

# One Health Approach to Emerging Viral and Vector-borne Diseases

## Faculty Affiliates

**Andrea Bertke**, Neurovirology, Department of Population Health Sciences

**Sally Paulson**, Arbovirology and Zoonotic Disease, Department of Entomology

**Cassidy Rist**, Global Outreach, Center for Public and Corporate Veterinary Medicine

**Korine Kolivras**, Medical Geography, Department of Geography

**Laura Hungerford**, Epidemiology, Department of Population Health Sciences

**Kathleen Alexander**, Disease Ecology, Department of Fish and Wildlife Conservation

**Valerie Ragan**, Global Outreach and Biosecurity, Center for Public and Corporate Veterinary Medicine

**Julia Gohlke**, Environmental Health and Global Environment Change, Department of Population Health Sciences

## Anticipated Faculty Affiliates

**Stephen Eubank**, Data Analytics and Network science, Network Dynamics and Simulation Science Laboratory

**Dana Hawley**, Pathogen Ecology and Evolution, Department of Biological Sciences

**Leah Johnson**, Quantitative Ecology and Biostatistics, Department of Statistics

**Carlyle Brewster**, Quantitative Ecology for Integrated Pest Management, Department of Entomology

**Jonathan Auguste**, Arbovirology, Department of Entomology

**Xiaofeng Wang**, Virus-Host Interactions, Department of Pathology, Physiology, and Weed Science

**Kathy Hosig**, Health Education and Community Outreach, Department of Population Health Sciences

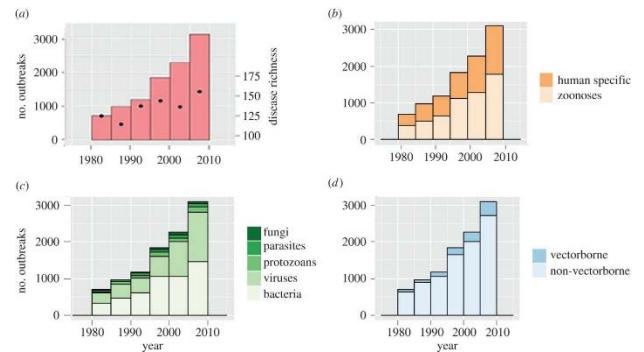
**Susan Marmagas**, Health Education, Department of Population Health Sciences

**Bill Pierson**, Biosecurity, Departments of Biomedical Sciences and Pathobiology and Population Health Sciences

**New Virology Hire**, Flavivirologist, Department of Biomedical Sciences and Pathobiology

**Vision Statement:** Understanding the spatial and temporal distribution of novel infectious diseases is among the most important and challenging tasks for the coming century. Emerging viral and vector-borne diseases are a significant threat to humans, animals, and plants across the globe. In the previous 40 years, the number of new emergent pathogens affecting humans have increased more than 300%. Approximately 60% of these organisms are zoonotic, transferred to humans from animals, and the number of vector-borne pathogens have increased more than 300% in the same time frame. Viruses affecting plants impact agricultural food sources, as well as regional and global economies. Understanding how these pathogens emerge and evolve, transmit from animals to humans and adapt to new hosts to increase morbidity and mortality, spread geospatially and temporally through regions or the global community, and how human behavior and beliefs impact these processes are of critical importance.

Deciphering these processes requires an integrated approach, combining expertise across multiple fields of study and outreach. This integrated approach leverages Virginia Tech existing strengths in molecular and cellular virology, vector biology, human and animal disease pathogenesis, plant disease pathogenesis, human and animal behavior, epidemiology, health education, environmental ecology, climate change, neuroscience, and geospatial and economic analytics and modeling, as well as community and international outreach and partnerships. Furthermore, this program will build upon those strengths through focus of combined expertise on a common goal, which will enhance multidisciplinary funding initiatives and recognition of Virginia Tech as an international destination for One Health and Emerging Viral and Vector-borne Diseases.



Emerging disease outbreaks since 1980. a) number of outbreaks have increased >300%, b) ~60% are zoonotic, c) viruses and bacteria are primary agents, d) vector-borne diseases continue to increase.

**Relevance:** This concept takes a transformative approach to solving the problem of pathogen emergence and spread through populations, using a fully integrated One Health Approach to advance the vision of Virginia Tech as a destination area for One Health and Emerging Viral and Vector-borne Diseases. As new pathogens continue to emerge, further impacting humans, animals, and plants, an integrated One Health approach is a necessity to understand the dynamic processes contributing to emergence and spread. Understanding emergence and transmission dynamics, as well as interrelationships between pathogens and their vectors and hosts, will continue to be a much-needed focus area.

Federal funding continues to increase for emerging infectious diseases. Government funding sources tend to be reactive, rather than preemptive, which requires perception and policy changes at all levels of government. Virginia Tech's presence and partnerships in northern Virginia can be leveraged to increase a focus on preemptive strategies, to increase extramural funding streams to support this One Health Approach to understanding viral disease dynamics *before* new pathogens emerge, rather than in response to outbreaks. Defense funding sources would also be available, as our military personnel are among the highest risk due to geographic presence, exposure to conditions that increase susceptibility, and global repositioning that contributes to spread of disease.

Industrial partners can be leveraged through development of new tools and products that enhance surveillance, response, treatment, prevention, and infrastructure. Pharmaceutical companies are currently utilizing academic partners for research and development of vaccines and therapeutics; as a destination area for emerging viral and vector-borne diseases, Virginia Tech would benefit from increasing such partnerships.

Emerging disease outbreaks pervade the media. Through news sources, social media, popular literature and cinema, the public is exquisitely aware, and even fearful, of outbreaks of new emerging diseases. Preventing and responding to these diseases is perceived as an essential part of life, particularly when these diseases negatively impact children or specific communities to which people emotionally connect. Those perceptions can be leveraged for philanthropic opportunities.

A One Health Approach to Emerging Viral and Vector-borne Diseases extends beyond Global Systems Science. The vast majority of recent emergent viruses impact the brain, integrating with Adaptive Brain and Behavior. West Nile, Influenza, Ebola, and Zika Viruses infect the brain, causing direct damage, but can also impact the developing brain of fetuses and children. Recently emergent bacteria include vector-borne Rickettsia and Borrelia, which also impact the nervous system, often causing chronic debilitating neurological impairment. These diseases can have devastating effects to the individual, but also to families and

communities as a result of impaired cognitive and behavioral development of those infected. In addition, stress and fear associated with disease outbreaks and unknown outcomes of infection requires an approach bringing together multiple levels of inquiry to address the impacts of emerging diseases. The One Health Approach to Emerging Viral and Vector-borne Diseases naturally includes disease dynamics and economics analyses and modeling, incorporating Data Analytics and Decision Sciences. Furthermore, sources of data regarding disease outbreaks are varied and vast, from health records and web databases to social media. Analyses of healthcare, infrastructure, biosecurity and social sources are an integral part of understanding disease emergence. Emerging disease outbreaks are a global problem, with greater threats in some communities compared to others. Prevention and containment requires an understanding of the security of communities, the nation, and the world, integrating with the Integrated Security destination area. The recent ebola virus outbreak transcended geopolitical boundaries and devastated economic security of several African nations, and threatened the security of countless others throughout the world. National security and preparedness issues were at the forefront of the ebola outbreak, and will remain at the forefront of all future emerging disease outbreaks. The driving force behind many emerging diseases, particularly zoonotic and vector-borne pathogens, is interaction between humans and their environment, which integrates with the Intelligent Infrastructure for Human-Centered Communities destination area. Intelligent design of sustainable technologies and infrastructure that improve human health and safety are essential to prevent and respond to disease emergence.

**Curriculum opportunities:** A One Health Approach to Emerging Viral and Vector-borne Diseases engages students (undergraduate, PhD, MPH, DVM, MD) in an integrated curriculum providing learning opportunities on virus, bacteria, vector, and human dynamics, from molecule to population. Existing courses would be leveraged to develop a series of undergraduate courses that integrate the concepts essential for a VT-shaped student to embrace the One Health Concept and understand factors in emerging disease dynamics. The MPH and DVM curricula within the College of Veterinary Medicine (CVM) already integrate the One Health Approach, and the PhD program within CVM is currently undergoing redevelopment to incorporate additional One Health didactic and experiential opportunities at the doctoral level. The Bachelor's of Science in Public Health (BSPH) program, currently progressing through governance and anticipated for a Fall 2018 implementation, was designed to fully integrate the One Health Approach; inclusion of courses in virology, microbiology, disease ecology, climate change, vector biology, and medical geography would provide a holistic bachelor's degree integrating the One Health Approach to Emerging Viral and Vector-borne Diseases at the undergraduate level. Experiential learning opportunities in One Health are currently available through multidisciplinary laboratory training, community outreach initiatives, and study abroad opportunities, and additional opportunities and partnerships are currently in development.

**Description of resource needs:** With few exceptions, the One Health Approach to Emerging Diseases is sustainable with existing Virginia Tech faculty. The most immediate faculty need is a flavivirologist, as this family of viruses has produced several notable viral disease outbreaks in our area and throughout the world, including LaCrosse, West Nile, Zika, and Dengue. However, CVM is currently considering flavivirologists in a new faculty hire. New faculty hires are needed to teach courses within the undergraduate BSPH curriculum and teaching assistantships need to be made available for MPH and PhD students to engage graduate students in undergraduate teaching opportunities. To fully implement the One Health Approach to Emerging Viral and Vector-borne Diseases, resources are needed to engage students in laboratory, community, and global outreach opportunities, including undergraduate, graduate and professional students. In addition, personnel resources are needed to assist with curriculum coordination at undergraduate, graduate and professional levels of education and to assist with grant writing and philanthropic outreach to secure external funding. Resources are also needed to further develop community partnerships locally, nationally and globally to enhance experiential learning and outreach.

**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: Andrea S. Bertke

eRA COMMONS USER NAME: ANDREABE

POSITION TITLE: Assistant Professor of Infectious Diseases

**EDUCATION/TRAINING**

INSTITUTION AND LOCATION	DEGREE (if applicable)	Completion Date MM/YYYY	FIELD OF STUDY
Bowling Green State University	BS	12/2001	Microbiology
Uniformed Services University of the Health Sciences	PhD	05/2007	Emerging Infectious Diseases
UTMB Galveston	Postdoctoral	2007-2008	Neurotropic RNA Viruses
SUNY Buffalo	Postdoctoral	2008	Developmental Neuroscience
UC San Francisco	Postdoctoral	2009-2012	HSV Latency

**A. Personal Statement**

My long term research interests are focused on mechanisms through which neurotropic viruses reach and interfere with the neuronal environment, as well as neuronal and viral factors that modulate viral replication within different types of neurons. A primary focus of my work is understanding how different types of neurons respond to neurotropic viral infections. My lab is currently working on the role of sensory neuron infection with Zika Virus in the development of Guillain-Barre Syndrome and persistent viral shedding in semen and vaginal secretions. We are also working on the role of autonomic neuron infection with Herpes Simplex Viruses 1 and 2 in differential neurovirulence and recurrent disease.

Prior experience in the labs of Dr. Philip Krause at FDA, Dr. Slobodan Paessler at University of Texas Medical Branch, Dr. Brian Pierchala at SUNY Buffalo and Dr. Todd Margolis at UCSF have provided expertise in mechanisms regulating DNA and RNA virus pathogenesis in animal models and primary neuronal cultures.

**B. Positions and Honors****Positions**

2002	Clinical Diagnostics Lab Technician & Phlebotomist, Findlay Family Practice, Findlay, OH
2002-2007	Graduate Student, Emerging Infectious Diseases Program, Uniformed Services University of the Health Sciences, Bethesda, MD
2007-2008	Postdoctoral Fellow, Dept of Pathology, University of Texas Medical Branch, Galveston, TX
2008	Postdoctoral Trainee, Dept of Neuroscience, State University of New York at Buffalo, NY
2009-2012	Postdoctoral Fellow, Dept of Ophthalmology, University of California San Francisco, CA
2011	Lecturer, Neural Systems Physiology, Health Professions Certificate Program, San Francisco State University, San Francisco, CA
2012-present	Assistant Professor of Infectious Diseases, MPH Infectious Disease Concentration Coordinator, Dept of Population Health Sciences, Maryland-Virginia College of Veterinary Medicine, Virginia Polytechnic Institute & State University (Virginia Tech), Blacksburg, VA

**Other Experiences**

2012-present	<i>ad hoc</i> reviewer, Journal of Visualized Experiments
2013-present	Reviewer, VMCVM Internal Research Competition
2014-present	Member, Colorado Alphaherpesvirus Latency Symposium Planning Committee

2014-present *ad hoc* reviewer, Journal of Veterinary Microbiology

**Memberships:** American Society for Microbiology, Society for Neuroscience

### Honors

2005 President's Poster Showcase Award, Uniformed Services University of the Health Sciences  
2005-2007 Intramural Research Training Award (IRTA), Oak Ridge Institute for Science and Education  
2006 Fellows Award for Research Excellence, NIH  
2006, 2007 Travel Award, International Herpesvirus Workshop, Seattle WA and Asheville NC  
2008 T32 Postdoctoral Research Training Award in Emerging and Re-emerging Infectious Diseases, University of Texas Medical Branch, Galveston, TX  
2009, 2010 Travel Award, International Herpesvirus Workshop, Ithaca NY and Salt Lake City UT  
2014 Virginia Tech Scholar of the Week

### C. Contribution to Science

1. **Role of sensory neuronal infection in Zika Virus pathogenesis, persistent viral shedding and development of Guillain-Barre Syndrome.** Very little is known about how neurons regulate Zika virus infection. Epidemiological and laboratory evidence demonstrates a strong link between Zika virus infection and neuronal damage to developing neurons leading to microcephaly and Guillain-Barre Syndrome. It is not clear how adult neurons control the virus, while the virus is unregulated in developing neurons, or how Zika Virus infection leads to GBS. Using our primary adult neuronal culture model and a guinea pig infection model, we are investigating how the route of infection impacts disease pathogenesis and the role of sensory neuron and satellite glial cell infection in the genital shedding and the development of GBS. We have also identified nucleotide polymorphisms between South American and African strains; we will identify which of these polymorphisms contribute to sensory neurotropism by site-directed mutagenesis using our infectious clone that we constructed.
  - a. Hsu, IWY, Wattam R, Bertke AS. Phylogenetic and protein sequence analysis to identify polymorphisms between African, Asian, and South American Zika Virus strains. *Manuscript in preparation.*
  - b. Swarthout BS, Zlotnick M, Yanez A, Price E, Bertke AS. Zika Virus infection of primary adult sensory neurons. *Manuscript submitted.*
  
2. **Development of primary adult neuronal cultures to investigate mechanisms regulating viral infections.** Animal models of infection and latency are valuable in the study of HSV pathogenesis but have limitations for studying mechanisms that regulate virus-host interaction at the cellular and molecular level. These limitations include the relatively small proportions of ganglionic neurons in which latency is established *in vivo*, the asynchronicity of events, the small number of neurons that can be induced to reactivate, and the difficulty of manipulating the molecular state of infected neurons. *In vitro* models overcome some of these limitations but previously available *in vitro* models did not represent the heterogeneity and characteristics of mature sensory and autonomic ganglia. To examine neuronal mechanisms that regulate differences in HSV1 and HSV2 lytic and latent infections in biologically relevant neurons, I developed a neuronal culture model using primary *adult* sensory, autonomic and central neurons from mice and guinea pigs, which maintains neuronal heterogeneity and infection characteristics previously seen *in vivo*. Several labs in the herpesvirology field have adopted this model for their own studies, validating the model and providing significant data advancing understanding of virus-neuron interactions.
  - a. Bertke AS, Swanson SM, Chen J, Imai Y, Kinchington PR, Margolis TP. A5-positive primary sensory neurons are nonpermissive for productive infection with herpes simplex virus 1 *in vitro*. *J Virol.* 2011 Jul;85(13):6669-77. Epub 2011 Apr 20.
  - b. Bertke AS, Ma A, Margolis MS, Margolis TP. Different mechanisms regulate productive herpes simplex virus 1 (HSV-1) and HSV-2 infections in adult trigeminal neurons. *J Virol.* 2013 Jun;87(11):6512-6.
  - c. Lee S, Ives, AM, Bertke AS. HSV-1 reactivates from autonomic ciliary ganglia independently from sensory trigeminal ganglia to cause recurrent ocular disease. *J Virol.* 2015 Jun 3. pii: JVI.00456-15. Epub 2011 Apr 20.

- 3. Identification of different mechanisms regulating neuronal behavior of HSV1 and HSV2.** Although much work has been performed to identify mechanisms regulating HSV1, relatively little work has clarified HSV2 mechanisms regulating lytic vs latent infections and reactivation at the cellular level. By directly comparing HSV1 and HSV2 behavior in primary neuronal cultures and relevant animal models, I have provided evidence showing that HSV1 and HSV2 function by very different mechanisms. The goal is to identify new antiviral targets that can be manipulated in a virus type-specific manner and provide a greater understanding of the different ways that neurons control virus infections.
- Bertke AS**, Apakupakul K, Ma AA, Imai Y, Gussow AM, Wang K, Cohen JI, Bloom DC, Margolis TP. LAT region factors mediating differential neuronal tropism of HSV-1 and HSV-2 do not act in trans. *PLOS ONE*. 2012;7(12):e53281. Epub 2012 Dec 31.
  - Bertke AS**, Ma A, Margolis MS, Margolis TP. Different mechanisms regulate productive herpes simplex virus 1 (HSV-1) and HSV-2 infections in adult trigeminal neurons. *J Virol*. 2013 Jun;87(11):6512-6.
  - Yanez AA, Harrell T, Sriranganathan HJ, Ives AM, **Bertke AS**. Neurotrophic factors NGF, GDNF, and NTN selectively modulate HSV1 and HSV2 lytic infection and reactivation in primary adult sensory and autonomic neurons. *Pathogens*. 2017 Feb 7;6(1).
  - Ives AM, **Bertke AS**. Stress hormones epinephrine and corticosterone selectively modulate HSV1 and HSV2 productive infection in sympathetic, but not sensory, neurons. *J Virol*. 2017 Apr 12.
- 4. Involvement of the autonomic nervous system in HSV1 and HSV2 pathogenesis.** Very little is known about the role of the autonomic nervous system in HSV pathogenesis, despite the fact that the autonomic nervous system is exquisitely sensitive to known HSV reactivation stimuli. To date, I have determined that HSV1 and HSV2 show preferences for different divisions of the autonomic nervous system, the viruses replicate in autonomic neurons during recurrences, they use autonomic pathways to reach the central nervous system, and the viruses behave very differently in adult autonomic neurons than in sensory neurons. HSV infection in autonomic neurons contributes to severity of disease and recurrence frequency. Because autonomic neurons have different signaling pathways and regulatory mechanisms than sensory neurons, work in my lab focuses on understanding how these neurons control HSV infections and how these mechanisms differ from other types of neurons. This work also has broader impacts on how different types of neurons control viral infections, in general.
- Bertke AS**, Patel A, Krause PR. Herpes simplex virus latency-associated transcript sequence downstream of the promoter influences type-specific reactivation and neurotropism. *J Virol* 2007 Jun;81(12):6605-13. Epub 2007 Apr 4.
  - Ohashi M, **Bertke AS**, Patel A, Krause PR. Spread of herpes simplex virus to the spinal cord is independent of spread to dorsal root ganglia. *J Virol*. 2011 Mar;85(6): 3030-2. Epub 2010 Dec 15.
  - Lee S, Ives AM, **Bertke AS**. HSV-1 reactivates from autonomic ciliary ganglia independently from sensory trigeminal ganglia to cause recurrent ocular disease. *J Virol*. 2015 Jun 3. pii: JVI.00456-15. Epub 2011 Apr 20.
- 5. Identification of HSV2 latency associated transcript (LAT) regions that regulate reactivation and neuronal tropism.** Previous studies had shown that the HSV latency-associated transcript (LAT) plays an important role in recurrent disease. To further define the regions of HSV2 LAT important for reactivation, I made additional HSV2 chimeric viruses and tested them in the guinea pig genital model, finding that the HSV2 LAT exon 1 between the TATA box and the 5' splice site of the LAT intron regulates neuronal tropism for specific types of sensory neurons. Identifying specific genetic sequences involved in HSV2 reactivation and neuronal tropism improves understanding of HSV2 pathogenic mechanisms, leading the way towards development of targeted antivirals.
- Bertke AS**, Patel A, Krause PR. Herpes simplex virus latency-associated transcript sequence downstream of the promoter influences type-specific reactivation and neurotropism. *J Virol* 2007 Jun;81(12):6605-13. Epub 2007 Apr 4.
  - Bertke AS**, Patel A, Imai Y, Apakupakul K, Margolis TP, Krause PR. Latency-associated transcript (LAT) exon 1 controls herpes simplex virus species-specific phenotypes: reactivation in the guinea pig genital model and neuron subtype-specific latent expression of LAT. *J Virol* 2009 Oct;83(19):10007-15. Epub 2009 Jul 29.

[http://www.ncbi.nlm.nih.gov/sites/myncbi/1nW-ord\\_wooQw/bibliography/47337743/public/?sort=date&direction=ascending](http://www.ncbi.nlm.nih.gov/sites/myncbi/1nW-ord_wooQw/bibliography/47337743/public/?sort=date&direction=ascending)

#### **D. Research Support**

1 K22 AI097299-01 Bertke (PI) 02/2013 – 01/2016

NIH/NIAID

“The Role of the Autonomic Nervous System in HSV Infection”

The major goal of this project is to define the role of the autonomic nervous system in establishment of HSV1 and HSV2 latent infection and reactivation.

Role: PI

Startup Funding Bertke (PI) 08/01/12 – 12/31/2016

Virginia Tech

“HSV1 and HSV2 Latency and Reactivation”

The major goal of the research is to identify the different mechanisms by which HSV1 and HSV2 establish latent infection and reactivate from different anatomical locations and different types of neurons.

Role: PI

IRC Intramural Grant Bertke (PI) 07/01/14 – 06/30/15

Virginia-Maryland Regional College of Veterinary Medicine

“Epinephrine and Corticosterone Reactivation of HSV1 and HSV2”

The major goal of this project is to evaluate the expression of glucocorticoid receptors in autonomic neurons and determine if corticosterone induces ICP0 expression through the glucocorticoid receptor.

Role: PI

IRC Intramural Grant Bertke (PI) 07/01/15 – 06/30/16

Virginia-Maryland College of Veterinary Medicine

“HSV2 LAT exon 1 regulation of neuronal specificity and reactivation”

The major goal of this project is to functionally validate three specific regions of HSV2 LAT that promote lytic infection in TrkA+ neurons, inhibit lytic infection in IB4+ neurons, and regulate reactivation.

Role: PI

Global Education Development Grant Bertke (PI) 05/01/2016 – 06/30/17

Virginia Tech Office of Global Education

“Emerging and Neglected Tropical Infectious Diseases”

The major goal of this project is to develop research collaborations and partnerships involving Zika virus and other vectorborne diseases through the Virginia Tech Center for Tropical Studies in Punta Cana, Dominican Republic, and also develop an experiential learning course entitled “Emerging and Neglected Tropical Infectious Diseases” to be taught in Punta Cana.

Role: PI

**Biographical Sketch**  
**KATHLEEN ALEXANDER**

**(a) Professional Preparation**

**Degrees:**

University of California, Davis	Zoology	BSc, 1988
University of California, Davis	Wildlife Health	DVM, 1992
University of California, Davis	Ecology, Virology	PhD, 1995

**(b) Appointments**

2015-present	<b>Professor</b> , Department of Fisheries and Wildlife Sciences Virginia Polytechnic and State University (Virginia Tech), Blacksburg, VA
2007-2015	<b>Associate Professor</b> , Department of Fisheries and Wildlife Sciences Virginia Polytechnic and State University (Virginia Tech), Blacksburg, VA
2001-present	<b>President</b> , Centre for Conservation of African Resources: Animals, Communities and Land use Botswana (CARACAL)
2004-2006	<b>Ecological Advisor to the Office of the President</b> ; Attorney General's Chambers, Botswana
1995-2001	<b>Senior Wildlife Veterinary Officer, Unit Head</b> Wildlife Veterinary Unit, Department of Wildlife and National Parks, Kasane, Botswana
1989-1994	<b>Research Associate Attachment</b> , National Museums of Kenya, Nairobi, Kenya

**Service, Specialist Memberships, and Certification**

2010-present	Associate Editor, <i>Frontiers in Ecology and the Environment</i>
2001-present	Commission on Ecosystem Management, World Conservation Union
1999-present	Wildlife Health Specialist Group, IUCN Species Survival Commission
2000-present	African Lion Working Group, Affiliate of the Cat Specialist Group, ICUN Species Survival Commission
2004-2008	Environmental Working Group, Ministry of Wildlife, Environment and Tourism, Botswana Government
1995-present	Registered Botswana Veterinarian

**(c) Products**

(i) *Five relevant publications (selected from 56 peer reviewed publications including books and book chapters):*

1. **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
2. 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*. doi: 10.3389/fvets.2015.00063.
3. 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 .
4. **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
5. **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*, In press. DOI: <http://dx.doi.org/10.7589/2014-11-257>

(ii) *Five other significant publications*

1. **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.



2. Pesapane, R.\* Ponder, M. and **K.A. Alexander**. 2013. Tracking pathogens at the human wildlife interface. *EcoHealth*, DOI: 10.1007/s10393-013-0838-2.
3. **Alexander, K.A.** Lewis, B., Madav, M. Eubank, S. and J.K. Blackburn. 2012. Modeling of Wildlife Associated Zoonoses: Applications and Caveats. *Vector-Borne and Zoonotic Diseases*, *Accepted for publication*.
4. **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. *Vector borne and Zoonotic Disease*. PLoS ONE 7(3):e32842.
5. **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.

#### **(d) Synergistic Activities**

##### **Outreach Programs Designed to Identify African Leadership and Capacity Development in Natural Resource Management:**

1. **Chobe Children's Environmental Education Club** (in collaboration with CARACAL, Directed by PI) approximately 253 students (grades 5-7) are enrolled in weekly conservation education classes in Chobe District.
2. **Botswana Youth Field Research Internships Program** –Scientific Mentoring of African youth in association with the Botswana Youth Council (three month field internship, 15 students per intake four times per year) 2007-Present

##### **Development of databases to support research and education:**

3. **Biodiversity Strategy Action Plan: Biodiversity Inventory Database** (2001-2003): This is the first spatial inventory of biodiversity in Botswana and was used to prioritize resource conservation and research efforts under the National Biodiversity Strategy Action Plan, which was developed in part by Dr. Alexander (ecoregion and faunal components) for the Botswana Government.

##### **Other synergistic activities: Development of policy documents in support of natural resource and wildlife health management in Botswana**

4. **Contribution to Botswana National Policy Development:** (a) Botswana's Wildlife Health Strategic Plan, Department of Wildlife and National Parks (1995), Update 2001 (b) Botswana's Biodiversity Strategy Action Plan-Fauna and Ecoregions sections -2004
5. **Chobe Household Resource Mapping and Resource Threat Inventory:** First assessment of community natural resource use, threats and spatial mapping exercise in Chobe District.

#### **e) Collaboration and Other Affiliations**

**Collaborators and Co-Editors: Collaborations:** Hawley, D.M. (VT), Blackburn, JK. (UF), Diamond, U. (UF), Kracalik, IT (UF), Widmer, J. (VT), Brown, W. (Sustainable Aid Supporting Haiti), Morrissey, B.D. (FISH Ministries at Christianville Foundation, Inc.), Curtis, A.J. (Kent State), Ali, A. (UF), and J.G. Morris (UF) Asher, V. (Turner Enterprises), Stokke, S., (State Diagnostics Lab, Montana Department of Livestock), Hunter, D.L., Bagamian, K. (UF), Hadfield, T.L. (Hedeco LLC), Ponder, M. (VT), Carzolio, M., (VT), Goodin, D. (KS), Vance, E. (VT), Heirben, J. (Lab Tech Inc), Zajac, A. (VT), Lewis, B. (VT), Madav, M., (VT), Eubank, S. (VT), Ganswindt (University of Stellenbosch), A., Ganswindt, S. (University of Stellenbosch), Biopoledi, K.A. (Botswana Government, Department of Animal Health), Vandewalle, M.E. (CARACAL), Frimpong, E.A. (VT), McNutt, J.W. (Botswana Predator Research Program), Godrij, A. (VT), Michel, A.L. (University of Pretoria), Williams, M. (University of Pretoria), van Helden, P.D. (University of Stellenbosch), Warren, R.M. (University of Stellenbosch), Gey van Pittius, N.C. (University of Stellenbosch), Briggs, M.B. (Global Veterinary Consultancy), Funston, P. (University of Pretoria), Hemson, G. (Oxford University), Keet, D. )Kruger Park, Directorate of Animal Health, van Vuuren, M. (University of Pretoria).

**Graduate Advisors and Postdoctoral Sponsors:** Bennie I. Osburn (PhD Advisor) - University of Davis, School of Veterinary Medicine

**Thesis Advisor and Postgraduate-Scholar Sponsor:** John Fox, Kuruthumu Mwamende, Virginia Tech. (ii) Completed: Risa Pesapane, Pete Laver, Bonnie Fairbanks, Megan Holcomb C. Chang, S. Jobbins, C. Sanderson (Virginia Tech), Chris Gibbons (Kings College, London, UK).

**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: Hungerford, Laura

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

POSITION TITLE: Professor and Head

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

INSTITUTION AND LOCATION	DEGREE	START DATE	END DATE	FIELD OF STUDY
Michigan State University, E. Lansing, MI	DVM	07/1977	06/1980	
University of Illinois School of Public Health, Chicago, IL	MPH	01/1985	06/1987	Biostatistics and Epidemiology
University of Illinois College of Veterinary Medicine, Urbana, IL	PHD	07/1981	06/1989	Veterinary Epidemiology
University of Illinois College of Veterinary Medicine, Urbana, IL	Other training	07/1980	06/1981	Food Animal Medicine and Surgery Intern
University of Illinois College of Veterinary Medicine, Urbana, IL	Resident	07/1981	06/1986	Veterinary Diagnostic Microbiology

**A. Personal Statement**

This proposal is designed to use a One Health approach to transform the way that we think about and teach about disease transmission and the inter-relationships between environment, plants, animals, vectors, pathogens, and humans. This will position VT to address societal grand challenges through generation of innovative solutions and creation of the next generation of innovative problem solvers. My extensive experience in teaching and mentoring students (primary mentor or chair for 2 postdoctoral fellow, 7 MS, 14 MPH and 4 PhD students and committee membership for an additional 17 MS and 18 PhD students), recognized by my academic appointments, promotions and awards, and by the success of my previous students, will allow me to strongly contribute to this effort. I have blended academic and federal leadership roles which provides additional experiences for both traditional research, mentoring and finding innovative funding sources. My work at both the university and FDA has been and remains largely as an integrator and problem-solver in team science; which is well suited to working with the multidisciplinary approach of this proposal. My specific research experience in vector-borne disease, transdisciplinary studies, geographic health, dynamic modeling and quantitative epidemiology align well with the project aims.

**B. Positions and Honors****Positions and Employment**

1980 - 1981	Food Animal Medicine and Surgery Intern, University of Illinois College of Veterinary Medicine, Urbana, IL
1981 - 1986	Veterinary Diagnostic Microbiology Resident, University of Illinois College of Veterinary Medicine, Urbana, IL
1989 - 1996	Assistant Professor, University of Illinois College of Veterinary Medicine, Urbana, IL
1996 - 1998	Associate Professor with Tenure, University of Illinois College of Veterinary Medicine, Urbana, IL
1998 - 2002	Associate Professor with Tenure, Great Plains Veterinary Educational Center, University of Nebraska, Clay Center, NE
2002 - 2005	Associate Professor, University of Maryland School of Medicine, Baltimore, MD
2002 - 2016	Senior Advisor for Science and Policy, US FDA Center for Veterinary Medicine, Rockville, MD
2004 - 2006	Interim head, Division of Foodborne and Emerging Pathogens, University of Maryland School of Medicine, Baltimore, MD

- 2005 - 2016 Professor with Tenure (2006), University of Maryland School of Medicine, Baltimore, MD
- 2012 - 2015 Director, Graduate Program in Epidemiology and Human Genetics, GPILS, University of Maryland School of Medicine, Baltimore, MD
- 2015 - 2016 Vice Chair for Academic Programs, Department of Epidemiology and Public Health, University of Maryland School of Medicine, Baltimore, MD
- 2016 - Professor and Head, Department of Population Health Sciences, Virginia-Maryland College of Veterinary Medicine, Virginia Tech, Blacksburg, VA

### **Other Experience and Professional Memberships**

- 1980 - Member, American Veterinary Medical Association
- 1987 - Founding member, Beta Tau Chapter, University of Maryland, Baltimore and Delta Mu Chapter, Virginia Tech; Chapter President, 2010-2012, 2017-, DELTA OMEGA Honorary Society for Public Health
- 1990 - Executive Board (1990-1996, 2001-2008), President Elect (2001-2002), President (2003-2004); Schwabe Symposium Co-Chair (2002, 2004), Schwabe Symposium Chair (2005), Association for Veterinary Epidemiology and Preventive Medicine
- 1991 - External Reviewer, USDA/ARS and USDA/CSRS
- 1997 - Section Head (2000-2010), Executive Board (2005-2009), Vice President (2009-2010), President (2010-2011), Co-Chair of Epidemiology Session (1991, 1992, 1994, 1997, 1998, 1999, 2003), Leader, Epidemiology Section (1998-1999), Nominations Committee (1999), ACVPM Awards Committee (1999), Section founder and Companion Animal Epidemiology Section Co-Chair (2010 - present), CRWAD - Conference of Research Workers in Animal Disease
- 1998 - Panel member (1998, 1999, 2008, 2014), U.S.D.A., NRI Competitive Grants
- 2002 - Member, Maryland Veterinary Medical Association
- 2005 - Panel member (2005, 2006, 2008); external reviewer in other years, N.S.F, EID Competitive Grants

### **Honors**

- 1975 National Merit Scholar, National Merit Scholarship Corporation
- 1983 Inductee, PHI KAPPA PHI Honorary Society
- 1986 Inductee, SIGMA XI Honorary Scientific Research Society
- 1987 Inductee, PHI ZETA Honorary Society for Veterinary Medicine
- 1987 Inductee, DELTA OMEGA Honorary Society for Public Health
- 1990 Teachers Rated as Excellent (and 1992, 1994, 1996), University of Illinois
- 2008 Outstanding Teacher Award, Department of Epidemiology and Preventive Medicine, University of Maryland School of Medicine
- 2009 Honorary Diploma, American Veterinary Epidemiology Association
- 2011 First Annual Student Teaching Award in Recognition of Outstanding Teaching and Mentoring, University of Maryland School of Medicine MPH Program
- 2013 Distinguished Scholar and Fellow, National Academies of Practice, Veterinary Medicine Academy

### **C. Contribution to Science**

1. My initial engagement in infectious disease epidemiology was a direct response to questions that I developed as a clinician about the extent and transmission patterns at the species interface between cattle and deer. To address these questions, I have applied a blend of quantitative epidemiologic methods with approaches from other disciplines. For anaplasmosis, this allowed us to map and analyze disease patterns; find key factors associated with disease at the animal and county level; provide information to veterinarians and regulators; and suggest interventions. For sheep diseases, we combined environmental monitoring, risk factors, production practices, producer preferences, economics and simulation modeling to understand the impact of mortality and management in sheep. In raccoons, by integrating health questions into ongoing wildlife ecology studies, we examined

infection in the context of animal behavior and population dynamics. For *E. coli* O157:H7, we developed a novel pen-level sampler and used laboratory methods and longitudinal designs to demonstrate the ubiquitous nature and sources of variability in the occurrence of this pathogen. More recently, I have used this same transdisciplinary approach to collaborate on studies of a range of human microparasites.

- a. Hungerford LL, Smith RD. Variations in seroprevalence and host factors for bovine anaplasmosis in Illinois. *Vet Res Commun*. 1997 Jan;21(1):9-18. PubMed PMID: [9060138](#).
  - b. Hungerford LL, Mitchell MA, Nixon CM, Esker TE, Sullivan JB, Koerkenmeier R, Marretta SM. Periodontal and dental lesions in raccoons from a farming and a recreational area in Illinois. *J Wildl Dis*. 1999 Oct;35(4):728-34. PubMed PMID: [10574532](#).
  - c. Nash ML, Hungerford LL, Nash TG, Zinn GM. Risk factors for perinatal and postnatal mortality in lambs. *Vet Rec*. 1996 Jul 20;139(3):64-7. PubMed PMID: [8857578](#).
  - d. Smith D, Blackford M, Younts S, Moxley R, Gray J, Hungerford L, Milton T, Klopfenstein T. Ecological relationships between the prevalence of cattle shedding *Escherichia coli* O157:H7 and characteristics of the cattle or conditions of the feedlot pen. *J Food Prot*. 2001 Dec;64(12):1899-903. PubMed PMID: [11770614](#).
2. Throughout my research, I've pioneered transdisciplinary approaches to health research, building partnerships that introduced new methodologies that subsequently became inculcated in the field. I was one of the first to promote use of geographic information systems (GIS) and spatial statistics in animal disease epidemiology, working with pioneers outside the veterinary or health fields. I worked with other faculty to develop methods for outside assessment of veterinary training to guide curriculum reform; a practice now commonly used in program review. We used detailed follow-up of individual raccoons to show that drugs used to handle the animals have behavioral impacts and can affect population estimates, which had never been considered. We used recognition of the natural curiosity and 'mouthing' behavior of cattle to design a new, efficient, pen-level, bacterial sampling system that allowed us to conduct many studies and is now widely used in research and monitoring. We used molecular epidemiology to examine the influence of the microbiome on health of children in the developing world. Currently, with the enormous advancement of methods within disciplinary silos, the potential for new insights through cross-disciplinary fertilization continues to grow rapidly.
- a. Gehrt SD, Hungerford LL, Hatten S. Effects of immobilization agents on post-release behavior and population estimates of raccoons. *Wildlife Society bulletin*. 2001; 29:833-7.
  - b. Hungerford L. Use of spatial statistics to identify and test significance in geographic disease patterns. *Prev Vet Med*. 1991 December; 11(3-4):237-42.
  - c. Smith DR, Gray JT, Moxley RA, Younts-Dahl SM, Blackford MP, Hinkley S, Hungerford LL, Milton CT, Klopfenstein TJ. A diagnostic strategy to determine the Shiga toxin-producing *Escherichia coli* O157 status of pens of feedlot cattle. *Epidemiol Infect*. 2004 Apr;132(2):297-302. PubMed PMID: 15061505; PubMed Central PMCID: PMC2870106.
  - d. Lindsay B, Oundo J, Hossain MA, Antonio M, Tamboura B, Walker AW, Paulson JN, Parkhill J, Omoro R, Faruque AS, Das SK, Ikumapayi UN, Adeyemi M, Sanogo D, Saha D, Sow S, Farag TH, Nasrin D, Li S, Panchalingam S, Levine MM, Kotloff K, Magder LS, Hungerford L, Sommerfelt H, Pop M, Nataro JP, Stine OC. Microbiota that affect risk for shigellosis in children in low-income countries. *Emerg Inf Dis*. 2015 21:242-50.
3. Many diseases, particularly zoonotic and vector-borne infections, have inherently heterogeneous and meaningful geographic distributions. I have helped develop, used, and taught GIS and spatial methodology throughout my career. This was key to understanding the epidemiology of anaplasmosis in Illinois. In another project, we worked with geographers to develop methods to use satellite data to understand tsetse fly distributions. With ecologists, we used mapping and regression to examine relationships predicting the vulnerability and resiliency of endangered amphibian populations and found associations that were later confirmed by laboratory studies. We used similar approaches to examine individual-, environmental-, and hamlet-level associations with malaria in a low transmission setting. This success has led to significant funding and, most recently, to a grant to foster inter-campus collaborations to build new partnerships in health geography for other faculty.

- a. Hungerford LL, Smith RD. Spatial and temporal patterns of bovine anaplasmosis as reported by Illinois veterinarians. *Preventive veterinary medicine*. 1996; 25:301-13.
  - b. Kitron UD, Otieno LH, Hungerford LL, Odulaja A, Brigham WU, Okello OO, Joselyn Mark, Mohamed-Ahmed MM, Cook E. Spatial analysis of the distribution of tsetse flies in the Lambwe Valley, Kenya, using Landsat TM satellite imagery and GIS. *The Journal of animal ecology*. 1996; 65:371-80.
  - c. Lawpoolsri S, Chavez IF, Yimsamran S, Puangsa-Art S, Thanyavanich N, Maneeboonyang W, Chaimungkun W, Singhasivanon P, Maguire JH, Hungerford LL. The impact of human reservoir of malaria at a community-level on individual malaria occurrence in a low malaria transmission setting along the Thai-Myanmar border. *Malar J*. 2010 May 26;9:143. PubMed PMID: 20504308; PubMed Central PMCID: PMC2887882.
  - d. Witte CL, Sredl MJ, Kane AS, Hungerford LL. Epidemiologic analysis of factors associated with local disappearances of native ranid frogs in Arizona. *Conserv Biol*. 2008 Apr;22(2):375-83. PubMed PMID: [18261148](#).
4. Epidemiologic methods traditionally focus on identification of risk factors in a dataset. However, this describes the risk in the past. We may infer the future, but dynamic modeling provides explicit methodology for conceptualizing complex future results or consequences. In addition to using modeling to study sheep disease management costs and options, we used preliminary models to explore if distemper epidemics in raccoons and measles epidemics in humans could be generated by pathogen shifts rather than the traditional herd immunity explanation. This led us to molecular studies to explore this finding and the resulting discovery of previously unrecognized strain diversity in a raccoon outbreak. We also used modeling to explore cross-species transmission risk from primates to humans and enhanced treatment schemes for malaria in low transmission areas. A current student is using modeling to examine potential effects of a new vaccine for *Salmonella*. At a larger scale, we have combined spatial analysis and modeling to create transmission risk maps for avian influenza and are applying this to raccoon rabies.
- a. Engel G, Hungerford LL, Jones-Engel L, Travis D, Eberle R, Fuentes A, Grant R, Kyes R, Schillaci M. Risk assessment: A model for predicting cross-species transmission of simian foamy virus from macaques (*M. fascicularis*) to humans at a monkey temple in Bali, Indonesia. *Am J Primatol*. 2006 Sep;68(9):934-48. PubMed PMID: 16900504.
  - b. Lawpoolsri S, Klein EY, Singhasivanon P, Yimsamran S, Thanyavanich N, Maneeboonyang W, Hungerford LL, Maguire JH, Smith DL. Optimally timing primaquine treatment to reduce *Plasmodium falciparum* transmission in low endemicity Thai-Myanmar border populations. *Malar J*. 2009 Jul 15;8:159. PubMed PMID: 19604346; PubMed Central PMCID: PMC2718908.
  - c. Lednicky JA, Dubach J, Kinsel MJ, Meehan TP, Bocchetta M, Hungerford LL, Sarich NA, Witecki KE, Braid MD, Pedrak C, Houde CM. Genetically distant American Canine distemper virus lineages have recently caused epizootics with somewhat different characteristics in raccoons living around a large suburban zoo in the USA. *Virology*. 2004 Sep 2;1:2. PubMed PMID: 15507154; PubMed Central PMCID: PMC524033.
  - d. Prosser DJ, Hungerford LL, Erwin RM, Ottinger MA, Takekawa JY, Ellis EC. Mapping avian influenza transmission risk at the interface of domestic poultry and wild birds. *Front Public Health*. 2013;1:28. PubMed PMID: 24350197; PubMed Central PMCID: PMC3854848.
5. A final area of work has been to use my strong quantitative expertise, my background in clinical medicine, and my communication skills to advance clinical epidemiology and population health in veterinary medicine. In general, these collaborations have resulted in publications with co-authors from fields outside of population health. Among the many examples across my career are articles with clinical pathologists, equine clinicians, and animal behaviorists. All of these collaborations focused on answering clinical questions in an evidence-based manner. This approach is also a fundamental aspect of my role with FDA. As an example, we conducted and published a study that demonstrated the potential for use of systematic review and meta-analysis in drug review. This led to a paradigm shift in viewing evidence for safety and effectiveness that provided a new path recently used for approval of a new cattle drug.

- a. Austin SM, Foreman JH, Hungerford LL. Case-control study of risk factors for development of pleuropneumonia in horses. J Am Vet Med Assoc. 1995 Aug 1;207(3):325-8. PubMed PMID: 7628934.
- b. Baird-Heinz HE, Van Schoick AL, Pelsor FR, Ranivand L, Hungerford LL. A systematic review of the safety of potassium bromide in dogs. J Am Vet Med Assoc. 2012 Mar 15;240(6):705-15. PubMed PMID: 22380809.
- c. Gaskins LA, Hungerford L. Nonmedical factors associated with feather picking in pet psittacine birds. J Avian Med Surg. 2014 Jun;28(2):109-17. PubMed PMID: 25115039.
- d. Solter PF, Hoffmann WE, Hungerford LL, Peterson ME, Dorner JL. Assessment of corticosteroid-induced alkaline phosphatase isoenzyme as a screening test for hyperadrenocorticism in dogs. J Am Vet Med Assoc. 1993 Aug 15;203(4):534-8. PubMed PMID: [8407509](#).

## **D. Additional Information: Research Support and/or Scholastic Performance**

### **Recently Completed Research Support**

FDA IPA: Hungerford, Laura

06/01/13-10/25/16

Innovation in Science and Regulatory Decision-making for Animal Drugs

Role: PI

Zoological Society of San Diego

11/01/15-10/01/16

Systems Modeling and Network Analysis of Disease Epidemiology among Wild and Captive Species

Role: PI

State MPowering Maryland Initiative

01/01/15-06/01/16

Piloting Collaboration between the UMCP Center for Geospatial Information Science and the UMB Schools of Medicine, Nursing and Pharmacy

Role: Multiple PI

Zoological Society of San Diego

08/01/13-10/01/15

Developing Population Health-based Research among Wildlife Species

Role: PI

AHRQ, Johns Hopkins University subaward

01/01/12-08/01/13

MidAtlantic Public Health Training Center

Role: PI

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## BIOGRAPHICAL SKETCH

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NAME Kolivras, Korine Nicole		POSITION TITLE Associate Professor of Geography		
eRA COMMONS USER NAME (credential, e.g., agency login) KOLIVRAS				
EDUCATION/TRAINING				
INSTITUTION AND LOCATION		DEGREE <i>(if applicable)</i>	MM/YY	FIELD OF STUDY
Shippensburg University, Shippensburg, PA		BA	05/97	Geography
University of Arizona, Tucson, AZ		MA	12/00	Geography
University of Arizona		PhD	08/04	Geography Minor: Epidemiology

### A. Personal Statement

As a broadly-trained health/medical geographer with specific training and expertise in the impacts of environmental variability and change on emerging infectious diseases using geospatial techniques, I have the expertise and training to contribute to the Global Systems Science destination area concept on emerging viral and vector-borne diseases. I regularly collaborate with multidisciplinary teams, and during these collaborations, I bring a spatial perspective to address complex problems, as well as the ability to use geospatial techniques to understand, analyze, and visualize the spatial patterns of health concerns, and the underlying processes that contribute to those patterns. As PI on an NSF-funded grant, I worked with an interdisciplinary team of researchers, including geographers, statisticians, an entomologist, and a forestry specialist to examine links between land cover change and the emergence pattern of Lyme disease in Virginia using GIS and remotely-sensed data. We identified specific land cover patterns that are associated with human cases with the use of data at multiple spatial scales. I have a strong commitment to teaching, as evidenced by college and disciplinary national teaching awards, and a proven track record of mentoring graduate students on research projects through the completion of their degrees. This application builds on my training and background, which combines geography and epidemiology, and strengths in interdisciplinary work.

### B. Positions and Honors

#### Positions and Employment

1997-1998 GIS Analyst, Advanced Technology Solutions (now GeographIT), Lancaster, PA  
1998-1999 Graduate Teaching Assistant, Department of Geography, University of Arizona, Tucson, AZ  
1999-2002 Graduate Research Assistant, Department of Geography, University of Arizona, Tucson, AZ  
2002-2004 NASA Space Grant Fellow, University of Arizona, Tucson AZ  
2004-2011 Assistant Professor, Department of Geography, Virginia Tech, Blacksburg, VA  
2011- Associate Professor, Department of Geography, Virginia Tech, Blacksburg, VA

#### Other Experience and Professional Memberships

2015- Treasurer, Southeastern Division of the American Association of Geographers

- 2013 Invited Speaker, University of North Carolina-Chapel Hill, Department of Geography Colloquium Series
- 2010-2012 Board Member, Health and Medical Geography Specialty Group
- 2006-2008 Board Member, Health and Medical Geography Specialty Group
- 2005-2008 Outreach project in collaboration with the Director of the Punta Cana Ecological Foundation in the Dominican Republic on research related to health, housing, and land use in a shantytown.
- 2005-2008 Moderator, World Geography B
- 2004- Reviewer for National Science Foundation, *Annals of the Association of American Geographers*, *Climate Research*, *Environmental Health Perspectives*, *Geography Compass*, *Global Change Biology*, *International Journal of Biometeorology*, *International Journal of Climatology*, *International Journal of Health Geographics*, *Journal of Applied Geography*, *Professional Geographer*, *Singapore Journal of Tropical Geography*, *Southeastern Geographer*, *Social Science & Medicine*
- 1999- Member, American Association of Geographers
- 2005- Member, Southeastern Division of the American Association of Geographers

### Honors

- 2005 Finalist, J. Warren Nystrom Award for Best Paper from a Dissertation in Geography. Association of American Geographers.
- 2006 Curriculum Club Outstanding Teacher, Department of Geography, Virginia Tech.
- 2010 Higher Education Distinguished Teaching Award, National Council for Geographic Education.

### **C. Publications**

#### **Most Relevant Journal Articles** (selected from n=26)

- Krometis, L.-A., J. Gohlke, **K.N. Kolivras**, E. Satterwhite, S.W. Marmagas, L. Marr. 2017. Environmental health concerns and disparities in the central Appalachian region of the United States. *Reviews on Environmental Health*. Accepted.
- Bandzuh, J.T., L. Juran, **K.N. Kolivras**, A. Wallis. 2017. Local perceptions of measures to control Aedes mosquitoes and mosquito-borne diseases in Puntarenas and San Jose, Costa Rica. *Journal of Latin American Geography*. Accepted.
- Juran, L., J. Trivedi, and **K.N. Kolivras**. 2017. Considering the 'public' in public health: Poplar resistance to the Smallpox Eradication Programme in India. *Indian Journal of Medical Ethics* 2(2): 104-111.
- Seukep, S.E., **K.N. Kolivras**, Y. Hong, J. Li, S. Prisley, J. Campbell, D. Gaines, R. Dymond. 2015. An examination of the demographic and environmental variables correlated with Lyme disease emergence in Virginia. *EcoHealth* 12(4): 634-644.
- Li, J., **K.N. Kolivras**, Y. Hong, Y. Duan\*, S.E. Seukep\*, S. Prisley, J. Campbell, D. Gaines. 2014. Spatial and Temporal Emergence Pattern of Lyme Disease in Virginia. *American Journal of Tropical Medicine & Hygiene*. 91(6): 1166-1172.
- Khan, M., Bryceson, I., **K. N. Kolivras**, Faruque, F., Rahman, M., and Haque, U. 2014. Natural Disasters and land-use/land-cover change in the southwest coastal areas of Bangladesh. *Regional Environmental Change*. DOI 10.1007/s10113-014-0642-8.
- Haque, U., Hashizume, M., **Kolivras, K.N.**, Overgaard, H. J., Das, B., and Yamamoto, T. 2012. Reduced death rates from cyclones in Bangladesh – What more needs to be done?. *Bulletin of the World Health Organization* 90: 150-156.
- Haque, U., Magalhães, R.J., Mitra, D., **Kolivras, K.N.**, Schmidt, W.P., Haque, R. and Glass, G.E. 2011. The role of age, ethnicity and environmental factors in modulating malaria risk in Rajasthali, Bangladesh.





**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: Sally L. Paulson

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

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
Miami University, Oxford, Ohio	B.A.	06/1976	Zoology
Miami University, Oxford, Ohio	M.S.	12/1981	Zoology
University of Notre Dame, South Bend, Indiana	Ph.D.	05/1987	Biology
University of Texas, Austin, Texas	Postdoctoral	08/1988	Arbovirology

**A. Personal Statement**

I have the experience, training, leadership and motivation to successfully carry out the proposed project. I have a broad background in medical entomology and arbovirology. I have nearly 30 years experience teaching both graduate and undergraduate students in courses including Medical and Veterinary Entomology, Virology, Advanced Virology, Urban and Public Health Entomology, and Animal and Plant Biosafety and Biosecurity. Former students have gone on to medical and graduate school and careers in medical entomology in positions for organizations such as the University of California, the University of Virginia, the California Department of Public Health and Rentokil North America Pest Control. Research in my lab is focused on the bionomics of mosquitoes, their control, and the viruses they carry. We have shown that several endemic viruses are evolving to make use of exotic mosquito vectors as they expand into the southern and Appalachian regions of the US. We have also found that virus infection may alter the susceptibility of mosquitoes to insecticides and repellents (Yang, Chan and Paulson, unpublished data). In addition, we are developing new surveillance techniques to track *Aedes aegypti* and *Aedes albopictus*, the primary vectors of Zika virus. Patent disclosures are being prepared for a dual-use mosquito trap and an auditory attractant to facilitate the collection of male mosquitoes. Funding for my lab has come from NIH, FNIH, DoD, VDH, CDC and Syngenta.

**B. Positions and Honors****Positions and Employment**

1978-79 Laboratory Analyst, Miles Laboratories, Dayton, Ohio.  
1979--80 Research Assistant, Experimental and Surgical Pathology, University of Cincinnati Medical Center, Cincinnati, Ohio.  
1980-81 Instructor, Allied Health Division, Cincinnati Technical College, Cincinnati, Ohio.  
1988-94 Assistant Professor, Department of Biological Sciences, Florida Atlantic University, Boca Raton, Florida.  
1994-95 Associate Professor, Department of Biological Sciences, Florida Atlantic University, Boca Raton, Florida.  
1995- Associate Professor of Entomology, Department of Entomology, Virginia Polytechnic Institute and State University, Blacksburg, Virginia

## **Other Experience and Professional Memberships**

1982-	Member, American Mosquito Control Association
1983-	Entomological Society of America
1984-	Society of Tropical Medicine and Hygiene
1999 –03	Editorial Board member and chair (2003) Environmental Entomology, Entomological Society of America
2000-05	West Nile Virus Task Force, State of Virginia
2009	NIH Peer Review Committee: Stage 1 reviewer for NIH Challenge Grants in Health and Science Research

## **Honors**

1989-90	Outstanding Lecturer, FAU Medical Technology Program
1990	Outstanding Achievement Award, FAU
1990-91	McKnight Junior Faculty Fellow
1995	Leadership Enhancement & Advancement Award, FAU
1994	Excellence in Undergraduate Teaching Award, FAU
2003	Delivered “Highlights in Medical Entomology” at Entomological Society of America annual meeting.

## **C. Contributions to Science**

1. Emerging Foci of Vector-borne Disease: Arbovirus surveillance of field-collected mosquitoes is an important aspect of public health and mosquito control programs. We have shown that LACV and Cache Valley virus are evolving to make use of accessory vectors as they expand into the southern and Appalachian regions of the US.

- a. Fan Yang, K. Chan, P.E. Marek, P.M. Armstrong, P. Liu, J.E. Bova, J.N. Bernick, B.E. McMillan, B.G. Weidlich, and S.L. Paulson. 2016. Discovery of Cache Valley virus in *Aedes japonicus japonicus* mosquitoes in the Appalachian Region, United States. Submitted to Emerging Infectious Diseases.
- b. Harris, M.C., E.J. Dotseth, B.T. Jackson, S.D. Zink, P.E. Marek, L.D. Kramer, S.L. Paulson, and D.M. Hawley. 2015. La Crosse Virus in *Aedes japonicus japonicus* Mosquitoes in the Appalachian Region, United States. Emerging Infectious Diseases 21(4):646-649.
- c. Harris, C.M., F. Yang, D.M. Jackson, E.J. Dotseth, S.L. Paulson, and D.M. Hawley. 2015. La Crosse virus field detection and vector competence of *Culex* mosquitoes. Am. J. Trop. Med. Hyg. 93(3): 461-467.

2. Molecular Design of Selective Anticholinesterases for Mosquito Control: I was part of a large collaborative project (funded by Grand Challenges in Global Health-FNIH) that sought to develop selective mosquitocides with low toxicity to humans to produce tools for the antimalarial arsenal. These chemicals may provide viable alternatives to pyrethroids as part a resistance management scheme to control the malaria vector, *Anopheles gambiae*. My contribution was to supervise mosquito rearing and conduct whole insect toxicity testing. This work resulted in several publications and 2 patents.

- a. Wong, D. M., Li, J., Han, Q., Mutunga, J. M., Wysinski, A., Anderson, T. D., Ding, H., Paulson, S. A., Carpenetti, T. L., Lam, P. C. H., Totrov, M. M., Bloomquist, J. R., Carlier, P. R., 2012. Select small core structure carbamates exhibit high contact toxicity to “carbamate-resistant” strain malaria mosquitoes, *Anopheles gambiae* (Akron), PLoS ONE 7(10):e46712
- b. Carlier, P., J. Bloomquist, S. Paulson, E. Wong. Insecticidal carbamates exhibiting species-selective inhibition of acetylcholinesterase (ACHE). Patent: US86181625B2, December 2013.
- c. Hartsel, J., M. Ma, T. Anderson, R. Choudhury, P. Carlier, J. Bloomquist, S. Paulson, E. Wong. Highly Species-Selective Insecticidal Carbamates for Mosquito Control. Patent: US8129428, September 2012.

## **D. Additional Information: Research Support and/or Scholastic Performance**

### **Ongoing Research Support**

**Syngenta** 06/2016-present  
Project PPM16503: Comparison of multiple residual pesticides for long-term control of *Aedes albopictus* when applied to landscaping vegetation in VA.  
Role: PI

**Virginia Department of Health** 2016-present  
Evaluating Virginia populations of *Aedes albopictus* for insecticide resistance.  
Role: PI

**Maryland Department of Health** 2016-present  
Evaluating Virginia populations of *Aedes albopictus* for insecticide resistance.  
Role: PI

### **Completed Research Support**

**Syngenta** 07/2015 – 12/2015.  
Project PPM15504: Evaluate residual effectiveness of Demand CS (lambda-cyhalothrin) against *Aedes albopictus* when applied to various landscaping vegetation in VA.  
Role: PI

**Department of Defense, SBIR Program** 04/ 2013 – 10/ 2013.  
Evaluation of a Novel Sampling Device for Adult Flying Insect Vectors.  
Role: Co-PI

**Foundation for the NIH** 08/31/05—4/30/11  
Molecular Design of Selective Anticholinesterases for Mosquito Control.  
Role: Co-PI

**VBI/Fralin Life Science Institute Exploratory Grant** 12/01/08-11/30/09  
The influence of land use on vector feeding behavior and arboviral dynamics in forest communities.  
Role: Co-PI

**NIH** 04/01/05-08/31/08  
Emerging Foci of La Crosse Encephalitis Virus Activity.  
Role: Co-PI

**Virginia Department of Health** 02/2003 – 02/2005  
Developing a Team Approach for Mosquito Surveillance in Southwest Virginia  
Role: PI

**Virginia Department of Health** 2000-2001  
Canine serosurvey to determine distribution and prevalence of vector-borne disease in southwest Virginia  
Role: Co-PI

**Centers for Disease Control** 1997-1999  
Prospective case/control study of La Crosse encephalitis behavioral and environmental risk factors in Nicholas and Fayette counties, West Virginia  
Role: Co-PI

**NIH** 1994-1997  
Gregarine infection of container-breeding *Aedes*  
Role: PI

**Florida Department of Agriculture and Consumer Services** 1993-1994

Replacement of *Aedes aegypti* by *Aedes albopictus* in Florida: Effect of gregarine parasites on competition

Role: PI

**Joint Center for Environmental and Urban Problems** 1998-1999

Exotic Mosquitoes in Florida: Distribution in South Florida and Competition with a Native Species

Role: PI

**Florida Atlantic University Internal Research Grant** 1989-1991

Persistent Virus Infections in Mosquitoes: The Role of an Antiviral Factor

Role: PI

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**BIOGRAPHICAL SKETCH**

NAME: Cassidy L. Rist

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POSITION TITLE: Assistant Professor, Department of Population Health Sciences, Virginia-Maryland College of Veterinary Medicine

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**EDUCATION/TRAINING**

INSTITUTION AND LOCATION	DEGREE	Completion MM/YYYY	FIELD OF STUDY
University of Florida, Gainesville, FL	DVM	06/2005	Veterinary Medicine
Emory University, Atlanta, GA	MPH	06/2014	Global Epidemiology

**A. Professional Summary**

Veterinary epidemiologist with strength of knowledge in One Health and zoonoses, infectious disease prevention and control strategies, and emergency preparedness and response. Prior experience in small animal private practice; Research Fellow with the One Health Office at the Centers for Disease Control and Prevention; postdoctoral researcher with Emory University and Harvard Medical School; and Veterinary Medical Officer with the U.S. Department of Agriculture. Interest in promoting the role of livestock health in global food and economic security, strengthening domestic and international veterinary capacity for disease detection and response, and building collaborative research and development programs at the intersection of human, animal and environmental health.

**B. Positions and Honors****Positions and Employment**

- 2016 – Assistant Professor, Department of Population Health Sciences, Virginia-Maryland College of Veterinary Medicine, Virginia Tech, Blacksburg, VA
- 2015 – 2016 Veterinary Medical Officer, United States Department of Agriculture, Richmond, VA
- 2014 – 2016 Contractor, Centers for Disease Control and Prevention, Atlanta, GA
- 2014 – 2015 Postdoctoral Research Fellow, Department of Global Health and Social Medicine, Harvard Medical School, Boston, MA
- 2012 – 2014 Research Fellow, National Center for Emerging and Zoonotic Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, GA
- 2011 – 2012 Veterinarian, General Practice, Trenton Animal Hospital, Trenton, FL
- 2009 – 2011 Veterinarian, Emergency and Critical Care, Affiliated Pet Emergency Services, Gainesville, FL
- 2007 – 2009 Veterinarian, Emergency and Critical Care, Veterinary Emergency and Specialty Center, Santa Fe, NM
- 2006 – 2007 Intern, Small Animal Surgery, Wheat Ridge Veterinary Specialists, Wheat Ridge, CO
- 2005 – 2006 Intern, Small Animal Emergency and Critical Care, New England Animal Medical Center, West Bridgewater, MA

**Honors and Awards**

- 2013 Emory Global Health Institute, Multidisciplinary Team Field Scholar
- 2004 Dr. Mark Bloomberg Memorial Scholarship for Excellence in Academics and Leadership
- 2004 Allen H. Hart/IDEXX Scholarship for Excellence in Clinical Pathology

## C. Contributions to Science

### Select Publications

**Rist CL**, Arriola CS, Rubin C (2014). Prioritizing zoonoses: A proposed One Health tool for collaborative decision-making. PLoS ONE 9(10): e109986. doi:10.1371/journal.pone.0109986

**Rist CL**, Ngonghala CN, Garchitorena A, Brook CE, Ramananjato RH, Miller AC, Randrianarivelosia M, Wright PC, Gillespie TR, Bonds MH (2015). Modeling the burden of poultry disease on the rural poor in Madagascar. One Health, vol 1:p60-65. doi:10.1016/j.onehlt.2015.10.002

**Rist CL**, Garchitorena A, Ngonghala CN, Gillespie TR, Bonds MH (2015). The burden of livestock parasites on the poor. Trends in Parasitology, 31(11):p527-530. doi:10.1016/j.pt.2015.09.005

### Select Invited Presentations:

**International Society for Veterinary Epidemiology and Economics**, October 3<sup>rd</sup>, 2015. *"A coupled epidemiological-economic model for measuring the burden of poultry disease on the rural poor in Madagascar"*

Education and Research Center for Occupational Safety and Health Seminar Series at the **Johns Hopkins University, Bloomberg School of Public Health**, April 6<sup>th</sup>, 2015. *"Reaching National Consensus for Disease Control: Prioritization at the Human, Animal and Environmental Health Interface"*

Division Seminar at the **Centers for Disease Control and Prevention**, Division of High-Consequence Pathogens and Pathology, April 2, 2014. *"Lemurs In the Backyard, Chickens In the Kitchen: Finding One Health Solutions for Madagascar"*.

### Professional Memberships

- American Veterinary Medical Association
- International Society for Veterinary Epidemiology and Economics
- International Society for Infectious Diseases
- International Society for Disease Surveillance – One Health Surveillance Working Group
- United States Animal Health Association
- Network for the Evaluation of One Health

## D. Research Support

### Ongoing Research Support

PIVOT Research Grant 10/01/16 – 09/30/17  
Design and deployment of a regional dried blood spot sampling program for improved tuberculosis diagnostics in Ifanadiana District, Madagascar.  
Role: Co-PI

Faculty Resources Grant, Virginia-Maryland College of Veterinary Medicine 12/01/16 – 08/01/17  
Environmental conditions incurred by dried blood spot samples under drone transport.  
Role: PI

### Completed Research Support

Bill and Melinda Gates Foundation, Phase I Grand Challenges Explorations 07/01/14 – 09/01/15  
The economic burden of disease: A combined metric of human and animal health in rural Madagascar.  
Role: Co-Investigator