Antimicrobial Resistance Mitigation [ARM] Concept Paper

Project Lead

Vikesland (*Civil and Environmental Engineering*; COE). Development of nanotechnology based analytics for the study of antimicrobial resistance dissemination.

Core Project Team

Alexander (*Fish and Wildlife Conservation*; CNRE). Expertise in the spread of antimicrobial resistance both within and between different environmental reservoirs, wildlife, and human populations.

Badgley (*Crop Soil and Environmental Sciences*; CALS). Application of environmental genomics to determine the fate of microorganisms in natural and engineered systems.

Krometis (*Biological Systems Engineering*; CALS and COE). Identification and tracking of waterborne agents responsible for disease.

Knowlton (*Dairy Science*; CALS). Excretion and environmental fate of antibiotics and ARGs by livestock.

Gohlke *(Population Health Sciences*; VMCVM*).* Expertise in environmental epidemiology approaches and toxicology. Current projects focus on population-level outcomes (mortality, birth outcomes) associated with environmental factors related to global change (extreme heat events, resource extraction methods).

Hall (*Urban Affairs and Planning*; CAUS). Evaluation of the financial and technical sustainability of water supply and sanitation services in developing countries.

Hawley (*Biological Sciences*; COS). Impacts of antibiotic use on pathogen virulence.

Heath (Computer Science; COE). Development of computational tools for the evaluation of next-generation sequencing data.

Hession (*Biological Systems Engineering*; CALS and COE). Bacterial transport in the environment and influence of human activity on streams.

Hull (*Forest Resources and Environmental Conservation*; CNRE). Sustainable development in the face of converging demographic, environmental, governance, and market transformations.

Moeltner (*Agriculture and Applied Economics*; CALS). Environmental economics and the valuation of natural resources and environmental amenities.

Ponder (*Food Science and Technology*; CALS). Microbial ecology of agricultural commodities, effects of food processing, and the interactions of pathogens and antimicrobial resistant bacteria with the gut microbiome.

Pruden (*Civil and Environmental Engineering*; COE). Quantification and Mitigation of antimicrobial resistance dissemination via natural and engineered environments.

Schoenholtz (*Virginia Water Resources Research Center; Forest Resources and Environmental Conservation*; CNRE). Development and coordination of interdisciplinary undergraduate and graduate curricula in water resources. Expertise in influence of human activities on water and soil quality.

Wu (*Statistics*; COS). Statistics, stochastic processes, and statistical genetics.

Xia (*Crop Soil and Environmental Sciences*; CALS). Quantification of antibiotics and evaluation of antibiotic fate in natural and engineered systems.

Zhang (Computer Science; COE). Development of computational tools for the evaluation of next-generation DNA sequencing data and identification of critical control points for dissemination of antibiotic resistance.

Vision Statement The development of viable solutions to the global threat of antimicrobial resistance requires a transdisciplinary approach that simultaneously considers the clinical, biological, social, economic, and environmental drivers responsible for this emerging threat. The vision of the Antimicrobial Resistance Mitigation (ARM) group is to build upon and leverage the present strengths of Virginia Tech in ARM research and education using a multifaceted systems approach. Such a framework will empower our group to recognize the interconnectedness and interdependent nature of this threat and enable the delineation, development, and testing of resilient approaches for its mitigation. We seek to develop innovative and sustainable approaches that radically advance detection, characterization, and prevention of antimicrobial resistance emergence and dissemination in human-dominated and natural settings. This effort builds upon over $10 million of currently funded research and brings together faculty from the Colleges of **Agriculture and Life Sciences (CALS)**, **Architecture and Urban Studies (CAUS)**, **Engineering (COE)**, **Natural Resources and Environment (CNRE)**, **Science (COS)**, and the **Virginia-Maryland College of Veterinary Medicine (VMCVM)**. The ARM group is highly collaborative as evidenced by NSF funding for the *Halting Environmental Antimicrobial Resistance Dissemination [HEARD]* PIRE Project and USDA funding for the *Reducing Antibiotic Resistance from Farm to Fork* Projects. The combination of these multi-million dollar projects with other antibiotic resistance or infectious disease focused efforts across Virginia Tech provides a nationally and internationally recognized platform that will grow in scale and societal relevance with strategic investment from the university.

Relevance The Global Systems Science (GSS) destination area focuses on critical problems that simultaneously affect both natural and human systems. Resilient solutions to GSS challenges will require the restructuring of research and education using an interdisciplinary perspective that is integrated in a meaningful, quantitative manner based on a solid foundation of systems science. ARM is a cross-boundary global challenge with implications not only for humans, but also for animals and ecosystems [***Figure 1***]. Because antimicrobial resistance does not respect international borders it must be addressed locally, regionally, and internationally. As such, a holistic approach that considers not only the science underlying the spread of resistance, but also the economic, political, and social factors that contribute to its dissemination is required. Such a multi-faceted approach is the only means to feasibly mitigate the spread of resistance. To our knowledge there is no university in the country attempting to holistically address the challenge of ARM. Most programs focus on antimicrobial resistance either in a clinical or an agricultural setting, with only a few considering the important role of interactions between humans, animals, and the environment. ARM is truly transdisciplinary and will simultaneously address resistance from a number of different perspectives. For example:

Globalization. Increased population densities in urban centers are a key aspect of most approaches to achieve global sustainability. In the absence of thoughtful planning, however, increased population densities often result in concomitant increases in the local spread of infectious disease. Antimicrobial resistance threatens to make this planning challenge even worse, such that one could plausibly die from something as benign as a simple cut to the skin if it were to be infected by a resistant bacterial strain. Failure to address these challenges may result in population-level transitions such that infectious diseases, which are no longer the primary cause of death in much of the world, rebound and once again afflict people globally. To have any hope of understanding these highly inter-related systems requires the development and implementation of data analytics approaches that can reliably process and interpret the 'big data' found in publicly available databases (e.g., census, economic, GIS, climate) and couple it with the shot-gun metagenomic data (and the corresponding metadata) being generated by next-generation DNA sequencing approaches.

Agriculture. Smart and sustainable agricultural production and food security will require means to efficiently produce food with minimum input of resistant bacteria to the environment and transmission of resistance from farm to fork. To meet this goal requires alternatives to antibiotics, better understanding of how ecosystem processes control natural levels of resistance among microorganisms, as well as identification of best management practices that allow beneficial use of manure, often enriched with antibiotics, antibiotic resistant bacteria, and antibiotic resistant genes, as a soil amendment, while reducing the risk of spreading resistance. New federal policy, such as the Veterinarian's Feed Directive that bans the use of antibiotics as a growth promoter, places pressure on the need for alternatives and based on the EU experience will be associated with increased therapeutic use of antibiotics. Research is required to continue to inform science-based policy that effectively limits the spread of antimicrobial resistance.

Economics. The economic implications of ARM are manifold, ranging from the design of incentives for producers and consumers to avoid or mitigate the amplification and spread of resistance, to the valuation of the economic benefits of curbing resistance. The latter can take the form of higher future profits for producers,

a reduction of future health costs and morbidity on the consumer end, and the avoidance of loss of productivity for both sides. In many cases, this process requires the collection and analysis of large, complex, and spatially explicit data on producers' decisions, consumers' choices, and medical outcomes, stressing the importance of modern data analytical methods as envisioned in the Data Analytics and Decision Sciences (DADS) destination area.

Given the importance of the threat of resistance to the global economy there is rapidly growing support for programs that fund research in this area both nationally and internationally. Within the U.S. the majority of this research has been funded by the NIH to evaluate the clinical implications of resistance, with considerably less supported by NSF, USDA, and other federal agencies. At the international level, NGOs such as the Bill and Melinda Gates Foundation, the Wellcome Trust, and others also support ARM research. In addition, cross-national groups such as USAID, the WHO, and the World Bank have programs examining ARM from an international health perspective. **With seed funding from the GSS DA, we will 1) develop the core research program required for development of a NSF Science and Technology Center (STC) or equivalent proposal that expands upon our existing NSF PIRE and USDA grants, and 2) comprehensively evaluate the capacity for VT to compete for funding opportunities from Federal and International funding agencies**. A STC proposal is a logical extension of the existing multimillion dollar PIRE and USDA grants and would expand the number of VT faculty involved in these important efforts.

The concept outlined herein is pertinent not only to the GSS Destination Area, but also to the DADS, Integrated Security (IS), and Intelligent Infrastructure for Human-Centered Communities (IIHCC) DAs as well as the Policy and the Economical and Sustainable Materials Strategic Growth Areas (SGAs) [***Figure 2***]. As of 2006, the world population is now predominantly urban and it will become increasingly so in the coming decades. To ensure the security of the villages, cities, and megacities of the future they must be intelligently developed in a manner that not only considers human needs, but also the needs of the natural and engineered ecosystems that surround and support them. Continued survival of humanity requires smart and sustainable agriculture, clean water, and food security. ARM represents an opportunity to not only address a critical national and international issue directly relevant to the GSS, but also to use the research and educational tools developed here as a framework for how to address other pressing GSS issues in an integrated manner that connects with the other DAs and SGAs.

Curriculum Opportunities **Our educational objective is to train students to develop sustainable solutions to the challenge of antimicrobial resistance and ensure that they simultaneously recognize that viable solutions require transdisciplinary approaches and skills**. Antimicrobial resistance is truly a transdisciplinary problem with potential solutions requiring an understanding of science, engineering, medicine, economics, policy, and many other fields. No one individual or discipline has the capacity to solve such a complex issue. To holistically address this challenge requires the development of research teams that are well-versed in the language not only of their own fields, but also of those with whom they work and collaborate. As such, the ARM program will build upon the experience gained from faculty participation in the Global Change, Sustainable Nanotechnology, and Water INTERface IGEPs as well as the USDA Agricultural Sources of Antimicrobial Resistance (AgSOAR) training program, the Translational Biology Undergraduate Program, the Public Health Program, the Environmental Science Program, and the Water Resources, Policy, and Management Degree Program. At the outset of ARM, we will augment these existing programs by incorporating modules focused on antibiotic resistance in existing courses as well as by offering new courses at both the undergraduate and graduate level that bring together students from different parts of campus [***Table 1***]. These ARM 'capstone' courses are intended to facilitate intra-team communication and will explicitly include communication-based activities that teach how to communicate with stakeholders, legislators, other scientists, and the general public. These courses will incorporate experiential learning activities (both locally and internationally) that will develop knowledge and augment the production of VT-shaped students with expertise in a core-subject area. These students will have the capacity not only to apply their knowledge to the critical problem of antimicrobial resistance, but will do so in a manner that benefits society. These skills will provide ARM students with the critical ability to solve other complex (i.e., *wicked*) problems of the 21st century.

Description of Resource Needs Antimicrobial resistance is a threat to both people and the animals with which they come into contact. As described herein, VT has broad expertise in delineating the microbiology, ecology, and environmental dissemination of resistance. This expertise has made VT a global player in community-derived resistance; however, to date, VT has made only minor inroads in NIH funding or in clinically focused resistance research. To better access such opportunities and build upon our existing strengths, we will enhance ARM with five targeted faculty hires that span the institution: 1) human health epidemiologist, 2)

public policy, 3) clinical antimicrobial resistance, 4) quantitative microbial risk assessment, 5) microbial ecology. The tenure homes for these hires will of course depend on the hiring strategies of the pertinent colleges and departments involved in ARM. However, we expect that the hires will be allocated across a range of colleges (including the Virginia Tech-Carilion School of Medicine). To ensure the smooth operation of ARM, these FTEs and the overall group will be supported by a Ph.D. level administrator (Research Scientist) whose purpose is to bridge cross-campus divides and enhance group productivity.

The $75,000 budget for the June 2017-June 2018 period will provide 1) 6 months of support for the Research Scientist charged with the initial implementation of this combined research and education plan; 2) A one course buyout for the project lead (or a surrogate) in Spring 2018. This individual will use this time to coordinate the project, organize on-campus interviews, and direct the submission of a NSF STC proposal. [It is assumed that job advertisements for the five FTEs will be developed and finalized in Summer/Fall 2017 with applications due in Fall 2018 and on-campus interviews in early Spring 2018. This schedule is of course dependent on the timing of the availability of the FTEs.]; 3) $10,000 in unrestricted funds for transdisciplinary research in support of the planned STC submission in Spring 2018; 4) Any remaining funds will be used to support an on campus research symposium that includes outside antimicrobial resistance experts who will provide expert advice about the research and teaching priorities of ARM. A subset of these experts will be asked to serve either as collaborators on or External Evaluators for the STC proposal.

Appendix I - Biosketches

Peter Vikesland
Professor
Virginia Tech, Department of Civil and Environmental Engineering, Blacksburg, VA 24061
540-231-3568
pvikes@vt.edu

(a) Professional Preparation

A list of the individual's undergraduate and graduate education and postdoctoral training as indicated below:

Grinnell College	Grinnell, IA	Chemistry	B.A. 1993
University of Iowa	Iowa City, IA	Civil and Environmental Engineering	M.S. 1995; Ph.D. 1998
Johns Hopkins	Baltimore, MD	Geography and Environmental Eng.	1999-2001

(b) Appointments

Professor	Virginia Tech	2013-Present
Associate Professor	Virginia Tech	2007-2013
Assistant Professor	Virginia Tech	2002-2007
Postdoctoral Fellow	Johns Hopkins University	1999-2001

(c) Products

(i) up to five **products** most closely related to the proposed project

1. Dai, D.; Prussin, A.J.; Marr, L.C.; Vikesland, P.J.; Edwards, M.E.; and Pruden, A.J. (2017) "Factors Shaping the Human Exposome in the Built Environment: Opportunities for Engineering Control." *Environmental Science and Technology, In Press*.

2. Wei, H.; Willner, M.; Marr, L.; and Vikesland, P.J. (2016) "Highly Stable SERS pH Nanoprobes Produced by Co-Solvent Controlled AuNP Aggregation" *Analyst*, Vol. 141, 5159-5169. (http://dx.doi.org/10.1039/C6AN00650G).

3. Kim, B.; Miller, J.; Monsegue, N.; Levard, C.; Hong, Y.; Hull, M.; Murayama, M.; Brown, G.E.; Vikesland, P.J.; Knocke, W.R.; Pruden, A.; and Hochella, M.F. (2016) "Silver Sulfidation in Thermophilic Anaerobic Digesters and Effects on Antibiotic Resistance Genes." Vol. 33, 1-10. (http://dx.doi.org/10.1089/ees.2015.0226).

4. Wei, H. and Vikesland, P.J. (2015) "pH-Triggered Molecular Alignment for Reproducible SERS Detection via an AuNP/Nanocellulose Platform." *Scientific Reports*, Vol. 5, Article number: 18131, (http://dx.doi.org/10.1038/srep18131).

5. Ma, Y.; Metch, J.W.; Vejerano, E.P.; Miller, I.J.; Leon, E.C.; Marr, L.C.; Vikesland, P.J.; and Pruden, A. (2015). "Microbial Community Response of Nitrifying Sequencing Batch Reactors to Silver, Zero-Valent Iron, Titanium Dioxide and Cerium Dioxide Nanomaterials." *Water Research*, Vol. 68, pp. 87-97. (http://dx.doi.org/10.1016/j.watres.2014.09.008).

(ii) up to five other significant products, whether or not related to the proposed project.

1. Abtahi, S.M.H.; Burrows, N.D.; Idesis, F.A.; Murphy, C.J.; Saleh, N.B.; and Vikesland, P.J. (2017) "Sulfate Mediated End-to-End Assembly of Gold Nanorods". *Langmuir*, Vol. 33, pp. 1486-1495 (http://dx.doi.org/10.1021/acs.langmuir.6b04114).
2. Kent, R.D. and Vikesland, P.J. (2016) "Dissolution and Persistence of Copper-Based Nanomaterials in Undersaturated Solutions with Respect to Cupric Solid Phases" *Environmental Science and Technology*, Vol. 50, 6772-6781. (http://dx.doi.org/10.1021/acs.est.5b04719)
3. Singh, G.; Chandoha-Lee, C.; Zhang, W.; Vikesland, P.J.; Renneckar, S.; and Pruden, A. (2016) "Biodegradation of Nanocrystalline Cellulose by Environmentally-Relevant Anaerobic Cellulose-Degrading Consortia." *Water Research,* Vol. 104, pp. 137-146. (http://dx.doi.org/10.1016/j.watres.2016.07.073).
4. Vikesland, P.J.; Rebodos, R.L.; Bottero, J.Y.; Rose, J.; and Masion, A. (2016) "Aggregation and Sedimentation of Magnetite Nanoparticle Clusters" *Environmental Science: Nano*, Vol. 3, 567-577 (http://dx.doi.org/10.1039/C5EN00155B).
5. Afrooz, A.R.M.; Das, D.; Murphy, C.M.; Vikesland, P.J.; and Saleh, N. (2016) "Co-transport of Gold Nanospheres with Single-walled Carbon Nanotubes in Saturated Porous Media." *Water Research*, Vol. 99, 7-15. (http://dx.doi.org/10.1016/j.watres.2016.04.006).

(d) Synergistic Activities

- Vikesland currently has approximately 3,300 citations (Google scholar) and an h-index = 29.
- Vikesland is Director and lead PI for the NSF supported international research program *PIRE: Halting Environmental Antimicrobial Resistance Dissemination (HEARD)*. This global effort connects researchers from Virginia Tech, U. Michigan, University at Buffalo, and Rice University with international colleagues in Europe (Portugal, Sweden, Switzerland) and Asia (China, India, Hong Kong, Philippines) in the systematic evaluation of how antibiotic resistance can develop within wastewater treatment plants.
- Vikesland is Director of the VT Sustainable Nanotechnology Interdisciplinary Graduate Research Program (SuN IGEP) and is co-Director of the Sustainable Nanotechnology Center (VTSuN) within the Virginia Tech Institute for Critical Technology and Applied Science (ICTAS). Contributing faculty member of the NSF-EPA funded Center for the Environmental Implications of Nanotechnology (CEINT; PI Mark Wiesner, Duke University) and co-PI of the NSF NNCI *NanoEarth* Node.
- *Mentoring Undergraduate Research*. Over the past five years, twelve Virginia Tech undergraduate students have been supported to work in my laboratory. Of these students, four have gone on to enter graduate programs in environmental engineering and one in environmental toxicology. During each summer in 2011-2016 our laboratory has hosted one or more CEINT NSF REU students.
- *Development of New Courses in Nanotechnology for Environmental Chemists and Engineers*. In Spring 2010, a special topics course *Environmental Nanotechnology* was developed and taught at Virginia Tech for the first time. This course focused on the description of the environmental implications of nanomaterials and introduced nanomaterial fundamentals to graduate engineering and geoscience students. The course has been subsequently taught in Spring 2012 and Fall 2014. An advanced version of the class that is specifically focused on nanotechnology for environmental sustainability is being taught in Fall 2016.

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. DO NOT EXCEED FIVE PAGES.

NAME: Kathleen Ann Alexander

eRA COMMONS USER NAME (credential, e.g., agency login): kathyalx

POSITION TITLE: Associate Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of California, Davis	BSc	1988	Zoology
University of California, Davis	DVM	1992	Wildlife Health Program
University of California, Davis	PhD	1995	Disease Ecology

A. Personal Statement

My research program and background allows me to make a unique contribution to the training of the next generation of scientist DVM professionals.My research program and background allows me to make a unique contribution to the training of the next generation of scientist DVM professionals. I am a disease ecologist and have been conducting research in Africa for over 20 years. I have implemented numerous long-term field projects directed at developing a translational understanding of the disease emergency process using various model animals. I ask questions about how system processes drive emerging infectious disease using a “One Health” framework, investigating human, animal, and environmental couplings in disease transmission. My research is focused on understanding the cascade of interactions and effects that drive disease emergence, integrated across scales from within host to multi-host communities and interactions with the environment. My approach incorporates consideration of complexities across scales from the microbiome to landscape dynamics. As the Chief Wildlife Veterinarian for the Botswana Department of Wildlife and National Parks (1995-2001), and the Ecological Advisor to the Office of the President in Botswana (2004-2006), I have worked extensively within government and bring experience in incorporating scientific advances and understanding into high-level policy development and intervention design. My background has also allowed me to serve on numerous specialist groups such as the Committee on Agricultural and Food Microbiology, Public and Scientific Affairs Board, American Society for Microbiology, IUCN Commission on Ecosystem Health and the IUCN Species Survival Commission’s, Wildlife Health Specialist Group. My research program has also attracted significant attention in Africa with a site visit from the US Ambassador to Botswana and invitation to present my research findings to the US Embassy Regional Environment and Health Office for Southern Africa and the Directors of US agencies such as the Centers for Disease Control (CDC) Botswana, USAID President’s Emergency Plan for AIDS Relief, and Southern African Regional Environmental Program. I have a long history of successfully coordinating health research among large groups of scientists and public officials across Africa, Europe and the United States and communicating public health research findings effectively within complex foreign institutional settings. I have long-term practical experience in disease ecology investigations at the human-animal-environment interface allowing me to make an important and lasting contribution to the training of next geneartion workforce in public and animal health.

a) Alexander, K.A., Sanderson, C.E.*, Marathe, M., Lewis, B.L., Rivers, C.M.+, Shaman, J., Drake, J.M., Lofgren, E., Dato, V.M., Eisenberg, M.C., and S. Eubank. 2015. What factors might have led to the emergence of Ebola in West Africa? 2015. *Plos Neglected Tropical Diseases, DOI: 10.1371/journal.pntd.0003652*

b) Alexander, K.A., and J.W. McNutt. 2010. Human behavior can influence the emergence of infectious disease at the human - wildlife interface. *Frontiers in Ecology and Environment*, 8: 522–526.
c) Pesapane, R., Ponder, M. and K.A. Alexander. 2013. Tracking pathogens at the human wildlife interface. *EcoHealth,* DOI: 10.1007/s10393-013-0838-2.

B. Positions and Honors

Positions and Employment

1989-1994	Visiting Scientist, National Museums of Kenya, Kenya Agricultural Research Institute, Nairobi, Kenya
1993	Guest Researcher, Foreign Animal Disease Diagnostic Laboratory, Plum Island, Greenport, NY
1994-1995	Visiting Scientist, Centers for Disease Control, Rabies Unit, Atlanta Georgia
1995-2001	Senior Wildlife Veterinary Officer, Unit Head, Wildlife Veterinary Unit, Department of Wildlife and National Parks, Kasane, Botswana
2004-2006	Ecological Advisor to the Office of the President, Office of the President of Botswana and Attorney General's Chambers, Gaborone, Botswana
2001-Present	Board President, Centre for Conservation of African Resources: Animals, Communities and Land Use (CARACAL), Kasane, Botswana
2007-present	Associate Professor, Virginia Tech, Blacksburg, VA

Other Experience and Professional Membership

1999-Present	Wildlife Health Specialist Group, IUCN Species Survival Commission
2000-Present	African Lion Working Group, Affiliate of the Cat Specialist Group, ICUN
1999-Present	Wildlife Health Specialist Group, IUCN Species Survival Commission
2001-Present	Commission on Ecosystem Management, World Conservation Union
2004-2008	Environmental Working Group, Ministry of Wildlife, Environment and Tourism, Botswana
2011- 2013	Working Group- Operational Epidemiological Modeling Process-National Center for Integrated Civilian-Military Domestic Disaster Medical Response (ICMDDMR)
2013	Subject Matter Expert: United States Food and Drug Administration (FDA)-Game Meat Working Group
2012-Present	Honorary Member -Iota Delta Rho - Interdisciplinary Research Honor Society
2010-Present	Associate Editor, *Frontiers in the Ecology and the Environment*
2014-Present	Phi Beta Delta Honor Society for International Scholars, Gamma Omega Chapter
2015-Present	Committee on Agricultural and Food Microbiology, Public and Scientific Affairs Board, American Society for Microbiology

Certification: United States National Board of Veterinary Medicine Certification
California State Board Certification
United States Clinical Competency Test Certified
Registered Botswana Veterinarian

Examples of Honors:

2015	Alumni Award for Excellence in International Research
2013	Alumni Award for Excellence in International Outreach
2012	Nominated speaker - TEDx Virginia Tech
2000	Department of Wildlife and National Parks Officer of the Year Award
1994	Pfizer Award for Outstanding Scholastic Achievement and Contribution to Veterinary Medicine

C. Contribution to Science

1. In my long-term study site in Botswana, I have discovered a novel, emerging pathogen *Mycobacterium mungi sp. Nov* in banded mongoose (*Mungos mungo*), closely related to the human-pathogen *M. africanum*. This *M. tuberculosis* complex pathogen is environmentally transmitted between mongoose hosts providing an important model system for evaluating factors that drive and control environmentally associated pathogens that infect humans and animals. I take an integrated methodological approach that links molecular genetic studies

of the host and pathogen with population biology and behavioral ecology studies of mongoose social groups that occur across both protected and unprotected areas of the landscape. The banded mongoose presents an ideal model for understanding zoonotic disease transmission the human-animal interface. For example, results from our research have identified the influence of disease on dispersal in banded mongoose, with sick animals displaying lower dispersal rates compared to healthy individuals. Urban environments appear to indirectly impact disease transmission as well. Utilization of human garbage in these environments changes space use and puts mongoose at a greater risk of acquiring TB since fighting over human-associated food resources increases injuries and the apparent risk of pathogen invasion. I am also using this host-pathogen system to evaluate the interaction between infectious disease and Allee effects (AEs), work that will contribute to our theoretical understanding of these interactions and provide the foundation for creating advanced computational tools needed to evaluate these complex systems. Our recent publication in *Science* highlights the importance of AEs in the management of group-living wildlife, particularly those impacted by infectious disease with zoonotic potential (e.g., gorillas and Ebola).

a) Alexander KA, Sanderson CE*, MH Larsen, Robbe-Austerman SR, Williams MC, Palmer M. 2016. Emerging tuberculosis pathogen hijacks social communication behavior in the group-living banded mongoose (Mungos mungo). *mBio*, vol. 7 no. 3 e00281-16.
b) Alexander, K.A. Laver, P. N., Michel, A.L., Williams, M., van Helden, P.D., Warren, R.M., and N.C. Gey van Pittius. 2010. The emergence of a previously unidentified *Mycobacterium tuberculosis* complex pathogen, *M. mungi, sp nov*. *Emerging Infectious Diseases*, 16(8):1296 - 1299.
d) Fairbanks, B.M., Hawley, D.M., and K.A. Alexander. 2014. The Impact of Health Status on Dispersal Behavior in Banded Mongooses (Mungos mungo) *EcoHealth*: Volume 11, Issue 2 (2014), Page 258-262
e) Alexander K.A. and C.E. Sanderson*. 2014. Conserving Carnivores: More than Numbers, *Science* Mar 14:343(6176):1199.

2. My research has been directed at understanding the disease emergence process at the human-animal-environmental interface. My work in this area has increasingly focused on the role of water as a primary connection between many hosts and pathogen types across landscapes. Together with a large collaborative team that I lead under a National Science Foundation award, I am investigating the manner in which human behavior and environmental drivers influence waterborne disease dynamics in dryland river floodplain systems. In this system, I have used *Escherichia coli* as a model fecal indicator organism to evaluate fecal movement into surface water sources and to track microbial transmission across the landscape and through hosts. We have discovered that diarrheal outbreaks coincide with major hydrological phenomena, water quality declines, and peaks in multidrug resistance (MDR) in isolated *E. coli*. Water quality was lowest in the national park and spatially correlated with flood plain distribution. Multidrug resistance patterns in *E. coli* were similar among humans, wildlife (domestic and wild), and surface water isolates. When comparing life history strategies across species, we found higher levels of MDR in isolates from animals living in association with the river, providing important mechanistic insight into the movement of antibiotic resistance across the landscape. Through household and hospital outbreak studies, my work with communities has identified important sociological factors that can contribute to disease exposure from health seeking behavior to water, sanitation, and health practices (WASH). Using a unique 30-year national data set that I created from archived materials, I have identified significant relationships between diarrheal disease case incidence and meteorological variables at the national level, patterns that diverge from my study area in the north of the country. The limited presence of surface water in this dryland region may be an important determining factor. This work at the national level also identifies increased human health vulnerability under forecasted climate change for the region. Findings from this work were used in a brief to the Botswana Parliament and have contributed to public health strategy development in the region.

a. **Alexander, K.A.** and A.N. Godrej. 2015. Greywater disposal practices in Northern Botswana – a silent spring? *International Journal of Environmental Research and Public Health,* 12(11), 14529-14540.
b. Fox, T.J.* and **K.A. Alexander**. 2015. Spatiotemporal variation and the role of wildlife in seasonal water quality declines in the Chobe River, Botswana, *Plos One, DOI: 10.1371/journal.pone.0139936.*
c. Jobbins, S.E.* and **K.A. Alexander**. 2015. From whence they came - dynamics of antibiotic-resistant *Escherichia coli* in African wildlife. *Journal of Wildlife Diseases*, 51(4), 2015, pp. 811–820, http://dx.doi.org/10.7589/2014-11-257
d. **Alexander, K.A**., Carzolio, M., Goodin, D, and E. Vance. 2013. Climate change is likely to worsen the public

health threat of diarrheal disease in Botswana. *Environmental Research and Public Health,* 10, 1202-1230.

e. **Alexander, K.A.,** and J.K. Blackburn. 2013. Overcoming barriers in evaluating outbreaks of diarrheal disease in resource poor settings: Assessment of recurrent outbreaks in Chobe District, Botswana. *BMC Public Health*, 13:775.

3. Across Africa, malaria has been a dominant focus in public health potentially obscuring the occurrence of other important zoonotic pathogens that can cause acute fibril syndromes. In Northern Botswana, I have identified the presence of *Brucella abortus* infection in buffalo as well as the occurrence of Rift Valley Fever exposure in this same species. Rift Valley fever is an important viral hemorrhagic virus similar to Ebola and can be transmitted through bushmeat and vectors. I have identified for the first time, the presence and widespread nature of leptospirosis among a diversity of wildlife species in Botswana. Human infection has not been identified in the government health care system as the presence of the pathogen had not been previously identified. My work on these zoonotic pathogens has had significant public health impact, providing important motivation for the development of the appropriate diagnostics for detection of human infection for these zoonotic diseases. My work with these zoonotic pathogens also includes evaluation of the role of culture and its influence on the manner in which bushmeat is utilized and how this may influence zoonotic disease transmission potential. I am now analyzing my large collection of human samples from the region to screen for zoonotic disease infections, extending my research to identify a more mechanistic understanding of transmission dynamics at this interface.

a) Jori, F., **Alexander, K.A.**, Mokopasetso, M., Munstermann, S., Moagabo, K and J.T. Paweska. 2015. Serological evidence of Rift Valley fever virus circulation in domestic cattle and African buffalo in Northern Botswana (2010-2011). *Frontiers in Veterinary Science. 25;2:63. doi: 10.3389/fvets.2015.00063*
b) Jobbins, S.E. and K.A. Alexander. 2014. Evidence of Leptospira among a diversity of African wildlife species - Beyond the usual suspects. *Transactions of the Royal Society of Tropical Medicine and Hygiene*. doi: 10.1093/trstmh/trv007.
c) Jobbins, J., Sanderson, C., and **K.A. Alexander**. 2013. *Leptospira interrogans* at the human – wildlife interface in Northern Botswana: a newly identified public health threat, *Zoonoses and Public Health.* DOI: 10.1111/zph.12052.
d) Alexander, K.A. Blackburn, J.K., Biopoledi, K.A., Vandewalle, M.E., Pesapane, R.*, and P. Elzer. 2012. Buffalo, bush meat and the zoonotic threat of brucellosis in Botswana. *PLoS ONE*, 7(3):e32842.

Complete List of Published Work at MyBibliography: http://www.ncbi.nlm.nih.gov/sites/myncbi/12I68yy-rJ1k-/bibliograpahy/48728071/public/?sort=date&direction=descending

D. Research Support

Ongoing Research Support

479367 PI: K.A. Alexander 05/15/2016- 05/27/2017
NSF PSC Supplement REU
Broadening Africa American undergraduate participation in International Infectious Disease Research

479367 PI: K.A. Alexander 06/01/2016-08/15/2017
NSF PSC:RET/RAHSS
Immersing Minority High School Students in International Infectious Disease Research

479371 PI: K.A. Alexander 05/01/2015-04/31/2019
NSF CNH – L The coupled dynamics of human - dryland river systems: linkages and feedbacks between anthropogenic and environmental drivers of water quality and human and animal health in water scarce environments. The goal of this project is to identify linkages and advance computational tools to evaluate and manage coupled dynamics of human behavior, environmental change, declining water quality and waterborne disease.

479367 PI: K.A. Alexander 08/01/2015-07/31/2019
NSF EEID
Ecology and Evolution of Infectious Disease: Can group living and the influence of Allee Effects explain infectious disease vulnerability in social species? Emergence of M. mungi in the cooperative breeding banded

mongoose. The project is directed at investigating and characterizing interactions between infectious disease and Allee Effects in group-living banded mongoose *(Mungos mungo)* in Botswana infected with the novel, emerging tuberculosis (TB) pathogen, *Mycobacterium mungi*.

NIH 2U01GM070694-09 PI: S. Eubank (Co-I: Alexander) 05/01/2011 - 08/31/2017
Synthetic Information Systems for Better Informing Public Health Policymakers
This proposal will develop tools that assist public health decision makers address issues related to surveillance and detection, dynamics of infectious diseases, response strategies, and behavior.

European Union - Botswana Non-State Actors PI: K.A. Alexander 07/01/2015-08/01/2017
Managing threats to early childhood development in Chobe, Botswana
This project is directed at understanding diarrheal disease dynamics in children under five years of age including community perceptions of risk and treatment.

458208 PI: K.A. Alexander 07/01/2014 - 06/30/2017
CARACAL/Forest Conservation Board. Identifying threats and status of forest resources in Botswana

450-117 PI: K.A. Alexander 05/01/2014 - 08/31/2017
Conservation, Food and Health: Bringing New Light to an Old Disease. Integrating environmental data collected from a cohort of study households and diarrheal case reports from the village, the project will develop a refined understanding of the drivers of diarrheal disease and potential options for mitigating public health interventions.

Selected Completed Research Support

443365 PI: K.A. Alexander 05/01/2014 - 04/31/2017
Morris Animal Foundation. Epidemiology of *Mycobacterium mungi*. This project will identify the reservoir and transmission dynamics of the Mycobacterium tuberculosis pathogen, *M. mungi that* I discovered in Northern Botswana among banded mongoose. This organism is closely related to the human tuberculosis pathogen *M. africanum* and the host range and public health threat is currently unknown.

NIH 2U01GM070694-09 PI: Eubank (Co-I: Alexander) 05/01/2011 - 04/31/2016
Synthetic Information Systems for Better Informing Public Health Policymakers
This proposal will develop tools that assist public health decision makers address issues related to surveillance and detection, dynamics of infectious diseases, response strategies, and behavior.

National Science Foundation PI: K.A. Alexander 09/01/2011 - 08/31/2013
CNH-EX: Water quality and environmental health in Botswana-coupled dynamics in a water-scarce environment

Morris Animal Foundation(D10Z0-828A) PI: K.A. Alexander 04/01/2010 - 03/31/2011
Tracking Pathogens at the Human–Wildlife Interface

United Nations Development Program (1000267) PI: K.A. Alexander 01/01/2006 - 08/10/2010
Global Environmental Facility – Small Grants Program Botswana. Wetlands Inventory for the Chobe-Linyanti-Kwando Wetlands: International Waters and Developing Good Governance for Shared Resources. This project is investigating wetlands health, community use and development of shared governance structures through participatory techniques.

Brian D. Badgley

Crop & Soil Environmental Science
Virginia Tech
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Blacksburg, VA 24061
(540) 231-9629
badgley@vt.edu

(a) Professional Preparation

University of Georgia	Zoology	B.S., 1995
University of Maryland	Marine-Estuarine-Environmental Sciences	M.S., 2002
University of South Florida	Biology	Ph.D., 2009
University of Minnesota	Environmental Microbiology	Post-doc, 2009-12

(b) Appointments

2012-	Assistant Professor, Crop & Soil Environmental Science, Virginia Tech
2009-12	Post-Doctoral Associate, BioTechnology Institute, University of Minnesota
2002-04	Coastal Training Coordinator, Rookery Bay National Estuarine Research Reserve
2001-02	Sea Grant Fellow, NOAA, Estuarine Reserves Division
1996-97	Environmental Education Instructor, Jekyll Island 4-H Center, Jekyll Island, Georgia

(c) Products

(i) Related products (*student co-authors)

*Sun S, Li S, Avera BN, Strahm BD, **Badgley BD** (in press) Bacterial and fungal communities show distinct succession patterns during ecosystem restoration. *Appl Environ Microbiol.*

Wepking C, Avera B, **Badgley BD**, Barrett JE, *Franklin J, Knowlton KF, Ray PP, *Smitherman C, Strickland MS (2017) Exposure to dairy manure leads to greater antibiotic resistance and increased mass-specific respiration in soil microbial communities. *Proc Roy Soc B* 284.

Li X, *Sun S, **Badgley BD**, He Z (2016) Long-term performance and microbial community characterization of an osmotic anammox system for removing reverse-fluxed ammonium. *Bioresource Tech* 211:628-635.

Li X, *Sun S, **Badgley BD**, Sung S, Zhang H, He Z (2016) Nitrogen removal by granular nitritation - anammox in an upflow membrane-aerated biofilm reactor. *Water Res* 94:23-31.

Scholz F[#], **Badgley BD[#]**, Sadowsky MJ, Kaplan DH (2014) Immune mediated shaping of microflora community composition depends on barrier site. *PLoS One* 9:e84019. ([#]co-first authors)

(ii) Other Significant Products

Harwood VJ, Staley C, **Badgley BD**, Borges K, Korajkic A. (2014) Microbial source tracking markers for detection of human sewage and fecal contamination in environmental waters: relationships to pathogens and human health outcomes. *FEMS Mirobiol Rev.* 38:1-40.

Sugawara M, Epstein B, **Badgley BD**, Unno T, Xu L, Reese J, Gyaneshwar P, Denny R, Mudge J, Bharti AK, Farmer AD, May GD, Woodward JE, Medigue C, Vallenet D, Lajus A, Rouy Z, Martinez-Vax B, Tiffin P, Young ND, Sadowsky MJ (2013) Comparative genomics of the core and accessory genomes of 48 *Sinorhizobium* strains comprising five genospecies. *Genome Biol* 14:R17.

Badgley BD, Thomas FIM, Harwood VJ (2011) Quantifying environmental reservoirs of fecal indicator bacteria associated with sediment and submerged aquatic vegetation. *Environ Microbiol* 13:932-942.

Badgley BD, Thomas FIM, Harwood VJ (2010) The effects of submerged aquatic vegetation on the persistence of environmental populations of *Enterococcus* spp. *Environ Microbiol* 12:1271-1281.

Badgley BD, Nayak BS, Harwood VJ (2010) The importance of sediment and submerged aquatic vegetation as potential habitats for persistent strains of enterococci in a subtropical watershed. *Water Res* 44:5857-5866.

(d) Synergistic Activities

- Co-organized and hosted a workshop entitled “Strategies for sequence-based analyses of microbial communities (and the caveats)” which was attended by over 35 students, post-docs, and faculty from eight different departments across the Virginia Tech campus (2013)

- President of the Virginia Branch of the American Society of Microbiology (2015-2017)

- Cofounded a microbial ecology networking group of students and faculty at Virginia Tech to facilitate collaboration, discussion, and project development on campus (2012-ongoing)

- Dedicated to providing undergraduate research opportunities, including direct mentoring of 6 NSF REU students, 3 VT Minority Summer Research Interns, and 7 paid undergraduate research assistants since 2013.

- Manuscript reviewer for *Appl Env Microbiol, Bioremediation, Environ Sci Tech*, *FEMS Microbiol Ecol*, *J Environ Mon*, *J Great Lakes Res*, *Sci Tot Environ*, *Water*, *Water Res* (ongoing)

Leigh-Anne Krometis, Ph.D., E.I.T.
Assistant Professor
Department of Biological Systems Engineering
Virginia Tech
http://ww2.bse.vt.edu/krometis/
krometis@vt.edu

(a) Professional Preparation

Virginia Tech	Blacksburg, VA	Biological Systems Engineering	B.S. 2002
Virginia Tech	Blacksburg, VA	Biological Systems Engineering	M.S. 2004
U. of North Carolina	Chapel Hill, NC	Environmental Sci. & Eng.	PhD 2009

(b) Appointments

2011-Present	Biological Systems Engineering, Virginia Tech	Assistant Professor
2009-2011	Biological Systems Engineering, Virginia Tech	Research Assistant Professor
2009	Environmental Science & Eng, Univ of NC	Postdoctoral Researcher

Select Publications (out of 32 total peer-reviewed, H Index=11)

i. Five Related Publications

1. Liao, H., L. Krometis, K. Kline. 2016. Coupling a continuous watershed-scale microbial fate and transport model with a stochastic dose-response model to estimate risk of illness in an urban watershed. *Science of the Total Environment.* **2016**, (551/552): 668-675.
2. Liao, H., L Krometis, C. Hession, R. Benitez, R. Sawyer, E. Schaeberg, E. von Wagoner, B. Badgley. Storm loadings of general and human-specific fecal indicators in an inland urban stream. *Science of the Total Environment.* **2015**, (530/531): 347-356.
3. Liao, H., L. Krometis, K. Kline, C. Hession. Long-term impacts of bacteria-sediment interactions in watershed-scale microbial fate and transport modeling. *Journal of Environmental Quality.* **2015**, 44(5): 1483-1490.
4. Fahrenfeld, N., K. Knowlton, L. Krometis, W. C. Hession, K. Xia, E. Lipscomb, K. Libuit, B. Green, A. Pruden. Manure application's effect on levels of antibiotic resistance genes and their attenuation rates in soil: Field-scale mass balance approach. *Environmental Science and Technology.* **2014**, 48(5): 2643-2650.
5. Coffey, R., B. Benham, L. Krometis, M. L. Wolfe, E. Cummins. Assessing the effects of climate change on waterborne microorganisms: Implications for EU and USA water policy. *Human and Ecological Risk Assessment.* **2014**, 20: 724-742.

ii. Other Relevant Publications

1. Cantor, J., L. Krometis, E. Sarver, N. Cook, B. Badgley. Tracking the Downstream Impacts of Inadequate Sanitation in Central Appalachia. *Journal of Water and Health*. **In press, April 2017**.
2. Pieper, K., L. Krometis, D. Gallagher, B. Benham. Simultaneous influence of geology and system design on drinking water quality in private systems. *Journal of Environmental Health.* **2016***,* 79(2): S1-S8.
3. Cook, N., E. Sarver, L. Krometis, J. Huang. Habitat and water quality as drivers of ecological system health in Central Appalachia. *Ecological Engineering.* **2015**, 84: 180-189.

4. Liao, H., L. Krometis, C. Hession, L. House, K. Kline, B. Badgley. Hydrometeorological and physicochemical drivers of fecal indicator bacteria in urban stream bottom sediments. *Journal of Environmental Quality.* **2014**, 43: 2034-2043.
5. Smith, T., L. H. Krometis, C. Hagedorn, B. Benham, A. H. Lawrence, E. Ling, P. Ziegler, S. W. Marmagas. Associations between fecal indicator bacteria prevalence and demographic data in private water supplies in Virginia. *Journal of Water and Health.* **2014**, 12(4): 824-834.

(d) Synergistic Activities

- *Co-Director,* NSF StREAM REU ("Dynamics of Water and Societal Systems: An Interdisciplinary Research Program at the Virginia Tech StREAM Lab"), 2012-2014. Co-led summer research program focused on interdisciplinary watershed management; hosted 28 undergraduates from 18 different home institutions representing 18 different disciplinary degrees.
- *Virginia Tech Imagination Camp Faculty Volunteer,* 2010-2014. Designed and led hands-on field and lab-scale activities focused on environmental microbiology and public health for 100 middle-school students participating in a Virginia Tech summer camp.
- *Faculty Member*, Virginia Tech Center for Global Change, 2014-present. (steering committee for Interfaces of Global Change PhD Program, 2014-2015).
- *Team Member and Research Student Advisor*, Cooperative Extension Virginia Household Water Quality Program, 2011-2015. Provides education and low cost water quality testing to homeowners reliant on private water supplies (e.g. wells, springs); program received the Florence Hall Award from the National Extension Association of Family and Consumer Science in May 2013; six resultant peer-reviewed publications led by students.
- *Faculty Fellow*, Virginia Tech Honors Residential Commons, 2010-present. Broad aim is to support the development of interdisciplinary residential colleges that will house and nurture students academically throughout their college career.

Biographical Sketch

KATHARINE F. KNOWLTON

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phone: (540) 231-5287 • e-mail: knowlton@vt.edu

EDUCATION

Ph.D.	**University of Maryland**, **USDA-ARS, BARC East**, Animal Science. Dissertation: Starch digestion and glucose metabolism in early lactation dairy cows. Advisors: Dr. Richard Erdman and Dr. Barbara Glenn. 1993-97.
M.S.	**Michigan State University**, Thesis: Effect of level of rumen degradable starch and lasalocid on rumen fermentation, performance and feeding behavior in early lactation dairy cattle. Advisor: Dr. Michael S. Allen. 1991-93.
B.S.	**Cornell University**, Ithaca, NY. Animal Science, Agricultural Economics. Graduated with Distinction. 1987-91.

RESEARCH AND TEACHING EXPERIENCE

2014-pr.	**The Colonel Horace E. Alphin Professor of Dairy Science,** Virginia Tech. Qualitative and quantitative research on achieving the three pillars of sustainability of the US dairy industry – economic, environmental, societal
1997-14	**Research Scientist** (1997-99), **Assistant Professor** (2000-05), **Associate Professor** (2005-10), **Professor**. Department of Dairy Science, Virginia Tech. Research and teaching in ruminant nutrition and nutrient management.
2015-pr.	**Instructor: Humane Dairy Cattle Handling**. Department of Dairy Science, Virginia Tech
2011-pr.	**Instructor: Dairy Cattle Evaluation**. Virginia Tech
2001 -pr.	**Instructor: Animal Agriculture and the Environment**. Virginia Tech.
2003-pr.	**Instructor: Introduction to Dairy Science.** Virginia Tech.
2000-pr.	**Instructor: Advanced Ruminant Nutrition Colloquium**. College of Agriculture and Life Sciences, Virginia Tech.

PROFESSIONAL ACTIVITIES

2013-pr.	**Collaboration** (sabbatical and follow up) with Dr. Marina Von Keyserlingk, Animal Welfare Program, University of British Columbia
2011-pr.	**Dairy 2050** founding member. Providing strategic scientific leadership toward sustainability of the U.S. dairy industry in a global market
2009-12	**President** (2011-12), **Vice President** (2010-11) and **Secretary** (2009-10). ADSA Production Division Council
2009-12	**Associate Editor**, Journal of Environmental Quality
2006-13	**Board of Directors**, National Dairy Shrine. Finance, Scholarship committees
2000-pr	**FASS Program Committees:** Education (2006-pr.); ADSA Foundation Scholar (2006-pr.); Women & Minorities Issues (2005-06); Ruminant Nutrition (2000-03)
1996-pr.	**Assistant Coach**. Virginia Tech dairy cattle judging team. 2006, 2008, 2009 & 2013 National Champions

DEPARTMENT, COLLEGE, AND UNIVERSITY SERVICE

2004-pr. **Virginia Waste Solutions Forum Steering Committee**, **Chair** (2004-05, 2009-11), **member** (05 to 09, 11-pr.)

2005-pr. **Chair, CALS-Dairy Science Nutrient Management committee,** Virginia Tech

2010-pr. **Curriculum Coordinator.** Department of Dairy Science, Virginia Tech

2004-pr. **Chair** (2008-11)**, member** (2004-07, 2012-pr.) **Scholarship committee.** Dept of Dairy Science, Virginia Tech

2002-pr. **Fundraising committee chair,** (2010-pr.), **member** (2002-09), Dept of Dairy Science, Virginia Tech

GRANTS FUNDED

Dr. Knowlton is Principal or Co-Principal Investigator on $11.2 million in externally funded grants for research on environmental issues pertaining to animal agriculture. Funding agencies include USDA, NSF, industry groups, and conservation organizations.

PUBLICATIONS

Dr. Knowlton has authored 74 peer-reviewed research papers and 4 book chapters in ruminant nutrition and/or environmental issues associated with animal agriculture.

Kulesza, S. B, J. Cushman, **K. Knowlton**, R. O. Maguire , P. Ray, and K. Xia. 2016. Manure injection impacts fate of pirlimycin in surface runoff and soil. J. Environ. Qual. 45: 511-518.

Chambers, L., Ying Yang, Heather Littier, Partha Ray, Tong Zhang, Amy Pruden, Michael Strickland, and **Katharine Knowlton**. 2015. Metagenomic analysis of antibiotic resistance genes in dairy cow feces following therapeutic administration of third generation cephalosporin. PLOS-ONE 10.8 (2015) E0133764

Jarrett, J. P., J. W. Wilson, Ray, P. P. and **K. F. Knowlton**. 2014. The effects of forage particle length and exogenous phytase inclusion on phosphorus digestion and absorption in lactating cows. J. Dairy Sci. 97: 411-418. ***J. Dairy Science featured article of the month.***

Ray, P. P., Z. Zhao and **K. F. Knowlton**. 2014. Emerging contaminants in livestock manure: Hormones, antibiotics, and antibiotic resistance genes. *In* E. Kebraib (Ed.) Sustainable Animal Agriculture. CAB International.

von Keyserlingk, M.A.G., N. P. Martin, E. Kebreab, **K. F. Knowlton**, R. J. Grant, M. Stephenson, C. J. Sniffen, J. P. Harner, III, A. D. Wright, and S. I. Smith. 2013. Sustainability of the U.S. dairy industry. J. Dairy Sci. 96: 5405-5425. ***J. Dairy Science Top 15 Most Downloaded Articles 2013***

Feng, X. **K. F. Knowlton**, A. D Dietrich, and S. Duncan. 2013. Effect of abomasal ferrous lactate infusion on phosphorus absorption in lactating dairy cows. J. Dairy Sci. 96: 4586-4591. ***J. Dairy Science featured article of the month***

Liu, Z., J. A. Ogejo, A. Pruden, and **K. F. Knowlton**. 2011. Occurrence, fate and removal of synthetic oral contraceptives (SOCs) in the natural environment: A review. Science of the Total Environment 409:(5149-5161)

Knowlton, K. F. and T. Denckla Cobb. 2006. Implementing waste solutions for dairy and livestock farms. J. Dairy Sci. 89: 1372-1383.

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Gohlke, Julia M

eRA COMMONS USER NAME (credential, e.g., agency login): jgohlke

POSITION TITLE: Assistant Professor of Environmental Health

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of Michigan, Ann Arbor, MI	B.S.	12/1997	Biology
University of Washington, Seattle, WA	M.S.	12/2001	Environmental Health
University of Washington, Seattle, WA	PhD	12/2004	Environmental Health
National Institute of Environmental Health Sciences, RTP, NC	Postdoc	08/2009	Environmental Health

A. Personal Statement

For this application, Dr. Gohlke's expertise in environmental factor measurement and toxicity pathways will bring an important perspective to the training of pre-doctoral veterinarian students interested in animal model research. Her research utilizes human and animal model research, giving students the opportunity to explore a wide range of approaches. Her previous work developed hypothesis generating bioinformatics techniques combining genomics and genetics datasets to prioritize environmentally regulated molecular pathways. This work identified several conserved pathways and she is now developing *Daphnia pulex* as a model system for examining the combinatorial effect of exposure to a mixture of chemicals or other stressors on lipid storage, reproduction, and lifespan. The short lifespan and ease with which multi-generational effects can be evaluated makes *Daphnia pulex* an excellent alternative model system for prioritizing potential toxicants for further research in mammalian species. She is also performing research on the effects of human exposure to high temperatures in urban versus rural settings in Alabama. As PI of an R21 award under the inaugural NIH Climate Change and Health Program, and subsequent R01 awardee, her research team has developed risk estimates for preterm birth and non-accidental mortality using 20 years of Alabama birth and death records, satellite-derived climate data, and geospatial data analysis techniques. Several additional accomplishments and recognitions make her particularly suited for a mentorship role. Dr. Gohlke has served on the Board of Scientific Counselors for the National Center for Environmental Health/Agency for Toxic Substances and Disease Registry (NCEH/ATSDR), Centers for Disease Control. At the international level, Dr. Gohlke served as a temporary advisor at the World Health Organization, Geneva Switzerland.

B. Positions and Honors

Positions and Employment

08/98 to 12/98	Research Assistantship	University of Michigan, Ann Arbor, MI
06/01 to 09/01	Research Assistantship	University of Washington, Seattle, WA
03/02 to 06/02	Research Assistantship	Environmental Protection Agency, RTP, NC
09/02 to 12/02	Teaching Assistantship	University of Washington, Seattle, WA
2002 to 2004	Research Assistantship	University of Washington/EPA , Seattle, WA

2002 to 2004	Research Internship	Environmental Protection Agency, RTP, NC
01/05 to 08/09	Postdoctoral Fellowship	NIEHS/ National Institutes of Health, NC
07/08 to 08/08	Temporary Advisor	World Health Organization, Switzerland
09/09 to 08/10	AAAS Fellow	Department of State, Washington DC
8/10 to 07/15	Assistant Professor	University of Alabama at Birmingham
8/15 to present	Assistant Professor	Virginia Polytechnic Institute and State University

Other Experience and Professional Memberships

2012-2015	Member of the Board of Scientific Counselors, National Center for Environmental Health/Agency for Toxic Substances and Disease Registry
2016	Army Corps of Engineers Engineer Research and Development Center FY 16 Basic Research Proposal Reviews
2016	NIOSH Special Emphasis Panel (PAR 15-353: Centers for Agricultural Safety and Health)
2016	NASA ROSES 2015 A.46 Health and AQ Applied Sciences Team (H-AQAST) review panel
2015	Environmental Protection Agency, Science to Achieve Results (STAR) Graduate Fellowship Program review panel member
2014-	Editorial Board member, *Journal of Health and Pollution*, Blacksmith Institute, NY
2014-	Review Editor, *Frontiers in Public Health-Radiation and Health* specialty section, Frontiers, Lausanne, Switzerland
2014	Invited Reviewer: National Science Foundation Graduate Research Fellowship Program
2013,2012	Invited Reviewer: NIH Climate Change and Health Special Emphasis Panel (ZRG1 PSE-D (56)), NIH Behavioral Interventions to Address Multiple Chronic Health Conditions in Primary Care (ZRG1 HDM-T(02)); Army Corps of Engineers Engineer Research and Development Center FY 14 Basic Research Proposal Reviews; EPA's draft "Next Generation Risk Assessment: Incorporation of Recent Advances in Molecular, Computational, and Systems Biology Interim Report."
1/08-12/12	Editorial Board member, *Reproductive Toxicology*, Elsevier, NY
2011-	Gulf of Mexico Reef Fish Shareholders' Alliance Advisory Board member
2010	Ad Hoc Expert Reviewer, Centers for Disease Control and Prevention, Environmental Health Tracking Branch, Atlanta GA
2009-2010	Member of the U.S. Interagency Working Group on Climate Change and Health
2009	External Review Panel Member for EPA Toxicogenomics in Risk Assessment Report
2006-	Invited Reviewer: *Nature Communications, Neurotoxicology, Current Anthropology, Birth Defects Research, Environmental Health Perspectives, Environmental Research, Gene Regulation and Systems Biology, Toxicological Sciences, Food and Chemical Toxicology, Obesity, Environment International, Mathematical Biology, Environmental Health, Journal of Health and Pollution, Reproductive Toxicology*, *American Journal of Public Health, Frontiers in Public Health, International Journal of Molecular Sciences, Journal of Occupational Medicine and Toxicology, Neurobiology of Aging, PeerJ, Science of the Total Environment, Toxicology and Applied Pharmacology, BMC Public Health, International Journal of Environ Res Public Health, Regional Environmental Change, American Journal of Human Biology, American Journal of Clinical Nutrition, Frontiers in Ecology*
1999-	Society of Toxicology member
1999-	Teratology Society member

Honors

2001-2006 Six Society of Toxicology awards from Risk Assessment Specialty Section and Biological Modeling Specialty Section for papers, presentations, and posters of predoc and post-doc research results.

2004 Dose-Response Specialty Group best poster presentation award, Society for Risk Analysis
2005 James C. Bradford Memorial Post-doc Poster Award, Teratology Society
2009 Best Publication in *Birth Defects Research* in 2008
2011 Invited participant in NIH Director's 'Innovation Brainstorm: Transforming Discovery into Impact' to develop ideas for scientific programs for the NIH Common Fund
2011 Invited participant in NIEHS Strategic Planning meeting, July 12-14th and Oct 13-14th, RTP, NC
2011 Winner of UAB NORC "Creativity is a Choice" Award
2013 Future Leader Award, International Life Sciences Institute, N.A.
2014 F. Clarke Fraser New Investigator Award, Teratology Society, Reston, VA
2016 First prize, NIEHS Climate Change and Environmental Exposures Challenge for PIE Viz, Populations, Infrastructures, and Exposures Visualization Tool with Samarth Swarup and Dawen Xie, Biocomplexity Institute, VT

C. Contributions to Science

Throughout my career, my primary interest has been determining how environmental processes impact health outcomes. To pursue this interest I have employed a variety of computational, bioinformatic, and epidemiological approaches.

Quantitative methods for estimating interspecies differences in brain development. Early in my career, I was interested in understanding how datasets generated in model species can be used to predict effects in humans. The current methods for determining risk associated with environmental pollutants relies heavily on testing conducted in rodent species. Chemicals are evaluated for neurodevelopmental effects through exposure in rodents and subsequent behavioral testing and pathology exams. Compared to the neocortex of the rodent brain, the primate neocortex is overdeveloped and this is thought to underlie higher order processes such as executive functioning present in primates but not rodents. To address this translational issue, I developed computational models to predict neuronal cell number in the developing rat, mouse, monkey, and human neocortex based on cell cycle kinetics and apoptosis during neurogenesis. We examined the effects of ethanol on neuronal proliferation, differentiation, and death as a case study for use in assessing the risk of chemicals using rodent datsets to predict effects in humans.

- Gohlke JM, Griffith, WC, & Faustman, EM (2005). A systems-based computational model for dose-response comparisons of two mode of action hypotheses for ethanol-induced neurodevelopmental toxicity. *Toxicological Sciences*, 86(2), 470-484
- Gohlke JM, Griffith, WC and Faustman, EM (2007). Computational Models of Neocortical Neuronogenesis and Programmed Cell Death in the Developing Mouse, Monkey and Human. *Cerebral Cortex*, 17: 2433-2442

Bioinformatic techniques for disseminating the molecular underpinnings of environmental effects on human health. After exploring interspecies differences in cellular processes during neocortical development, I became interested in understanding the molecular changes necessary to produce these cellular differences. Collaboratinig with Francois Guillemot's lab, who produced transcriptomics datasets in several proneural bHLH loss of function and gain of function mice, I was able to develop a gene regulatory network describing differentiation into glutamatergic and GABAergic neurons. This work led to a broader application of network theory and pathway analysis to define hypotheses of the most likely molecular targets of environmental factors affecting disease processes based on available datasets from genetic association studies in humans and toxicology studies performed in rodent and other model organisms. We are currently evaluating lifespan and transcriptomic differences associated with early-life exposures to mixtures using *D. pulex* as a model organism.

- Gohlke, JM, O Armant, FM Parham, MV Smith, D Castro, L Nguyen, JS Parker, G Gradwohl, CJ Portier, F Guillemot. (2008). A Gene Regulatory Network for Telencephalon Development Combining Experimental and Bioinformatics Approaches. *BMC Biology* 6(1): 15. PMCID: PMC2330019
- Gohlke JM, R Thomas, Y Zhang, MC Rosenstein, AP Davis, C Murphy, CJ Mattingly, KG Becker, CJ Portier (2009). Genetic and Environmental Pathways to Complex Diseases. *BMC Systems Biology* 3: 46. PMCID: PMC2680807

- Thomas R, JM Gohlke , F Parham, CJ Portier. (2009). Choosing the right path: Enhancement of biologically-relevant sets of genes or proteins using pathway structure. *Genome Biology* 10(4):R44. PMCID: PMC2688935
- Hudson SL, DA Doke, JM Gohlke. (2016). The effect of a low iron diet and early life methylmercury exposure in *Daphnia pulex*. *Food Chem Toxicol*. 89: 112-119. PMID: 26806633.

Human health implications of global environmental change. Traditionally the field of environmental health has focused on health outcomes associated with exposure to single chemicals. More recently, large-scale changes in the environment such as climate change, urbanization, and land use change have been characterized by earth and physical scientists but have been largely unexplored by human health scientists. I have developed a research program examining health outcomes associated with large-scale environmental changes across urban and rural landscapes. Using a combination of satellite-derived datasets and vital records, we have confirmed associations between mortality and extreme heat events and we were also able to detect an association between preterm birth and extreme heat events. Importantly, we were able to detect mediation of the association by rurality, suggesting persons in urban centers may be more at risk. To assess adaptation strategies in human populations, community engaged research is being conducted in underserved urban and rural communities in Alabama, where we have piloted a method for measuring individual level exposure using a small device attached to the shoe.

- Gohlke JM, R Thomas, A Woodward, D Campbell-Lendrum, A Prüss-Üstün, S Hales, CJ Portier. (2011). Estimating the global health implications of electricity and coal consumption. *Environ Health Perspect.* 119(6): 821-6. PMCID: PMC3114817
- Smith, TT, BF Zaitchik, JM Gohlke. (2013). Heat waves in the United States: definitions, patterns and trends. *Climatic Change* 118: 811-825 PMCID: PMC3711804
- Kent ST, McClure LA, Zaitchik BF, Smith TT, & JM Gohlke. (2013). Heat Waves and Health Outcomes in Alabama (USA): The Importance of Heat Wave Definition. *Environ Health Perspect.* 122(2): 151-8 PMCID: PMC3914868.
- Bernhard, MC, ST Kent, MA Sloan, MB Evans, McClure LA, JM Gohlke. (2015). Measuring personal heat exposure in an urban and rural environment. *Environmental Research* 137: 410-418 PMCID: PMC4355189.

Assessing human health risk after a large-scale oil spill. Applying my expertise in risk assessment, I evaluated seafood safety protocols used following the Deepwater Horizon blowout. After outlining a set of data gaps and recommendations for further state and federal monitoring, samples collected from fishermen were also evaluated and compared to federal level testing. Our assessment concluded there was minimal human health risk associated with seafood consumption after waters were re-opened for fisheries.

- Gohlke JM, D Doke, M Tipre, M Leader, T Fitzgerald. (2011). A review of seafood safety after the Deepwater Horizon blowout. *Environ Health Perspect.* 119(8): 1062-9 PMCID: PMC3237364
- Fitzgerald TP, JM Gohlke. (2014). Contaminant levels in Gulf of Mexico reef fish after the Deepwater Horizon oil spill as measured by a fishermen-led testing program. *Environ. Sci. Technol.*48(3): 1993-2000 PMID: 24401096

List of published work in Google Scholar:
https://scholar.google.com/citations?hl=en&user=RKwPrDoAAAAJ

D. Research Support

Ongoing Research Support

NIH/NIEHS R01ES023029 Gohlke (PI) 02/01/15 – 10/31/19
Project Title: Environmental exposures across urban and rural communities in the Deep South
Working with community groups, we will determine whether significant differences in vulnerability to heat-related health impacts exist between underserved urban and rural communities in the Deep South.

NSF 1605355 Dietrich (PI) 07/01/16 - 06/30/19
Project Title: Assessing Inhalation Exposure to Aerosolized Contaminants from Drinking Water.

The project is determining exposure and assessing potential health risks from inhalation of metals from humifier use.

Selected Recently Completed Research Support

NIH/NIEHS 1R21ES020205 Gohlke (PI) 08/15/11 – 07/31/2014
Extreme Heat Events-Evolving risk patterns in urban and rural communities
This study examined the impacts of heatwaves in urban versus rural communities in Alabama using retrospecitve analysis of birth and death records and satellite-derived datasets.

Red Cross Gohlke and B Zaitchik (Co-PIs) 09/01/15-02/15/16
American Red Cross and Red Crescent Climate Center Contract
Project title: Health impacts of extreme heat in the informal settlements of Nairobi
The goal of this project was to estimate a threshold temperature that would like increase mortality due to extreme heat exposure in Nairobi via a meta-analysis of studies conducted elsewhere.

NIH/NIOSH 2 T42 OH008436 08 Lungu(PI) 07/01/13 – 6/30/15
Deep South Occupational Safety and Health Education and Research Center
Developing professionals who protect and promote the health and safety of workers through interdisciplinary education, research, and outreach programs.

EPA/VDH Marmagas(PI) 03/25/16-7/15/16
Environmental Protection Agency/Virginia Department of Health Contract
Project title: Home radon testing in Tazewell County, VA
The goal of this work was to evaluate radon exposure in Tazewell County by randomly recruiting 300 homeowners to conduct home radon testing.

VT GCC Krometis(PI) 01/01/16-09/30/16
Global Change Center at VT Seed Grant
Project title: How does environmental landscape change shape community and ecological health in the Central Appalachian Coalfields? A pilot study in Tazewell County, Virginia.
The goal of this pilot project is to analyze VA vital statistics (birth, death records) for trends in birth weight and primary causes of mortality as it relates to landuse/land cover changes over the past 30 years.

UAB CSCH ROSA Award Gohlke(PI) 09/01/15-08/30/16
UAB Center for the Study of Community Health Researchers Omnibus Survey of Alabama
Project Title: An environmental health phone survey of Alabama residents and public health professionals
The aim of this work is to determine urban and rural environmental health priorities, preferred methods for addressing those priorities, and opportunities and barriers in the development of a statewide environmental health tracking program in Alabama.

UAB NORC/CSCH pilot grant Gohlke (PI) 03/01/12 – 12/30/12
UAB Nutrition and Obesity Research Center and Center for the Study of Community Health
Project Title: A pilot project to assess individual temperature and light exposures in urban and rural populations

UAB ETM pilot Gohlke(PI) 10/01/12 – 09/30/13
UAB Environmental and Translational Medicine Program
Project Title: Geospatial analysis of health outcomes in North Birmingham: A spatial time-series analysis of birth and death records (1990-2010) to determine whether living in close proximity to coke facilities.

NIH Fogarty 5 D43 TW05497-09 Sathiakumar(PI) 10/01/12 – 10/30/13
Project Title: UAB International Training and Research in Environmental and Occupational Health in South East Asia: the Aga Khan University in Karachi, Pakistan; Manipal University (MU) in Manipal, India; and University of Kelaniya (UKe) in Sri Lanka.

Ralph P. Hall, MEng, S.M., S.M., PhD

Associate Professor, Urban Affairs and Planning, School of Public and International Affairs, Virginia Tech, http://ralphphall.wordpress.com/

Professional Preparation

Stanford University, California	Civil & Environmental Engineering	Postdoc 2008
MIT, Massachusetts	Technology, Management, & Policy	PhD 2006
MIT, Massachusetts	Technology & Policy	S.M. 2002
MIT, Massachusetts	Civil & Environmental Engineering	S.M. 2002
University of Southampton, England	Civil Engineering	MEng 1999

Recent Appointments

2016-pr.	Associate Professor, Urban Affairs and Planning, VT
2015-pr.	SPIA Undergraduate Program Director, VT
2013-pr.	Affiliate Scholar, Global Forum on Urban and Regional Resilience, VT
2013-pr.	Affiliate Member, Myers-Lawson School of Construction, VT
2011-pr.	Faculty Fellow, Metropolitan Institute, VT
2009-2016	Assistant Professor, Urban Affairs and Planning, VT
2006-2008	Postdoctoral Scholar, Civil & Environmental Engineering, Stanford

Five Related Publications

1. **Hall, R. P.**, Ranganathan, S, and Raj, G. C. (2017) A General Micro-level Modeling Approach to Analyzing Interconnected SDGs: Achieving SDG 6 and More through Multiple-Use Water Services (MUS). *Sustainability*, *9*(2), 314.
2. Van Houweling, E., **Hall, R. P.**, Carzolio, M., and Vance, E. (2016) My neighbor drinks clean water, while I continue to suffer;" an analysis of the intra-community and intra-household impacts of a rural water project in Mozambique. *Journal of Development Studies*. DOI: 10.1080/00220388.2016.1224852.
3. Gudmundsson, H., **Hall, R. P.**, Marsden, G., and Zietsman, J. (2015). Sustainable Transportation: Indicators, Frameworks, and Performance Management. Springer, New York, 304 pages. ISBN: 9783662469231.
4. **Hall, R. P.**, Vance, E. A., and Van Houweling, E. (2014). The Productive Use of Rural Piped Water in Senegal. *Water Alternatives, 7*(3), 480-498.
5. **Hall, R. P.**, Van Koppen, B., and Van Houweling, E. (2013). The Human Right to Water: The Importance of Domestic *and* Productive Water Rights. *Science and Engineering Ethics, 20*(4), 849-868.

Other Closely Related Publication

6. Ashford, N. A. and **Hall, R. P.** (2011). Technology, Globalization, and Sustainable Development: Transforming the Industrial State. Yale University Press, New Haven, 752 pages. ISBN: 9780300169720.

Synergistic Activities

Hall has over a decade of academic and professional experience in applying the concept of sustainable development to large-scale infrastructure systems with a specific emphasis on transportation, water supply, and sanitation systems. Hall's most recent co-authored book, entitled *Sustainability in Transportation: Making it Count*, provides students and practitioners with a deep understanding of the basic concepts of sustainability as well as a coherent framework for how to apply them consistently in the context of transportation planning, management, and decision making at different levels.

1. **Sustainability-related Research**: PI of the Indian Institute of Technology-Kanpur (IIT-K) and Virginia Tech (VT) partnership on Sustainable and Resilient Infrastructure Development. The partnership was funded by the Obama-Singh 21st Century Knowledge Initiative.
2. **Professional Society Involvement**: Member of the Transportation Research Board (TRB) Committee on Transportation and Sustainability (ADD40); Member of TRB, 2002-present; Member of the Society of Socio-Economists, 2013-present.
3. **New Course Development (last 3 years)**: Advanced Urban Infrastructure Planning (undergraduate/graduate course); Experience WASH in Malawi – Study Abroad (undergraduate/graduate course); International Development Planning Studio (graduate course); and Technology, Globalization, and Sustainable Development (graduate course).
4. **Reviewer:** Transport Policy; Transportation Research, Part D: Transport and Environment; Journal of Water, Sanitation, and Hygiene for Development; Urban Planning; The William & Mary Policy Review; Journal of Planning History; World Development; Water Alternatives; and Environmental Innovation and Societal Transitions.

Collaborators & Other Affiliations

Collaborators & Co-Editors

Nicholas Ashford (MIT); Robert Ashford (Syracuse University); Jennifer Davis (Stanford University); Michael Garvin (Virginia Tech); Henrik Gudmundsson (Technical University of Denmark); Robert Hope (University of Oxford); Anne Khademian (Virginia Tech); Brian Kleiner (Virginia Tech); Greg Marsden (University of Leeds); Shalini Misra (Virginia Tech); Sudhir Misra (IITK); Nicolas Polys (Virginia Tech); Tara Ramani (Texas A&M University); Shyam Ranganathan (Virginia Tech); Peter Soderbaum (Mälardalen University); Peter Sforza (Virginia Tech); Venkataramana Sridhar (Virginia Tech); Eric Vance (Virginia Tech); Emily Van Houweling (University of Denver); Sophie Wenzel (Virginia Tech); Josias Zietsman (Texas A&M University).

Graduate and Postdoctoral Advisors

Nicholas Ashford (MIT); Joseph F. Coughlin (MIT); David Marks (MIT); Joseph M. Sussman (MIT)

Thesis Advisor and Postgraduate Scholar Sponsor

Jessica Agnew (Virginia Tech); Yehyun An (Virginia Tech); Selma Elouardighi (Virginia Tech); Mark Fialkoff (Virginia Tech); Khushboo Gupta (Virginia Tech); Raj Kumar (Virginia Tech); Emily Van Houweling (Virginia Tech)

Current: [a] Doctoral Students: 4 (committee chair/co-chair), 7 (committee member); [b] Masters Students: 1 (committee chair), 4 (committee member); [c] Undergraduate Students: 2.

Former: [a] Doctoral Students: 3 (committee chair), 4 (committee member); [b] Masters Students: 14 (committee chair), 32 (committee member); [c] Undergraduate Students: 4.

Biographical Sketch
Dana M. Hawley

A. Professional Preparation

College of William & Mary	Biology with Highest Honors	B.S. 1999
Cornell University	Ecology & Evolutionary Biology	Ph.D. 2005
Smithsonian Institution	Molecular Evolution Postdoctoral Fellowship	2005 - 2006

B. Appointments

Associate Professor, Department of Biological Sciences, Virginia Tech	2013 - present
Assistant Professor, Department of Biological Sciences Virginia Tech	2007- 2013
Adjunct Professor, Department of Fish & Wildlife Conservation, Virginia Tech	2008 - present

C. Publications ([U]=Hawley lab undergraduate student; [G]=graduate student; [P]=postdoc)

Most closely-related to proposed work:

[P]Thomason, C.A., [G]Leon, A., Kirkpatrick, L.T., Belden, L.K., and Hawley, D.M. 2017. Eye of the finch: characterization of the ocular microbiome of house finches in relation to mycoplasmal conjunctivitis. *Environmental Microbiology* 19:1439-1449.

Pflaum, K., Tulman, E.R., Beaudet, J., Liao, X., Dhondt, K.V., Dhondt, A.A., **Hawley, D.M.**, Ley, D.H., Kerr, K.M., and Geary, S.J. 2017. Attenuated phenotype of a recent house finch-associated *Mycoplasma gallisepticum* isolate for domestic poultry. *Infection and Immunity*. Online early: 10.1128/IAI.00185-17.

Hawley D.M., Osnas, E.E., Dobson, A.P., Hochachka, W.M., Ley, D.H., and Dhondt, A.A. 2013. Parallel patterns of increased virulence in a recently emerged wildlife pathogen. *PLoS Biology* 11: e1001570.

[P]Adelman, J.S., Kirkpatrick, L., [G]Grodio, J.L., and **Hawley, D.M.** 2013. House finch populations differ in early inflammatory signaling and pathogen tolerance at the peak of *Mycoplasma gallisepticum* infection. *American Naturalist* 181: 674-689.

[G]Grodio, J.L., Ley, D.H., Schat, K.A., **Hawley, D.M**. 2013. Chronic Mycoplasma conjunctivitis in house finches: host antibody response and *M. gallisepticum* VlhA expression. *Veterinary Immunology and Immunopathology* 15: 129-137.

Other significant products:

[P]Adelman, J., and **Hawley, D.** 2017. Tolerance of infection: a role for animal behavior, potential immune mechanisms, and consequences for parasite transmission. *Hormones and Behavior*. Online early: http://dx.doi.org/10.1016/j.yhbeh.2016.10.013

[U]Love, A.C., [G]Foltz, S.L., [P]Adelman, J.S., Moore, I.T., and **Hawley, D.M.** 2016. Changes in corticosterone concentrations and behavior during *Mycoplasma gallisepticum* infection in house finches (*Haemorhous mexicanus*). *General and Comparative Endocrinology* 235: 70-77. DOI: 10.1016/j.ygcen.2016.06.008.

[G]Harris, M.C., Dotseth, E.J., Jackson, B.T., Zink, S.D., Marek, P.E., Paulson, S.L., Kramer, L.D., and **Hawley, D.M.** 2015. Detection and isolation of La Crosse virus in field-collected *Aedes japonicus japonicus* (Diptera: Culicidae) in the Appalachian Region, USA. *Emerging Infectious Diseases* 21: 646-649.

[P]Adelman, J.S., [G]Moyers, S.C., Farine, D.R., and **Hawley, D.M.** 2015. Feeder use predicts both acquisition and transmission of a contagious pathogen in a North American songbird. *Proceedings of the Royal Society of London Series B* 282: 20151429.

Hawley, D.M. and Altizer, S.A. 2010. Disease ecology meets ecological immunology: Understanding the links between organismal immunity and infection dynamics in natural populations. *Functional Ecology* 25: 48-60.

D. Synergistic Activities

Research Mentor for Underrepresented Groups 2009-present

As part of multiple programs at Virginia Tech (IMSD, VT-PREP, MAOP, and SURF), I mentor undergraduate students, post-baccalaureate scholars, and graduate students from groups who have been historically underrepresented in science; I have participated in multiple conferences and workshops on mentoring and teaching diverse students (e.g., Advancing Diversity at Virginia Tech conference in Jan 2017; 2-day "Inclusive Pedagogy workshop in 2014"; "Best Practices in Mentoring Underrepresented Minorities in Biomedical Research" workshop in 2010).

Public Outreach Activities 2003-present

I design and carry out a variety of outreach activities for local classrooms (most recent classroom visit occurred in April 2016), the *Virginia Science Festival* (2014, 2015, 2016), the local town nature center, and as part of Virginia Tech's *Kindergarten to College Program*, which brings in 5th graders from around Virginia for an academic experience. I served as an Outreach Workshop Leader at the *National Zoological Park* during my postdoctoral fellowship (2005-06) and led bird behavior and ecology workshops for three years (2003-05) at Cornell University as part of the *Expanding Your Horizons in Science and Math* Program for middle-school aged girls.

Integration of Outreach into Undergraduate and Graduate Education 2010-present

In my undergraduate *Ornithology* course, students design and carry out educational activities about birds at a variety of community venues (local parks, K-12 classrooms, the library, the town nature center). In 2013, I developed a graduate-level *Outreach in Biology* course whereby Virginia Tech graduate students learn how to effectively communicate science and conduct scientific outreach; students then design and complete individual outreach projects based on their own dissertation research. In Fall 2016, I taught a Science Communication unit for graduate fellows in an inter-disciplinary *Interfaces of Global Change* graduate program.

Broad Dissemination of Research Results 2003-present

Research featured in radio and TV programs for *Pulse of the Planet* (3 segments; 2016), *WDBJ7* (TV station for Roanoke, VA), Canada's National Public Broadcast Station's *As It Happens* (2015), WAMC's *Academic Minute* (2013), *Virginia Public Radio* (2011), *Scientific American's* 60-second podcast (2010), and *AAAS* (Jan 2006). Research also featured in a diversity of national and local print outlets including *CBS News* (2015), *Discovery Magazine* (2015), *The Washington Post* (2015), *The Roanoke Times* (2015), *Science Daily* (2011), Nature's *News and Views* (2010), and Virginia Tech's *Daily News* (2009-2016) and *Research Magazine* (2010); I have also written public pieces about my research for Cornell University's *Plantation Notes*, the Cornell Laboratory of Ornithology's *Birdscope* (readership 45,000+), and the Audubon Society's *The Quail.*

Associate Editor, *Functional Ecology* 2011-present

I handle approximately 20 papers a year for the journal *Functional Ecology* (impact factor 5.21), one of the leading journals in my field of study.

Curriculum Vitae — Lenwood S. Heath

Professional Preparation

University of North Carolina, Chapel Hill	Mathematics	B.S., 1975
University of Chicago	Mathematics	M.S., 1976
University of North Carolina, Chapel Hill	Computer Science	Ph.D., 1985

Appointments

2003–	Professor	Computer Science	Virginia Tech
1993–2003	Associate Professor	Computer Science	Virginia Tech
1987–1993	Assistant Professor	Computer Science	Virginia Tech
1985–1987	Instructor of Applied Mathematics	Mathematics	MIT

Five Most Relevant Publications

1. "DeNovo: Virus-Host Sequence-Based Protein-Protein Interaction Prediction," Fatma-Elzahraa Eid, Mahmoud ElHefnawi, and Lenwood S. Heath. **Bioinformatics 32,** 2016, pp. 1144-1150.
2. "CoSREM: A Graph Mining Algorithm for the Discovery of Combinatorial Splicing Regulatory Elements," Eman Badr and Lenwood S. Heath. **BMC Bioinformatics 16,** 2015, 15 pages.
3. "Similarity-Based Codes Sequentially Assigned to Ebolavirus Genomes are Informative of Species Membership, Associated Outbreaks, and Transmission Chains," Alexandra J. Weisberg, Haitham A. Elmarakeby, Lenwood S. Heath, and Boris A. Vinatzer. **Open Forum Infectious Diseases 2,** 2015, 11 pages.
4. "Identifying Splicing Regulatory Elements with de Bruijn Graphs," Eman Badr and Lenwood S. Heath, **Journal of Computational Biology 21,** 2014, pp. 880-897.
5. "A System to Automatically Classify and Name Any Individual Genome-Sequenced Organism Independently of Current Biological Classification and Nomenclature," Haitham Marakeby, Eman Badr, Hanaa Torkey, Yuhyun Song, Scotland Leman, Caroline L. Monteil, Lenwood S. Heath, and Boris A. Vinatzer. **PLOS ONE,** 2014, 12 pages.

Five Other Publications

1. "Potential Targets of VIVIPAROUS1/ABI3-LIKE1 (VAL1) Repression in Developing *Arabidopsis thaliana* Embryos," Andrew Schneider, Delasa Aghamirzaie, Haitham Elmarakeby, Arati N. Poudel, Abraham J. Koo, Lenwood S. Heath, Ruth Grene, and Eva Collakova. **The Plant Journal 85,** 2016, pp. 305–319.
2. "Transcriptome-wide Functional Characterization Reveals Novel Relationships Among Differentially Expressed Transcripts in Developing Soybean Embryos," Delasa Aghamirzaie, Dhruv Batra, Lenwood S. Heath, Andrew Schneider, Ruth Grene, and Eva Collakova. **BMC Genomics 16,** 2015, 23 pages.
3. "Evidence for Extensive Heterotrophic Metabolism, Antioxidant Action, and Associated Regulatory Events during Winter Hardening in Sitka Spruce," Eva Collakova, Curtis

Klumas, Haktan Suren, Elijah Myers, Lenwood S. Heath, Jason A. Holliday, and Ruth Grene. **BMC Plant Biology 13,** 2013, 16 pages.

4. "Mining for Meaning: Visualization Approaches to Deciphering Arabidopsis Stress Responses in Roots and Shoots," Lecong Zhou, Christopher Franck, Kuan Yang, Guillaume Pilot, Lenwood S. Heath, and Ruth Grene. **OMICS: A Journal of Integrative Biology 16,** 2012, pp. 208–228.
5. "A Theoretical Model for Whole Genome Alignment," Nahla A. Belal and Lenwood S. Heath. **Journal of Computational Biology 18,** 2011, pp. 705–728.

Synergistic Activities

(1) Editor, **Journal of Interconnection Networks (JOIN),** 2003–. (2) Guest editor, with Naren Ramakrishnan, of the **Special Issue of IEEE Computer on Bioinformatics Software,** 2002. (3) Member of program committee of **High Performance Computing Symposium 2002 (HPC 2002),** for two tracks on Bioinformatics Applications. (4) Supervisor of summer bioinformatics research of a VT Minority Academic Opportunities Program (MAOP) student from Auburn University, 2005. (5) Editor-in-Chief of the **Special Issue of Proceedings of the IEEE on Bioinformatics of DNA,** to appear, 2016.

W. Cully Hession
Biological Systems Engineering, Virginia Tech
540-231-9480; chession@vt.edu

A. Professional Preparation

Virginia Tech	Agricultural Engineering	B.S. 1984
Virginia Tech	Agricultural Engineering	M.S. 1988
Oklahoma State University	Biosystems Engineering	Ph.D. 1995

B. Appointments

2012 – present	Professor, Biological Systems Engineering, Virginia Tech
2005 – 2012	Assoc. Professor, Biological Systems Engineering, Virginia Tech
1999 – 2005	Assist. & Assoc. Professor, Civil and Environmental Eng., Univ. of Vermont
1995 – 1999	Assist. Curator, Patrick Center, Academy of Natl. Sciences, Philadelphia, PA
1992 – 1995	PhD Candidate, Biosystems Engineering, Oklahoma State University
1989 – 1992	Sr. Environ. Engineer, VA-DCR, Richmond, VA.
1987 – 1989	Watershed Modeler, USDA-ARS, Morris, MN

C. Publications (** indicates undergraduate students; * indicates graduate students)

(i) Five Relevant Publications

Polys, N.F., P. Sforza, W.C. Hession, and J. Munsell (2016), Extensible experiences: Fusality for stream and field, Proceedings of the 21st International Conference on Web3D Technology, 179-180. doi: 10.1145/2945292.2945320.

Abel, S., L.C. Hopkinson, W.C. Hession (2016), Hydraulic and physical structure of runs and glides following stream restoration, River Res. App., 32, 1890-1901.

Jones, C.N.*, D.T. Scott, C. Guth*, E.T. Hester, and W.C. Hession (2015), Seasonal variation in floodplain biogeochemical processing in a restored headwater stream, Environmental Science & Technology, 49, 13190-13198.

Hofmeister, K.L.**, C.M. Cianfrani, and W.C. Hession (2015), Complexities in the stream temperature regime of a small mixed-use watershed, Blacksburg, VA, Ecological Engineering, 78, 101-111.

Liao, H.*, L.H. Krometis, W.C. Hession, R. Benitez**, R. Sawyer**, E. Schaberg**, E. Wagoner**, and B.D. Badgley (2015), Storm loads of culturable and molecular fecal indicators in an inland urban stream, Science of the Total Environment, 530-531, 347-356.

(ii) Five Other Significant Publications

Ludwig, A.L., W.C. Hession, D. Scott, and D. Gallagher (2016), Simulated flood of a small constructed floodplain wetland in Virginia: Even-scale pollutant attenuation, Trans. ASABE, 59(5), 1321-1331.

Ludwig, A.L.*, and W.C. Hession (2015), Groundwater influence on water budget of a small constructed floodplain wetland in the Ridge and Valley of Virginia, USA, Journal of Hydrology: Regional Studies, 4, 699-712.

Liao, H.*, L.H. Krometis, W.C. Hession, L.L. House, K. Kline, and B.D. Badgley (2014), Hydrometeorological and physicochemical drivers of fecal indicator bacteria in urban stream bottom sediments, Journal of Environmental Quality, 43, 2034–2043.

Fahrenfeld N., K. Knowlton, L.A. Krometis, W.C. Hession, K. Xia, E. Lipscomb*, K.B. Libuit**, K.B. Green**, and A. Pruden-Bagchi (2014), Effect of manure application on

abundance of antibiotic resistance genes and their attenuation rates in soil: Field-scale mass balance approach. Environmental Science & Technology, 48, 2643-2650.
Brown, K.R.*, K.J. McGuire, W.C. Hession, and W.M. Aust (2016), Can the Water Erosion Prediction Project model be used to estimate best management practice effectiveness from forest roads? Journal of Forestry, 114(1), 17-26.

D. Synergistic Activities

Research Infrastructure Development, Design, and Construction:

- *Stream Research, Education, and Management Laboratory* (StREAM Lab, Blacksburg, VA). Installing extensive monitoring/sensor array for real-time website access for research, education, and outreach. Includes four flow and water quality monitoring stations, a full weather station, groundwater wells, and web cameras utilizing wireless communication technologies.
- *Prices Fork Research Farm* (Blacksburg, VA). Reviving three small watershed hydrology research sites. Currently conducting interdisciplinary research related to pasture management.
- *Urban Horticultural Center* (Blacksburg, VA). Designed and installed 33 small, flexible plots (3 x 3 m) with collection systems for evaluating water and sediment runoff from various land use practices.

Interdisciplinary Research and Education:

- *Director of Virginia Tech's StREAM Lab* (Blacksburg, VA; 2010-current). Utilized to promote interdisciplinary research, education, and outreach. Sixteen classes from across campus use the lab for field excursions, laboratories, and research projects. More than 20 graduate students have done all or portions of MS or PhD research using data from the site. http://vtstreamlab.weebly.com/.
- *Director NSF-REU Site: Dynamics of Water and Societal Systems, An Interdisciplinary Research Program at the Virginia Tech StREAM Lab* (Blacksburg, VA; 2012-14). An interdisciplinary undergraduate research experience.
- *PI USDA-REEU: Training Future Leaders to Solve Resource Challenges at the Confluence of Water and Society* (Blacksburg, VA; Due March 24, 2016). Interdisciplinary research and extension training program with five co-PIs and fifteen Faculty Mentors from eleven different departments.
- *Co-PI USDA-AFRI: Identification and Management of Critical Control Points in tfie Spread of Antibiotic Resistance from Manure to Raw Produce* (Virginia Tech; 2015-2017). Extremely interdisciplinary research effort (~$2.25 M) seeks to identify critical control points for the spread of antibiotic resistance from farm to fork. Includes eight co-PIs from six different departments.
- *Co-PI Virginia Tech-ICAT Science, Engineering, Art, and Design Grant: Fusality for Stream and Field* (Virginia Tech; 2015-17). Interdisciplinary effort to collect, fuse, and deliver of geo-referenced data to Web3D environments for research, education, and outreach. We are working to publish environmental monitoring data and citizen sensors to create compelling and scientific experiences of local places using human-centered computing.
- *Member University Water Degree Steering Committee* (Virginia Tech; 2011-current). University-wide committee that developed a new interdisciplinary undergraduate degree at Virginia Tech – "Water: Resources, Policy, and Management".

BIOGRAPHICAL SKETCH

NAME: Robert Bruce Hull IV

POSITION TITLE: Professor

EDUCATION/TRAINING

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Davis and Elkins College	NA	1975-77	Humanities
Virginia Tech	BS	05/1979	Environ Conservation
Virginia Tech	MS	05/1981	Natural Resources
University of Arizona	NA	1982	Environ Psychology
Virginia Tech	PhD	1984	Human Dimensions Natural Resources

A. Personal Statement

I write and teach about leadership for sustainable development in the Anthropocene and how to influence change in the cross sector space where government, business, and civil society intersect. I've researched and published on social science topics that support environmental management, but in last decade or so realized that I can have a greater impact by helping professionals enhance their impact and influence, i.e., leadership. I argue that, here on the cusp of the Anthropocene, sustaining development depends more on mobilizing people to meet current challenges than it depends on better science and technology. Towards that end, I've helped develop an executive, professional development graduate degree for sustainability professionals working at the intersection of business, government, and civil society and have started a new research program studying content and pedagogy needed for that purpose (i.e., the XMNR in Arlington). More recently, I've also focused my teaching of leadership and collaboration on graduate global change science students. As part of that effort, I lead or co-lead graduate study abroad programs to India for the MNR and co-teach seminar and capstone courses for the Global Change IGEP. Also, I am President of the Board of a nonprofit, Climate Solutions University, whose mission is to help communities adapt to climate change, work across jurisdictional boundaries, and protect vulnerable citizens and the natural resources on which they depend.

B. Positions and Honors

Positions and Employment

1984-1987 Research Fellow, Faculty of Architecture, University of Melbourne, Australia
1988-1994 Associate Professor, College of Architecture, Texas A&M University
1995-2001 Associate Professor, College of Natural Resources and Environment, Virginia Tech
2001-now Professor, College of Natural Resources and Environment, Virginia Tech

Other Experience

2000-2010 Advisory Board Member, US Forest Service Land Use Interface Advisory Board Region 2.
2004-now Fellow Virginia Natural Resource Leadership Institute
2010-now Board President, Climate Solutions University
2012-now Senior Fellow, Center for Leadership in Global Sustainability, Virginia Tech
2015-now Fellow, Advisory Board Member, and (recently) co-director of PhD IGEP, Center for Global Change, Virginia Tech
2017-now Advisory Board Member, Center for Communicating Science

C. Contributions to Science

My early work focused on contributions of social science to environmental management. The research was used, for example, to inform state and federal programs that work at the interfaces of land use change. For example,

- Gobster, P. and Hull, R.B. (Eds.) 2000. *Restoring Nature: Perspectives from the Social Sciences and Humanities.* Washington DC: Island Press
- Goldstein, B. and Hull, R.B. 2008. Socially Explicit Fire Regimes. *Society and Natural Resource*s. 21:469–482
- Kendra, Angelina; Hull, R. Bruce 2005. Motivations and Behaviors of New Forest Owners in Virginia. *Forest Science,* 51 (2): 142-154
- Hull, R.B., Robertson, D.P., Buhyoff., G.J. 2004. Boutique Forestry: New forest practices in urbanizing landscapes. *Journal of Forestry*: 102 (1): 14-19.
- Robertson, D.P. and Hull, R.B. 2003. Public ecology: an environmental science and policy for global society. *Environmental Science & Policy* 6 (5): 399-410
- Dedrick, J., Hall, T, Hull, RB., and Johnson, J. 2000. The Forest Bank: an experiment in Managing Fragmented Forests. *Journal of Forestry* 98 (3): 22-25.
- Hull, R.B. 2010. Valuing Urban Forests: Lessons to Learn from Hurricanes In K.G. Tidball and M Krasny (eds). *Greening in the Red Zone: Disaster, Resilience, and Community Greening.* Springer. Chapter 19: 165-172.
- Hull, R.B. 2011. Forestry's Conundrum: High Value, Low Relevance. *Journal of Forestry:* 109 (1): 50-56.

The next phase of my work focused on using social science tools to help facilitate local economic activities for sustainable development. Toward that end we established and studied two local cooperatives that still exist although in different guises: Grayson Landcare and Catawba Landcare. For example,

- Kimmel, C. E., R. B. Hull, Stephenson, M.O., D. P. Robertson and K. Cowgill (2012). "Building community capacity and social infrastructure through landcare: a case study of land grant engagement." Higher Education **64**: 223-235.
- Robertson, D., Hull, RB., Moles, J, et al. 2008. Landcare in America. In D. Catacutan & C. Neely (Eds*) Landcare: Local Action-Global Progress*. Landcare International. Adams Printers Pty Ltd. Melbourne, Australia.
- Kimmel, C. and Hull, R.B. 2011. Ecological Entrepreneurship Support Networks: Roles and Functions for Conservation Organizations. *Geoforum 43:* 58–67

Most of my current work does not contribute to science directly. Instead, I focus on content and pedagogy of teaching leadership to sustainability professionals. For example,

- Hull, RB. 2006. *Infinite Nature*. University of Chicago Press.
- Wasserman, A., Hull, R. B., & McCutchan, B. (2014). How Cargill cultivated greener soybean production in the Amazon. *GreenBiz*. April. Online.
- Hull, RB, Kimmel, C., Robertson, D. and McCutchan, B. 2014. Collaborative Leadership for Sustainable Development in Global Supply Chains: Linking Agriculture and Deforestation in the Amazon to Consumers in Europe and Asia. *Solutions* 5(4): 51-59.
- Hull, R.B. (2017) Leadership for Adaptive Management. *Companion to Environmental Ethics.* Edited by Benjamin Hale and Andrew Light. Routledge.
- Hull, R. Bruce, et al. (2016) "International field experiences promote professional development for sustainability leaders." *International Journal of Sustainability in Higher Education* 17(1):86-104.
- I also blog a bit on the topic, eg.,

- What will you do after marching for science? www.globalchange.vt.edu/2017/04/18/what-will-you-do-after-marching-for-science
- Scientific Facts Don't Win Arguments: http://www.globalchange.vt.edu/2017/03/06/scientific-facts-dont-win-arguments/
- The end of expertise: http://www.globalchange.vt.edu/2017/02/24/the-end-of-expertise/
- Population is not the problem. http://cligs.vt.edu/population-not-problem/
- Leadership 101 for Global Sustainability: http://www.constructingsustainability.com/leadership101.html
- Leadership as simple as DAC: http://www.constructingsustainability.com/leadership-as-simple-as-dac.html

KLAUS MOELTNER

Professor, Department of Agricultural and Applied Economics
Virginia Tech, Blacksburg, VA 24061; Tel: (540) 231-8249; email: moeltner@vt.edu

Professional Preparation

Univ. of Life Sciences, Vienna, Austria	MS	Environmental Planning & Engineering, 1990
Monterey Institute of International Studies	MA	International Policy Studies, 1994
University of Washington	MA	Economics, 1998
University of Washington	Ph.D.	Economics, 2000

Appointments

2015- Professor, Department of Agricultural and Applied Economics, Virginia Tech
2011-2015 Associate Professor, Department of Agricultural and Applied Economics, V.Tech
2006-2010 Associate Professor, Department of Resource Economics, University of Nevada,
2000-2006 Assistant Professor, Department of Resource Economics, University of Nevada,

Recent Publications

Moeltner, K., C. Blinn, T. Holmes (forthcoming). Forest Pests and Home Values: The Importance of Accuracy in Damage Assessment and Geocoding of Properties, ***Journal of Forest Economics***

Cohen, J., K. Moeltner, J. Reichl, M. Schmidthaler (forthcoming). Linking the Value of Energy Reliability to the Acceptance of Energy Infrastructure: Evidence from the EU, ***Resource and Energy Economics***

Cohen, J., K. Moeltner, J. Reichl, M. Schmidthaler (forthcoming). An Empirical Analysis of Local Opposition to new Transmission Lines across the EU-27, ***Energy Journal***, 37(3)

Cohen, J., C. Blinn, K. Boyle, T. Holmes, K. Moeltner (2016). Hedonic Valuation with Translating Commodities: Mountain Pine Beetles and Host Trees in the Colorado Front Range. ***Environmental and Resource Economics***, 63(3), 613-642

Vinoles, V., K. Moeltner, S. Stoddard (2015). Length of Residency and Water Use in an Arid Urban Environment, ***Water Resources and Economics***, 12 (Oct.), p. 52-66

Yu , L., S. B. Ball, C. E. Blinn, K. Moeltner, S. Peery, V.A. Thomas, R. H. Wynne (2015). CloudSourcing: Using an Online Labor Force to Detect Clouds and Cloud Shadows in Landsat Images. ***Remote Sensing***, 7(3), 2334-2351

Castledine, A., K. Moeltner, M.K. Price, S. Stoddard (2014), Free to Choose: Promoting Conservation by Relaxing Outdoor Watering Restrictions. ***Journal of Economic Behavior & Organization***, 107(A), 324-343

Johnston, R., K. Moeltner, (2014). Meta-Modeling and Benefit Transfer: The Empirical Relevance of Source-Consistency in Welfare Measures. ***Environmental and Resource Economics***. 59, 337-361

Moeltner, K, R.S. Rosenberger, (2014). Cross-Context Benefit Transfer: A Bayesian Search for Information Pools. ***American Journal of Agricultural Economics***, 96(2), 469-488

Moeltner, K, M.K. Kim, E. Zhu, W. Yang, (2013). Wildfire Smoke and Health Impacts: A Closer Look at Fire Attributes and their Marginal Effects. ***Journal of Environmental Economics and Management***, 66(3), 476--496

A. Synergistic Activities

- Co-editor, Environmental and Resource Economics, 2013 – current
- Editorial Council, Journal of the Association of Environmental and Resource Economists
- Keynote speaker: Symposium on the "Public acceptance of electricity infrastructure," Johannes Kepler University, Linz, Austria, June 3, 2014.
- Invited panelist and speaker at the 1st and 3rd Urban Water Roundtables, Global Institute of Sustainability, Arizona State University, 2013 and 2015.
- Scientific Advisory Panel, EU-funded project "Securing the European Electricity Supply against Malicious and Accidental Threats (SESAME)," 2012 – 2015.

Collaborators & Other Affiliations

G. Amacher, S. Ball, C. Blinn, K. Boyle, J. Campbell, J. He, R. Jin, N. Lau, D. Lee, L. Resler, Y. Shao, V. Thomas, R. Wynne, Virginia Tech; T. Holmes, USFS; R. Johnston, Clark University; M.K. Keun, Utah State University; M. Kobayashi, World Bank; M.K. Price, Georgia State University; J. Reichl, M. Schmidthaler, Energy Institute, Linz, Austria; K. Rollins, W. Yang, Univ. of NV, Reno; S.S. Stoddard, Truckee Meadows Water Association;

Graduate and Postdoctoral Advisors

G. Brown, R. Halvorsen, E. Rose, University of Washington

Thesis Advising (Chair or Co-chair)

O.Bagheri, S. Ehsan, V. Kesiz-Abnousi, L. Yu, Virginia Tech; A. Castledine, Public Utilities Commission, Carson City, NV; Jed Cohen (West Virginia University, post-doc.), Danielle Hagerty (Booz Allen Hamilton, Washington, D.C.), Yiheng Li (IXI Services, Washington, D.C.), Valeria Oscherov (Protiviti Inc. Consulting), Vanessa Vinoles (Virginia Department of Taxation), Erquian Zhu (China Center of International Economic Exchanges, Zhejiang)

Total number of graduate students advised (as Chair or Co-chair): 1 Master's, 10 PhD

Monica A. Ponder
Department of Food Science and Technology
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Virginia Tech; Blacksburg, VA 24061
mponder@vt.edu; 540-231-5031; 540-231-9293 (fax)

Professional Preparation

Institution	Major	Degree and Date
Miami University, Oxford, OH	Microbiology	B.A. 1999
Michigan State University, East Lansing, MI	Microbiology and Molecular Genetics	Ph.D. 2005
Centers for Disease Control and Prevention, NCVZED, DFBMD, Atlanta, GA	Enteric Diseases Surveillance and Epidemiology	Postdoc 2007

Appointments

Associate Professor – Food Microbiology **2014 to Present**
Assistant Professor – Food Microbiology **2007 to 2014**
Department of Food Science and Technology, Virginia Tech, Blacksburg, VA

Products (out of **30 total, 23** for period of **2010-2017)**

Five related Publications

- Mitchell, C., Davy, K., Davy, B., Halliday, T., Nielsen, A., Hulver, M. and **M. Ponder** 2015. The effect of prebiotic supplementation with inulin on cardio-metabolic health: Rationale, design, and methods of a controlled feeding efficacy trial in adults at risk for type 2 diabetes. Contemporary Clinical Trials
- Pollard, S. diStefano, J., Boyer, R., Chapman, B., Archibald, T. **Ponder, M**. and Rideout S. 2015. Identification of risky food safety practices at Southwest Virginia Farmers' Markets Food Protection Trends.
- Lopez-Velasco G., Carder, P., Welbaum, G. and **M. Ponder** 2013. Diversity of the spinach (Spinacia oleracea) spermosphere and phyllosphere bacterial communities**.** FEMS Microbiol Lett. 2013 Sep;346(2):146-54.
- Aviles, B., Klotz, C., Eifert, J., R. Williams and **M. Ponder**. 2013. Effect of physiological state, prolonged dry storage, and in vitro digestion on the survival and gene expression of *Salmonella enterica* sv. Tennessee. International Journal of Food Microbiology. 162 (3): 252–259.
- Shepherd, M., Swecker, W., Jensen, R and **M. Ponder.** 2012. Characterization of the fecal bacteria communities of forage-fed horses by pyrosequencing of the 16S rRNA V4 gene amplicons. FEMS Microbiology Letters. FEMS Microbiology Letters. 326(1): 62-68.

Other Relevant Publications

- Lopez-Velasco G., R. Boyer, G. Welbaum, **M. Ponder**. 2011. Changes in spinach phylloepiphytic bacteria communities following minimal processing and refrigerated storage described using pyrosequencing of 16S rRNA amplicons. Journal of Applied Microbiology. 110 (5): 1203-1214.
- Price, K., H. Totty, H. Lee, M. Utt, J. Escobar and **M. Ponder.** 2010. Use of *Saccharomyces cerevisiae* fermentation product on growth performance and microbiota of weaned pigs during *Salmonella* infection. Journal of Animal Science. 88:3896-3908.
- Lopez-Velasco, G., M. Davis, R. Boyer, R. Williams and **M. Ponder**. 2010. "Alterations of the phylloepiphytic bacterial community associated with interactions of *E. coli* O157:H7 during storage of packaged spinach at refrigeration temperatures". Food Microbiology. 27(4): 476-486.
- Shepherd, M., Swecker, W., Burk, A., and **M. Ponder**. 2014. Fiber digestibility, fecal bacterial 16s rRNA gene abundance, and fecal and plasma acetate concentrations in overweight and moderate condition adult mares. Journal of Nutritional Science. 3:e10.

- Baltasar, Patricia P., Milton, S., Swecker, W., Elvinger, F., and **M. Ponder**. 2014. Shiga toxin-producing *Escherichia coli* distribution and characterization in a pasture-based cow-calf production system. Journal of Food Protection. 77(5):722-31.

Synergistic Activities

- Courses Designed, Implemented and Taught
  - 2017-present- Undergraduate course in Food Microbiology
  - 2013-present- Graduate course Advances in Food Microbiology
  - 2009- present Graduate level course in Epidemiology of Foodborne and Waterborne Disease
  - 2009-present Undergraduate course in Epidemiology of Food and Waterborne Disease

Professional Activities

- Associate editor: BMC Microbiology
- Editorial Board Member of Journal of Food Protection
- Ad hoc reviewer: Applied and Environmental Microbiology, Food Chemistry, International Journal of Food Microbiology, International Journal of Systematics and Evolutionary Microbiology, , Microbial Ecology
- College of Agriculture and Life Sciences Representative to the University Curriculum Committee, Virginia Tech 2015-2018
- 2007-present: Member of graduate and curriculum committees of the Virginia Tech Department of Food Science and Technology

Collaborators & Other Affiliations 2010-2017

Collaborators and Co-Editors

K. Alexander (Virginia Tech), B. Aviles (D.D. Williamson), H. Ayala del Rio (U. Puerto Rico at Humacao), J. Blackburn (University of Florida), J. Bock (Fullerton University), R. Boyer (Virginia Tech), L. Byerly (Louisiana State University), P. Carder (King Phamaceuticals)), B. Chapman (NC State), M. Davis (US Food and Drug Association), B. Davy (Virginia Tech,), K. Davy (Virginia Tech), G. DiBartolo (Joint Genome Institute), Joseph Eifert (Virginia Tech), El-Kahdi, Saler (Virginia Tech), J. Escobar (Novus International), J. Falkinham (Virginia Tech), P. Fields (Centers for Disease Control), G. Fundaro (Virginia Tech), P. Gerner-Smidt (Centers for Disease Control), K. Goodrich (Virginia Tech), A. Grant (Virginia Tech), L. Griffin (Virginia Tech), M. Hanigan (Virginia Tech), , L. Hintz (US Food and Drug Association), M. Hulver (Virginia Tech),), R. Jensen (Virginia Tech), X. Kang (Virginia Tech), C. Klotz (Novozymes),K. Knowlton (Virginia Tech), D. Kuhn (Virginia Tech), L. Krometis (Virginia Tech), G. Lopez-Velasco (UC Davis), K. Mallikarjunan (Virginia Tech), C. Maxwell (University of Arkansas), M. McClelland (UC San Diego), N. Nanthakumar (VA-MD College of Veterinary Medicine), A. Nielson (Virginia Tech), S. Porwollik (Sidney Kimmel Cancer Center), A. Pruden (Virginia Tech), M. Rhoads (Virginia Tech), R. Rhoads (Virginia Tech), S. Rideout (Virginia Tech), , M. Shepherd (VA-MD College of Veterinary Medicine), T. Smith (A.M. Briggs), W. Swecker (VA-MD College of Veterinary Medicine), D. Taylor (Virginia Tech), M.F. Thomashow (Michigan State), J.M. Tiedje (Michigan State U), H.R. Totty (Biomerieux), J. Waitt (Registrar Corp.), G. Welbaum (Virginia Tech), R. C. Williams (Virginia Tech)

Graduate Advisors and Postdoctoral Sponsors

Graduate J. M. Tiedje (Michigan State University); Postdoctoral P. Fields (Centers for Disease Control and Prevention)

Graduate students

Bryan Aviles (D.D. Williamson), Lauren Bowman (Not employed), Phyllis Carder (King Pharmaceuticals), Christopher Caver (Tyson Foods), Courtney Klotz (Novozymes), Gabriella Lopez-Velasco (3M Corporation), Jordan Newkirk (Tyson Foods), Steven Nimitz (Merck), Twyla Smith (A.M. Briggs) Heather Totty (Biomerieux), Heather Tydings (Monogram), Jesse Waitt (Registrar Corp.) Marjorie Davis (US Food and Drug Administration), Leslie Hintz (US Food and Drug Administration), Thomas Kuntz (US FDA)

Amy Pruden- Biographical Sketch
Department of Civil & Environmental Engineering
418 Durham Hall, 1145 Perry Street
Blacksburg, VA 24061

(a) Professional Preparation

University of Cincinnati	Biology, Department of Biological Sciences	B.S., 1997
University of Cincinnati	Environmental Science, Dept. Civil/Environ Engg.	Ph.D., 2002

(b) Appointments

2016-present:	College of Engineering, Virginia Tech, W. Thomas Rice Chaired Professor
2014-present:	Graduate School, Virginia Tech, Associate Dean Interdisciplinary Graduate Education
2013-present:	Dept. Civil & Environ. Engg, Virginia Tech, Professor
2008-2013:	Dept. Civil & Environ. Engg, Virginia Tech, Associate Professor
2002-2008:	Dept. Civil & Environ. Engg, Colorado State University, Assistant Professor

(c) Select Products (out of 95 total peer-reviewed publications, Google Scholar H Index=37)
(ci) Most Relevant

1. Schwake, D.O., Garner, E., Strom, O., Pruden, A., and Edwards, M.A. Legionella DNA Markers in Tap Water Coincident with a Spike in Legionnaires' Disease in Flint, MI. Environ. Sci. Technol. Lett. 2016, doi 10.1021/acs.estlett.6b00192.
2. Garner, E.D., Zhu, N., Strom, L.E., Edwards, M.E., and Pruden, A. A human exposome framework for guiding risk management and holistic assessment of recycled water quality. Environ. Sci.: Water Res. Technol., 2016, 2, 580 – 598.
3. Luby, E., Ibekwe, A.M., Zilles, J., Pruden, A. Molecular Methods for Assessment of Antibiotic Resistance in Agricultural Ecosystems: Prospects and Challenges. Journal of Environmental Quality. 45(2):441-53, 2016 45(2):441-53.
4. Rhoads, W.J., Ji., P., Pruden, A., Edwards, M.A. Water heater temperature set point and water use patterns influence Legionella pneumophila and associated microorganisms at the tap. Microbiome, Special Issue on Microbiology of the Built Environment. 2015, 3, 67.
5. Rhoads, W.R., Pruden, A., Edwards, M.A. Survey of green building water systems reveals elevated water age and water quality concerns. ES: Water Res. Technol. 2015, 2, 164-173.

(cii) Other Relevant Publications

6. Ji, P., Parks, J., Edwards, M.A., Pruden, A. Impact of water chemistry, pipe material and stagnation on the building plumbing microbiome. PLoS ONE. 2015, 10, (10) e0141087.
7. Falkinham, J.O., III, Hilborn, E.D., Arduino, M., Pruden, A., and M.A. Edwards. Epidemiology and ecology of opportunistic premise plumbing pathogens: Legionella pneumophila, Mycobacterium avium, and Pseudomonas aeruginosa. Environ. Health Persp. 2015, 123 (8), 749-758.
8. Proctor, C.R., Edwards, M.A., Pruden, A. Microbial composition of purified waters and implications for regrowth control in municipal water systems. ES: Water Res. Technol. 2015, 1, 882-892.
9. Wang, H., Masters, S., Falkinham III, J.O., Edwards, M.A., Pruden, A. Distribution system water quality affects responses of opportunistic pathogen gene markers in household water heaters. Environ. Sci. Technol. 2015, 49 (14), 8416-24.
10. Masters, S., Wang, H., Pruden, A., Edwards, MA. Redox gradients in distribution systems influence water quality, corrosion, and microbial ecology. Water Res. 2015, 68 (1), 140.

(d) Synergistic Activities

Co-PI on NSF PIRE: Halting Environmental Antibiotic Resistance Dissemination (HEARD), PI-Vikesland (2015-2020). Supports international collaboration among graduate and undergraduate students in tracking antibiotic resistance genes in wastewater treatment plants along a global transect of countries.

Co-Director Virginia Tech ICTAS Center for Science and Engineering of the Exposome (SEE):

- Institute for Critical Technology and Applied Science (ICTAS)- Sustainable Water Thrust

Associate Editor: *Environmental Science & Technology,* American Chemical Society, Editor-in-Chief: David Sedlak

Synergistic Research in Opportunistic Pathogens in Premise Plumbing and Antibiotic Resistance:

- Water Research Foundation Report on Opportunistic Pathogens in Premise Plumbing: Pruden, A., Edwards, M.A., Falkinham III, J.O., Arduino, M., Bird, J., Birdnow, R., Bédard, E, Camper, A., Clancy, J., Hilborn, E., Hill, V., Martin, A., Masters, S., Pace, N.R., Prevost, M., Rosenblatt, A., Rhoads, W., Stout, J.E., and Zhang, Y. (2013). Research Needs for Opportunistic Pathogens in Premise Plumbing: Methodology, Microbial Ecology, and Epidemiology. Water Research Foundation Project 4379 Final Report. Water Research Foundation. Denver, CO, 188 pages.
- Recent Book Chapter: Pruden, A., and Arabi M. (2012) *Quantifying Anthropogenic Impacts on Environmental Reservoirs of Antibiotic Resistance*. In Antibiotic Resistance in the Environment. Eds. Mark Monforts and Patricia Keen. Wiley & Sons, Inc. Hoboken, NJ.

Core faculty member on Student Training Sites at VT:

- *Interdisciplinary Water Sciences and Engineering:* http://www.vwrrc.vt.edu/nsf_reu.html
- Water INTERface, Global Change, and Sustainable Nanotechnology Interdisciplinary Graduate Education Programs: https://interdisciplinary.graduateschool.vt.edu/

Stephen H. Schoenholtz
Director and Professor
Virginia Water Resources Research Center and
Department of Forest Resources and Environmental Conservation
Virginia Tech
Phone (540) 231-0711; Fax (540) 231-6673; Email Stephen.Schoenholtz@vt.edu

A. Professional Preparation

Pennsylvania State University	Forest Science	B.S. with Distinction, 1979
Pennsylvania State University	Biology	B.S. with Distinction, 1979
Virginia Tech	Forest Biology	M.S. 1983
Virginia Tech	Forest Soils	Ph.D. 1990
Virginia Tech	Restoration Ecology	Postdoc. 1990

B. Appointments

Virginia Tech, Blacksburg, Virginia
Virginia Water Resources Research Center, *Director,* 2006-Present
Department of Forest Resources and Environmental Conservation, *Professor,* July 2006 to Present

Oregon State University, Corvallis, Oregon
Department of Forest Engineering, Resources, and Management, *Associate Professor, Professor,* 2001-2006, *Courtesy Professor,* 2006-2012

Mississippi State University, Mississippi State, Mississippi
Department of Forestry, *Assistant Professor, Associate Professor, Professor,* 1990-2001, *Adjunct Professor,* 2001-Present
Mississippi Water Resources Research Institute, *Director,* 2001

New Zealand Forest Research Institute, Rotorua, New Zealand
Soil and Site Productivity Research Group, *Visiting Senior Research Fellow,* January-July 1998 and January-February 2015

Virginia Tech, Blacksburg, Virginia
Department of Crop and Soil Environmental Sciences, *Postdoctoral Research Associate* 1990

Texas Forest Service, College Station, Texas
Staff Forester II, 1984-1986

Columbia University, Palisades, New York
Lamont-Doherty Earth Observatory, Tree-Ring Laboratory, *Research Assistant,* 1983-1984

C. Recent Relevant Refereed Journal Publications

Krenz III, R.J., **S.H. Schoenholtz**, and C.E. Zipper. 2016. Riparian subsidies and hierarchical effects of ecosystem structure on leaf breakdown in Appalachian coalfield constructed streams. *Ecological Engineering* 97:389-399.

Boehme, E.A., C.E. Zipper, **S.H. Schoenholtz**, D.J. Soucek, and A.J. Timpano. 2016. Temporal dynamics of benthic macroinvertebrate communities and their response to elevated specific conductance in Appalachian Coalfield headwater streams. *Ecological Indicators* 64: 171-180.

Christopher, S.F., **S.H. Schoenholtz**, and J.E. Nettles. 2015. Water quantity implications of regional-scale switchgrass production in the southeastern U.S. *Biomass and Bioenergy* 83: 50-59.

Evans, D.M., C.E. Zipper, E.T. Hester, and **S.H. Schoenholtz**. 2015. Hydrologic effects of surface coal mining in Appalachia (USA). *Journal of American Water Resources Association* 51(5): 1436-1452.

Slesak, R.A., **S.H. Schoenholtz**, and D.M. Evans. 2015. Hillslope erosion from high-risk sites following wildfire and salvage logging in southern Oregon, USA. *Forest Ecology and Management* 342: 1-7.

Timpano, A.J., **S.H. Schoenholtz**, D.J. Soucek, and C.E. Zipper. 2015. Salinity as a limiting factor for biological condition in mining-influenced Central Appalachian headwater streams. *Journal of American Water Resources Association* 51(1): 240-250.

Little, C., J.G. Cuevas, A. Lara, M. Pinto, and **S. Schoenholtz**. 2014. Buffer effects of streamside native forests on water provision in watersheds dominated by exotic forest plantations. *Ecohydrology.* doi: 10.1002/eco.1575

Evans, D.M., **S.H. Schoenholtz**, P.J. Wigington, Jr., S.M. Griffith, and W.C. Floyd. 2014. Spatial and temporal patterns of dissolved nitrogen and phosphorus in surface waters of a multi-land use basin. *Environmental Monitoring & Assessment* 186(2):873-887.

Danehy, R.J., R.E. Bilby, R.B. Langshaw, D.M. Evans, T.R. Turner, W.C. Floyd, **S.H. Schoenholtz**, and S.D. Duke. 2012. Biological and water quality responses to hydrologic disturbances in third order forested streams. *Ecohydrology* 5(1):90-98.

Northington, R.M., E.F. Benfield, **S.H. Schoenholtz**, A.J. Timpano, J.R. Webster, and C.E. Zipper. 2011. An assessment of structural attributes and ecosystem function in restored Virginia coalfield streams. *Hydrobiologia* 671(1):51-63.

Floyd, W.C., **S.H. Schoenholtz**, S.M. Griffith, J.P. Wigington, Jr., and J.J. Steiner. 2009. Nitrate-N, landuse/landcover, and soil drainage associations at multiple spatial scales. *Journal of Environmental Quality* 38(4): 1473-1482.

D. Grants and Contracts Received

- Virginia Tech -- $3,030,000 for my individual research program
  - Administer annual budget for Virginia Water Resources Research Center of $750,000-$1,000,000
- Oregon State University -- $1,164,000 for my individual research program
- Mississippi State University -- $2,198,000 for my individual research program

E. Graduate Students and Post-docs Supervised

- Virginia Tech – 8 MS 5 PhD 2 Post-docs
- Oregon State University – 9 MS 3 PhD
- Mississippi State University – 13 MS 2 PhD

F. Synergistic Activities

- Developed new courses: Properties and Processes of Forested Watersheds, Forest Hydrology, Forest Soils, Advanced Forest Soils, Wetland Ecology and Management at Mississippi State Univ. & Oregon State Univ.
- Coordinated development and now oversee new interdisciplinary B.S. degree program in Water: Resources, Policy, and Management, Virginia Tech.
- *National Institutes for Water Resources,* President-Elect 2015-2016, President 2016-2017
- *Soil Science Society of America,* Former Chair, Forest, Range, and Wildland Soils Division
- *American Water Resources Association, Ad Hoc* Science Advisory Council member
- External reviewer for promotion and tenure: Univ. Alberta, Oregon State Univ., Univ. Arizona, Univ. Colorado, Univ. Georgia, SUNY-ESF, Louisiana State Univ., Texas A&M Univ., West Virginia Univ.
- Testified on behalf of the Mississippi State Univ. Forest and Wildlife Research Center before U.S. House of Representatives Subcommittee on Forests and Forest Health
- Organizing Committee, 10th, 12th, and 13th North American Forest Soils Conferences
- Committee Chair, Virginia Department of Environmental Quality Academic Advisory Committee
- International water-resources service activities in Armenia, Chile, Costa Rica, New Zealand, Sweden

Biographical Sketch:

Xiaowei Wu

Department of Statistics
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061
Tel: (540) 231-0023 Email: xwwu@vt.edu

PROFESSIONAL PREPARATION

Wuhan University, China	Electrical Engineering	B.S.	1997
Wuhan University, China	Electrical Engineering	M.S.	2003
Rice University	Statistics	Ph.D.	2010
The University of Chicago	Statistics	Postdoc	2010 – 2012

APPOINTMENTS

Assistant Professor, Virginia Polytechnic Institute and State University	2012 – Now
Postdoctoral fellow, The University of Chicago	2010 – 2012

MOST RELATED PRODUCTS

1. Wang, Z., Xu, K., Zhang, X., **Wu, X.** and Wang, Z. (2017). Longitudinal SNP-set association analysis of quantitative phenotypes. *Genetic Epidemiology*, 41(1):81–93.

2. Leon-Novelo, L.G., Womack, A., Zhu, H. and **Wu, X.** (2017). A Bayesian analysis of quantal bioassay experiments incorporating historical controls via Bayes factors. *Statistics in Medicine*, 36(12):1907–1923.

3. Zhu, H., Casters, P., Morris, J.S., **Wu, X.** and Müller, R. (2017). A unified analysis of structured sonar-terrain data using Bayesian functional mixed models. In press. *Technometrics*.

4. **Wu, X.** and Zhu, H. (2015). Fast maximum likelihood estimation of mutation rates using a birth-death process. *Journal of Theoretical Biology*, 366, 1–7.

5. **Wu, X.** and Kimmel, M. (2013) Modeling neutral evolution using infinite-allele Markov branching processes. *International Journal of Stochastic Analysis* Vol. 2013 Article ID 963831.

OTHER SIGNIFICANT PRODUCTS

1. Sun, M., Sun, Z., **Wu, X.**, Rajaram, V., Keimig, D., Lim, J., Zhu, H. and Xie, H. (2016). Mammalian brain development is accompanied by a dramatic increase in cell-subset specific DNA methylation. *Scientific Reports*, 6:32298.

2. Tran, H., **Wu, X.**, Tithi, S., Sun, M., Xie,H. and Zhang, L. (2016). A Bayesian assignment method for ambiguous bisulfite short reads. *PLoS One*, 11(3):e0151826.

3. **Wu, X.**, Sun, M., Zhu, H., and Xie, H. (2015). Nonparametric Bayesian clustering to detect bipolar methylated genomic loci. *BMC Bioinformatics*, 16:11.

4. **Wu, X.** and Zhu, H. (2015). A Bayesian analysis of copy number variations in array comparative genomic hybridization data. *International Journal of Biomedical Data Mining*, 4:116.

5. Karunasena, E., McIver, L.J., Bavarva, J.H., **Wu, X.**, Zhu, H., Garner, H.R. (2015). 'Cut from the same cloth': Shared microsatellite variants among cancers link to ectodermal tissues-neural tube and crest cells. *Oncotarget*, 6(26):22038–22047.

SYNERGISTIC ACTIVITIES

1. **Reviewer for journals (2010 – present):** *Genetica, Computational and Mathematical Methods in Medicine, BMC Genetics, Scientific Reports, Journal of Theoretical Biology, ICSA Springer Book.*

2. **Invited presentations given at conferences/institutes (2016 – present)**:
   - New England Statistics Symposium, New Haven, CT, USA, Apr 2016
   - ICSA Applied Statistics Symposium, Atlanta, GA, USA, Jun 2016
   - Virginia Commonwealth University, Department of Biostatistics, Richmond, VA, USA, Sep 2016
   - University of Texas MD Anderson Cancer Center, Department of Biostatistics, Houston, TX, USA, Oct 2016
   - James Madison University, Department of Mathematics and Statistics, Harrisonburg, VA, USA, Feb 2017

3. **Editorial Board Member:** *Frontiers*, Bioinformatics and Computational Biology

COLLABORATORS

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Sharon E. Plon	(Baylor College of Medicine)
Zuoheng Wang	(Yale University)
Hehuang D. Xie	(Virginia Tech)
Liqing Zhang	(Virginia Tech)
Hongxiao Zhu	(Virginia Tech)

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a. Professional Preparation

Beijing Agricultural University	Soil Chemistry	B.S.	1989
Louisiana State University	Soil Chemistry	M.S.	1993
University of Wisconsin-Madison	Soil Chemistry	Ph.D.	1997
University of Wisconsin-Madison	Environmental Chemistry (Postdoctoral Associate)		1997-1998

b. Appointments

2016 to present	Professor, Dept. Crop & Soil Environ. Sci., Virginia Tech
2011 to 2016	Associate Professor, Dept. Crop & Soil Environ. Sci., Virginia Tech
2006 to 2011	Director for Research Division and Industrial and Agricultural Services Division, Mississippi State Chemical Laboratory
2010 to 2011	Associate Professor, Dept. of Chemistry, Mississippi State University
2006 to 2010	Assistant Professor, Dept. of Chemistry, Mississippi State University
2002 to 2005	Assistant Professor, University of Georgia
1998 to 2001	Assistant Professor, Kansas State University
1997 to 1998	Postdoctoral Researcher, University of Wisconsin-Madison

c. Publications

[out of 52 peer-reviewed journal publications and book chapters]

5 most related:

1. Chen, C. Q., and **K. Xia**. 2017. Fate of Land Applied Emerging Organic Contaminants in Waste Materials. Current Pollution Reports. Curr. Pollution Rep. 3:38-54.
2. Ray, P*, C.Q. Chen, K. F. Knowlton, A. Pruden, and **K. Xia**. 2017. Fate and effect of antibiotics in beef and dairy manure during static and turned composting. J. Environ. Qual. 46:45-54.
3. Kulesza, S. B., R. O. Maguire, **K. Xia**, J. Cushman, K. F. Knowlton, and P. Ray. 2016. Impact of manure injection on pirlimycin transport in surface runoff. J. Environ. Qual. 45:511–518.
4. Chao Q., D. Troya, C. Shang, S. Hildreth, R. Helm, and **K. Xia**. 2015. Surface Catalyzed Oxidative Oligomerization of 17β-estradiol by $Fe3^{+}$-Saturated Montmorillonite. Environ. Sci. Technol. 49:956–964.
5. Ray, P., K.F. Knowlton, C. Shang, and **K. Xia**. 2014. Method development and validation: solid phase extraction (SPE)-ultra performance liquid chromatography-tandem mass

spectrometry (UPLC-MS/MS) quantification of pirlimycin in bovine feces and urine. J AOAC International. 97:1730-1736.

5 other significant publications:

6. Ray, P., K.F. Knowlton, C. Shang, and **K. Xia**. 2014. Development and validation of a UPLC-MS/MS method to monitor cephapirin excretion in dairy cows following intramammary infusion. PLOS ONE. 9:1-12.
7. Gunatilake, S. R., J. W Kwon, T. E. Mlsna, and **K. Xia**. 2014. A novel approach to determine estrogenic hormones in swine lagoon wastewater using QuEChERS method combined with solid phase extraction, and LC/MS/MS analysis. Anal. Methods. 6:9267 – 9275.
8. Fahrenfeld, N., K. Knowlton, L. A. Krometis, W. C. Hession, **K. Xia**, E. Lipscomb, K. Libuit, B. L. Green, A. Pruden. 2014. Effect of Manure Application on Abundance of Antibiotic Resistance Genes and their Attenuation Rates in Soil: Field-Scale Mass Balance Approach. Environ. Sci. Technol. 48:2643–2650.
9. Keith A. Maruya, D. E. Vidal-Dorsch, S. M. Bay, J. W. Kwon, ***K. Xia***, and K. L. Armbrust. 2012. Organic contaminants of emerging concern in sediments and flatfish collected near outfalls discharging treated wastewater effluent to the Southern California Bight. Environ. Toxicol. Chem. 31:2683–2688.
10. ***Xia, K.***, G. Hagood, C. Childers, J. Atkins, B. Rogers, L. Ware, K. Armbrust, J. Jewell, D. Diaz, N. Gatian, and H. Folmer. 2012. Polycyclic Aromatic Hydrocarbons (PAHs) in Mississippi Seafood from Areas Affected by the Deepwater Horizon Oil Spill. Environ. Sci. Technol. 46 (10):5310–5318.

d. <u>Synergistic Activities</u>

Major advisor for graduate students in environmental chemistry; Panel member of the USDA Soil Process Program; Reviewer of approximately 20 papers and proposals every year; Associate Editor for Journal of Environmental Quality. Conduct interdisciplinary research to investigate mineral surface reactivity and soil organic C and N dynamics using synchrotron-based spectroscopic techniques, to study the environmental fate of emerging contaminants in animal waste and biosolids-affected soil and water environment, and to develop chromatographic analytical methods for detecting trace level organic contaminants.

Curriculum Vitae — Liqing Zhang

Professional Preparation

Lanzhou University, China	Biochemistry	B.S., 1997
University of California, Irvine	Molecular Evolution/Population Genetics	Ph.D., 2002
University of Chicago	Molecular Evolution	Postdoc., 2004

Appointments

2011	Visiting Professor	Institute for Systems Biology	Seattle WA
2010–	Associate Professor	Computer Science	Virginia Tech
2004–2010	Assistant Professor	Computer Science	Virginia Tech

Products

Five Most Relevant Products

1. Garner E, Wallace JS, Argoty GA, Wilkinson C, Fahrenfeld N, Heath LS, Zhang L, Arabi M, Aga DS, Pruden A. Metagenomic profiling of historic Colorado Front Range flood impact on distribution of riverine antibiotic resistance genes. Scientific Reports. 2016 Dec 5; 6(38432). doi: 10.1038/srep38432. PubMed PMID: 27917931
2. Arango-Argoty G, Singh G, Heath LS, Pruden A, Xiao W, Zhang L. MetaStorm: A Public Resource for Customizable Metagenomics Annotation. PLoS One. 2016 Sep 15; 11(9):e0162442. doi: 10.1371/journal.pone.0162442. PubMed PMID: 27632579; PubMed Central PMCID: PMC5025195.
3. Tran H, Wu X, Tithi S, Sun MA, Xie H, Zhang L. A Bayesian Assignment Method for Ambiguous Bisulfite Short Reads. PloS One. 2016 Mar 24; 11(3):e0151826. doi: 10.1371/journal.pone.0151826. PubMed PMID: 27011215; PubMed Central PMCID: PMC4806927.
4. Chen, W. and **L.Q. Zhang**. 2015. The pattern of DNA cleavage intensity around indels. Scientific Reports. PMC4321175.
5. Liu M, Watson LT, Zhang L. HMMvar-func: a new method for predicting the functional outcome of genetic variants. BMC Bioinformatics. 2015 Oct 30;16:351. doi: 10.1186/s12859-015-0781-z. PubMed PMID: 26518340; PubMed Central PMCID: PMC4628267.

Five Other Significant Products

6. Chen, W., X. Zhang, J. Brooker, L. Hao, **L. Q. Zhang***, and K. Chou, 2014. PseKNC-General: a cross-platform package for generating various modes of pseudo nucleotide compositions. *One of the corresponding authors. Bioinformatics. PMC25231908.
7. Liu, M., L.T. Watson, and **L.Q. Zhang**. 2014. Quantitative prediction of the effect of genetic variation using hidden Markov models. BMC Bioinformatics. PMC3893606.
8. Li, Z., X. Wu, B. He, and **L.Q. Zhang**. 2014. Vindel: a simple pipeline for checking indel redundancy. BMC Bioinformatics. PMC4245841.
9. Porter, J., M. Sun, H. Xie, and **L.Q. Zhang**. 2015. Investigating Bisulfite Short-Read Mapping Failure with Hairpin Bisulfite Sequencing Data. To appear in BMC BI and Genomics Special Issues.

10. **Zhang, L. Q.**, B.S. Gaut and T. J. Vision. 2001. Gene duplication and evolution. Science 293.

Synergistic Activities

(a).Associate Editor for BMC Bioinformatics; Associate Editor for Scientific Reports. (b). Program committee for the 7th Annual RECOMB Satellite Workshop on Comparative Genomics, Budapest, Hungary, 2009; Session chair for the Advanced Intelligent Computing Technology and Applications (ICIC2008) conference, September, 2008; Program committee for ISMB/ECCB (International Society for Computational Biology & 8th European Conference on Computational Biology), Stockholm, Sweden, 2009; Program committee of the fifth Asian Pacific Bioinformatics Conference 2007 (APBC 2007); Program committee for ISMB 2008 (International Society for Computational Biology), Toronto. (c). Supervisor of five female students from Distributed Research Experiences for Undergraduates (DREU) for summer of 2010-2014. Supervisor of summer bioinformatics research of a VT Minority Academic Opportunities Program (MAOP) student from Auburn University, 2005.

Appendix II - Figures and Tables

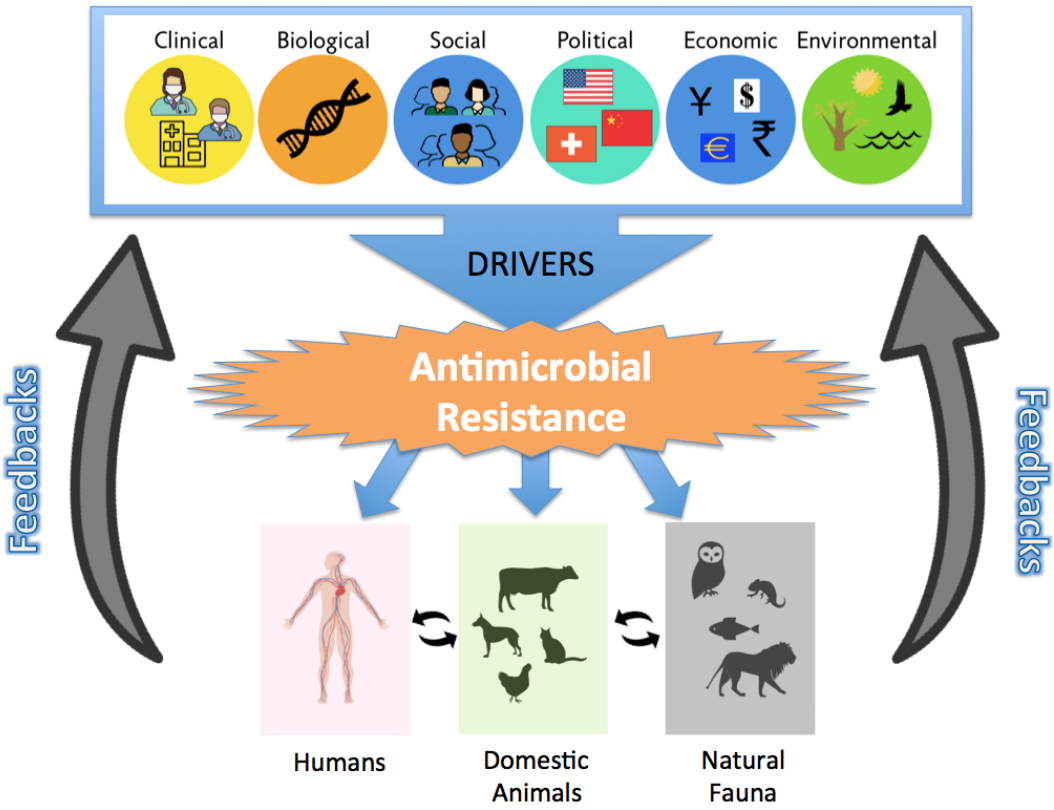

Figure 1. Antimicrobial resistance is a cross-boundary challenge that is driven by clinical, biological, social, political, economic, and environmental drivers and affects not only humans, but also domestic and nondomestic animals and ecosystems. The impacts of resistance exert feedbacks on the drivers that are difficult to predict.

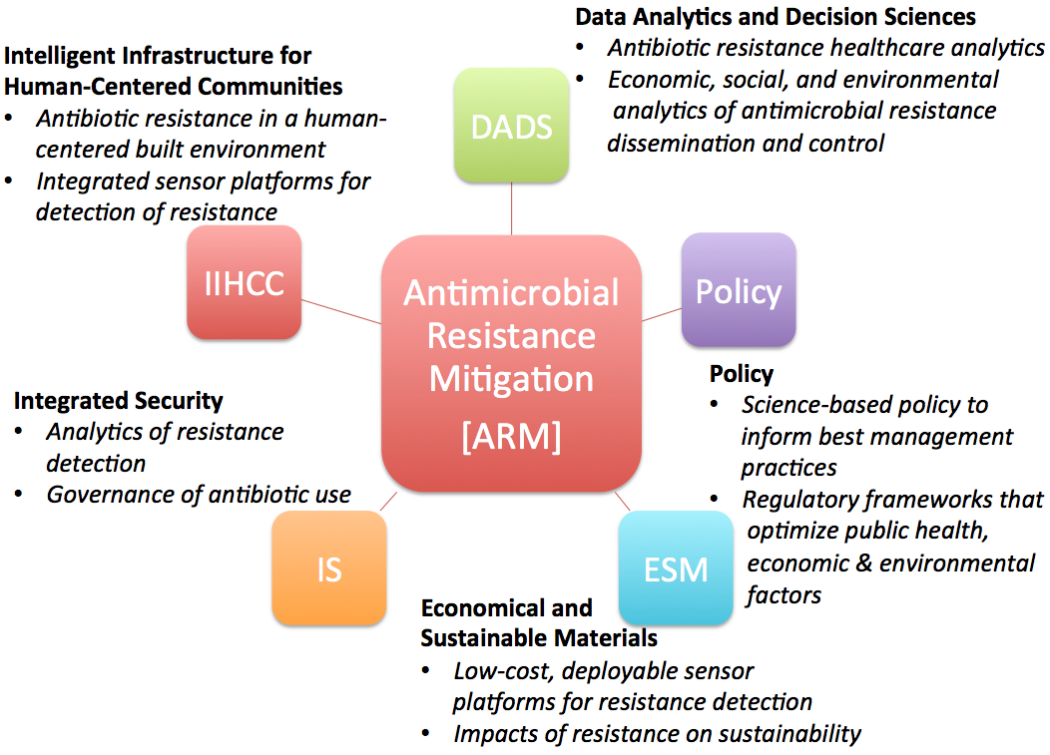

Figure 2. ARM is pertinent not only to the GSS Destination Area (DA), but also to the DADS, IIHCC, and IS DAs and the ESM and Policy Strategic Growth Areas. Some representative areas of overlap are indicated.

Table 1. Curriculum opportunities at the undergraduate and graduate level. At the outset of the ARM effort, both undergraduate and graduate students will have curricular homes in existing departments and thus we have identified 'core' courses in ARM affiliated departments across campus that students will be able to take as part of their normal degree programs. These courses will incorporate ARM focused modules and will be augmented by new 'Capstone' ARM classes (*italicized* below). As the ARM effort moves forward, however, we will consider development of ARM focused undergraduate and graduate degree and certificate programs.

Existing ARM Courses - Undergraduate

Course Number	Course Title	Instructor
BIOL/CSES/ENSC 4164	Environmental Microbiology	Badgley
BIOL 4564/5564	Infectious Disease Ecology	Hawley
BSE 3334	Nonpoint Source Pollution Assessment and Control	Krometis
BSE 4344	GIS for Engineers	Hession
BSE 4394	Water Supply and Sanitation in Developing Countries	Hall
CEE 4114	Fundamentals of Public Health Engineering	Vikesland
CSES/ENSC 4764	Bioremediation	Badgley
CSES/ENSC 4314	Water Quality	Xia
CS 3824	Introduction to Computational Biology and Bioinformatics	Zhang/Heath
DASC/APSC 3134	Animal Agriculture and the Environment	Knowlton
ENSC 4414	Monitoring and Analysis of the Environment	Xia
FIW 3414	Disease Ecology and Ecosystem Health	Alexander
FST 4634	Epidemiology of Food and Waterborne Diseases	Ponder
FST 3604	Food Microbiology	Ponder

Existing ARM Courses - Graduate

Course Number	Course Title	Instructor
BSE 5344	Applied GIS	Hession
CS 5045 & 5046	Computation for the Life Sciences I & II	Heath
FST 5634	Epidemiology of Food and Waterborne Diseases	Ponder
TBMH 5054	Fundamentals of Immunity and Infectious Disease	Alexander (co-instructor)
AAEC 6524	Environmental Economic Theory and Policy Analysis	Moeltner
CEE 5194	Environmental Engineering Microbiology	Pruden
CEE 5984	Nanotechnology for Environmental Sustainability	Vikesland
GRAD 5134	Team Science - Sustainable Nanotechnology & Water Interface Science	Vikesland/Pruden
PHS 5014	Environmental Health	Gohlke
UAP 5324/BSE 4394	Water Supply and Sanitation in Developing Countries	Hall
NR 5014	Constructing Sustainability	Hull

Proposed ARM Courses

Course Number	Course Title	Instructor
XXX 5984	*Scientific, Economic, Health, and Policy Implications of Antibiotic Resistance (2 semester sequence)*	*All ARM faculty*
GRAD 5134	*Antibiotic Resistance Mitigation*	*All ARM faculty*
TBD	Epidemiology of Antibiotic Resistance	New FTE
TBD	Quantitative Microbial Risk Assessment	New FTE
TBD	Policy Implications of Antibiotic Resistance	New FTE

Appendix III - Provisional Job Ad

Position Summary:

The global threat of antimicrobial resistance requires a transdisciplinary approach that simultaneously considers the clinical, biological, social, economic, and environmental drivers responsible for this emerging challenge. As part of a university-wide emphasis in Global Systems Science, Virginia Tech seeks to hire five faculty members with research and teaching expertise in the broad area of antimicrobial resistance. These hires will join a robust cross-campus team investigating antimicrobial resistance and will add important transdisciplinary capacity. These appointments are anticipated to be at the rank of Assistant Professor. Exceptional candidates may also be considered for appointment at the rank of Associate or Full Professor depending on experience and accomplishments.

Persons with expertise in any area of antimicrobial resistance are encouraged to apply. However, the current search will emphasize expertise in the following areas:

Human health epidemiologist - Utilization of epidemiology to prevent, detect, and respond to antimicrobial resistance outbreaks in local, regional, and global settings.

Public policy - Science based policy to inform best-management practices; regulatory frameworks that optimize public health, economic, and environmental drivers of antimicrobial resistance.

Clinical antimicrobial resistance - Mechanisms and factors contributing to antimicrobial resistance; options for clinical control of resistance; the role of the animal-human interface in antimicrobial resistance.

Quantitative microbial risk assessment - Development of cross-media exposure assessments and transfer models; evaluation of risk factors; QMRA model-development

Microbial ecology - Evaluation of impacts of antimicrobial resistance on microbial ecology at the population, community, or ecosystem level.

Faculty members in these positions will further establish and grow the Antimicrobial Resistance Mitigation (ARM) program of the Global Systems Science Destination Area (http://provost.vt.edu/destination-areas/da-global-systems.html). Opportunities to work and interact with the Global Change, Sustainable Nanotechnology, and Water INTERface IGEPs as well as the USDA funded Agricultural Sources of Antimicrobial Resistance (AgSOAR) training program, the Translational Biology Undergraduate Program, the Public Health Program, the Environmental Science Program, and the Water Resources, Policy, and Management Degree Program are encouraged.

Required Qualifications:

Applicants must have excellent potential for developing a well-funded research program focused on antimicrobial resistance and its impacts on Global Systems Science; the capacity to work in transdisciplinary teams; the desire to interact with diverse colleagues, students, and the public. Applicants must have an earned doctorate (or equivalent) in a relevant discipline at the time of appointment.