

ANDREW R. WARGO

Virginia Institute of Marine Science, College of William and Mary
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INTERESTS

Ecology and evolution of infectious diseases, pathogen fitness traits, host-pathogen co-evolution, within-host pathogen dynamics, anthropogenic impacts on pathogen evolution, virulence selection, vaccination, drug resistance, disease in aquaculture, epidemiology, infectious disease mathematical modeling

PROFESSIONAL EMPLOYMENT

Assistant Professor 2012 - present
Department of Environmental and Aquatic Animal Health, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA

- Research focus: *Ecology and evolution of infectious diseases*

POSTDOCTORAL EXPERIENCE

University of Washington and Western Fisheries Research Center, Seattle, WA 2006 – 2012

- Research topic: *Virulence evolution and in vivo fitness of fish viruses*
- Techniques: Animal studies, qRT-PCR, plaque assays, cloning, sequencing, mathematical modeling
- Duties: Laboratory research, project management, grant writing, manuscript publication, mentoring
- Mentors: Gael Kurath, Ph.D. and Benjamin Kerr, Ph.D.

EDUCATION

Ph.D. **Biological Sciences**, University of Edinburgh 2006
Thesis: *In-host ecology and transmission dynamics of malaria parasites*
Advisor: Prof. Andrew F. Read, Ph.D.

B.A. **Biology, Chemistry Minor, Summa Cum Laude**, University of Vermont 2001
Semester abroad: James Cook University, Townsville, Australia

GRANTS

USDA EEID Grant (Consultant), University of Washington (\$2,062,822) 2012 – present
● Title: “*Ecological Drivers of Transmission, Emergence, and Displacement of an Aquatic Virus in Fish Hosts*”

NSF EID Grant EFF0812603 (Co-Author), University of Washington (\$986,088) 2008 – 2012
● Title: “*Virulence Trade-offs in a Vertebrate Virus*”

NIH NRSA Postdoctoral Training Grant, University of Washington (\$100,000) 2006 – 2008
● Title: “*The Association between Virulence and Fitness in a Vertebrate Virus*”

British Society for Parasitology Ann Bishop Travel Grant, Tanzania, Africa (£1,500) 2005
● Funded international malaria field research at the Ifakara Health Institute

GRANTS (continued)

Wellcome Trust Ph.D. Studentship Grant , University of Edinburgh (£107,453)	2003 – 2006
Universities UK Ph.D. Studentship Grant , University of Edinburgh (£18,000)	2003 – 2006
SUGR/FAME Undergraduate Research Grant , University of Vermont (\$1,500)	2001
Helix Undergraduate Summer Research Grant , University of Vermont (\$5,000)	2000

PRE-DOCTORATE RESEARCH EXPERIENCE

Laboratory Technician II <u>Department of Medicine, University of Vermont, Burlington, VT</u> <ul style="list-style-type: none"> • <i>Explored kidney physiology</i> • Trained laboratory personnel • Managed laboratory inventory 	2002 – 2003
Laboratory Technician II <u>Microbiology and Molecular Genetics Department, University of Vermont, Burlington, VT</u> <ul style="list-style-type: none"> • <i>Examined cancer cell biology using molecular, tissue culture, and microscopy methods</i> • Advised undergraduate students • Developed laboratory protocols 	2001 – 2002
Field Research Technician <u>USDA Forest Service, Rocky Mountain Research Station, Albuquerque, NM</u> <ul style="list-style-type: none"> • <i>Investigated the impact of deforestation on reptile, amphibian, and bat population ecology</i> • Utilized mark-recapture and acoustical detection field research techniques 	2001
Undergraduate Researcher <u>Biology Department, University of Vermont, Burlington, VT</u> <ul style="list-style-type: none"> • <i>Researched life-history trait evolution in malaria parasites of lizards</i> • Project combined molecular tools, international field ecology research, and parasitological methods • Advisor: Prof. Jos. J. Schall, Ph.D. 	1997 – 2001
NSF Research Experience for Undergraduates <u>Michigan State University W.K. Kellogg Biological Station, Gull Lake, MI</u> <ul style="list-style-type: none"> • <i>Designed and conducted a committee reviewed project on flower morphology and pollinator attraction</i> 	1999

RESEARCH SKILLS TRAINING

Advanced R Programming workshop , RStudio, Tysons Corners, VA	2013
Summer Institute in Modeling Infectious Diseases workshop , University of Washington	2009
Ecological Data Analysis with R workshop , USGS Western Fisheries Research Center	2009
Ecology of Infectious Disease Modeling workshop , Cornell & University of Georgia	2007 & 2009
Evolution of Infectious Disease workshop , Pennsylvania & Colorado State Universities	2006 & 2008
Small Animal Research training , University of Edinburgh & University of Washington	2003 & 2007
Chemical Safety and Radiation training , University of Vermont	2001

TEACHING EXPERIENCE**Lecturer**

Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA 2013

- Prepared and presented lectures for: “*Principles in Pathobiology*”

Department of Biology Future Faculty Fellow, University of Washington, Seattle, WA 2008

- Designed and taught undergraduate course: “*The evolutionary arms race between hosts and pathogens*”

Mentor

Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA 2012 – present

- Co-mentored graduate student, and a lab technician

University of Washington, Seattle, WA 2006 – present

- Mentored two graduate students, numerous research assistants, and directly supervised a lab technician

University of Edinburgh, Scotland 2003 – 2006

- Advised two undergraduate honors project students

Teaching Assistant

University of Washington, Seattle, WA 2007

- Ran weekend field workshops on salmon ecology for undergraduates in *Introductory Biology*

University of Edinburgh, Scotland 2003 – 2006

- Tutorial Instructor: *Biometrics, Field Ecology*
- Laboratory Assistant: *Parasite Biology, Quantification in Life Sciences, Evolution in Action, Animal Biology, The Dynamic Cell, Evolutionary and Ecological Modeling, Population and Community Ecology*
- Grader: *Environmental and Community Biology, Origins and Diversity of Life*

Outreach Educator 2004 – 2006

Science Communication Team, University of Edinburgh, Scotland

- Delivering science education to high school students and adults throughout the United Kingdom

Tutor 1999 – 2000

Learning Cooperative, University of Vermont, Burlington, VT

- Subjects: *chemistry, organic chemistry, calculus, and biology*

TEACHING SKILLS TRAINING

Howard Hughes Future Faculty Fellows Workshop, University of Washington 2007

Academic Career Skills Workshop, University of Edinburgh 2006

Teaching Assistant Workshop, University of Edinburgh 2003

Science Communication Workshop, Edinburgh 2003

ACADEMIC HONORS & AWARDS

George Perkins Marsh Award for top Undergraduate in Ecology, University of Vermont 2001

John Dewey Undergraduate Honors Program Scholar, University of Vermont 2001

Phi Beta Kappa Bogorad Award for top 3rd year Undergraduate, University of Vermont 2000

Phi Beta Kappa Honors Society, Alpha Chapter, University of Vermont 2000 – 2001

Phi Eta Sigma Honors Society, University of Vermont 1998 – 2001

Golden Key Honors Society, University of Vermont 1998 – 2001

Vermont Scholar, University of Vermont, 1997 – 2001

PROFESSIONAL SERVICE AND AFFILIATIONS

Reviewer for scientific journals	2003 – present
● <i>Plos Pathogens, Evolution, American Naturalist, Trends in Parasitology, Journal of Virological Methods, Ecological Monographs, Veterinary Microbiology, Proceedings of the Royal Society of London-Series B</i>	
Grant proposal reviewer	2013
● Agence Nationale Recherche France	
University of Washington Department of Biology Undergrad Program Committee	2011 – 2012
University of Washington Postdoctoral Association	2009 – 2011
● Co-Chair & Public Relations Officer	
Member of British Society for Parasitology	2003 – 2006

PUBLICATIONS

- 17) Kell, A.M., **Wargo, A.R.**, Kurath, G. 2013. The role of virulence in *in vivo* superinfection fitness of a vertebrate RNA virus, Infectious Hematopoietic Necrosis Virus. *Journal of Virology*. In press.
- 16) **Wargo, A.R.** and Kurath, G. 2012. Virus fitness: Definitions, measurements, and current insights. *Current Opinion in Virology*. 2, 538-545.
- 15) **Wargo, A.R.**, Kell, A.M., Scott, R.J., Thorgaard, G.H., Kurath, G. 2012. Analysis of host genetic diversity and viral entry as sources of between-host variation in viral load. *Virus Research*, 165, 71-80.
- 14) **Wargo, A.R.** and Kurath, G. 2011. *In vivo* fitness associated with high virulence in a vertebrate virus is a complex trait regulated by host entry, replication, and shedding. *Journal of Virology*, 85, 3959 – 3967.
- 13) Peñaranda, M.M.D., **Wargo, A.R.**, and Kurath, G. 2011. Replication fitness correlates with host-specific virulence of *Infectious hematopoietic necrosis virus* (IHNV) in sockeye salmon and rainbow trout. *Virology*, 417, 312 – 319.
- 12) Park, J.W., Moon, C.H., Harmache, A., **Wargo, A.R.**, Purcell, M.K., Bremont, M., and Kurath, G. 2011. Restricted growth of U type IHNV in rainbow trout cells may be linked to casein kinase II activity. *Journal of Fish Diseases*, 34, 115 – 129.
- 11) **Wargo, A.R.**, Garver, K.A., and Kurath, G. 2010. Virulence correlates with fitness *in vivo* for two M group genotypes of *Infectious hematopoietic necrosis virus* (IHNV). *Virology*, 404, 51 – 58.
- 10) Metzger, D.C., Elliott, D.G., **Wargo, A.R.**, Park, L.K., and Purcell, M.K. 2010. Pathological and immunological responses associated with differential survival of Chinook salmon following *Renibacterium salmoninarum* challenge. *Diseases of Aquatic Organisms*, 90, 31 – 41.
- 9) Park, J.W., Moon, C.H., **Wargo, A.R.**, Purcell, M.K., and Kurath, G. 2010. Differential growth of U and M type infectious hematopoietic necrosis virus in a rainbow trout-derived cell line, RTG-2. *Journal of Fish Diseases*, 33, 583 – 591.

PUBLICATIONS (continued)

- 8) Huijben, S., Nelson, W.A., **Wargo, A.R.**, Sim, D.G, Drew, D.R., and Read, A.F. 2010. Chemotherapy, within-host ecology and the fitness of drug-resistant malaria parasites. *Evolution*, 64, 2952 – 2968.
- 7) Troyer, R.M., Garver, K.A., Ranson, J.C., **Wargo, A.R.**, and Kurath, G. 2008. *In vivo* virus growth competition assays demonstrate equal fitness of fish rhabdovirus strains that co-circulate in aquaculture. *Virus Research*, 137, 179 – 188.
- 6) **Wargo, A.R.**, Huijben, S., De Roode, J.C., Shephard, J., and Read, A.F. 2007. Competitive release and facilitation of drug-resistant parasites following therapeutic chemotherapy in a rodent malaria model. *Proceedings of the National Academy of Sciences of the United States of America*, 104, 19914 – 19919.
- 5) **Wargo, A.R.**, De Roode, J.C., Huijben, S., Drew, D.R., and Read, A.F. 2007. Transmission stage investment of malaria parasites in response to in-host competition. *Proceedings of the Royal Society of London, Series B -Biological Sciences*, 274, 2629 – 2638.
- 4) **Wargo, A.R.**, Randle, N., Chan, B.H.K., Thompson, J., Read, A.F., and Babiker, H.A. 2006. *Plasmodium chabaudi*: reverse transcription PCR (RT-PCR) for the detection and quantification of transmission stage malaria parasites. *Experimental Parasitology*, 112, 13 – 20.
- 3) De Roode, J.C., Pansini, R., Cheesman, S.J., Helinski, M.E.H., Huijben, S., **Wargo, A.R.**, Bell, A.S., Chan, B. H. K., Walliker, D., and Read, A. F. 2005. Virulence and competitive ability in genetically diverse malaria infections. *Proceedings of the National Academy of Sciences of the United States of America*, 102, 7624 – 7628.
- 2) Vardo, A.M., **Wargo, A.R.**, and Schall, J.J. 2005. PCR detection of lizard malaria parasites: prevalence of *Plasmodium* infections with low-level parasitemia differs by site and season. *Journal of Parasitology*, 91, 1509 – 1511.
- 1) Osgood, S.M., Eisen, R.J., **Wargo, A.R.**, and Schall, J.J. 2003. Manipulation of the vertebrate host's testosterone does not affect gametocyte sex ratio of a malaria parasite. *Journal of Parasitology*, 89, 190 – 192.

PUBLISHED CONFERENCE ABSTRACTS

- Huijben, S., **Wargo, A.R.**, Drew, D., Sim, D. 2007. The effects of sub-curative drug treatment on the outcome of competition for drug resistant parasites in mixed-clone malaria infections. *Tropical Medicine & International Health*, 12, 69.
- Nicole, J., **Wargo, A.R.**, Bishop-Rimmer, E., Segal, A.S. 2004. Membrane cholesterol content regulates the mechanosensitivity of a nonselective cation channel in renal proximal tubule. *Journal of General Physiology*, 124, 14A.

ORAL PRESENTATIONS

- Invited:*** “Testing the virulence evolution paradigm in a vertebrate virus system” 2013
Instituto Gulbenkian De Ciencia, Oeiras, Portugal
- Invited:*** “Ecological drivers of infectious disease severity in aquatic hosts” 2013
USDA NCCCWA, Leetown, WV
- Invited:*** “Impacts of host culling on virulence evolution of Infectious hematopoietic necrosis virus” 2013
Virus Evolution Meeting, Pennsylvania State University, State College, PA
- Invited:*** “Ecological drivers of aquatic infectious disease severity” 2012
VIMS College of William and Mary, Gloucester Point, VA
- Invited:*** “How an understanding of the ecological principles governing infectious disease severity can assist in the management of fish pathogens” 2011
USDA ARS Dairy Forage, Milwaukee, WI
- Invited:*** “Anthropogenic impacts on animal infectious disease severity” 2011
Oregon State University, Corvallis, OR
- “Drivers of pathogen burden variation” 2011
Department of Biology Retreat, University of Washington, Friday Harbor, WA
- Invited:*** “Ecological drivers of animal infectious disease severity” 2011
University of California, Davis, CA
- Invited:*** “Shedding dynamics of two *Infectious hematopoietic necrosis virus* (IHNV) genotypes which differ in virulence in rainbow trout” 2010
Virus Evolution Meeting, Noble Foundation, Ardmore, OK
- “Is there an advantage to being a deadly virus” 2010
Department of Biology Retreat, University of Washington, Friday Harbor, WA
- “Virulence-fitness trait associations in a vertebrate virus” 2010
Department of Biology Seminar Series, University of Washington, Seattle, WA
- “Does IHNV virulence have a fitness tradeoff?” 2009
WFRC Research Seminar Series, USGS WFRC, Seattle, WA
- “Virulence trade-offs in a vertebrate virus” 2009
Ecology and Evolution of Infectious Disease Meeting, University of Georgia, Athens, GA
- Invited:*** “Investigating the virulence and fitness trait relationship in a vertebrate virus” 2009
NSF Ecology of Infectious Disease Grant Holders Meeting, Park City, UT
- Invited:*** “Virulence and fitness in IHNV” 2008
Marrowstone Research Conference, USGS WFRC, Marrowstone, WA
- “Are pathogens evolving towards becoming super-killers?” 2007
Postdoctoral Mini-Symposium, University of Washington, Seattle, WA

ORAL PRESENTATIONS (continued)

- “Low drug treatment dosage to curtail drug resistance evolution in malaria” 2006
Ecology and Evolution of Infectious Disease Meeting, Pennsylvania State University, State College, PA
- Invited*: “Does curative drug treatment accelerate the evolution of drug resistance in malaria?” 2006
Co-infection Workshop, University of Edinburgh, Scotland
- “Experimental evidence of accelerated drug resistance evolution in malaria” 2005
American Society of Tropical Medicine and Hygiene Meeting, Washington, D.C.
- Invited*: “Competition, transmission, and drug resistance evolution in mixed malaria infections” 2005
Protozoan Parasite Seminar Series, University of Edinburgh, Scotland
- Invited*: “Ecology and evolution of malaria parasite transmission” 2004
Protozoan Parasite Seminar Series, University of Edinburgh, Scotland
- “Quantification and detection of transmission stage malarial parasites” 2004
European Evolution PhD Student Meeting, Shrewsbury, England

POSTER PRESENTATIONS

- “Potential impacts of host culling on the virulence evolution of a virus in fish aquaculture” 2013
Ecology and Evolution of Infectious Disease Meeting, Pennsylvania State University, State College, PA
- “Is there a trade-off between transmission potential and virulence in an aquatic vertebrate virus?” 2011
Ecology and Evolution of Infectious Disease Meeting, University of California, Santa Barbara, CA
- “Transmission stage dynamics of vertebrate virus genotypes that differ in virulence” 2010
Ecology and Evolution of Infectious Disease Meeting, Cornell University, Ithaca, NY
- “Virulence trade-offs in an acute vertebrate virus” 2008
Ecology and Evolution of Infectious Disease Meeting, Colorado State University, Ft. Collins, CO
- “Virulence and *in vivo* competitive fitness of an acute RNA virus” 2007
Ecology and Evolution of Infectious Disease Meeting, Cornell University, Ithaca, NY
- “Transmission in chronic malaria infections” 2005
American Society of Tropical Medicine and Hygiene, Washington, D.C.
- “Intra-specific competition and transmission dynamics of malaria” 2005
European Society for Evolutionary Biology Meeting, Krakow, Poland