and risk communication. Society for Environmental Toxicology and Chemistry (SETAC) North America 38th Annual Meeting. November 12-16, Minneapolis, MN.

Bock, M., and P. Fuchsman. 2016. Advances in the fugacity modeling of emerging substances in aquatic systems. Society for Environmental Toxicology and Chemistry (SETAC) North America 37th Annual Meeting. November 6–10, Orlando, FL.

Bock, M., R. Reash, J. Goodrich-Mahoney, L. Friedrich, and N. Halden. 2016. Comparison of tissue mercury and selenium in fish otoliths and fillets: Can we reconstruct the past? Society for Environmental Toxicology and Chemistry (SETAC) North America 37th Annual Meeting. November 6–10, Orlando, FL.

P. Fuchsman, M. Henning, L. Brown, M. Bock, and V. Magar. 2016. Methylmercury effects on bird reproduction: critical review and identification of toxicity reference values. Society for Environmental Toxicology and Chemistry (SETAC) North America 37th Annual Meeting. November 6–10, Orlando, FL.

Bock, M., M Bunge, M. Vosteen, I. Gutiérrez, J. Wölz, P. Stoldt, E Mihaich, S. Gestermann, R. Werner. 2016. FlowEQ – A coupled flow-network and fugacity based fate and transport model for the assessment of bisphenol A in the environment. SETAC Europe Annual Meeting. Nates, France.



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- Bock, M., 2015. Statistical fingerprinting and a line of evidence in a forensic evaluation. Invited Short Course. INEF Annual Meeting. Toronto, CA.
- Bock, M., 2015. "Outliers" in multivariate statistical fingerprinting. INEF Annual Meeting. August 3-6, Toronto CA.
- Barber, T., M. Bock, J. Lyndall, M. Capdevielle, and M. Vandeven. 2014. Species Sensitivity Distributions: An evaluation of methods using triclosan as a case study. Society for Environmental Toxicology and Chemistry (SETAC) Europe 25th Annual Meeting. May 3–7, Barcelona, Spain.
- Bock, M., T. Barber, P. Fuchsman, M. Capdevielle, and R. Hartsook. 2014. Triclosan transformation products: Environmental risk evaluation. Society for Environmental Toxicology and Chemistry (SETAC) Europe 25th Annual Meeting. May 3–7, Barcelona, Spain.
- Bock, M., T. Barber, and L. Brown. 2014. A Fugacity-based model to predict PAH weathering and its implications for predicting future sediment toxicity. Society for Environmental Toxicology and Chemistry (SETAC) North America 35th annual meeting. November 9–13, Vancouver, BC, Canada.
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