

ANNUAL REPORT

FY 2024

Seeking to understand the host-parasite relationship in nature

DIRECTOR'S MESSAGE

Looking back over the previous year, I'm extremely grateful for my colleagues who have helped to grow the CEID into one of the world's preeminent centers of infectious disease research. When we founded the CEID in 2016, I envisioned a center that would encourage rigorous scientific debate and discovery among graduate students, postdocs, staff, and faculty at the University of Georgia. Over the past eight years, the CEID has grown from 36 members to more than 120 researchers in 14 UGA colleges, schools, departments, and 20 external organizations. In a December 2023 external review, an independent advisory board wrote that **"the CEID has raised the profile of UGA in the field of infectious disease biology and ecology,"** and that we have embraced **"much bigger issues that reach out to public health, veterinary science, and biodiversity."**

As the CEID's director, I am extremely proud of the long-term relationships that we have formed with our members. In FY24, we established a new Vector Working Group while continuing ongoing projects in the Macroparasite and Forecasting Working Groups. With projects such as a \$1 million research initiative funded in FY23 by NSF's Predictive Intelligence for Pandemic Prevention (PIPP) program, we continue to expand our research capabilities to better meet the needs of our members and community. Through our public-private partnership, the Global Infectious Disease Intelligence Consortium (GIDIC), our relationships with industry have continued to help us learn how we can help solve pressing domestic and global infectious disease challenges. Our GIDIC partners have also provided us with financial support for our Japanese Encephalitis Virus Information Sharing Network (JEVISN.org) which we launched in October 2023, and three inperson symposia scheduled for FY25.

In Summer of 2024, the CEID welcomed Dr. Scott Carver as Associate Director. As an accomplished infectious disease ecologist, Scott's enthusiasm, broad interests, and deep interdisciplinary experience will help the CEID continue to prosper. I am pleased that Scott will serve as Acting Director for parts of FY25 and FY26 as I continue to advance our mission as a visiting fellow at Oxford University's Pandemic Sciences Institute.

With heartfelt gratitude, I am pleased to share this report celebrating the CEID's accomplishments over the past year, and I look forward with great anticipation to the opportunities and progress awaiting us in the year ahead.

John M. Drake

Cover photo: l'iwi at Hakalau Forest NWR (Dan Clark/USFWS). The i'iwi is at severe risk from avian malaria. See page 10

FY 2024 BY THE NUMBERS



Faculty

126 Members

Working Groups

Peer Reviewed **Publications**

> Seminars & Workshops





Infectious Disease Intelligence

Public-private Partnership

The Global Infectious Disease Intelligence Consortium (GIDIC) is a collaboration between the CEID, academia, industry, and NGO partners. GIDIC was established to help members identify, prepare for, and respond to emerging disease threats.

In FY24, GIDIC continued to develop and provide Infectious Disease Intelligence in collaboration with its members. In the wake of the CEID's FY23 international symposium "Japanese Encephalitis Virus: Emerging Global Threat to Humans and Livestock", the CEID and GIDIC launched the Japanese Encephalitis Virus Information Sharing Network (JEVISN.org).

Funded by the Swine Health Information Center (SHIC), a GIDIC member since 2021, JEVISN is a centralized source of information on JEV ecology and epidemiology and provides links to governmental, industry, and academic resources on JEV economic impacts and response plans. Managed by the CEID, JEVISN is designed to help global scientists, public health authorities, and other stakeholders control future IEV outbreaks in people and commercial swine herds. GIDIC was instrumental in securing a multiyear cooperative research agreement between UGA

and the College of Veterinary Medicine at Kansas State University to model how JEV spread across Australia in 2022. This funded research will also be used to build a West Nile virus spatial interaction model for the United States that will inform a model of JEV introduction and spread for the United States.

GIDIC's third annual Horizon Report, a high-level assessment of endemic and emerging infectious disease trends of both humans and livestock, addressed the threats posed by African swine fever virus (ASFV), antimicrobial resistance, bluetongue disease virus (BTDV), foot and mouth disease virus (FMDV), fungal pathogens, highly pathogenic avian influenza (HPAI), Japanese encephalitis virus (JEV), malaria, Nipah virus, and SARS-CoV-2. The report concluded with a report on the CEID's systematic global catalog of emerging and re-emerging infectious diseases of humans since 1918.

New Associate Director Scott Carver

Dr. Scott Carver joined the Center for the Ecology of Infectious Diseases (CEID) as Associate Director in July 2024. With a career spanning nearly two decades, Carver has made significant contributions to the understanding of the ecology and management of infectious diseases in wildlife. His research bridges field ecology, disease dynamics, and conservation, focusing on how diseases affect wildlife and what measures can mitigate their impacts.

Carver's academic journey began with a focus on mosquito-borne diseases during his doctoral studies in Australia, where he investigated the ecology of halotolerant mosquito vectors in salt marsh habitats and their role in the transmission of Ross River virus. This early work highlighted how human agricultural practices and environmental changes can disease influence dynamics. Followina his PhD, Carver expanded his expertise in North America, studying hantavirus transmission in small mammals during his postdoctoral research in Montana, as well as pathogen transmission among wild and domestic cats during his time at Colorado State University.

At the University of Tasmania, where prior to his appointment at the University of Georgia, Carver had been a principal investigator for several years. His lab became a global leader in studying sarcoptic mange, a debilitating disease affecting wildlife such as wombats, black bears, and ibex. He collaborated with government agencies, wildlife rehabilitators, and international researchers to develop effective management frameworks integrating fieldwork, veterinary sciences, and ecological modeling. During this period, he also contributed to a lighthearted but significant side project that earned his team an Ig Nobel prize for uncovering why wombat feces are cube shaped.

In his role as Assistant Director, Carver aims to enhance the CEID's global impact by advancing research on disease management and multi-host disease dynamics. He plans to explore innovative approaches in vector biology and distribution

> modeling, leveraging artificial intelligence to address challenges like climate-driven changes in vector habitats.

> Beginning in January 2025, Carver will also serve as Acting Director while CEID Director Dr. John Drake is out of the country, ensuring continuity in leadership and strategic direction for the center. He is committed to further cementing the CFID's status as a hub for fostering collaborations across disciplines and institutions, ensuring sustainability its and relevance in addressing the pressing challenges of infectious diseases well into the future.

Carver's appointment reflects the CEID's continued commitment to fostering interdisciplinary research and innovative disease management strategies. His leadership and expertise align seamlessly with our mission to advance the understanding of infectious diseases through integrative research. As he steps into this pivotal role, the center and its collaborators are poised to further enhance excellence in disease ecology, shaping a healthier and more resilient future for both wildlife and human populations.



CUSTER Hire Presidential Interdisciplinary Hiring Initiative Artificial Intelligence, Data Science, & Infectious Disease Dynamics

Tamika Lunn



Dr. Tamika J. Lunn joins the Odum School of Ecology as an Assistant Professor specializing in wildlife disease ecology. Her research focuses on the dynamics and drivers of infectious diseases, particularly those carried by bats. Lunn's work integrates field studies and quantitative approaches to explore how ecological and environmental changes

influence host-pathogen interactions across spatial and temporal scales.

Lunn earned her PhD from Griffith University in Australia, where she investigated how urban-altered roost structures influence the transmission of Hendra virus

Olivia Ginn



Dr. Olivia Ginn joins the School of Chemical, Materials, & Biomedical Engineering as an Assistant Professor with expertise in environmental engineering.

Her research addresses pressing challenges in sanitation, public health, and conservation by combining engineering, microbiology, and environmental science.

Ginn's work focuses on the characterization and modeling of antimicrobial resistance and pathogens in air and water, with implications for global health.

Ginn earned her BS and PhD in Environmental Engineering from the Georgia Institute of Technology. Her doctoral

in Australian flying foxes (*Pteropus* spp.). Following her doctoral work, she conducted postdoctoral research at the University of Arkansas, studying the ecology of bat ebolaviruses in East Africa, including *Bombali ebolavirus* in the Angolan freetailed bat (*Mops condylurus*) and the little free-tailed bat (*Mops pumilus*). As a member of the BatOneHealth consortium, Lunn has contributed to advancing knowledge on zoonotic spillover mechanisms, landscape immunology, and the ecology of henipaviruses and coronaviruses.

At UGA, Lunn is building a research program integrating international studies of bat-virus systems with local projects on bat ecology and health. Her work aims to address fundamental questions about drivers of disease, inform public health interventions, and promote bat conservation efforts.

research utilized advanced detection methods like digital PCR and metagenomics to study pathogens and antimicrobial resistance in air and water systems.

As a Postdoctoral Research Assistant at the University of Notre Dame, she continued her interdisciplinary research on environmental health, investigating the air-water interface in contaminated systems.

At UGA, Ginn is establishing a research program that integrates engineering, public health, and microbiology, combining cuttingedge detection methods with computational modeling leveraging machine-learning techniques to explore the dynamics of antimicrobial resistance and pathogens in diverse environments. Her research aims to help shape interventions that protect human and environmental health.

New Faculty Profiles

Amy Winter



Dr. Amy K. Winter is an Assistant Professor in the Department of Epidemiology and Biostatistics at the University of Georgia's College of Public Health.

Winter's work as a quantitative demographer bridges epidemiology, public health, and policy, with a focus on infectious diseases.

Her current research

emphasizes the use of serological data to address immunity gaps for diseases like measles and rubella, particularly in low-resource settings. Her innovative methods inform vaccination and surveillance programs worldwide, with the goal of strengthening public health infrastructure.

Winter earned her PhD in Demography from Princeton University, an MPH in Global Health from Emory University, and a BA in International Relations & History from UGA. Her work is internationally recognized, with affiliations at Johns Hopkins University, the Center for Ecology of Infectious Diseases, and the Vaccine Impact Modelling Consortium. Her research has been published in top journals such as The Lancet Infectious Diseases, highlighting her contributions to pressing public health challenges such as COVID-19.

As a UGA alumna, Winter brings a passion for mentorship and collaboration to her teaching, which includes courses like Fundamentals of Epidemiology and Introduction to Coding in R, Data Science, and Simulation for Public Health and the Life Sciences. She is committed to engaging with the UGA community and applying her expertise to real-world policy questions, with the goal of improving global health outcomes.

Doug Paton



Dr. Douglas Paton is an Assistant Professor in the Department of Infectious Diseases at the University of Georgia's College of Veterinary Medicine.

Paton specializes in the transmission dynamics of the malaria parasite *Plasmodium falciparum*, with a particular focus on the interactions of this protozoan with *Anopheles* mosquitoes,

the only known vectors for malaria.

Combining molecular biology and multi-omics, with experimental mosquito infections, his research explores innovative strategies for malaria control, particularly targeting parasite development within mosquito vectors. Paton earned his PhD from Keele University, where his research investigated the fitness and mating competitiveness of laboratory and transgenic Anopheles gambiae strains, particularly the ecological and genetic factors influencing their potential for vector disease control. Prior to joining UGA, he completed postdoctoral research at Harvard University, where he focused on advanced molecular and ecological approaches to understanding and controlling vector-borne disease.

Paton's work extends to field studies at the Savannah River Ecology Laboratory (SREL), where his team examines vector-parasite interactions in natural settings, including mosquito overwintering. In addition to the CEID, he is also a member of UGA's Center for Tropical and Emerging Global Diseases, where he contributes to interdisciplinary efforts to combat malaria and other infectious diseases. Paton is dedicated to advancing global health through innovative research and education.

Graduate Student Profile Guppy Stott



Our featured graduate student this year is Guppy Stott, a dedicated and innovative bioinformatician who is approaching the final stretch of their PhD at the University of Georgia's Institute of Bioinformatics.

With a career built on curiosity, technical expertise, and a commitment to advancing infectious disease research, Stott has focused their efforts on developing computational tools to better understand the evolution of avian influenza. Their work is shaping the future of disease surveillance and preparedness by offering novel solutions to complex data challenges.

Stott's research is centered on optimizing the way scientists analyze influenza's vast genetic landscape. Through their research, they have developed an advanced pipeline that constructs a graph database, integrating phylogenetic trees, metadata, and related datasets. This innovative system enables the strategic subsampling of influenza data, allowing researchers to extract the most valuable insights from the overwhelming volume of available sequences. By applying Bayesian phylodynamic methods, Stott aims to uncover long term evolutionary patterns, shedding light on how the virus spreads and evolves across different ecological and epidemiological contexts.

Before pursuing their PhD, Stott made significant contributions as an Influenza Data Science Fellow at the Centers for Disease Control and Prevention (CDC), where they developed a high throughput reassortment detection algorithm for influenza viruses and contributed to the Data Modernization Initiative. Their prior experience as a Senior Data Scientist at TIAA involved leading projects that optimized data workflows, improved cybersecurity measures, and implemented machine learning solutions to tackle business challenges. These experiences have honed Stott's ability to translate complex data into actionable insights, a skill they now bring to infectious disease research.

In addition to their research, Stott is a passionate advocate for science communication and inclusivity in STEM. As the Co-Editor-in-Chief of the Athens Science Observer, they are committed to making science accessible to the public. Their leadership extends to their roles within the University of Georgia's Bioinformatics Graduate Student Association, where they serve as President, and the International Society of Non-Binary Scientists, where they co-chaired the peer mentorship committee.

Stott's diverse background in bioinformatics, statistics, and data science, combined with their dedication to improving infectious disease surveillance, positions them as a valuable contributor to the field. Their work on computational tools for avian influenza evolution not only enhances our understanding of the virus but also demonstrates the importance of interdisciplinary approaches in tackling complex public health challenges. Beyond their research, Stott's commitment to science communication and inclusivity highlights their dedication to making science more accessible and fostering a supportive environment for future researchers.

Staff Profile Victor Felix

Victor Felix joined the Center for the Ecology of Infectious Diseases as a scientific programmer in October 2023. He earned a Master of Science in Geography from the University of Georgia, focusing on geospatial data science and time-series analysis



for integrative studies. holds He also α postgraduate degree in Geoprocessing from the Ceará State University in Brazil with a focus on environmental studies, geographic modeling, and geostatistical analysis, as well as a BS in Oceanography from the Federal University of Ceará, in Brazil. He received a Brazilian Science Without Borders scholarship for study

at the University of Georgia and for completing a summer research internship at the Florida Institute of Technology.

Felix's research experience includes a position in Portugal at the University of the Azores studying the climate and ecology of the Iberian region. In his professional trajectory, he has built a diverse skill set in data analysis, programming, and scientific research. His expertise includes geospatial data modeling, time-series forecasting, and the application of computational techniques to solving complex environmental challenges. At the CEID, he leverages his technical programming skills to support ecological and epidemiological research projects led by CEID members, focusing on computational modeling and spatial data science for studying infectious disease dynamics. Current projects include model ensembles, machine learning approaches and mathematical spatial models.

Felix's environmental background and commitment to interdisciplinary science enrich the CEID's mission, adding a unique perspective grounded in both geography and computational analysis. His role bridges critical areas of programming and ecological research, contributing to the center's cutting edge work on infectious disease ecology.

NSF GRANT

The CEID-led Pandemic Systems Group made significant strides in advancing infectious disease intelligence during the first year of its research initiative in heterogeneous model integration, funded by a \$1 million grant from NSF's Predictive Intelligence for Pandemic Prevention (PIPP) program. Introduced in the CEID's FY23 Annual Report, the initiative is already yielding results through several demonstration projects. Among them, the national surveys of vaccination intent and behavior, detailed here, have provided critical insights that are shaping the program's approach to pandemic prevention.

The initiative encompases six demonstration projects targeting highly pathogenic avian influenza (HPAI), bringing together CEID members **Justin Bahl, Mike Cacciatore, John Drake, Glen Nowak,** and **Pej Rohani**, along with scientists from the Cary Institute of Ecosystem Studies, Georgetown University, and the Universities of Michigan and Southern California.

The overarching goal is to demonstrate how diverse and independent models of domain-specific systems can communicate and share data among each other in realtime, effectively functioning as a "System of Systems" (SoS) which can capture complex feedbacks among domains affecting infectious disease emergence and transmission during a pandemic.

The group has applied new Knowledge Graph Embeddings (KGEs) to HPAI for the first time, providing a method of representing all that is known about HPAI and facilitating new discoveries.

In a second project, the group is using results of its national opinion surveys on vaccination to inform behavioral-epidemic models of HPAI transmission.

Heterogeneous Model Integration for Infectious Disease Intelligence

In an advance in "Explainable AI", the group has also trained a neural network on inputs from a multi-strain infectious disease epidemic model in order to identify features with the greatest impact on outbreaks, with a view to providing targets for intervention by decision makers.

Demonstration projects have been presented at the 2023 Modeling Infectious Diseases Agent Study (MIDAS) conference in Atlanta, the 2024 Ecology and Evolution of Infectious Diseases (EEID) conference, the 2024 Center for Excellence for Influenza Research and Response (CEIRR) conference, the 2024 Georgetown University Global Public Health Seminar Series in Washington D.C., and the 2024 Global Health Security Conference in Sydney, Australia. The research program concludes in January 2025.

Visit pandemicsystems.org for more information.

National Opinion Survey

A survey of 1280 adults commissioned by the **Center for Health and Risk Communication** in the Grady College at UGA and supported by the CEID's NSF-funded Predictive Intelligence for Pandemic Prevention (PIPP) project was conducted in August 2023 and January 2024, to better understand how Americans thinks about the risks and benefits of vaccines for COVID-19 and influenza.

The survey found that political ideology significantly influenced thinking about COVID-19 vaccines. More than 65% of self-identified liberals intended to receive both vaccines, while selfidentified conservatives were considerably more hesitant with 42% uninterested in receiving a flu vaccine, and at least 58% not intending to receive a COVID-19 vaccine.

Far-left and far-right leaning individuals showed the largest disparities, while self-identified moderates were more evenly distributed between vaccine acceptance and rejection. Survey

respondents were also asked if they believed that not receiving either a COVID-19 or flu vaccine increased their chances of becoming infected with either virus. Data analysis of survey responses and demographics (age, income, employment status, gender, education level, race, and preexisting health conditions such as diabetes) is ongoing. However, early results already suggest that information and messaging targeting like-minded groups might contribute to the success of vaccine messaging campaigns.

INFLUENZA VACCINATION



The results of the analysis are being used to inform innovative behavioral-epidemiological models of disease transmission in populations structured by age, ideology, and other demographic features.

WORKING GROUPS

Ecology & Evolution of Macroparasites

The Ecology & Evolution of Macroparasites Working Group focuses on how metazoan parasites evolve and persist in natural and modified ecosystems. Systems of interest include arthropod ectoparasites, helminths, and others.

The Ecology & Evolution of Macroparasites Working Group has begun assembling **The Atlas of Macroparasite Abundance (TAMPA)**, a collection of databases of macroparasite burdens across host species and ecological contexts worldwide. The collection currently includes 980 datasets, with contributors from North America, Europe, New Zealand, and Australia. Recent advances in comparative ecology of parasites have yielded tremendous insights into the evolution of the parasitic lifestyle and the mechanisms underlying host-switching and disease emergence. However, TAMPA represents the first comprehensive database for investigation in macroparasites.



Disease Mapping Working Group



The macroecology of avian malaria

This year, the Mapping Working Group conducted research to better understand the spatial occurrence of different lineages of malaria parasites and related haemosporidians in avian hosts. While disease ecology has made great strides in understanding patterns of parasite richness, this is typically at a coarse taxonomic scale (parasite types, or parasite species). However, within a group of closely related lineages, parasites often differ in their virulence, host range, and geographic distribution. The working group seeks to understand what explains similarity and difference in the parasite lineage profiles of ecoregions.

For each ecoregion pair, parasite lineage similarity is calculated using Jaccard indices tp understand:

- Geographical distance between ecoregions
- **Bird community similarity** for migratory birds, non-migratory birds, and all birds
- Environmental similarity, difference between ecoregion mean values for key variables taken from World Clim (Fick & Hijmans 2017, Int J Climatol.)



Ecoregion

The work was submitted to a journal for review in Fall 2024. Working group members on this project are (in alphabetical order): Christian Brown, Carlos Molinero, TJ Odom, Andrew Park, Daniel Suh.

Disease Forecasting Working Group

The Forecasting Working Group has continued developing next-generation forecasting methods using a range of mechanistic, statistical, and artificial intelligence methods, and pioneering hybrid epidemiological-AI models and novel ensemble modeling techniques.

The CEID contributed three forecast models to the CDC's 2023-24 FluSight influenza forecasting competition. Two of these models were the **#1 and #2 performing individual models in the FluSight competition** last year. CEID's member Spencer Fox's "INFLAenza" statistical model outperformed all other individual mechanistic, statistical, and Al models, and all but four of the ensemble models, which are generally expected to perform best. Fox's "Copycat" model came in a close second, beating all but six ensembles.

Led by Pej Rohani and John Drake, the working group has been developing a novel model for influenza forecasting, based on ensembles of rolling window statistical models with exogenous variables. The work was presented at the 2024 Ecology and Evolution of Infectious Diseases conference (EEID) and is being used to study geographical gradients in forecasting performance.



Rolling fit / forecast for a single state. A 2-year rolling window is used to sequentially fit models to weekly "influenza-like illness" case data and covariates. Models are combined in weighted ensembles and used to forecast 1, 2, 3, and 4 weeks ahead. WIS is calculated for each model and forecast target.

CEID member He Li's group has a manuscript under review on their physics-informed neural network (PINN) approach to disease forecasting.

New Vector Working Group

A new Vector Working Group has been formed to support engagement among CEID members and other UGA faculty with an interest in vectors and vector-borne disease.

The Vector Working Group met for the first time on December 4th, with goals: of bringing together researchers at UGA with an interest in vectors and vector-borne disease, as well as serving as an incubator, supporting and facilitating collaboration and grant development among group members.

Sixteen rapid fire presentations were given by in-person and virtual attendees, followed by a

group discussion on emerging areas of common research interests. It is planned that the Vector Working Group will continue in the new year through sub-group formation around topics of interest.



MEMBER ACCOMPLISHMENTS



Sonia Altizer

Martha Odum Distinguished Professor of Ecology, was named a **Fellow of the** *Ecological Society of America*. Altizer was also named a **Southeastern Conference Academic Leadership Development Program Fellow** for 2023-2024.



Richard Hall

Associate Professor, received a **Richard B. Russell Excellence** in Undergraduate Teaching Award.

Carlos Molinero

PhD student, won a session award in the 2024 Odum School of Ecology **Graduate Student Symposium (GSS)** for his presentation "Effects of phylogeny, range overlap, and ecological traits on parasite sharing in birds."



Annakate Schatz

Recent PhD (awarded Spring 2024), won Outstanding Student Paper in Disease Ecology from the *Ecological Society of America* for "Patterns of host-parasite coinvasion promote enemy release and specialist parasite spillover," published in the *Journal of Animal Ecology.*





Nikki Solano

PhD student, received a 2024 Outstanding Teaching Assistant Award from the Center for Teaching and Learning.

Alex Strauss

Assistant Professor, received a **UGA Outstanding Teaching Faculty Award** for innovative teaching approaches and exceptional mentoring of students.

Kelsey Vaughn PhD student, received a 2024 Outstanding Teaching Assistant Award from the Center for Teaching and Learning.



Anna Willoughby

PhD candidate, received the Student Science Policy Award from the American Society of Mammalogists. The award supported a Congressional Hill visit to advocate for NSF funding in FY2025. Willoughby was also awarded the 2023 Howard McCarley Student Research Award by the Southwestern Association of Naturalists. This grant will fund Odum School of Ecology undergraduate stipends to characterize the diet and parasites of tourist-fed rock squirrels. She also won a 2024 Outstanding Teaching Assistant Award from the Center for Teaching and Learning.





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