

Cole Butler

Biomathematics Ph.D. Student

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Personal Statement

Driven and accomplished student who thoroughly enjoys attacking any problem with rigor and analytical clarity. Skilled in leadership and experienced working with others. Enjoys working on challenging problems in groups. Knowledgeable in using various programming languages, including but not limited to R, Python, and MATLAB. Maintains a creative way of thinking and enjoys cultivating new friendships. Passionate about studying natural systems—especially concerning disease transmission and mosquitoes—and science outreach.

Education

- 2020- **North Carolina State University**
Ph.D. in Biomathematics, minor in Statistics, co-minor in Interdisciplinary Perspectives on Genes and Genomes; Genetics and Genomics Scholar; 4.0 GPA
- 2016-2020 **University of Maine**
B.S. in Mathematics, summa cum laude; Honors College (highest honors); Dean's list; 3.95 GPA

Grants and Fellowships

- Co-PI, GGA Seed Grant, 2024, *Evaluating genetic and socio-economic factors affecting insecticide resistance in a population of Aedes albopictus from Wake County, NC* (\$25,000)
- Co-PI, GOHA Seed Grant, 2024, *One Health Implications of Insecticide Resistance in Pathogen Vectors* (\$35,096)
- NSF Graduate Research Fellowship, 2022-present, \$138,000
- CMI Young Scholar, 2021-22
 - Co-PI, *Proof of concept for in vitro influenza immunogenicity screening* (\$9,000)
 - Co-PI, *Mathematical modeling of mechanisms of antimicrobial resistance in Campylobacter species* (\$9,000)
- NC State University Research Training Group, 2021, approx. \$5,000
- NC State University Graduate Fellowship 2020-21, \$4,000
- NC State University Provost's Doctoral Fellowship 2020-21, \$28,000
- College of Liberal Arts and Sciences Fellowship 2018, \$4,000
- Center for Undergraduate and Graduate Research Fellowship 2016 and 2019, \$1,000 each

Honors and Awards

- GOHA Graduate Travel Award (2024)
- GGA Graduate Student Travel Award (2023)
- Lucas Citizenship Award (2023)
- University of Maine CLAS Student Award (2020-21)
- College of Liberal Arts and Sciences Outstanding Junior Award
- Margaret Chase Smith Public Affairs Scholarship
- Ray M. Boynton Scholarship
- Theodore and Dorothy Whitehouse Scholarship
- Carl Whitcomb Meinecke Award
- James S. Stevens Award
- Edward Morrison Pacesetter Scholarship

- Michael and Jana Cote Scholarship
- Civil Engineering Department Award
- University of Maine Presidential Award
- Dominic J. Roux Scholarship

Publications

Yadav, A., **Butler, C.**, Yamamoto, A., Patil, A., Lloyd, A., and M. Scott. CRISPR-Cas9 based split homing gene-drive targeting *doublesex* for population suppression of the global fruit pest *Drosophila suzukii*. *Proc Natl Acad Sci U S A*. 120(25); 2023.

Butler, C., and P. Stechlinski. Modeling opioid abuse: A case study of the opioid crisis in New England. *Bull Math Biol*. 85(6); 2023.

Butler, C., Cheng, J., Correa, L., Preciado, M., Ríos, A., Montalvo, C., and C. Kribs. Comparison of screening for methicillin-resistant *Staphylococcus aureus* (MRSA) at hospital admission and discharge. *Letters in Biomathematics*. 8(1); 2021.

Butler, C., and A. Lloyd. How the consequences of genetic load are modulated by density-dependence. (In preparation.)

Research Experience

2020 – Present

Graduate student in the Lloyd/Gould lab

- Working with Drs. Alun Lloyd and Fred Gould studying gene drives in mosquitoes
- Projects past and present include exploring how density dependence in juveniles affects gene drive performance, balancing gene drive spread and lethality, and the effects of functional resistance on drive efficiency with Dr. Sumit Dhole
- Also involved in modeling gene drive in cage trials with the fruit fly *Drosophila suzukii* with Dr. Max Scott; includes statistical analysis of experimental data
- Involves heavy usage of MATLAB, Python, and Mathematica for simulating and analyzing high dimensional population dynamic and genetic systems

2023 – Present

Mosquito sampling and DNA extraction

- Working with Dr. Michael Reiskind studying biomarkers of pyrethroid resistance in *Ae. albopictus* mosquitoes in Raleigh, NC
- Mosquito adult and egg samples collected between August and September 2023
- Ongoing work to extract and sequence DNA from adult samples to determine extent of biomarker presence with assistance of Dr. Jen Baltzegar
- Future work will expand scope of study to historical samples and bioassay reared mosquitoes, followed by statistical analysis

2020

Dynamics and Data in the COVID-19 Pandemic

- Workshop hosted by the American Institute of Mathematics to study COVID-19 and develop mathematical models to understand underlying disease dynamics
- Applied optimal control theory to different models to determine mathematically ideal approaches in a variety of situations

2019 – 2020

Modeling the opioid epidemic in Maine

- Received funding from the Margaret Chase Smith Policy Center for a project developing an opioid epidemic model for the state of Maine
- The goal of the project was to better inform public policy decisions and serve as a template for future mathematical models of opioid use proliferation
- This work culminated in my undergraduate thesis and was eventually published with Dr. Peter Stechlinski (2023)

2019 – 2020

Mosquito species distributions and network models

- Studied how metapopulation network characteristics and mosquito species abundance affect disease transmission with a focus on Zika and Chikungunya
- Among other things, I developed a species distribution model of the *Ae. aegypti* mosquito in R

2018

MRSA research at the Mathematical and Theoretical Biology Institute

- Research Experience for Undergraduates (REU) program
- I led a team of international students with the help of Dr. Christopher Kribs
- We studied how hospital screening strategies control within-hospital spread of MRSA
- Our work has been presented at various conferences and resulted in a publication (2021)

2017 – 2018

Modeling organisms on artificial landscapes

- Proposed and received funding through a university grant with Dr. David Hiebeler
- Developed a computational model in R simulating artificial ecological systems on a discrete-state lattice
- Presented our findings at a local conference

2017 – 2020

Topological analysis of breast cancer simulations and wavelet processed mammograms

- Was a member of the Computational Modeling, Analysis of Imagery and Numerical Experiments (CompuMAINE) lab
- I wrote an algorithm to scan mammograms using a topological technique attempting to distinguish between benign and malignant cancerous growths
- My work involved extensive use of the ImageJ and R programming languages
- Also spent some time modeling the growth of cancer microcalcifications in artificial environments

Invited Talks

Butler, C. “**Modeling insect populations and the next generation of genetic pest control,**” 2023 Mathematics Colloquium, University of Maine, oral presentation in-person

Butler, C. “**The Importance of Dispersal in Gene Drive Control,**” presented at the following venues:

- 2023 Joint Mathematics Meeting, oral presentation in-person
- 2023 Biomathematics Seminar, Texas Tech University, oral presentation virtually

Presentations

Butler, C. “Screening for knockdown resistance in *Aedes albopictus* in NC,” 2023 North Carolina Mosquito and Vector Control Association Annual Meeting, Carolina Beach, oral presentation in-person

Butler, C. “Functional resistance in gene drive control,” 2023 Society for Mathematical Biology Annual Meeting, OSU, oral presentation in-person

Butler, C. “Sexy Peacocks: The Mathematics of Sexual Selection in Birds,” 2023 Triangle Area Graduate Mathematics Conference (TAGMaC), Duke, oral presentation in-person

Butler, C. “Gene drives and over-suppression,” presented at the following venues:

- 2022 TAGMaC, NC State oral presentation in-person
- 2022 NC State Graduate Symposium, NC State, poster presentation in-person
- 2022 Biology and Medicine Through Mathematics (BAMM) Conference, VCU, oral presentation in-person
 - Received \$350 travel award
- 2022 Gordon Research Conference on Genetic Biocontrol, Ventura, CA, poster presentation in-person
- 2022 Society for Industrial and Applied Mathematics LS22/AN22, Pittsburgh, PA, oral presentation in-person
 - Received \$650 travel award
 - Session leader
- 2022 Genetics and Genomics Academy 5th Annual Retreat, NC State, poster presentation in-person
- 2022 European Society for Mathematical and Theoretical Biology Conference, poster presentation virtually
 - Received Landahl-Busenbergl Award (\$750)
- 2022 International Conference on Mathematical Modeling and Analysis of Populations in Biological Systems, Lafayette, LA, oral presentation in-person
 - Received \$650 travel award

Butler, C. “Using differential equations to model individual behaviors that limit disease spread,” contributed paper and oral presentation at 2021 MathFest.

Butler, C. “Mathematically modeling gene drive control of mosquito-borne diseases,” presented at the following venues:

- 2021 Genetics and Genomics Initiative 4th Annual Retreat, NC State, poster presentation virtually
- 2021 Society for Mathematical Biology Annual Meeting, oral presentation held virtually
- 2021 Society for Industrial and Applied Mathematics Annual Meeting, oral presentation held virtually

Butler, C. “A mathematical model of the opioid epidemic in Maine,” 2020 TAGMaC, held virtually.

Butler, C. “A predator-prey model with parasitic infection of the predator,” 2020 Virtual Symposium on Biomathematics and Ecology Education and Research (BEER), held virtually.

Butler, C and M. Preciado. “Comparison of screening for methicillin-resistant *Staphylococcus aureus* (MRSA) at hospital admission and discharge,” presented at the following venues:

- 2018 Mathematical and Theoretical Biology (MTBI) Conference, Arizona State University, Tempe, AZ
- 2018 Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) Conference, San Antonio, TX
- 2018 National Institute for Mathematical and Biological Synthesis (NIMBioS) Conference, Knoxville, TN

Butler, C. “Population models on continuous-valued heterogeneous landscapes,” 2018 University of Maine Student Symposium, University of Maine, Orono, ME.

Teaching

Teaching

- Teaching assistant and recitation leader for MA 241 Calculus II, fall semester, 2021
- Teaching assistant and recitation leader for MA 241 Calculus II, spring semester, 2022

Tutoring

- Math Multimedia Center tutor for NC State students, spring semester, 2022
- Freelance tutor for subjects including calculus, differential equations, linear algebra, basic math, programming, and writing (2020-present)
- Volunteer algebra tutor for local high schools (2020-21)

Outreach

Community

- BugFest at the North Carolina Museum of Natural Sciences (2022-)
 - Volunteer at a mosquito exhibit as part of BugFest, an annual community event hosted at the museum
 - Oversaw interactive activities that educated children and parents on mosquitoes and their diseases
- North Edgecombe Teamship program
 - Through my tutoring connections, I recruited and led a team of four graduate students to oversee a project involving a class of local high school students
 - The goal of the project was to present students with a real-world problem for them to solve; our topic was how to improve recruitment and retention of students from underrepresented groups at NC State
- Science communication
 - I have given talks on my research and experiences in graduate school to students at Cardinal Gibbons and Edward Little High Schools
 - In 2022 I was a participant in ComSciCon-Triangle, a workshop for broadening a student's ability to communicate their research effectively

NC State and beyond

- Info session panelist for new Genetics and Genomics scholars (2022)
- Info session panelist for undergraduates in research at NC State (2022)
- Co-organizer of the Triangle Contest in Mathematical Modeling (TriCoMM) (2021-2023)
- Organizer of the Math Club at the University of Maine (2018-19)
- Member of Pi Mu Epsilon (2019-20)
- Sophomore Owl tradition society (2017)

Service

Service to professional organizations and societies

- Journal reviewer for *Letters in Biomathematics* (3), *PLoS Genetics* (1), *PLoS Computational Biology* (1), *Cell Reports* (1), *Journal of Mathematical Biology* (1), *Ecology Letters* (1), *Physical Review E* (1), and *Journal of Theoretical Biology* (1)
- Treasurer of SIAM NC State chapter (2022-23)
- Member of the SMB Website Publication Board (2022-2023)

Service to NC State

- President of the Biomathematics Graduate Student Association (2022-present)
 - Fundraised hundreds of dollars for department t-shirts, events, and office amenities
 - Organized weekly seminars featuring presentations from students, post docs, and faculty (both internal and external) (2022)
 - Assisted with department recruitment, including organizing and funding events
 - Served as Vice President from 2021-22
 - Organized a weekly journal club from 2020-21
 - Member (2021-23) and Chair (2023-24) of the Legislative Affairs and Student Advocacy Committee

- Participant and contributor to Gene Drives in Agriculture: Workshop on Risk Assessment and Research Prioritization (2022)

Mentorship

Community

- Assisted in mentoring a high school student interested in learning more about the mathematical modeling of COVID-19
- Mentor and tutor for correctional education program through a program offered at UNC Chapel Hill (2020-21)

NC State

- Undergraduate research mentor with the Comparative Medicine Institute (CMI) (2021-22)
 - Drafted and submitted two interdisciplinary grant proposals to CMI at NC State to fund a semester and a summer of research with interested undergraduate students; both projects received funding
 - Mentored three undergraduate students in topics ranging from statistics to agent-based modeling
 - Research projects culminated in the students presenting their work at the CMI Annual Research & Innovation Summit
- Mentor for the Genetics and Genomics Scholars program (2021-23)
- Volunteer for Undergraduates Union Graduates (UUG), helping math undergraduates at NC State plan for their future (2020-22)

Programming Languages

- Very knowledgeable in MATLAB, R, Mathematica, Python, and NetLogo
- Knowledgeable in HTML, C++, Git, Bash, and ImageJ

Professional Memberships

Society of Mathematical Biology (2019-)

Society of Industrial and Applied Mathematics (2020-)

North Carolina Mosquito and Vector Control Association (2024-)