

Oklahoma Scenic Rivers Joint Phosphorus Criteria Study

Statement of Qualifications

*Tetra Tech Inc.
Center for Ecological Sciences*

Prepared for:

Oklahoma Scenic Rivers Joint Phosphorus Criteria Study Committee
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Introduction

The Tetra Tech Inc. Center for Ecological Sciences in partnership with Dr. Song Qian of the University of Toledo is excited to provide this statement of qualifications for consideration by the Oklahoma Scenic Rivers Joint Phosphorus Criteria Study Committee. Our research team has been following with great interest the development of phosphorus criteria for Scenic Rivers in Oklahoma and the resultant legal and scientific issues. Much of that work and debate has paralleled our own work on similarly challenging nutrient threshold development projects around the country (e.g., Florida Everglades, Cahaba River, Alabama, Wissahickon Creek, Pennsylvania, and Florida Statewide Nutrient Criteria). This work has included not only determination of magnitude, but also duration and frequency components, which are equally challenging. Our work has also addressed the often vexing challenge of overcoming the array of confounding factors (e.g., habitat, hydrology, canopy, etc.) and co-occurring stressor effects when conducting stressor-response relationship analysis with survey data, to which we have applied novel statistical approaches. For these reasons, we consider the development of appropriate, defensible nutrient criteria to be one of the most significant scientific and regulatory challenges facing environmental resource managers today and we believe this project has the potential to greatly forward the related science on this issue. We are therefore pleased to propose our experience and expertise for your consideration. We sincerely hope you will find our qualifications worthy of a proposal invitation as we have assembled a team with the highest level of objective expertise and experience that will be required for successful completion of such a high profile and technically demanding project.

1.0 Description of Experience with Similar Projects

This project requires expertise in a variety of areas: nutrient criteria development, study design/implementation, statistical analysis, quality assurance/quality control, and report development/project management. Our team includes experts in algal biology (phycology), invertebrate ecology, statistical analysis, stream biogeochemistry/nutrient cycling, study implementation, and quality assurance/quality control.

Tetra Tech Research Team:

Name	Location	Expertise
Dr. Michael J. Paul	Tetra Tech Inc., Research Triangle Park, NC	Stream Biogeochemistry/Nutrient Cycling; Nutrient Criteria Development; Study Design/Analysis
Dr. Lei Zheng	Tetra Tech Inc., Owings Mills, MD	Phycology/Algal Ecology; Nutrient Criteria Development; Study Design/Analysis
Dr. Song Qian	University of Toledo, Toledo, OH	Study Design; Statistical Analysis
Dr. Jeroen Gerritsen	Tetra Tech Inc., Owings Mills, MD	Nutrient Criteria Development; Study Design/Analysis
Dr. Jon Harcum	Tetra Tech Inc., Clemson, SC	Nutrient Criteria Development; Hydrology; Study Design/Analysis
Dr. James Stribling	Tetra Tech Inc., Owings Mills, MD	Aquatic Entomology; Study Design; Taxonomic Quality Assurance/Quality Control
Jennifer Linder	Tetra Tech Inc., Owings Mills, MD	Field Study Design and Management; Logistics
John O'Donnell	Tetra Tech Inc., Fairfax, VA	Quality Assurance/Quality Control
Sue Lanberg	Tetra Tech Inc., Fairfax, VA	Quality Assurance/Quality Control

Our team has been involved in nutrient criteria development since its inception. Team members participated in the USEPA 1995 National Nutrient Assessment Workshop, helped co-author National Nutrient Criteria Guidance documents including the recent EPA Stressor-Response Guidance document cited in the Request for Qualifications, and published peer-reviewed scientific research on criteria development. Our study lead (Dr. Michael Paul) has managed the national nutrient criteria development center (NSTEPS) since 2005 through which our team has provided assistance to more than 25 states in areas including technical review and analysis assistance in study design, statistical modeling (including techniques for overcoming confounding factors and co-occurring stressors), mechanistic modeling and development of magnitude, frequency and duration elements. Our team has also been involved in providing the highest quality scientific support to inform decision-making for the development of site-specific nutrient criteria, including duration and frequency components, for nutrient sensitive waters under contentious settings in a variety of locations including the Florida Everglades and in the Cahaba River, Alabama. These studies used a combination of field ecological assessments as well as nutrient addition experiments, and examined a variety of response endpoints including diatom and soft algal assemblages, algal biomass, invertebrate assemblage structure, fish assemblage structure, and other water quality endpoints (e.g., dissolved oxygen and pH). This work also included the development and application of novel statistical models (e.g., propensity score analysis, hierarchical models) to overcome confounding factors and co-occurring stressor effects.

This study will require careful study design and implementation to meet the specific study goal to determine “the total phosphorus threshold response level, in milligrams per liter (mg/L), at which any statistically significant shift occurs in algal species composition or algal biomass production resulting in undesirable aesthetic or water quality conditions in the Designated Scenic Rivers.” We foresee this requiring a mix of reach scale experimental as well as larger survey study components. Our team has a long history of study design expertise. This includes small scale stream reach-level studies involving nutrient additions to measure nutrient uptake and enrichment response (e.g., Atlanta, GA, Florida Everglades, Florida Springs, Florida), meso-scale segment and watershed surveys for stressor-response relationship development (e.g., West Virginia, Mississippi, California) as well as large scale national studies including the national aquatic resource surveys for the USEPA. These designs have all incorporated careful consideration of classification and the need to carefully pair biogeographically similar reference sites to the rest of the site population, as appropriately outlined in the RFQ. We have, in fact, published extensively on the importance of classification in assessment and criteria development. Our team has been involved in both the design and implementation of these projects, including all the complex logistical field and laboratory elements required for producing the highest quality, most complete datasets for conducting the analysis necessary to answer the study questions.

Statistical analysis is among our team’s greatest strengths. Our team members have long been involved in developing empirical stressor-response models using ecological survey and experimental data to develop site-specific and regional stressor thresholds for nutrients, conductivity, and sediment. This expertise includes statistical analysis for nutrient threshold development in the Florida Everglades, Cahaba River, Alabama, Wissahickon Creek, Pennsylvania, and statewide in Mississippi. Dr. Song Qian is author of a book on environmental statistics, is an international expert in change-point/threshold modeling, and helped lead nutrient threshold analysis in the Florida Everglades. We understand the importance of considering up front the statistical analysis necessary to properly answer the research question. Therefore, our statistical analysis expertise will play an important role in identifying the data needs/quality objectives and, therefore, the required study design; this will be critical in providing scientifically defensible answers to address the study goal.

We are listing quality assurance/quality control (QA/QC) experts on our team because we understand the importance of unassailable data quality to every project we conduct. Given the regional (and perhaps national) implications of this study, we know that there will be particular scrutiny of all aspects, including data collection and analysis. While we apply the highest quality to every project we conduct, we wanted

to highlight our experience in this regard. Our QA/QC team has a combined 43 years of experience and has prepared and implemented Quality Assurance Project Plans for a wide variety of projects from site-specific field and laboratory experimental studies to large regional surveys. This has included nutrient criteria pilot studies for Gulf of Mexico estuaries, dissolved oxygen TMDL studies in the Brazos River, nutrient criteria pilot studies for the Western Montane US, Florida Nutrient Criteria Development, and the National Aquatic Resource Surveys. In particular, we note that Dr. James Stribling of Tetra Tech has been a national leader in the development of taxonomic quality control, an often overlooked aspect of aquatic research. His taxonomic QA/QC procedures have been widely adopted by the USEPA national surveys, the National Wadeable Streams Assessment (WSA), the National Lakes Assessment (NLA), and the National Rivers and Streams Assessment (NRSA). QA/QC will be carefully coordinated with the committee to assure all participants that the data and analyses generated will be of the highest quality.

Lastly, in the arena of report development/project management, our team has a long history of producing high quality reports and scientific papers. We have more than 168 refereed articles, 59 refereed government reports, 26 refereed proceedings articles, and more than 12 refereed books/book chapters among our research team. Tetra Tech maintains a professional graphics and report production team that takes the technical excellence of our research and converts it into high quality reports in any platform required. Lastly, our team has more than 100 years combined experience in managing large projects for a variety of clients. We will use a dedicated project manager to oversee specific details of the project (Ms. Jennifer Linder), who has overseen projects from small field scale studies to eight large national scale studies, including the EPA National Aquatic Resource Surveys.

2.0 Example Projects

The request for qualifications requests two summary reports or peer-reviewed articles for inclusion. Finding only two examples was difficult and we encourage the committee to please review the specific qualifications section where we have included a small subset of relevant peer-reviewed publications with the biosketches of various team members.

The first example we provide is a recent 2012 paper by Dr. Song Qian of the University of Toledo on the ecological question of identifying thresholds in the journal *Ecological Indicators*.

The second example we provide is the peer-reviewed 2010 USEPA report: *Using Stressor-response Relationships to Derive Numeric Nutrient Criteria* co-authored by Dr. Michael Paul of Tetra Tech.

3.0 Specific Qualifications of the Research Team

For this requirement, we have provided the following biosketches of team members that summarize their experience, specific qualifications, relevant project work and a short list of their relevant publications. We would be happy to provide additional detail if desired.

EDUCATION

Ph.D. Ecology, University of Georgia, 1999

M.Sc. Zoology, University of Georgia, 1994

B.A., Biology, Colgate University, 1991

RELATED EXPERIENCE

Total: 19

With Tetra Tech: 12

OFFICE LOCATION

Research Triangle Park, NC

PROFESSIONAL AFFILIATIONS

Society for Freshwater Science

Ecological Society of America

American Institute for Biological Sciences

LICENSES & CERTIFICATIONS

None

KEY AREAS OF EXPERIENCE

- Freshwater Ecology
- Nutrient Biogeochemistry
- Invertebrate assessment modeling
- Assessment and management of nitrogen and phosphorus pollution
- Water Quality Standards and Criteria Development
- Watershed Monitoring and Assessment
- Study Design and Data Analysis
- Urbanization Effects
- Causal Analysis
- Technical writing and guidance development

Dr. Paul has been studying the ecosystem ecology of freshwater ecosystems for 20 years. His work, which has included teaching, research, and public policy, has focused on the ecology of freshwater, especially stream, ecosystems. His technical skills and experience include freshwater ecosystem ecology, stream ecology, nutrient cycling and biogeochemistry, bioassessment, nutrient criteria development, experimental design and analysis, microbial ecology, invertebrate zoology, and fluvial geomorphology. He has special expertise in the effects of land use, especially urbanization, on stream ecosystems and was analytical lead on a nationwide research study to develop and define biological potential along urban gradients. Dr. Paul has directed bioassessment/biocriteria work for several states and federal government agencies, has led workshops on bioassessment and analysis across the nation, and is an author of USEPA guidance on the statistical analysis of bioassessment data as well as the design, sampling and analysis of large rivers for bioassessment. He has also been involved in several USEPA Office of Research and Development (ORD) research projects developing causal analysis and multi-stressor analysis tools based on biological assessments and the effects of climate change on state bioassessment/biocriteria programs. Dr. Paul has more than 12 years of experience in water quality standards development and has directed nutrient, and biological criteria development projects across the nation. He helps manage the national nutrient criteria support center for EPA Office of Science and Technology and provides principal technical support to the State of Mississippi water quality standards program. In addition to nutrient criteria, Dr. Paul has led the development of nutrient and sediment targets to protect aquatic life use for TMDLs in several states. Most recently, Dr. Paul has also been involved in developing environmental impact assessment for flow regulation in both the Apalachicola-Chattahoochee-Flint (ACF) and Alabama-Coosa-Tallapoosa (ACT) basins to the Gulf.

Employment History

Tetra Tech, Inc., Project Manager and Senior Scientist, 2001–present

Howard University, Assistant Professor, 2003-2005

University of Georgia, Post-doctoral Research Scientist, 1999-2001

Relevant Project Experience**Technical Support for EPA/ORD/NCEA's Ecological Assessment**

Programs *Role:* Program Manager; *Client:* United States Environmental Protection Agency; *Duration:* 2012-2017. Dr. Paul is the overall Program Manager providing technical support to the USEPA Office of Research and Development National Center for Ecological Assessment. Tetra Tech has been providing ecological research support to the Office of Research and Development for over 10 years. This research supports the ecological risk assessment program and includes development of stressor response models

for aquatic organisms, climate change vulnerability and implication for aquatic ecosystems research, causal analysis support and development, and cutting edge development of ecological/statistical analysis tools including online applications. Specific skill applications have included aquatic ecology, hydrology, fluvial geomorphology, causal analysis, risk assessment, statistical analysis, study design, water quality

modeling, database management, web and web tool design, report writing, and workshop preparation and logistics.

Support for national water quality criteria program including nutrient criteria. *Role:* Project Manager and lead scientist; *Client:* United States Environmental Protection Agency; *Duration:* 2005-present. Dr. Paul has been a project manager and lead technical scientist supporting the national nutrient criteria program for more than 7 years. This work has included managing the national nutrient criteria support center (NSTEPS) for USEPA/OW/OST/HECD including designing and maintaining a technical support website, an online technical request system, developing white papers, managing and answering technical requests, developing and leading webcasts, supporting regional meetings, analyzing state/tribal data, and reviewing state criteria packages. Through this work, Dr. Paul has lead the technical analysis of data for nutrient criteria development and water quality criteria review in more than 25 states including Indiana, Illinois, Minnesota, Wisconsin and ORSANCO in the Midwest. He is the author of national guidance on nutrient criteria development. Dr. Paul has led nutrient criteria endpoint development analyses for several states and site specific nutrient and sediment endpoints to protect aquatic life in several states including to protect endangered species on the Cahaba River in Alabama and Pajaro River in California.

Support for Mississippi Water Quality Standards Program. *Role:* Project Manager and lead scientist; *Client:* State of Mississippi; *Duration:* 2005-present. For the state of Mississippi, Dr. Paul has been providing water quality standards support for more than 7 years including the development of statewide nutrient and biological criteria, as well as supporting the development of site specific dissolved oxygen and temperature criteria. Specific skill applications have included sampling design and analysis, field methods, statistical analysis, regulatory and policy analysis, report and brief writing for staff and management level audiences, and presentation and workshops for staff and management level audiences.

Development of biological indicators and biological criteria to assess water quality. *Role:* Lead Scientist; *Client:* Various including United States Environmental Protection Agency, states of Colorado, Montana, Wyoming, Illinois, West Virginia, and Maryland; *Duration:* 2001-2011. Led the technical design and development of biological indicator models to assess stream and riverine biological condition in several states. The modeling efforts included traditional multimetric model development as well as O/E-type discriminant models using discriminant analysis based on traditional, all-possible subsets, nearest neighbor, region of influence, null and random forests models. Merged multivariate predictive models with GIS-based landscape model to simultaneously predict hydrologic condition and expected biological condition for any stream in Maryland for use in planning and risk assessment within the GISHydro2000 platform. Developed and led workshops on biological indicator development and application in biocriteria setting in more than 15 states.

EPA statistical guidance for developing biological indicators for rivers and streams, developing nutrient criteria, and assessing and developing bioindicators for large river. *Role:* Lead Scientist; *Client:* United States Environmental Protection Agency; *Duration:* 2001-2010. Coauthored and directed the preparation of three different EPA guidance documents related to assessment and criteria development. The first was EPA/OST how-to guidance document for state monitoring personnel on analyzing biological field data for developing biological indexes for assessing the condition of waterbodies. Authored half of guidance document; wrote chapters on predictive models, multivariate statistics, and decision making. The second was EPA/OST guidance on how to use stressor response relationships to derive nutrient criteria to protect aquatic life. The document included statistical detail with analytical examples of different statistical approaches for exploring data, evaluating and defining stressor-response relationships, and deriving and evaluating criteria. Authored one-third of the document including sections on exploratory analysis and conceptual models. The last document for EPA/ORD is comprehensive guidance for assessing and developing bioindicators for non-wadeable streams and rivers. Authored or coauthored several chapters and edited several chapters and contributed to scientific

manuscript resulting from guidance. All guidance efforts required reviewing and extraction relevant information from existing literature and relevant case study data and sample analyses.

Selected Peer-Reviewed Publications and Technical Reports

- M.J. Paul.** 2012. Evaluation of Nutrients as a Stressor of Aquatic Life in Wissahickon Creek, PA. Prepared by Tetra Tech, Inc., Owings Mills, MD for United States Environmental Protection Agency, Region 3.
- Tsang, Y-P, G.K. Felton, G.E. Moglen, and **M.J. Paul.** 2011. Region of influence method improves macroinvertebrate predictive models in Maryland. *Ecological Modelling* 222: 3473– 3485.
- Flotemersch, J. E., J.B. Stribling, R.M. Hughes, L. Reynolds, **M.J. Paul,** and C. Wolter. 2011. Site length for biological assessment of boatable rivers. *River Research and Applications*, 27: 520–535.
- M.J. Paul.** 2011. Revised Draft Nutrient Thresholds to Protect Aquatic Life Uses in Mississippi Lakes and Reservoirs. Prepared by Tetra Tech, Inc., Owings Mills, MD for Mississippi Department of Environmental Quality, Office of Pollution Control.
- L. Zheng and **M.J. Paul.** 2011. Revised Draft Nutrient Thresholds to Protect Aquatic Life Uses in Mississippi Non-Tidal Streams and Rivers. Prepared by Tetra Tech, Inc., Owings Mills, MD for Mississippi Department of Environmental Quality, Office of Pollution Control.
- A.H. Roy, **M.J. Paul,** and S. J. Wenger. 2010. Urban Stream Ecology. Pp. 341-352 In Aitkenhead-Peterson, J. and A. Volder (eds.). *Urban Ecosystem Ecology*, ASA-CSSA-SSSA, Madison, WI.
- Barbour, M.J, and **M.J. Paul.** 2010. Adding Value to Water Resource Management through Biological Assessment of Rivers. *Hydrobiologia* 651: 17-24.
- United States Environmental Protection Agency (USEPA). (**MJ Paul** co-author). 2010. Technical Support Document for U.S. EPA's Final Rule for Numeric Criteria for Nitrogen/Phosphorus Pollution in Florida's Inland Surface Fresh Waters. United States Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC.
- USEPA. (Yuan, L.L., Thomas, D., J.F. Paul, **M.J. Paul,** and M.A. Kenney). 2010. Empirical Approaches for Nutrient Criteria Derivation. EPA-820-S-10-00. United States Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC.
- M.J. Paul.** 2010. Development of Models to Establish Links between Human-caused Nutrient Enrichment and Alterations to the Composition of Stream Communities. Prepared for: United State Environmental Protection Agency, Region 8 USEPA Montana Office, Helena, MT.
- Wenger, S.J., A.H. Roy, C.R. Jackson, E.S. Bernhardt, T.L. Carter, S. Filoso, C.A. Gibson, W.C. Hession, S.S. Kaushal, E. Marti, J.L. Meyer, M.A. Palmer, **M.J. Paul,** A.H. Purcell, A. Ramirez, A.D. Rosemond, K.A. Schofield, E.B. Sudduth, C.J. Walsh. 2009. Twenty-six key research questions in urban stream ecology: an assessment of the state of the science, *Journal of the North American Benthological Society* 28(4): 1080-1098.
- M.J. Paul,** D.W. Bressler, A.H. Purcell, M.T. Barbour, E.T. Rankin, and V.H. Resh. 2009. Assessment Tools for Urban Catchments: Defining Observable Biological Potential. *Journal of the American Water Resources Association* 45(2): 320-330.
- Purcell, A.H., D.W. Bressler, **M.J. Paul,** M.T. Barbour, E.T. Rankin, J.L. Carter, and V.H. Resh. 2009. Assessment Tools for Urban Catchments: Developing Biological Indicators. *Journal of the American Water Resources Association* 45(2): 306-319.

Appointments, Awards, and Achievements

- Society for Freshwater Science, Board of Directors, 2013-2016
- Adjunct faculty at Utah State University (2003-present), University of Maryland (2005-2010)
- Visiting lecturer, North Carolina State University (2011-present)
- Tetra Tech Inc., Technical Achievement Award, 2010
- Faculty Performance Award, Howard University, 2004
- Faculty Authors Award, Howard University, 2004
- New Faculty Research Award, Howard University, 2003
- University System of Georgia Research Award, 1999
- Review support to more than 20 technical journals and agency programs

EDUCATION

Ph.D., Ecology and Zoology dual major, Michigan State University, 1989

M.S., Phycology, Department of Biology, Xiamen University, 1988

B.S., Botany, Xiamen University, 1973

YEARS OF EXPERIENCE

Tetra Tech: 10

Total: 17

PROFESSIONAL AFFILIATIONS

Society for Freshwater Science

AREAS OF EXPERIENCE

- Algal Ecology
- Nutrient Criteria
- Water Quality Criteria
- Water quality assessment
- Causal assessment
- Environmental statistics

Dr. Zheng is a senior aquatic ecologist in Tetra Tech Inc., Center for Ecological Sciences, located in Owings Mills, Maryland. He is a research scientist with more than 11 years of broad experience in aquatic environmental sciences especially in biological assessment of aquatic ecosystems. He is an algal ecologist and nutrient expert, specialized in algal ecology, taxonomy, and physiology; and his particular interest is in the use of biological indicators (algae, macroinvertebrates, fish, and plants) to assess ecosystem health. During his professional career, he has been involved in a range of multidisciplinary research in streams, lakes, wetlands, and marine systems. He has applied his strong background in experimental design and statistical analysis to integrate complicated information into simple models and indices for environmental management. He has been active in the field of causal analysis, working with both U.S. EPA and state agencies to identify environmental stressors and human disturbance that cause the degradation of aquatic ecosystems. Dr. Zheng also has risk assessment experience, especially in quantifying the relative risk of a range of environmental stressors to aquatic systems. He has used this and his other skills to his work on water quality standards and criteria development, where his experience and technical skill has been integral to improving the scientific defensibility of criteria in many states. His other technical abilities include, but are not limited to, wetlands ecology, stream ecology, and algae-nutrient interactions.

Relevant Project Experience**Feasibility Analysis to Develop Algal Indicators for National Wetlands (2013).**

Contracted by EPA to conduct a thorough research to develop algal indicators for wetlands in the United States. Dr. Zheng led a team to conduct research on current best sciences and provided expert opinions for developing algal indicators for the nation's wetlands.

Support to Analyze Water Quality Impacts from the British Petroleum (BP) Oil Spill in the Gulf of Mexico (2010-2011). Contracted by USEPA to determine the statistical differences of levels of toxic metals and Polycyclic Aromatic Hydrocarbons (PAHs) in the Gulf of Mexico (GOM) before, during, and after the British Petroleum (BP) oil spill on April 20, 2010 and capped on August 2010. Dr. Zheng led the statistical analyses of water and sediment quality data collected from the Gulf of Mexico. Various statistical approaches (e.g., parametric maximum likelihood estimation, nonparametric Prentice-Wilcoxon rank test etc.) were used to conduct summary statistics and compare chemical concentrations among different groups with toxicology benchmarks stored in a central database, while dealing with a large proportion of multiple detection limits.

Using Field Data to Derive an Aquatic Life Benchmark for Conductivity (2009-2012). Contracted by National Center for Environmental Assessment (NCEA), USEPA to develop methodologies to derive conductivity criteria for mountain top mining (MTM) impacted regions in the U.S. Dr. Zheng explored numerous statistical methods, including weighted average, weighted/un-weighted cumulative distribution function (CDF), linear and quadratic logistic regression, generalized linear models (GLM), and generalized additive models (GAM) to analyze macroinvertebrate species compositional data and a number of environmental variables to derive numeric benchmarks for conductivity. The final product was a conductivity benchmark report which adapted the standard U.S. EPA methodology (species sensitive

distribution) for deriving ambient water quality criteria to this problem. The method was applied to derive effect benchmarks for dissolved salts as measured by conductivity in Central Appalachian streams using data from West Virginia and Kentucky. Upon request from USEPA region 3 and the states, Dr. Zheng has explored similar methodology to derive benchmarks for water quality parameters in Tennessee and Ohio.

Analyses to Develop Nutrient Criteria for Gulf of Mexico Estuaries (2012). Contracted by GOMA (Gulf of Mexico Alliances) to conduct a pilot study to develop nutrient criteria for the Weeks Bay watershed system. The analysis will be used as a template for nutrient criteria development for other estuaries within the Gulf region. Dr. Zheng led a thorough analysis to examine the environmental variability and possible causes of algal blooms and anoxia in the Weeks Bay.

Nutrient Criteria Development for Wadeable and Non-Wadeable Streams in the State of Mississippi (2007, 2010). The goal of this project was to develop scientifically defensible nutrient criteria for both wadeable and non-wadeable streams. Dr. Zheng took on the majority of the tasks of this project including: 1) building a comprehensive database with existing nutrient and biological data (mostly macroinvertebrates); 2) classifying streams and defining reference conditions for each class; he developed three stream classes (minimally disturbed, least disturbed, and biological attained reference conditions); 3) Using scientific approaches to analyze data to reach nutrient end points; he used a number of statistical approaches (change point analysis, LOWESS regression, and biological indicators) to identify thresholds 4) Making sure criteria were comparable across waterbodies.

Florida Nutrient Criteria Development (2009-2012). As important member of EPA team, Dr. Zheng is actively involved in an ongoing process of developing nutrient criteria for Florida's lakes, streams, and estuaries. Dr. Zheng reviewed and analyzed datasets for Florida's lakes, streams, and estuaries, and provided valuable comments and suggestions to EPA for revising and finalizing Florida's criteria documents. He applied various statistical techniques (regression analyses, change point analysis, hierarchical (mixed) models, cluster analysis, etc.) and his scientific expertise on algae to help EPA derive the final criteria.

N-STEPS Support: Nutrient Endpoint Development for Various States (2007-2012). Dr. Zheng provided technical support for EPA's nutrient criteria support center to help states develop scientifically defensible nutrient criteria for lakes and streams. With his expertise of algal ecology, Dr. Zheng has reviewed nutrient criteria guidance for various states, e.g., Maine, Ohio, Minnesota, etc. Dr. Zheng has also applied statistical analyses to derive numeric nutrient endpoints for waterbodies in various regions of Kentucky, West Virginia, and Montana. In order to more effectively conduct statistical analysis for similar sets of data from different regions and states, Dr. Zheng developed a statistical package using R programming to perform the main approaches commonly used for nutrient criteria development: summary statistical analysis, scatter plots and LOWESS regression, conditional probability analysis, change point analysis, uncertainty analysis, propensity function for covariance, and hypothesis testing. Dr. Zheng has also directed usages of the application for develop nutrient endpoints for Illinois, Indiana, Delaware, and many other states.

Nutrient Criteria Development for Wadeable and Non-Wadeable Streams in the State of Mississippi (2007, 2010). The goal of this project was to develop scientifically defensible nutrient criteria for both wadeable and non-wadeable streams. Dr. Zheng took on the majority of the tasks of this project including: 1) building a comprehensive database with existing nutrient and biological data (mostly macroinvertebrates); 2) classifying streams and defining reference conditions for each class; he developed three stream classes (minimally disturbed, least disturbed, and biological attained reference conditions); 3) Using scientific approaches to analyze data to reach nutrient end points; he used a number of statistical approaches (change point analysis, LOWESS regression, and biological indicators) to identify thresholds 4) Making sure criteria were comparable across waterbodies.

Nutrient Target for Northern Piedmont Ecoregion in PA (2007). The goal of this project was to develop nutrient TMDL targets for six watersheds in Southeast Pennsylvania, a project sponsored by EPA region 3. Due to limited sample size and data availability, Dr. Zheng expanded his analysis to the Northern Piedmont Ecoregion by collecting data from PA, NJ and MD. Dr. Zheng and colleagues used a Weighted Evidence Approach from multiple sources to develop nutrient targets for this region, including reference approach, stressor-response approach, modeling approach, and literature reviews. He applied a number of statistical techniques, e.g., regression tree, linear regression. He used both algal and macroinvertebrate metrics to examine biological condition gradients for the analysis.

Los Angeles San Gabriel River Algae Study (2005-2007). Dr. Zheng designed and implemented a two year study plan for EPA region 9 to study nuisance algal problems in the SG river watershed. The goal of this study was to identify stressors (possibly nutrients) that caused algal growth in the SG river watershed and to recommend targets for management. Dr. Zheng designed sampling plan and field and laboratory protocols, supervised field sampling, analyzed data, and prepared the final report. In the third year, Dr. Zheng used a modeling approach to derive nutrient and algal end points for the San Gabriel River watershed based on the two year study as well as data from the same region by others.

Nutrient and Harmful Algae Study in FL Springs (2003). Postdoctoral research associate for a project to assess nuisance algal growth in Florida springs and its relation to nutrient enrichment, a research program sponsored by Florida Department of Environmental Protection (FDEP).

Selected Peer-Reviewed Publications and Technical Reports

- Diamond, J. M., D. L. Denton, J.W. Roberts, and **L. Zheng**. 2013. Evaluation of the test of significant toxicity (TST) for determining the toxicity of effluents and ambient water samples. *Environmental Toxicology and Chemistry* 32(5):1101-8.
- Zheng, L.**, J. Diamond, and D.L. Denton. 2013. Evaluation of whole effluent toxicity data characteristics and use of Welch's t-Test in the Test of Significant Toxicity Analysis. *Environmental Toxicology and Chemistry* 468-474.
- Cormier, S.; G. Suter; **L. Zheng**; G. Pond 2013. Derivation Of A Benchmark For Freshwater Ionic Strength. *Environmental Toxicology and Chemistry* 32(2): 263 – 271.
- Cormier, S.; S. Wilkes, and **L. Zheng**. 2013. Relationship Of Land Use And Elevated Ionic Strength Of Appalachian Watersheds. *Environmental Toxicology and Chemistry* 32(2): 277 – 287.
- Cormier SM, Suter GW, II., **L. Zheng**, and Pond GJ. 2013. Assessing causation of the extirpation of stream macroinvertebrates by a mixture of ions. *Environmental Toxicology and Chemistry* 32(2): 296 – 303.
- Denton, D. L., J. Diamond, **L. Zheng**. 2011. Test of significant toxicity: a statistical application of assessing whether an effluent or site water is truly toxic. *Environmental Toxicology and Chemistry*, 30(5): 1117-1126.
- Zheng, L.** and J. Gerristen. 2007. Indicators of wetland condition on an urban gradient of the Twin Cities region of Minnesota. Prepared for Ramsey-Washington Metro Watershed District (RWMWD), Little Canada, MN.
- Zheng, L.**, R. J. Stevenson. 2006. Algal assemblages in multiple habitats of restored and extant wetlands. *Hydrobiologia*. 561:221–238.
- Zheng, L.**, R. J. Stevenson, and C. B. Craft. 2004. Assessment of Salt Marsh restoration using benthic algal attributes. *Wetlands*. 24(2): 309-323.

EDUCATION

PhD, Environmental Sciences,
Duke University, 1995

M.S., Statistics, Duke University,
1995

M.S., Environmental Systems
Engineering, Nanjing University,
Nanjing, China, 1988

B.S., Environmental Engineering,
Tsinghua University, 1985

YEARS OF EXPERIENCE

Total: 17

PROFESSIONAL AFFILIATIONS

International Association on Water
Quality

American Water Resources
Association

American Statistical Association

American Association for the
Advancement of Science

AREAS OF EXPERIENCE

- Safe Drinking Water Act support
- TMDL development
- Water quality modeling
- Guidance development
- Nutrient Criterion
- Setting environmental standards
- Ecological thresholds

Dr. Qian has engaged in research and practices in environmental and ecological statistics, water quality modeling and assessment, and ecological risk assessment for over 17 years. His work, including teaching, research, and consulting, is focused on environmental and ecological data analysis and modeling both for research and for environmental management. He has a long teaching career covering environmental science, water quality modeling and management, environmental and ecological data analysis and modeling, and risk assessment. Dr. Qian is known for his statistical skill reflected in his textbook in environmental and ecological statistics and his upcoming book in the applications of Bayesian hierarchical models in environmental and ecological studies. His work covers a wide range of environmental and ecological topics, including modeling phosphorus retention in the Everglades wetlands, detecting and quantifying ecological thresholds, watershed modeling for TMDL development, drinking water standard compliance study, effects of urbanization on stream ecosystem, environmental engineering, and various ecological topics. His research is focused on the development and adaptation of statistical modeling methods that are suitable for applied problems. He developed the Bayesian hierarchical model for EPA for assessing drinking water standard compliance, introduced the hockey stick model as a tool for developing numerical phosphorus criterion for the Everglades, applied the seasonal trend analysis using loess for assessing long term trends in nutrient concentrations in the Neuse River basin, developed the Bayesian SPARROW model, introduced the multilevel models to study the effects of urbanization on stream ecosystem, introduced the use of the change point model as a tool for nutrient criterion development, and the use of several advanced statistical tools (such as multinomial regression, zero-inflated regression) for analyzing species compositional data. Dr. Qian has published a textbook in environmental and ecological statistics, over 50 peer-reviewed journal articles, and numerous book chapters and conference presentations.

Employment History

University of Toledo, Assistant Professor, 2012 - present

Tetra Tech Inc., Senior Environmental Engineer, 2011-2012

Cardno-ENTRIX, Inc., Senior Consultant, August, 2011 to 2011

Duke University, Nicholas School of the Environment, Associate Research Professor, June 2004 to August 2011; Adjunct Assistant Professor, March 2001 - June 2004; Instructor: 1993 and 1996; Postdoctoral Research Associate, January - December 1996

The Cadmus Group, Inc., Associate, March 2000 - June 2004

University of North Carolina, Water Resources Research Institute, Visiting Scientist, September 2000 - December 2000

Portland State University, Environmental Sciences and Resources Program, Assistant Professor, January 1997 - May 2000

South China Research Institute for Environmental Sciences, National Environmental Protection Agency, Research Engineer, 1989 - 1990

Nanjing University, Department of Environmental Sciences, Lecturer, 1988 to 1989.

Relevant Project Experience

Environmental and Ecological Modeling Dr. Qian is a leading expert and practitioner in environmental and ecological data analysis and modeling, supported several EPA/OGWDW work assignments in developing statistical models supporting SDWA assessment of conventional and microbial pollutants. Dr. Qian served as PI on several EPA-STAR (developing methods for quantifying ecological thresholds, a Bayesian SPARROW model, and performance assessment of TMDL) and USGS (developing methods for assessing the effects of urbanization on stream ecosystems) grants. These federally funded projects were focused on risk assessment.

Environmental and Ecological Statistics Dr. Qian is a respected environmental statistician with over 15 years of experience in teaching and research. His textbook in environmental and ecological statistics is widely used and highly praised.

Ecological Thresholds Dr. Qian has published several papers on the use of statistical change point and hockey stick models for quantifying ecological thresholds for setting environmental standards. His papers were widely used by states in setting their nutrient criteria.

Environmental Education Dr. Qian has 10 years teaching experience at Portland State University and Duke University, including graduate level courses in water quality management and modeling, uncertainty analysis of environmental models, environmental and ecological statistics, and advanced statistical modeling, and undergraduate courses in environmental sciences and environmental processes. Dr. Qian has advised over 15 master students, co-advised two PhD students at Duke University, and served on over 10 PhD dissertation committees.

Bayesian Hierarchical Modeling Dr. Qian has recently evolved as a leading authority in the application of Bayesian hierarchical models in environmental and ecological studies. He is the editor of the Wiley book series on environmental and ecological data analysis and modeling and the author of the inaugural volume of the series on hierarchical/multilevel models.

International Experience Dr. Qian has collaborated with researchers from Finland, China, and India on various research topics. These collaborations resulted in four journal papers, including a paper on assessing China's drinking water source water quality published in *ES&T*. Dr. Qian served as external reviewers on two PhD committees in an Indian university.

Outreach and Technology Transfer Dr. Qian is an active publisher, has authored/co-authored more than 50 scientific papers and more than 20 proceedings and book chapters. He has made more than 20 presentations and led technical workshops on ecological threshold for DOI/NPS/USGS.

Selected Peer-Reviewed Publications and Technical Reports

Dr. Qian is the author/co-author of over 50 peer-reviewed journal papers, 6 book chapters, one textbook, and one research monograph. Targeted select papers:

Qian, S.S., Cuffney, T.F., McMahon, G. Multinomial regression for analyzing macroinvertebrate assemblage composition data. *Freshwater Science* 31 (3), 681-694

S.S. Qian. Analytical Options for Estimating Ecological Thresholds: Statistical Considerations. In: R.A. Gitzen, J.J. Millsbaugh, A.B. Cooper, and D.S. Licht, (Eds.) *Design and Analysis of Long-term Ecological Monitoring Studies*, Cambridge University Press. ISBN: 9780521191548. May, 2012.

S.S. Qian and T.F. Cuffney. To threshold or not to threshold? That is the question. *Ecological Indicators* (article in press, doi:10.1016/j.ecolind.2011.08.019), 2011.

Qian, S.S., 2010. *Environmental and Ecological Statistics* with R. Chapman and Hall/CRC Press. (Published in August 2009)

- I. Alameddine, S.S. Qian, and K.H. Reckhow. A Bayesian changepoint–threshold model to examine the effect of TMDL implementation on the flow-nitrogen concentration relationship in the Neuse River basin. *Water Research* 45(1): 51-62, 2010.
- S.S. Qian, T.F. Cuffney and I. Alameddine and G. McMahon and K.H. Reckhow, On the Application of Multilevel Modeling in Environmental and Ecological Studies, *Ecology*, 91(2): 355-361, 2010.
- S.S. Qian and J.K. Craig and M.M. Baustian and N.N. Rabalais, A Bayesian hierarchical modeling approach for analyzing observational data from marine ecological studies, *Marine Pollution Bulletin*, 58(12): 1916-1921, 2009.
- K.H. Reckhow, S.S. Qian, D. Hammel, A multilevel model of the impact of farm-level BMPs on phosphorus runoff. *Journal of the American Water Resources Association*, 45(2): 369377, 2009.
- C.J. Richardson, S.S. Qian, P. Vaithyanathan, Panchabi, R.S. King, R.G. Qualls, and C.A. Stow, Response to Comment on “Estimating Ecological Thresholds for Phosphorus in the Everglades”, *Environmental Science and Technology*, 42(17): 6772-6773, 2008.
- C.J. Richardson, R.S. King, S.S. Qian, P. Vaithyanathan, R.G. Qualls, and C.A. Stow, Estimating ecological thresholds for phosphorus in the Everglades. *Environmental Science and Technology*, DOI: 10.1021/es062624w, 2007.
- Arhonditsis, G.B., Qian, S.S., Stow, C.A., Lamon, E.C., and Reckhow, K.H., Eutrophication risk assessment using Bayesian calibration of process-based models: Application to a mesotrophic lake. *Ecological Modelling*, 208: 215229, 2007.
- Qian, S.S. and K.H. Reckhow, Combining model results and monitoring data for water quality assessment, *Environmental Science and Technology*, 41, 5008-5013, 2007
- Qian, S.S. and Shen, Z. Ecological applications of multilevel analysis of variance, *Ecology*, 88(10): 2489-2495, 2007
- Lamon, E.C. and Qian, S.S., Regional scale stressor-response models in aquatic ecosystems. *Journal of American Water Resources Association*, 44(3):771-781, 2007.
- Qian, S.S., K.H. Reckhow, J. Zhai, G. McMahon, Nonlinear regression modeling of nutrient loads in streams – a Bayesian approach *Water Resources Research*, 41(7):W07012, 2005.
- Qian, S.S., Y. Pan, and R. King. “Soil Total Phosphorus Threshold in the Everglades: A Bayesian Changepoint Analysis for Multinomial Response Data”, *Ecological Indicators*, 4: 2937, 2004.
- Qian, S.S., R. King, and C.J. Richardson. Two Statistical Methods for the Detection of Environmental Thresholds *Ecological Modelling*, 166:87-97, 2003.
- Qian, S.S., W. Warren-Hicks, J. Keating, D.R.J. Moore, and R.S. Teed, A Predictive Model of Mercury Fish Tissue Concentrations for the Southeastern United States, *Environmental Science and Technology*, 35(5):941-947, 2001.
- Richardson, C.J. and S.S. Qian, Long-term phosphorus assimilative capacity in freshwater wetlands: a new paradigm for sustaining ecosystem structure and function, *Environmental Science and Technology*, 33(10):1545-1551, 1999.
- Qian, S.S., K.H. Reckhow, Modeling phosphorus trapping in wetlands using nonparametric Bayesian analysis, *Water Resources Research*, 34(7):1745-1754, 1998.
- Qian, S.S. and C.J. Richardson, “Estimating the long-term phosphorus accretion rate in the Everglades: a Bayesian approach with risk assessment”, *Water Resources Research*, 33(7), 1997.

EDUCATION

Ph.D., Ecology and Evolutionary Biology, The Johns Hopkins University, 1978

M.A., Ecology, The Johns Hopkins University, 1976

B.S., Environmental Studies, Antioch College, 1974

YEARS OF EXPERIENCE

Tetra Tech: 20

Total: 34

LICENSES/REGISTRATIONS

None

PROFESSIONAL AFFILIATIONS

Ecological Society of America

Society for Freshwater Science

North American Lake Management Society

Society for Environmental Toxicology and Chemistry

AREAS OF EXPERIENCE

- Aquatic ecology
- Biological assessment
- Water quality criteria
- Statistical data analysis
- Causal analysis
- Project management

Jeroen Gerritsen has more than 34 years of experience in aquatic environmental sciences (20 years with Tt), including basic and applied research, teaching, environmental assessment, and project management. Dr. Gerritsen's technical contributions have been in the areas of biological assessment, biological indicators, biocriteria, nutrient criteria and stressor identification (SI). He contributed to several EPA guidance documents for biological assessment and criteria development in the nation's waters as coauthor, contributor, editor, or contract project manager. He has analyzed bioassessment data, developed biological indexes for several states and EPA Regions, and directed Tt's application of SI for biologically impaired streams in West Virginia. He was project co-manager for the development of the first version of CADDIS, now adopted into EPA's Web site. Current projects include nonlinear decision support models for tiered biological assessment; and evaluating ecological indicators of hydrologic alteration, including the effects of global climate change.

Employment History

Tetra Tech, Inc., CES. Principal Scientist, Director, 1992-present

Versar, Inc. Senior Scientist, 1987-1992

University of Georgia, Institute of Ecology Assistant Research Scientist' 1978-1987

Relevant Project Experience

Using Field Data to Derive an Aquatic Life Benchmark for Conductivity.

Project leader to provide technical and analytical support to ORD/NCEA to develop methods for deriving aquatic life criteria from field data. The objective of this project was to develop a scientifically defensible methodology to derive effect benchmarks for dissolved salts as measured by conductivity in Central Appalachian streams using field based data.

Supervised Tt's development of statistical models and synthesis of results to develop an aquatic life benchmark based on field data. Tt provided technical support for data analysis, GIS analysis, as well as report preparation. The final product is a report adapting the standard U.S. EPA methodology (species sensitivity distribution) for deriving ambient water quality criteria from lab data. The report, *A Field-based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams*, was reviewed by EPA's Science Advisory Board, and the benchmark value is under consideration for use by EPA to regulate discharges in Appalachia, following public release and comment.

Identification of Stressors Causing Ecological Degradation in West Virginia Streams. Directed Causal Analysis, using EPA methodology, in support of TMDL development for West Virginia. Directed development of conceptual and predictive models for ecological stream impairment in the region. Evaluated stressor-response hypotheses of the conceptual model. Directed statistical analysis; with Tt colleagues, developed the *dirty reference* model approach, using similarity analysis of unstressed and highly stressed biological communities, to determine the relative contribution of several potential stressors to impairment of a site. Directed application of weighted averaging models and EPA's

conditional probability model. Identified biological indicators and applied principles of causal analysis to identify the stressors most likely to have caused the ecological degradation observed in each stream. Streamlined many of the procedures in the SI guidance. Prepared results of causal analysis as a case study for NCEA (under a separate contract). Presented results at scientific meetings; preparing manuscript of dirty reference model approach.

Non-Indigenous Species Migration through the Chicago Area Waterways: (CAWs) Comparative Risk of Water Quality Criteria. Directed a risk assessment on mechanisms that might prevent or encourage the spread of invasive fish species through the Chicago Area Waterways (CAWs), between Lake Michigan and the Illinois River drainage basins, and vice-versa. The objective was to determine whether improvements in water quality criteria for the CAWs would increase the likelihood of invasive species migrating through the system. Applied a comparative risk assessment approach to synthesize available field and laboratory data.

Supervised data acquisition and analysis, including water quality and biological monitoring data, preference and tolerance information on each of the invasive species as well as several native species. Identified six groups of mechanisms for migration across the CAWs that were relevant to the changes proposed for the system. Supervised data analysis on each mechanism and evaluated each mechanism with respect to the species characteristics to project if proposed changes in the water quality criteria would be expected to result in an increased risk of migration of invasive species through this system. The weight of evidence refuted the hypothesis that improving water quality in the system will increase the risk of invasions. Tetra Tech also found that improvements in water and habitat quality within the CAWs as well as in the adjacent river and lake systems, may mitigate the effects of species invasions by reducing the abundance, dominance, and ecological impacts of the invasive species.

Risk Assessment of Plant Incorporated Protectants: Framework for Assessing Ecosystem Scale Impacts. Supervised development of a report on improving risk assessment of Plant Incorporated Protectants (PIPs) by the strategic adoption of ecological risk assessment practices and comparative risk assessment approaches. The report took into consideration such issues as agroecosystem complexity, consideration of spatial and temporal scale, the existence of data bases and utility of meta-analysis, and assessment flexibility to accommodate new PIP crops or new conditions for use of such crops.

Selected Peer-Reviewed Publications and Technical Reports

- U.S. Environmental Protection Agency. 2010. Technical Support Document for U.S. EPA's Final Rule for Numeric Criteria for Nitrogen/Phosphorus Pollution in Florida's Inland Surface Fresh Waters. <http://water.epa.gov/lawsregs/rulesregs/upload/floridatsd1.pdf> (coauthor).
- Gerritsen, J., L. Zheng, J. Burton, C. Boschen, S. Wilkes, J. Ludwig, and S. Cormier. 2010. Inferring Causes of Biological Impairment in the Clear Fork Watershed, West Virginia. U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, Cincinnati, OH. EPA/600/R-08/146. http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=496962.
- Zheng, L., J. Gerritsen, J. Beckman, J. Ludwig, S. Wilkes, and J. Burton. 2008. Land use, geology, enrichment, and stream biota in the eastern ridge and valley ecoregion: Implications for nutrient criteria development. *J. Am. Water. Resour. Assoc.* 44(6):1521-1536
- Tetra Tech, Inc. 2008. Non-Indigenous Species Migration through the Chicago Area Waterways (CAWs): Comparative Risk of Water Quality Criteria. Prepared for US EPA, Office of Science and Technology. Authors: J. Gerritsen, A. Hamilton, A. Roseberry-Lincoln, R. Manandhar, J. Stamp, D. Mosso, H. Latimer.

- Barbour, M.T., and J. Gerritsen. 2006. Key features of bioassessment development in the United States of America. In *Biological Monitoring of Rivers. Applications and Perspectives*, eds. G. Ziglio, M. Siligardi, G. Flaim. pp 351–366. John Wiley & Sons, Chichester, UK.
- Gerritsen, J., and M.J. Paul. 2006. *Statistical Guidance for Developing Biological Indicators for Rivers and Streams: A Guide for Constructing Multimetric and Multivariate Predictive Bioassessment Models*. Prepared for U.S. Environmental Protection Agency, ORD and OST, Washington, DC.
- USEPA (U.S. Environmental Protection Agency). 2005. *Use of Biological Information to Better Define Designated Aquatic Life Uses in State and Tribal Water Quality Standards: Tiered Aquatic Life Uses*. In state review and pilot trial. (Contributing author and editor.)
- Ofenböck, T., O. Moog, **J. Gerritsen**, M.T. Barbour. 2004. A stressor-specific multimetric approach for monitoring running waters in Austria using benthic macroinvertebrates. *Hydrobiologia*. 516:251-268.
- Ofenböck, T., O. Moog, **J. Gerritsen**, and M. Barbour. 2002. Multimetric Methoden zur charakteristik des "ökologischen zustandes" gemass EU-Wasserrahmenrichtlinie. Deutsche Gesellschaft für Limnologie: Tagungsbericht 2001 (Kiel), 157-162.
- Clements, W.H., S.N. Luoma, **J. Gerritsen**, A. Hatch, P. Jepson, T. Reynoldson, and R.M. Thom. 2001. Stressor interactions in ecological systems. Pp. 215-232 in D.J. Baird and G.A. Burton, Jr. eds. *Ecological Variability: Separating Natural from Anthropogenic Causes of Ecosystem Impairment*. Special publication, Society of Environmental Toxicology and Chemistry.
- U.S. EPA. 2000. *Nutrient Criteria Technical Guidance Manual. Lakes and Reservoirs*. Authors: G.R. Gibson, Jr. (Ed.), R.E. Carlson, S. Chapra, **J. Gerritsen**, S. Heiskary, J. Jones, M. Nozik, J. Simpson, E. Smeltzer. EPA-822-B00-001. U.S. EPA, Office of Water, Washington, D.C.

EDUCATION

Ph.D., Agricultural Engineering,
Colorado State University, 1990

M.S., Agricultural Engineering,
Colorado State University, 1986

B.S., Agricultural Engineering
Technology/Civil Engineering minor,
University of Delaware, 1984

YEARS OF EXPERIENCE

Tetra Tech: 24

Total: 24

PROFESSIONAL AFFILIATIONS

Engineer in Training

AREAS OF EXPERIENCE

- Clean Water Act support
- Environmental cost-benefit analyses
- Environmental statistics
- Guidance development
- Nonpoint source management
- Water quality assessment

OFFICE LOCATION

Fairfax, VA

Dr. Harcum is a principal engineer/hydrologist at Tetra Tech specializing in ground and surface water quality hydrology, data analysis, and water quality monitoring network design. He has managed or served as principal investigator on more than 50 environmental projects using multiple subcontractors and ranging in size from \$10K to \$2,700K. He has developed U.S. Environmental Protection Agency (EPA) guidance documents and training material for nutrient management plan development, calculating total maximum daily loads (TMDLs) in streams and rivers; tracking, evaluating, and reporting implementation of forestry, urban, and agriculture nonpoint source (NPS) control measures; determining the effectiveness of NPS controls; and the TMDL process. He supported development of EPA's risk-based assessment of sediment quality on a national level, which included assessment of toxicity, tissue residue, and sediment chemistry data to evaluate human and ecological risks. His work in support of EPA's nutrient criteria for Florida's coastal and estuarine waters includes compiling and organizing data from disparate data sets; proposing scientifically defensible analytical procedures; computing distributional and other summary statistics; evaluating stressor-response relationships; integrating detailed land use data to evaluate benchmark sites; and providing technical review of data, analyses, and reports prepared by federal, state, and local agencies. Dr. Harcum's research has included the evaluation and comparison of numerous trend detection and ambient condition estimation procedures commonly used to analyze water quality data that have data limitations such as multiple detection limits, irregular sampling, and missing values. As an adjunct faculty member, he taught a graduate level ground water hydrology course, developed a ground water model for the Jornada Del Muerto aquifer, and evaluated the changes in soil physical properties due to amendment of organic waste on agronomic soils.

Employment History

Tetra Tech, Inc., Principal Engineer and Hydrologist, 1993–present

Relevant Project Experience

Florida Inland, Estuary, and Coastal Nutrient Water Quality Criteria Development Support (EPA Office of Science and Technology [OST] / Standards and Health Protection Division [SHPD]; 2010 – 2013). Provided data management, analytical, and scientific support for EPA's development of nutrient criteria. Work included overseeing and implementing data analysis tasks, such as evaluation of a land development intensity index to assist in identifying reference sites for computing distributional statistics at streams and rivers; evaluation of land use data to assist in identifying Class III canals in South Florida; extraction of remote sensing data from MODIS and MERIS; compiling field-collected data for remote sensing calibration; application of multivariate analysis tools for developing and computing distributional statistics in South Florida marine waters; and development of stressor/response and light attenuation empirical models. Other work included preparing draft text documenting the procedures used and potential response to public comments.

Little Calumet East Branch Nutrient Analyses (EPA Office of Wetlands, Oceans, and Watersheds [OWOW]; 2013). Provided technical assistance to EPA staff and Save the Dunes, a nongovernment organization to analyze nutrient water quality data. Applied a robust "regression on order statistics" (ROS) approach together with bootstrapping to compute summary statistics and 90 percent confidence interval for nutrient data and provided recommendations on appropriate analyses for load estimations for data with numerous non-detects.

Nutrient Endpoint Development (EPA OST/SHPD; 2010 – 2013). Provided data management, analytical, and scientific support for nutrient endpoint development for Illinois, ORSANCO, and Pennsylvania. Work included compiling and organizing data from disparate data sets; proposing scientifically defensible analytical procedures; computing distributional and other summary statistics; evaluating stressor-response relationships; integrating detailed land use data to evaluate benchmark sites; and providing technical review of data, analyses, and reports prepared by federal, state, and local agencies.

Support for the National Sediment Quality Survey (EPA OST/SHPD; 1993 – 2012). Designed and developed the database and analysis tools used in the preparation of the 1997 and 2004 Reports to Congress on the incidence and severity of sediment contamination in the United States. The database includes a compilation of more than 4,750,000 chemical results associated with more than 200,000 sediment and tissue samples. In the first report, applied methods for evaluating sediment quality thresholds for nonionic organic chemicals and developed a data screening methodology to evaluate human and ecological risks with data collected from 1980 through 1993. In the second report, assisted in modifying the screening methodology to take advantage of advancements in risk-based methods, including implementation of a logistic model. Supported STORET staff in updating the WQX model to explicitly model sediment toxicity data; providing sample sediment chemistry and tissue residue data in WQX format to STORET staff to test earlier releases of WQX; assisted in development of a web-based, proof-of-concept application that allows Superfund data generators to convert data received from laboratories in the Staged Electronic Data Deliverable format into a WQX format; and developed a web-based proof-of-concept application that allows users to retrieve contaminated sediment data from EPA's WQX using a geographic user interface and convert that data into a format compatible with the National Oceanic and Atmospheric Administration (NOAA) desktop sediment analysis tool, Query Manager, for further analysis.

Technical and Economic Evaluation of Nitrogen and Phosphorus Removal at Municipal Wastewater Treatment Facilities (State of Washington, Department of Ecology; 2009). Developed study design to evaluate the types of technologies available, their performance and reliability, capital and operating costs, and other factors related to removing nutrients at municipal wastewater treatment facilities. Responsible for estimating statewide capital and O&M costs to implement various technology-based upgrades at facilities to achieve nutrient removal.

Water Resources Statistics Course (EPA OWOW; 1999 – 2000). Co-developed and presented a 2-day training course for state and federal water resource staff on the use of statistics in water resources. Course topics included data reduction, graphical presentations, hypothesis testing, regression, storm event data, and load estimation. Example analyses were developed based on attendee's data.

Delaware Estuary Monitoring Design (Delaware River Basin Commission; pre-2000). Served as project manager and principal investigator for the development of an environmental monitoring plan for the Delaware Estuary Program. This project included the development of information needs, monitoring objectives, measurement parameters, and performance criteria for water quality, living resources, toxics, habitat, and land use. Alternative monitoring scenarios were evaluated using power analysis and other statistical tools.

Exposure and Risk Assessment Methodology (EPA Office of Research and Development [ORD]; pre-2000). Served as project manager for the development of transport algorithms to assess exposure and risk from municipal solid waste combustor facility residuals. Involved the compilation of algorithms necessary to model fate and transport via air, soil, and water from release to exposure points.

Monitoring Program Design (pre-2000). Developed an analysis tool for spatial comparison of alternative monitoring network designs using multivariate time series analysis and Kalman filtering. Evaluated two monitoring networks (13 and 17 stations).

National Assessment of Water Quality Trends (EPA OWOW; pre-2000). Served as task leader for the evaluation of STORET data for assessing national trends. Work included the review and selection of an appropriate statistical test and indicator variables for analysis, as well as the development of specifications for reviewing ambient water column data. These specifications include logic for handling missing data, irregular sampling, and

censored observations that have been based on a combination of in-house Monte Carlo simulations and a thorough search of current literature.

Statistical Data Analysis (pre-2000). Investigated the development of a water quality data analysis protocol, summarized data limitations common to data records, and analyzed shortcomings of current statistical procedures. Compared alternative statistical procedures for summarizing ambient conditions and detecting trends in water quality data records that are subject to data limitations such as detection limits, irregular sampling, and missing values.

Selected Peer-Reviewed Publications and Technical Reports

Stoddard, A., J. Harcum, J. Pagenkopf, J. Simpson and R. Bastian. 2002. *Municipal Wastewater Treatment: Evaluating Improvements in National Water Quality*. John Wiley & Sons, Inc., New York, New York.

Harcum, J.B., Jim C. Loftis, and Robert C. Ward. 1992. Selecting trend tests for water quality series with serial correlation and missing values. *Water Resources Bulletin* 28(3):469-478.

EDUCATION

Ph.D., Entomology, The Ohio State University, 1986

M.S., Entomology, The Ohio State University, 1982

B.S., Zoology, The University of Mississippi, 1980

YEARS OF EXPERIENCE

Tetra Tech: 22

Total: 29

PROFESSIONAL AFFILIATIONS

American Association for the Advancement of Science (AAAS)

American Water Resources Association (AWRA)

Society for Freshwater Science (formerly, the North American Benthological Society) (SFS/NABS)

AREAS OF EXPERIENCE

- Sampling/monitoring design
- Quality assurance/quality control
- Biodiversity assessment
- Statistical analysis
- Project/program management
- Technical writing
- Methods development and testing
- Comparability and uncertainty analysis for biological assessments

OFFICE LOCATION

Owings Mills, Maryland

Dr. Stribling is an environmental scientist with 25 years of experience in applying ecological principles to natural resource management decision-making. He has been instrumental in developing methods for the U. S. Environmental Protection Agency for the assessment of biological condition, physical habitat quality, and landscape integrity and the use of QA/QC for ensuring improved data quality. Dr. Stribling has been a national lead for developing techniques for biological method performance characteristics and comparability analyses, led analyses of taxonomic data quality for the USEPA National Wadeable Streams Assessment, is a co-author of USEPA Rapid Bioassessment Protocols (RBP), and provided primary technical support to the USEPA Office of Research and Development for development of Large River Bioassessment Protocols. In addition, he has extensive experience in applying these tools to County- and State-scale environmental management needs including monitoring designs, uncertainty analyses, data and assessment comparability analysis, ecological assessments of streams and watersheds, NPDES permit requirements, stressor identification/restoration designs, stormwater management, and public outreach. He is author or coauthor of 20 publications in peer-reviewed technical journals, 4 book chapters, and numerous reports and documents for Federal, State, and local agencies, including the USEPA revised Rapid Bioassessment Protocols (RBPs) for streams (1999. *Revision to the Rapid Bioassessment Protocols for Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish*. EPA/841-D-97-002. U.S. EPA, Office of Water, Washington, DC), and the 2006 USEPA document *Concepts and Approaches for the Bioassessment of Non-Wadeable Streams and Rivers*. (EPA/600/R-06/127. U. S. EPA, Office of Research and Development, Cincinnati, OH.)

Employment History

- Tetra Tech, Inc., Center for Ecological Sciences, Director, Integrated Ecological Assessments; 2009-present
- Tetra Tech, Inc., Center for Ecological Sciences, Principal Scientist; 2001-2008
- Tetra Tech, Inc., Center for Ecological Sciences, Senior Scientist; 1991-2000
- EA Engineering, Science, and Technology, Inc., Environmental Scientist; June 1990-October 1991
- Georgetown University, Department of Biology, Assistant Research Professor; 1988-1990
- University of Wisconsin, Department of Entomology, Post-Doctoral Research Associate; 1988
- Smithsonian Institution, Departments of Entomology and Invertebrate Zoology, Museum Technician; 1987-1988
- Montgomery College, Department of Biology, Adjunct Professor and Lecturer; 1987

- The Ohio State University, Department of Entomology, Graduate Research/Teaching Associate; 1980-1986

Relevant Project Experience

Quality assurance, quality control, and uncertainty analysis for biological assessments Developed comprehensive process-control approach to isolating and evaluating potential sources of error that could lead to variability of biological assessment results. Procedure entailed specifying measurement quality and performance objectives for sequential phases of biological monitoring, including sampling design; field sampling; laboratory analyses; data entry, management, and analysis; and site and watershed/water body assessments. For State of Mississippi; developed comprehensive QA Plan and system of quality control checks and evaluations; established measurement quality objectives; directed field and laboratory audits and reporting system; evaluated duplicated data collection and analysis activities for precision, accuracy, bias, and other performance characteristics. Helped develop approach for documenting and communicating method performance using standard data quality characteristics as part of routine uncertainty analyses, leading to several publications, including his 2011 book chapter *Partitioning Error Sources for Quality Control and Comparability Analysis in Biological Monitoring and Assessment* (Chapter 4, IN, Eldin, A.B. [editor], *Modern Approaches to Quality Control*). Performed two different quality control exercises for the Maryland Biological Stream Survey (MBSS): evaluating the precision of taxonomic identifications of benthic samples; and the consistency of field sampling activity. In each, compared the relative percent differences and coefficients of variability of results from two independent taxonomists, and from two independent samples taken from the same stream reach. For U.S.EPA, Office of Water, authored document entitled "*Generic Quality Assurance Project Plan Guidance for Programs using Community-Level Bioassessment in Streams*".

Taxonomic data quality Dr. Stribling developed an innovative and unique approach for quantifying rates of taxonomic identification error in biological datasets used by routine monitoring and assessment programs. This quality control (QC) procedure allows unbiased (objective) documentation of the quality of data associated with taxonomic identifications. Ten percent (10%) of the samples are randomly-selected and shipped to a second taxonomist for QC identification, and the rates of error (disagreement) quantified as percent taxonomic disagreement (PTD). This technique has been applied to all of the USEPA national surveys, the National Wadeable Streams Assessment (WSA), the National Lakes Assessment (NLA), and the National Rivers and Streams Assessment (NRSA), which combined to a total of approximately 3,700 benthic macroinvertebrate samples. Dr. Stribling did detailed analysis of taxonomic comparison results, which has ultimately resulted in reduced error rates, through rigorous specification of taxonomic business rules, routine oversight, and recognition and communication of corrective actions to all laboratories and taxonomists. The documented error rate for the NRSA was 14.0%, for the NLA, 10.0%, and for the NRSA, 10.7%. Ultimately, this QC activity helped provide data of known quality and allowed a more defensible assessment of the nation's wadeable water resources. For approximately 8 years, he has applied the analysis approach routinely in smaller monitoring programs at state, county, watershed, and individual stream sampling initiatives, and is beginning to use it for biological assessment datasets of fish and diatoms.

Engineering and Scientific Technical Support for Water Quality Monitoring and Assessments, Watershed Management, and TMDL Activities. (Mississippi Department of Environmental Quality (MDEQ); 2005-2016). Dr. Stribling is the overall Program Manager providing technical support to the MDEQ Office of Pollution Control program in implementing the Clean Water Act. For over 10 years, he has personally performed or managed over 60 different projects including development of Quality Assurance Program Plans; training for field sampling and laboratory processing; instituting an ecological data management system; managing physical, chemical, and biological data from over approximately 3,000 samples and stream/river sites; calibration of multimetric biological indicators for wadeable streams and large rivers; development of nutrient criteria for flowing waters, lakes/reservoirs, and coastal estuaries; and the design of pilot studies for studying nutrient sources, fate, transport, and effects (SFTE) in coastal estuaries.

Design and Implementation of Sources, Fate, Transport, and Effects Studies for Pilot Nutrient Criteria in Inland Estuaries of the Northern Gulf of Mexico. (Gulf of Mexico Alliance, and the Mississippi Department of Environmental Quality; 2010-2013). Dr. Stribling developed a statistical sampling design, and a comprehensive field and laboratory QC program for developing pilot nutrient criteria for St. Louis Bay, Mississippi, and Weeks Bay, Alabama. He managed all aspects of sampling and analysis for hydrodynamic, meteorologic, field and laboratory water chemistry, benthic biological characteristics, and tidal features, including freshwater inflows in these estuaries. Analysis of the monitoring data and modelling of the interrelationships are allowing development of objective, numeric thresholds of nutrient concentrations for protection of aquatic life.

Benthic Indicator of Biological Integrity (Gulf Benthic Index [GBI]) for Estuarine and Near-Coastal Waters of the Gulf of Mexico. (Gulf of Mexico Alliance, and the Mississippi Department of Environmental Quality; 2010-2011). Dr. Stribling led a team of ecologists, along with specialists in statistical analysis and data management, in analyzing benthic sample data from over 1,500 sites, distributed from Puerto Rico and the USVI, through the FL Keys along the west coast of Florida, around to Brownsville, TX. Analyses resulted in three different indexes with a quantitatively acceptable rate of detecting environmentally stressed conditions. He developed an indicator that produces signals reflecting, in part, estuarine and near-coastal differences in salinity, dissolved oxygen, contaminated sediment, depth, physical habitat quality, and nutrient over-enrichment.

Rapid Bioassessment Protocols for Streams and Wadeable Rivers. Benthic Macroinvertebrates, Fish, and Periphyton. 2nd Edition. (USEPA/OWOW; 1998-99). Dr. Stribling was a primary co-author and technical lead in developing the second edition of this guidance document, which provide guidelines for field sampling and data analysis leading to stream and watershed assessments. The protocols are the basis of biological monitoring and assessment that have been customized by most states in the US, as well as for several international programs.

Calibration of the Ecological Response Model (ERM) for Metro Atlanta Urban Streams. (US Army Corps of Engineers – Mobile District; 2009- 2012). Dr. Stribling was the lead scientist and biologist evaluating the potential biological responses to stressor reduction activities in the ISIS watersheds. Modelled alterations in sediment input, hydrologic fluctuations, and overall physical habitat quality were evaluated as resulting from installation of stormflow management structures (best management practices [BMP]). He and his team quantified the potential for statistically meaningful improvement in biological condition, focused specifically on benthic macroinvertebrates and fish, as a result of these stressor control activities.

Countywide Biological Monitoring and Assessment of Streams and Watersheds (Prince George's County (Maryland) Department of Environmental Resources; 2010-2013). Dr. Stribling developed the statistical design for long-term monitoring of streams throughout the County's 41 subwatersheds of the Patuxent, Anacostia, and Potomac (non- Anacostia) Rivers contained by its land area. Since 1999, he has managed field sampling and laboratory and data analysis of two rounds of assessments, including of physical habitat, field water chemistry, and biological conditions (benthic macroinvertebrates and fish). He has applied the USEPA RBPs and the Maryland Biological Stream Survey benthic IBI to stream assessments and quantified (with known uncertainty) the proportion of stream miles that are degraded, and recommended stressor control activities, that is, BMPs, to help in stream rehabilitation.

Preliminary Draft Environmental Impact Statement (EIS) for the ACT-ACF Basins in Georgia and Alabama, USA. (US Army Corps of Engineers – Mobile District; 2008-2012). For the USACE-Mobile District, Dr. Stribling was lead author of the Biological Resources section of the Preliminary Draft Environmental Impact Statement (PDEIS) for the Alabama-Coosa-Tallapoosa (ACT) and the Apalachicola-Chattahoochee-Flint (ACF) basins. Effort focused on updating the 1998 DEIS to address potential operating alternatives and effects that might occur as a result of each of the alternatives, and deals with aquatic and riparian terrestrial habitat, and includes vegetation, mammals, birds, reptiles and amphibians, fish, and invertebrates, and compilation and review of Threatened and Endangered Species.

Developing the Second Generation of the Ecological Data Analysis System (EDAS2). (Mississippi Department of Environmental Quality (MDEQ); 2010-2012). Dr. Stribling led transition of the environmental monitoring and assessment database from the desktop MSAccess platform to web-based Oracle, with a .Net user interface. Oversaw migration of biological, physical, chemical, and hydrologic data from >1,800 stream and river sites, as well as development of code to provide calculations of QC statistics, primary biological metrics, and final condition index formulations. System features include direct linkages with ESRI ArcGIS functionality, with mapping and spatial analysis capabilities. EDAS2 currently houses all data and information used for the Mississippi-Benthic Index of Stream Quality (M-BISQ).

Selected Peer-Reviewed Publications, Book Chapters, and Relevant Reports

- Stribling, J.B.** 2011. Partitioning Error Sources for Quality Control and Comparability Analysis in Biological Monitoring and Assessment. Chapter 4 (pp. 59-84), IN, Eldin, A.B. (editor), *Modern Approaches to Quality Control*. ISBN 978-953-307-971-4. INTECH Open Access Publisher.
- Flotemersch, J.E., J.B. **Stribling**, R.M. Hughes, L. Reynolds, M.J. Paul, C. Wolter. 2011. Reach length for biological assessment of boatable rivers. *River Research and Applications* 27(4): 520-535 (published online 03/20/2010). doi: 10.1002/rra.1367.
- Stribling, J.B.**, K.L. Pavlik, S.M. Holdsworth, E.W. Leppo. 2008. Data quality, performance, and uncertainty in taxonomic identification for biological assessments. *Journal of the North American Benthological Society* 27(4): 906-919. doi: 10.1899/07-175.1.
- Flotemersch, J.E., J.B. **Stribling**, and M.J. Paul. 2006. *Concepts and Approaches for the Bioassessment of Non-Wadeable Streams and Rivers*. EPA/600/R-06/127. U. S. EPA, Office of Research and Development, National Exposure Research Laboratory, Cincinnati, OH. URL: <http://www.epa.gov/eerd/rivers/>
- Stribling, J.B.**, and S.R. Davie. 2005. Design of an Environmental Monitoring Program for the Lake Allatoona/Upper Etowah River Watershed. Proceedings of the Georgia Water Resources Conference. April 25-27, 2005. Kathryn Hatcher (editor). Institute of Ecology, University of Georgia, Athens, GA. 4 pp. (<http://cms.ce.gatech.edu/gwri/uploads/proceedings/2005/StriblingJ-GWRC%20paper%20revised.pdf>)
- Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. **Stribling**. 1999. *Revision to the Rapid Bioassessment Protocols for Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish. Second Edition*. EPA/841-D-97-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC. URL: <http://water.epa.gov/scitech/monitoring/rs1/bioassessment/index.cfm>

EDUCATION

B.S., Geography and Environmental Systems; University of Maryland, Baltimore County; 1998

YEARS OF EXPERIENCE

Tetra Tech: 15

Total: 15

AREAS OF EXPERIENCE

- Project/program management
- Sampling/monitoring
- Large monitoring study management
- Quality assurance/quality control
- Technical writing

OFFICE LOCATION

Owings Mills, Maryland

Ms. Jennifer Linder is a project manager and staff scientist for Tetra Tech. She has over fifteen years of experience in the water resource and environmental science fields, and has served as a project coordinator and manager for six national scale projects for the USEPA. She provides managerial and technical oversight on numerous, diverse projects on the local, state, and federal levels. She provides office-wide oversight for all technical proposals. She has extensive experience with technical trainings, public outreach, and document preparation and editing. Her fieldwork experience includes stream, large river, lake, wetland, and coastal bioassessment, including sampling of macroinvertebrates, fish, fish tissue, plankton, algae, vegetation, and sediment.

Employment History

Tetra Tech, Center for Ecological Sciences, July 1999 – present

USGS Patuxent Wildlife Research Center, August 1998 - July 1999

Relevant Project Experience

National Environmental Program Management Ms. Linder has served in a management and coordination role for the USEPA on their national survey programs. These include the ongoing National Aquatic Resource Surveys (NARS) and the National Study of Chemical Residues in Lake Fish Tissue. Ms. Linder managed the field sampling efforts and technical support for the NARS, including the Wadeable Streams Assessment (WSA), National Lakes

Assessment (NLA), National Rivers and Streams Assessment (NRSA), National Coastal Condition Assessment (NCCA), and National Wetland Condition Assessment (NWCA). She coordinated and conducted the field methods trainings across the country for federal, state, tribal, and contractor crews. She was the point of contact for technical questions for the field crews for the duration of the field sampling index period. She oversaw the field logistics and the equipment and supplies distribution, tracked the status of the sampling sites, and tracked the progress of the field teams. Ms. Linder coordinated the field sampling of fish for the National Fish Tissue Study, which investigated the prevalence of persistent, bioaccumulative, toxic chemicals in fish tissue from lakes and reservoirs of the United States. This involved managing the field sampling efforts and sample shipments of 48 state crews for a total of 500 lakes over a 5-year period. She oversaw the equipment and supplies distribution for the field crews. She was also responsible for updating and revising the EPA’s human health screening values for contaminants related to the study.

Bioassessment Ms. Linder is experienced in biological stream assessment and physical habitat assessment using the USEPA’s Rapid Bioassessment Protocols and the U.S. EPA’s Environmental Monitoring and Assessment Program (EMAP) methods. She has worked in diverse regions of the country, on both local and national projects, in 20 different states across the country. Ms. Linder was a member of the field crew for a USEPA pilot study to investigate the occurrence of pharmaceuticals and personal care products in fish tissue. The fish tissue was analyzed for 24 pharmaceutical compounds and 12 personal care product chemicals. She was involved in the initial project research and development, the field logistics planning, and overall coordination for the study. Ms. Linder was a member of a field crew for a pilot Clean Water Act Section 316(b) study intended to expand the current knowledge of water withdrawal effects at small facilities having cooling water intake structures. The study focused on obtaining entrainment and impingement data from six small facilities located in PA, NJ, and DE. The study involved extensive field sampling, ichthyoplankton sorting, database development, data entry, quality control, and data analyses.

Quality Assurance and Quality Control Development Ms. Linder has prepared QAPPs and ensured their execution for numerous national-scale bioassessment projects. She oversees the sampling and replacement of field sites for all the NARS projects to ensure adherence to the probabilistic study design. She prepared the field and laboratory auditing protocols and checklists for the NARS. She coordinated the field audits of over 175 field crews for the NARS (WSA, NLA, NRSA, and NCCA). She performed field visits and audits on many crews throughout these four NARS, and performed several laboratory audits. She assisted with the QC of fish tissue samples for analysis for the National Study of Chemical Residues in Lake Fish Tissue, the NRSA, and the NCCA.

Scientific Training and Public Outreach Ms. Linder developed the training workshop materials and presentations to be presented to EPA regional coordinators and sampling crews for the National Study of Chemical Residues in Lake Fish Tissue. She developed the training workshop materials and presentations for the USEPA's NARS (the WSA, the NLA, the NRSA, the NCCA, and the NWCA). She organized and oversaw the numerous webinars and on-site trainings throughout the country for the state, tribal, and contractor crews for each of these national-scale projects. She participated in the "Train the Trainer" workshop for all of the NARS, and served as a technical field trainer for every survey. Ms. Linder has developed fact sheets, website materials, and posters for technical conferences and symposiums for a variety of projects, including the USEPA's National Study of Chemical Residues in Lake Fish Tissue, the Pilot Study of Pharmaceuticals and Personal Care Products in Fish Tissue, the WSA, the NLA, and the NRSA.

Scientific Document Coordination and Preparation Ms. Linder was responsible for developing and editing the technical documents to support the USEPA's WSA, the NLA, the NRSA, the NCCA, and the NWCA. These documents include the Quality Assurance Project Plan, the Site Evaluation Guidelines, the Field Operations Manual, and the Laboratory Methods Manual that are used by all field and laboratory personnel. She also was responsible for developing and editing the Quality Assurance Project Plan and Field Sampling Plan for the USEPA's National Study of Chemical Residues in Lake Fish Tissue. She was part of the team of authors that produced the final study report for this project. She regularly provides technical editorial support in the preparation of technical reports and scientific manuscripts.

Selected Peer-Reviewed Publications and Technical Reports

Ramirez A.J., Brain R.A., Usenko S., Mottaleb M.A., O'Donnell J.G., Stahl L.L., Wathen J.B., Snyder B.D., **Pitt J.L.**, Perez-Hurtado P., Dobbins L.L., Brooks B.W., Chambliss C.K. Occurrence of pharmaceuticals and personal care products (PPCPs) in fish: Results of a national pilot study in the U.S. *Environmental Toxicology and Chemistry*. 2009. Vol. 28, 12: pp. 2587 – 2597. SETAC Press.

Stahl, L.L., B.D. Snyder, A.R. Olsen, and **J.L. Pitt**. Contaminants in Fish Tissue from U.S. Lakes and Reservoirs: A National Probabilistic Study. *Environmental Monitoring and Assessment*. 2009. 150: pp.3–19. Springer, Netherlands.

Olsen, A.R., B.D. Snyder, L.L. Stahl, and **J.L. Pitt**. Survey Design for Lakes and Reservoirs in the United States to Assess Contaminants in Fish Tissue. *Environmental Monitoring and Assessment*. 2009. 150: pp. 91–100. Springer, Netherlands.

EDUCATION

B.S., Business Administration,
Glendale University, 2009

YEARS OF EXPERIENCE

Tetra Tech: 12

Total: 32

PROFESSIONAL AFFILIATIONS

American Society for Quality

AREAS OF EXPERIENCE

- Quality assurance, Quality system development and implementation
- Quality documentation development (including Quality Management, Sampling and Analysis, Quality Assurance Project Plans, and standard operating procedures)
- Sampling design and implementation
- Environmental monitoring and data collection
- Data validation, verification, and interpretation – data quality and usability assessments
- Method development
- Clean Water Act Support
- Technical writing

OFFICE LOCATION

Fairfax, VA

John O'Donnell is an environmental quality assurance chemist with over 30 years of experience providing technical support to federal, state, regional, municipal, and private clients in the areas of quality systems development and implementation. Mr. O'Donnell is responsible for the overall management of the quality system for Tetra Tech's Fairfax Center offices. He has assisted in the development and implementation of quality systems and documentation to support multiple primary data collection programs (monitoring plans); assisted in the oversight of quality systems implementation; and conducted field, laboratory, and project audits and procedural reviews (surveillance) for the Texas Commission on Environmental Quality (TCEQ; Middle Brazos Dissolved Oxygen Study). Mr. O'Donnell also participated in the U.S. Environmental Protection Agency (EPA) Office of Science and Technology (OST) National Pilot Study of Pharmaceuticals and Personal Care Products (PPCPs) in Fish Tissue; EPA's Office of Wetlands, Oceans, and Watersheds (OWOW) National Aquatic Resource Surveys (NARS) including the Wadeable Streams Assessment (WSA), National Lakes Assessment (NLA), and National Rivers and Streams Assessment (NRSA); EPA Region 6 Best Practices Procedural Reviews for Toxic Metals Sampling and Analysis; EPA Regions 9 and 10, California EPA and Oregon Department of Environmental Quality's (ODEQ) Data Collection for Physical, Chemical, and Biological Characterizations of the Lost and Klamath Rivers; and the U.S. Army Corps of Engineers (USACE) Mobile District Long-Term Monitoring of the Lake Allatoona/Upper Etowah River Watershed, Georgia. Each of these efforts included either development or participation in the development of quality system guidance for multidiscipline field and laboratory measurements and data collection; procedural reviews, audits, and surveillance support; corrective action implementation and verification; and data verification, validation, and interpretation. He provides extensive technical support for the development and implementation of quality control (QC) and quality assurance (QA) activities and protocols to support water resources management; watershed and water quality assessment and data collection; best management practice (BMP) performance assessment; watershed modeling; total maximum daily load (TMDL) development; and water quality criteria and standards development for EPA. Throughout his career, Mr. O'Donnell has provided significant technical input and participated in the writing and development of many large quality system documents including numerous quality assurance project plans (QAPPs) and standard operating procedures (SOPs). At Tetra Tech he has supported development of many larger technical documents, most of which relate to implementation of regulatory compliance (monitoring and reporting requirements). Mr. O'Donnell currently serves as the QA manager for Tetra Tech's Fairfax Center offices and as QA officer on a number of EPA contracts including large, multidiscipline technical support contracts for the Office of Wastewater Management (OWM) and OWOW Assessment and Watershed Protection Division (AWPD).

Employment History

Tetra Tech, Inc., Environmental Quality Assurance Chemist, 2002–present

Quanterra / Severn Trent Laboratories, Inc., Customer Service Manager and Laboratory Director, 1998–2001

EA Laboratories, Project Manager and Section Chief, 1994–1997

Versar Laboratories, Inc., Environmental Chemist and Division Manager, 1982–1994

Project Experience

National Pilot Study of PPCPs in Fish Tissue (EPA OST; 03/06–present). Provides quality systems development and implementation support to OST for laboratory analysis of PPCPs in edible fish tissues and organ-specific analysis (livers). The pilot study included sampling and analysis of fish tissue samples from five effluent-dominated streams and one reference site. Quality system support included development of detailed statement of work for laboratory subcontracting; revision and refinement of the project QAPP and SOPs; ongoing procedural and technical project reviews and assistance visits; verification of analytical results; and summarizing findings. The PPCP pilot study resulted in three separate articles in peer-reviewed literature, in addition to poster presentations and discussions in national and international conferences. PPCPs remain an emerging contaminant focus in EPA's ongoing NARS conducted by OWOW, OST, and EPA's Office of Research and Development (ORD).

National Aquatic Resource Surveys (EPA OWOW; 2004–present). Schedules and coordinates field procedural reviews and assistance visits to over 100 field sampling teams over the 2 programs. The WSA and NLA were nationally orchestrated probabilistic sampling programs designed to report on the condition of the nation's surface waters. The WSA was conducted across 36 states in 7 EPA regions by over 30 EPA, state, and contractor collaborator and grantee teams trained specifically in project data collection protocols. Each team was then visited early in their sampling season to complete team qualifications (having been trained and audited by EPA-WSA staff), and to ensure adherence to WSA sampling protocols and implement real-time corrective action where necessary to optimize the data collection during the sampling season. Field audit and assistance visits were coordinated through EPA regional monitoring coordinators to facilitate early audits and corrective actions to minimize data qualification in the collection of water quality and macroinvertebrate samples and the collection of data for geomorphologic and physical habitat assessments in each of the 700 streams visited during the sampling season. The NLA was conducted across the lower 48 contiguous states and Alaska by over 70 individual sampling teams through over 1,000 site visits. Like the WSA, the NLA required project-specific training at EPA-sponsored training sessions, as well as field audits and assistance visits for each of the data collection teams. Sample collection for the NLA included additional indicators for sediment diatoms and mercury in core samples, as well as phytoplankton and recreational pathogen indicators at each location.

Participates in OST's Fish Tissue Study Support Team oversight of fish tissue indicators in more recent NARS work, including the National Rivers and Streams Assessment (NRSA 2008–2009 and 2013), which includes the former WSA and non-wadeable waters, and the National Coastal Condition Assessment (NCCA 2010), which included the Great Lakes Human Health Fish Tissue Study. OST's participation in the NARS focused on fish tissue and human health conditions of the nation's waters. Reviewed procedures and laboratory data, and participated in development of technical reports for fish tissue indicators including metals, legacy organics, and emerging contaminants such as PCPPs and musks, polybrominated diphenylethers (PBDEs), omega-3 fatty acids, and perfluorinated compounds.

Gulf of Mexico Nutrient Criteria Pilot Study (Mississippi Department of Environmental Quality [MDEQ] under EPA Gulf of Mexico Program Office Grant; 2009–2012). Assisted in the development of pilot monitoring designs and quality assurance plans to guide data collection supportive of nutrient criteria development. The pilot consisted of assembling candidate indicators from EPA, researchers and stakeholders in the Gulf region, and modeling and monitoring experts to develop a core monitoring program that establishes links between nutrient concentration and conditions and biological response. The pilot was developed to identify key indicators of water quality and associated measurement protocols and performance metrics in addition to biological measures to assist in developing site-specific standards. The pilot was implemented in two Gulf estuaries and compared to data collections and research conducted by others in three additional study areas.

Klamath River Basin Monitoring and Hydrodynamic and Water Quality Modeling Support (Oregon, California, and EPA; 2004–2007). Oversaw the primary data collection efforts for Oregon, California, and EPA in the 15,700 mi² Klamath River and Lost River basins. Assisted in the design of a comprehensive monitoring plan to conduct a series of sampling events that included physical, chemical, and biological monitoring (including sediment oxygen demand and periphyton surveys) at over 30 independent sites throughout the semi-arid, high-desert region of the basins. The sampling design addressed the needs of proposed hydrodynamic and water quality models. Developed procurement documents and relevant technical specifications to address laboratory analysis of surface

water samples collected in the basins, conducted negotiations with qualified respondents and developed detailed statements of work for award of the subsequent subcontract agreement. Assisted with developing the quality system documents to describe the requirements of the monitoring design and subsequent field data collection operations (Sampling and Analysis Plan [SAP]), and developed the detailed QAPP for review and approval.

Conducted field and laboratory procedural reviews concurrent with the first field mobilization to ensure complete understanding of field sampling protocols and laboratory requirements to optimize data quality for this important data collection, and retained primary oversight for field and laboratory activities throughout the data collection, including providing technical direction for selection of corrective action in instances of nonconformance in measurement system performance. Conducted primary laboratory measurements for nutrient and bacteriological impairments, and to characterize overall oxygen budget within the system. Provides continual support to modeling staff in interpretation of analytical measurement data and reports for monitoring conducted within the basin by other stakeholders.

Water Quality Monitoring for EPA Region 2 in the U.S. Virgin Islands (EPA Region 2; Spring 2007).

Developed and implemented quality system documents to support the primary data collection for the dissolved oxygen and overall oxygen budget (including sediment oxygen demand, respiration, diffusion, and productivity) investigation within St. Thomas Harbor in St. Thomas and Coral Bay on St. John in the U.S. Virgin Islands (the approved project QAPP). Conducted field procedural reviews for sample collection and in situ field measurements conducted within the study areas, and continued to support modeling staff in the interpretation and use of field and laboratory analytical results. Under this task order, Tetra Tech selected a field investigation team internationally recognized for their specialization in oxygen budget monitoring design and measurement.

Brazos River Basin (Basin Group D) Dissolved Oxygen TMDL Study (Texas; 2001–2005). Developed and formalized a water quality and biological monitoring plan in a project SAP to provide the necessary data to assess the status of impaired streams for modeling studies, Use Attainability Analyses (UAA), and TMDL development. Developed a QAPP to govern monitoring studies (biological and habitat assessments), laboratory analyses, data management, and reporting. In 2003 and 2004, conducted physical, biological, and chemical monitoring in two of the three creeks suspected to be impaired for dissolved oxygen. Monitored stream segments regularly for 2 years. In support of the QA function, updated the QAPP and SAP to reflect revised TCEQ program monitoring objectives scope (elimination of one of the three segments proposed for detailed investigation). Developed detailed statements of work to contractually direct quality requirements of the laboratory service subcontractors. Conducted annual on-site (field) sampling procedural reviews and laboratory technical project audits to ensure attainment of project goals, compliance with program requirements, and to verify adequacy of procedures and documentation. Prepared procedural review and audit reports detailing observed deficiencies (findings), required corrective actions, and recommendations (observations).

Selected Peer-Reviewed Publications and Technical Reports

- Mottaleb MA, Usenko S, O'Donnell JG, Ramirez AJ, Brooks BW, Chambliss CK. 2009. Gas chromatography-mass spectrometry screening methods for select UV-filters, synthetic musks, alkylphenols, an antimicrobial agent, and an insect repellent in fish. *Journal of Chromatography A*, 1216 (2009) 815–823.
- O'Donnell JG. 2005. Quality Assurance Documentation to Support Collection of Secondary Data Presented at USEPA 24th Annual Conference on Managing Environmental Quality Systems, April 2005.
- Ramirez AJ, Brain RA, Usenko S, Mottaleb MA, O'Donnell JG, Stahl LL, Wathen JB, Snyder BD, Pitt JL, Perez-Hurtado P, Dobbins LL, Brooks BW, Chambliss CK. Occurrence of pharmaceuticals and personal care products (PPCPs) in fish tissues: Results of a national pilot study in the U.S. *Environ Toxicol Chem.* 2009, 28, 2587 – 2597.
- Stahl LL, Wathen JB, Snyder BD, O'Donnell JG, Pitt JL. 2007. Poster "EPA Pilot Study of PPCPs in Fish Tissue" presented at 2007 National Forum on Contaminants in Fish (in Portland, ME on 23-26 July 2007), and the SETAC North America 28th Annual Meeting (In Milwaukee, WI on 11-15 November 2007).

EDUCATION

M.S., Environmental Sciences (Environmental Toxicology Concentration), Rutgers University, 2000

B.S., Environmental Science, Long Island University, 1995

YEARS OF EXPERIENCE

Tetra Tech: 13

Total: 17

PROFESSIONAL AFFILIATIONS

Society of Environmental Toxicology and Chemistry

AREAS OF EXPERIENCE

- Quality assurance/quality control
- Clean Water Act support
- Technical writing
- Permit support
- Guidance development
- Water quality assessment
- Air quality assessment
- Meeting planning

OFFICE LOCATION

Fairfax, VA

Susan Lanberg has more than 13 years of experience with Tetra Tech and more than 3 years of consulting experience at an environmental firm specializing in air pollution monitoring and contaminant analyses. At Tetra Tech, Ms. Lanberg provides support to the quality assurance (QA) program, preparing quality management plans, quality assurance project plans (QAPPs), standard operating procedures (SOPs), and other documents; conducting laboratory, field, and system audits; and reviewing and validating environmental data. She is adept at overseeing and participating in the development of technical documents, including U.S. Environmental Protection Agency's (EPA's) Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion and associated responses to public comments, responses to public comments received on EPA's Multi-Sector General Permit for stormwater discharges from industrial activities, and contaminant fact sheets for the Environmental Monitoring for Public Access and Community Tracking (EMPACT) project. Ms. Lanberg provides QA oversight for the development of the Technical Support Document for EPA's proposed rule for numeric nutrient criteria for Florida's estuaries, coastal waters, and South Florida inland flowing waters. Her technical expertise includes toxicology, water chemistry, and microbiology. Ms. Lanberg manages EPA's Federal-State Toxicology and Risk Analysis Committee (FSTRAC) meeting for the Health and Ecological Criteria Division (HECD) in EPA's Office of Science and Technology (OST). She has used her technical expertise to implement quality control (QC) aspects of surveys to collect environmentally related data (National Health Protection Survey of Beaches, Clean Watersheds Needs Survey); research pathogens found in sewage, swimmer illnesses, and bacterial indicator relationships for the economic analysis of EPA's proposed rule for sanitary sewer overflows (SSOs) and combined sewer overflows (CSOs); and prepare National Pollutant Discharge Elimination System (NPDES) MS4 permits. Ms. Lanberg also worked in an environmental testing laboratory, where she acquired knowledge of gas chromatography (GC); gas chromatography/mass spectrometry (GC/MS); wet lab; and QA/QC procedures used in the analysis of drinking water, ground water, surface water, other liquids, soil, sludge, and air samples using EPA methods.

Employment History

Tetra Tech, Inc., Environmental Scientist and Quality Assurance Officer, 2000-present

RTP Environmental Associates, Inc., Environmental Scientist, 1995–1998

Pedneault Associates, Inc., Laboratory Technician, 1992–1993

Relevant Project Experience

Florida Nutrient Criteria Development (EPA OST / Standards and Health Protection Division [SHPD] and HECD; 01/10–present). Prepares QAPPs for Nutrient-Scientific Technical Exchange Partnership System (N-STEPS) – Secondary Data Analysis; Scientific Study and Modeling for Mississippi River and Gulf of Mexico Nutrient Criteria Development; and Model Development in Support of Numeric Nutrient Criteria in Florida

Estuaries. Reviews and edits draft and final technical support documents that describe the data and methodologies used by EPA to determine the proposed criteria for Florida's estuaries, coastal waters, and south Florida's inland flowing waters. Reviews internal coding of public comments received on the proposed criteria for accuracy.

Federal-State Toxicology and Risk Analysis Committee (EPA OST/HECD; 06/07–present). Provides management and technical support for the FSTRAC on-site meetings and webinars. When on-site meetings are planned, oversee and participate in securing meeting space and audiovisual equipment, setting up the online meeting registration system, maintaining version control of presentations provided by technical speakers, preparing meeting agendas, and facilitating funding for several technical speakers to enable them to attend the meeting. Transcribes notes during the meetings or webinars and subsequently prepares meeting summaries. Updates text for the FSTRAC website as needed, including membership information, meeting agendas, upcoming activities, meeting registration, and basic background information and history. Provides information to the FSTRAC membership through email, including information on upcoming activities and availability of final meeting summaries.

Technical Support for Assessing the National Extent of Compliance with EPA's Water Quality Standards for Bacteria and Examining the Potential Risks to the Nation's Bathing Beaches and Other Recreational Waters (EPA OST/SHPD; 01/01–present). Assists in conducting a survey of county public health agencies to examine swimming beach monitoring programs. Assists in developing bathing beach advisories, as well as implementing freshwater and marine beach advisories and closures in the United States. Checks surveys for accuracy and completeness, contacts survey respondents for corrections and clarifications, and assists in tracking surveys throughout the internal review process. Assists in developing draft sanitary survey sampling forms and guidance. Acted as interim project manager for the Great Lakes Beaches Sanitary Survey project in summer of 2007. Prepared QAPP for data collection and analysis of data collected under the EPA Beach Program. Assisted in preparing Information Quality Guidelines checklists and supporting information for all public documents prepared for the project.

QA/QC Support for EPA Contracts (EPA OST/SHPD, OST/EAD, OWM, OWOW, and EPA Regions; 08/00–present). Serves as QA Officer for the EPA/OST SHPD contract for assessing, managing, and communicating the ecological and human health risks of contaminants in water, fish and sediments and microbial pathogens in surface waters. Prepares QAPPs for collecting primary and secondary data in accordance with *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5) for several EPA OST projects, including N-STEPS – Secondary Data Analysis, Collection of Data for Calibrating EPA's Quantitative Microbial Risk Assessment Methodology and Anchoring Results to an Epidemiology Data Collection Effort, Predictive Modeling Protocol Development (Part 2), Sensitivity Analysis on Freshwater Epidemiology Study Data, and Designated Uses Clearinghouse for performing use attainability analyses. Prepares QAPPs for collecting samples and measuring physicochemical parameters for regulatory support of effluent limitations guidelines and standards for aquaculture, meat processing, and construction and development industries. Prepares QAPPs and SOPs for reviewing environmentally related secondary data using the CWNS 2000 database and conducts precision and accuracy checks for CWNS 2000 and CWNS 2004 data evaluations. Performs data quality assessments of analytical data provided by aquaculture and meat and poultry processing facilities for adherence to QC documented in the project QAPPs. Assists in developing quality management plans (QMPs) based on *EPA Requirements for Quality Management Plans* (EPA QA/R-2).

Multiservice Environmental Consulting for Automation Technologies and NPDES Requirements (Prince George's County, Maryland; 2003–2011). Provided QA support for water quality monitoring projects performed to satisfy the county's NPDES permit requirements. Performed internal field audits of sampler maintenance procedures and stormwater sampling procedures. Assisted in developing and updating SOPs for water quality monitoring.

Guidance for CSO Post-Construction Compliance Monitoring (EPA OWM; 02/09–06/09). Co-authored text for the *CSO Post-Construction Compliance Monitoring Guidance* document. Assisted in reviewing text from subcontractor staff to ensure it was accurate and that it followed the client-approved outline or provided reasons explaining why text differed from the outline. Prepared a section on developing project planning documentation, including how to prepare QAPPs, SAPs, and SOPs for CSO post-construction compliance monitoring. Tracked edits in the draft guidance document to help ensure they were either addressed or discussed with the EPA WAM.

Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion (EPA OST/SHPD; 12/06–03/08). Participated in the development of methylmercury water quality criterion implementation guidance for EPA OST/SHPD. Prepared corresponding draft responses to public comments, including those related to recommended analytical methods for analyzing methylmercury and issues related to developing total maximum

daily loads (TMDLs) and permits. Corresponded with EPA staff to obtain technical direction in developing responses to public comments. Tracked and incorporated EPA edits to the implementation guidance. Performed QC checks of subcontractor-submitted information to ensure information was complete and correct.

Technical Support for Development of Aquaculture and Meat and Poultry Products Industry Effluent Limitations Guidelines (EPA OST; 10/00–06/03). Prepared QAPPs for collecting samples and measuring physicochemical parameters for regulatory support of effluent limitations guidelines and standards for aquaculture and meat processing operations. Performed data quality assessments of analytical data provided by aquaculture and meat and poultry processing facilities for adherence to quality criteria documented in the project QAPPs.

303(d) List Assessment and Calibration of the Index of Biological Integrity for Wadeable Streams and the 303(d) Monitoring and Assessment of Wadeable Streams in Mississippi (Mississippi Department of Environmental Quality; 2000–2003). Prepared a QAPP for the 303(d) list assessment and calibration of the index of biological integrity for wadeable streams in Mississippi. Performed field and laboratory audits for 303(d) monitoring and assessment of wadeable streams to determine conformance with the SOPs included in the QAPP and to ensure that data collected for this project were appropriate for use in assessing the ecological impairment of wadeable streams in Mississippi.

Technical Support for Development of Shenandoah PCB TMDL (EPA Region 3; 2001–2002). Developed a QAPP for EPA Region 3 for collecting and analyzing environmental data from a section of the Shenandoah River to support the development of the Shenandoah (PCB) TMDL for EPA Region 3. Assisted in developing the SOPs for collecting water, sediment, and sessile benthic organisms for PCB analysis.

Technical Support for Region 8 Multi-State Nutrient Criteria Pilot Study (EPA Region 8; 06/01–03/02). Prepared a QAPP for the EPA Region 8 multi-state nutrient criteria pilot study to improve the overall understanding of nutrient causes and effects for state agencies in Region 8 required to develop nutrient TMDLs. Coordinated development of, compiled, and described SOPs and QA/QC procedures to be used for collection and analyses of chemical, periphyton, and benthic macroinvertebrate samples by different laboratories and different state agencies in the QAPP.

Technical Support for Development of Idaho TMDL (EPA Region 8; 07/01–12/01). Developed a QAPP for collecting and analyzing environmental data from Black Lake, Coeur d'Alene Reservation, Idaho, to establish the level of nutrient pollution in the sediment of Black Lake. Used this information to determine whether a TMDL should be developed for this water body. Compiled information for and assisted in preparation of SOPs for collection of sediment cores in Black Lake for dating and total phosphorus analysis.

Selected Peer-Reviewed Publications and Technical Reports

Adair, S. 2000. The Effects of Single Compounds and Complex Mixtures of Compounds Found in Wood Preservatives on Embryos of the Japanese Medaka (*Oryzias latipes*). Master's Thesis, Graduate School - New Brunswick, Rutgers, the State University of New Jersey.