Cole Butler

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Summary

Driven researcher with expertise in modeling, leadership roles, and working in interdisciplinary teams spanning genetics, entomology, and mathematics. Extensive public speaking experience and enjoys working in groups. Known for creative problem-solving and a passion for cultivating new collaborations. Passionate about science outreach and studying natural systems—especially concerning disease transmission and pests.

Education

PhD **North Carolina State University**, Major: Biomathematics, Minors: Statistics; Interdisciplinary Perspectives on Genes and Genomes — 2020 – 2025

- GPA: 4.0/4.0; Genetics and Genomics Scholar

BS **University of Maine**, Mathematics, *summa cum laude* — 2016 – 2020

- GPA: 3.95/4.0; Honors College (highest honors); Dean's List all semesters

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)
- GSA Travel Assistance Award (2024)
- GGA Graduate Student Travel Award (2023)
- Lucas Citizenship Award (2023)
- University of Maine CLAS Student Award (2020-21)
- Dominic J. Roux Scholarship (2020)
- Margaret Chase Smith Public Affairs Scholarship (2019-20)
- Theodore and Dorothy Whitehouse Scholarship (2018-19)
- Carl Whitcomb Meinecke Award (2018-19)
- Edward Morrison Pacesetter Scholarship (2018-19)

- Michael and Jana Cote Scholarship (2018-19)
- College of Liberal Arts and Sciences Outstanding Junior Award (2018)
- Civil Engineering Department Award (2018)
- Ray M. Boynton Scholarship (2017-18)
- James S. Stevens Award (2017-18)
- University of Maine Presidential Award (2016)

Publications

- **Butler, C.** and A. Lloyd. How population control of pests is modulated by density dependence: The perspective of genetic biocontrol. *In preparation.*
- 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 U S A*. 120(25); 2023. **Received 2023 GGA Paper of the Year Award**
- **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., Rios, A., Montalvo, C., and C. Kribs. Comparison of screening for methicillin-resistant *Staphylococcus aureus* (MRSA) at hospital admission and discharge. *Letters in Biomath.* 8(1); 2021.

Research Experience

Measuring abundance of insecticide resistance in *Aedes albopictus* Mar 2023 – Present

- Worked with Dr. Michael Reiskind to lead field collections at 40 houses, including door-to-door participant enrollment, assisted with DNA isolation, and recruited the help of Dr. Jen Baltzegar to sequence samples, revealing an unprecedented 38% frequency of insecticide resistance in local mosquitoes
- Conducted statistical analysis and model selection to demonstrate a significant association between insecticide resistance frequency and certain socioeconomic predictors, resulting in 2 presentations (1 co-authored); assisted in writing two funded seed grants ($60,096) and a grant proposal to the National Institutes of Health

Functional resistance to genetic control strategies Nov 2022 – Present

- Collaborating with Dr. Sumit Dhole to simulate the dynamics of pest resistance to genetic population control by developing recursion equation models that capture sophisticated genetic mechanisms at various life stages of the organism's development
- Deterministic and stochastic simulations are used to highlight the effects of different forms of resistance, resulting in 4 presentations at top conferences

Organism dispersal and gene drive efficiency Aug 2022 – Present

- Extended models from separate projects to multi-patch framework to compare spatial dynamics of certain transgenic control strategies using novel tools in sensitivity analysis, making regular use of high-performance computer clusters
- Conducted sensitivity, Monte Carlo, and deterministic analyses using a discrete-time ordinary differential equation model coupling spatial, population, and genetic dynamics, advised by Drs. Alun Lloyd and Fred Gould
- Applied for and was subsequently awarded the 2021 National Science Foundation Graduate Research Fellowship to fund the remainder of my PhD (approx. $138,000), in addition to 2 invited talks, and 9 presentations at top conferences

Modeling genetic biocontrol of the crop pest *Drosophila suzukii* Jan 2022 – Present

- Collaborated with molecular biologists to test the potential of genetic technologies in *Drosophila suzukii* to achieve certain benchmarks *in vivo* using data-driven mathematical and statistical models, resulting in a peer-reviewed publication in PNAS (awarded GGA Paper of the Year), 1 invited talk, and a co-authored presentation at a top conference
- Identified possible technological deficiencies and areas requiring experimentation to be used in follow-up cage trials using simulation and statistical analysis
- Contributed writing and editing to a funded Biotechnology Risk Assessment Grant ($650,000); as part of this grant, I predict the performance of genetic population control by extending simpler models to include overlapping generations and more realistic female reproductive behavior to simulate large cage experiments

Studying effects of density dependence on genetic population control of *Aedes aegypti* Aug 2020 – Present

- Constructed high-dimensional ordinary differential equation models of pest dynamics to study how pest ecology affects population control, advised by Drs. Alun Lloyd and Fred Gould
- Conducted equilibrium and stability analyses to measure the performance of conventional and genetic suppression strategies to control *Aedes aegypti* populations for different strengths of density dependence, resulting in 1 first-author publication-in-preparation and 3 presentations at top conferences

A mathematical model of the opioid epidemic May 2019 - April 2023

- Conceived a data-driven modeling study to understand and predict the dynamics of the opioid epidemic in Maine, including sensitivity analysis and uncertainty quantification, using ordinary differential equations in MATLAB and Mathematica
- Applied to and was awarded the Margaret Chase Smith Public Affairs Scholarship ($3,500) to pursue this project with Dr. Peter Stechlinski and collaborate with health policy experts, resulting in 1 conference presentation and 1 peer-reviewed publication in BMB

Hospital screening strategies and transmission of MRSA June 2018 - July 2018

- Developed a computational model simulating population dynamics over a discrete-state lattice with clustering of habitat quality, supervised by Dr. David Hiebeler
- We measured population density over time and persistence for different assumptions of habitat quality and organism dispersal, resulting in an internal grant and 1 presentation

Population models on continuous-valued heterogeneous landscapes Mar 2017 - April 2018

- Developed a computational model simulating population dynamics over a discrete-state lattice with clustering of habitat quality, supervised by Dr. David Hiebeler
- We measured population density over time and persistence for different assumptions of habitat quality and organism dispersal, resulting in an internal grant and 1 presentation

Topological analysis of breast cancer simulations and wavelet-processed mammograms Aug 2017 - May 2020

- Undergraduate member of the Computational Modeling, Analysis of Imagery, and Numerical Experiments (CompuMAINE) Lab, advised by Dr. Andre Khalil
- Wrote an algorithm in FIJI (ImageJ) to scan wavelet-processed mammograms using topological techniques to distinguish between benign and malignant cancerous growths; modeled the growth of cancer microcalcifications in artificial environments

Mapping species distribution of *Aedes aegypti* and analyzing network models Mar 2017 - April 2018

- Analyzed how metapopulation network characteristics interact with mosquito species abundance and other anthropological factors to affect disease transmission with a focus on Zika and Chikungunya, advised by Drs. Brandon Lieberthal and Allie Gardner
- Utilized ArcGIS for handling complex spatial data and developed a species distribution model of *Ae. aegypti* in R, resulting in an internal grant and 1 presentation

Invited Talks

- **Butler, C.** "Modelling insect populations and the next generation of genetic pest control," 2023 Mathematics Colloquium, University of Maine, in-person talk
- **Butler, C.** "The importance of dispersal in gene drive control," presented at the following venues:
  - 2023 Joint Mathematics Meeting, in-person talk;
  - 2023 Biomathematics Seminar, Texas Tech University, virtual talk

Presentations

- **Butler, C.** and Dhole, S. "Partially functional resistance interferes with gene drive," presented at the following venues:
  - 2024 Society for Industrial and Applied Mathematics LS24, Portland, OR, in-person talk; [received SIAM travel award ($650)];
  - 2024 Gordon Research Conference and Seminar on Genetic Biocontrol, Barcelona, Spain, posters and talk; [received Global One Health Academy Travel Award ($2845) and GSA Travel Assistance Award ($500)];
  - 2024 One Health Research Symposium, poster
- **Butler, C.** "The importance of dispersal for gene drive effectiveness," 2024 Gordon Research Conference and Seminar on Genetic Biocontrol, Barcelona, Spain, poster
- **Butler, C.** "Screening for knockdown resistance in *Aedes albopictus* in NC," 2023 North Carolina Mosquito and Vector Control Association Annual Meeting, Carolina Beach, in-person talk
- **Butler, C.** "Functional resistance in gene drive control," 2023 Society for Mathematical Biology Annual Meeting, OSU, in-person talk
- **Butler, C.** "Sexy Peacocks: The Mathematics of Sexual Selection in Birds," 2023 Triangle Area Graduate Mathematics Conference (TAGMaC), Duke, in-person talk
- **Butler, C.** "Gene drives and over-suppression," presented at the following venues:
  - 2022 TAGMaC, NC State in-person talk;
  - 2022 NC State Graduate Symposium, NC State, poster;
  - 2022 Biology and Medicine Through Mathematics (BAMM) Conference, VCU, in-person talk; [received BAMM travel award ($350)];
  - 2022 Gordon Research Conference on Genetic Biocontrol, Ventura, CA, poster;
  - 2022 Society for Industrial and Applied Mathematics LS22/AN22, Pittsburgh, PA, in-person talk; [received SIAM travel award ($650); session leader];
  - 2022 Genetics and Genomics Academy 5th Annual Retreat, NC State, poster;
  - 2022 European Society for Mathematical and Theoretical Biology Conference, virtual poster; [received Landahl-Busenberg Award ($750)];
  - 2022 International Conference on Mathematical Modeling and Analysis of Populations in Biological Systems, Lafayette, LA, in-person talk; [received ICMA travel award ($650)]

- **Butler, C.** "Using differential equations to model individual behaviors that limit disease spread," MathFest 2021, contributed paper and talk
- **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, virtual poster;
  - 2021 Society for Mathematical Biology Annual Meeting, virtual talk;
  - 2021 Society for Industrial and Applied Mathematics Annual Meeting, virtual talk
- **Butler, C.** "A mathematical model of the opioid epidemic in Maine," 2020 TAGMaC, virtual talk
- **Butler, C.** "A predator-prey model with parasitic infection of the predator," 2020 Virtual Symposium on Biomathematics and Ecology Education and Research (BEER), virtual poster
- **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, poster;
  - 2018 Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) Conference, San Antonio, TX, poster;
  - 2018 National Institute for Mathematical and Biological Synthesis (NIMBioS) Conference, Knoxville, TN, poster
- **Butler, C.** "Population models on continuous-valued heterogeneous landscapes," 2018 University of Maine Student Symposium, University of Maine, Orono, ME, poster

Teaching, Tutoring, and Mentorship

Teaching

- Teaching assistant and recitation leader for MA 241 Calculus II in 2021. My role was preparing and conducting recitations twice a week, grading exams, and holding office hours for students seeking additional help (Jan. - May 2022).
- Mentored undergraduate researchers through the Comparative Medicine Institute (CMI) (Sep 2021 - Aug 2022). This involved:
  - Drafting and submitting two separate interdisciplinary grant proposals to CMI to a fund undergraduate students for a semester and a summer—both projects received funding;
  - Teaching three undergraduate students statistics in R, agent-based modeling in NetLogo, and programming in MATLAB during the semester—this involved meeting weekly to go over problem sets, lecture, or computational labs;
  - Mentoring undergraduate students during the summer to teach them how to conduct literature reviews, perform research, and communicate their findings. The students presented their work at the CMI Annual Research & Innovation Summit. The titles of the two projects are "Proof of concept for *in vitro* influenza immunogenicity screening" and " Mathematical modeling of mechanisms of antimicrobial resistance in *Campylobacter* species".
- Teaching assistant and recitation leader for MA 241 Calculus II. My role was preparing and conducting recitations twice a week, grading exams, and holding office hours for students seeking additional help (Aug - Dec 2021).

Tutoring

- Tutor in the NC State Math Multimedia Center, assisting students in mathematical subjects ranging from financial mathematics to multivariable calculus (Aug 2021 - May 2022).

- Volunteer mentor and tutor for North Carolina inmates through the Correctional Education program at UNC-Chapel Hill. Our correspondence involved exchanging letters, motivation, and math problems (Feb 2021 - Aug 2021).
- Volunteered as an algebra mentor/tutor for students at SouthWest Edgecombe High School to assist struggling teachers. This involved meeting with groups of students for an hour once a week to review classroom material and answer questions about course content or career options in STEM (Jan - April 2021).
- Freelance tutor in subjects such as calculus, differential equations, linear algebra, basic math, programming, and writing. I have had over a dozen students at levels ranging from high school to post-graduates (Aug 2020 - present).

Mentorship

- Mentored two GGS students, meeting with them semi-frequently to see how they were adjusting to NC State and the Genetics and Genomics program (May 2021 - Feb 2023).
- Mentored a high school student interested in modeling COVID-19. This involved regular meetings to discuss progress and teach her how to use MATLAB to simulate systems of ordinary differential equations fit these models to data (Feb 2021 - Feb 2022).
- Volunteer mentor and panelist for NC State's Undergrads Union Grads (UUG). In the former role, I mentored an undergraduate mathematics student, including meeting to give career advice and tips to succeed in college. I also served on an information panel hosted by UUG for undergraduates to learn more about REU experiences and opportunities (Sept 2020 - Feb 2021).

Outreach

- Volunteer with the Reiskind Vector Ecology Lab at BugFest, hosted by the North Carolina Museum of Natural Sciences. This involves educating the public about blood-sucking arthropods and assisting with interactive exhibits (2022-2024).
- Volunteered at the Biomathematics exhibit during the State of the Sciences. I educated the public on mosquito-borne disease control, organized interactive games for children, and prepared informative material—such as posters—to be displayed at the booth (April 2023).
- Sat on a graduate student panel for new Genetics and Genomics Scholars (July 2022).
- Sat on a graduate student panel for interested undergraduates to discuss research in graduate school with a focus on the NSF GRFP (July 2022).
- Organized a team of graduate students to participate in the North Edgecombe Teamship Program. Through my tutoring connections at SouthWest Edgecombe High School, I recruited and led a team of three graduate students to participate in a program in which high school students are presented with real-world problems; our problem was improving recruitment and retention of students from underrepresented groups at NC State (June - Nov. 2021).
- Co-organized the Triangle Contest in Mathematical Modeling (TriCoMM) with Dr. Veronica Ciocanel. I was responsible for organizing the NC State portion of the competition, which included finding funding, recruiting undergraduates, scheduling and running information sessions, and judging (Sept. 2021 - Oct. 2023).
- Delivered research talks to students at Cardinal Gibbons (Oct. 2021) and Edward Little High Schools (May 2019).
- Participated in ComSciCon-Triangle, a communication science workshop for broadening a student's ability to communicate their research effectively (Jan. 2022).
- Initiaited and served as the first President of the Math Club at the University of Maine (Sep. 2018 - May 2019).

Service

To Professional Organizations and Societies

- Journal reviewer for *Letters in Biomathematics* (3), *Molecular Ecology* (2), *PLoS Genetics* (1), *PLoS Computational Biology* (1), *Cell Reports* (1), *Journal of Mathematical Biology* (1), *Ecology Letters* (1), *Physical Review E* (1), *Mathematical Biosciences* (1), and *Journal of Theoretical Biology* (1).
- Served as treasurer of the SIAM NC State Chapter. In addition to managing accounts and budgeting for semester events, I prepared and delivered two public seminars on how to use MATLAB (Aug. 2022 - Sept. 23).
- Assisted in reading and judging applications for the SMB Landahl-Busenberg Award (April 2024).
- Served on the SMB Website Publication Board. Responsibilities included attending meetings, providing feedback on current projects, and brainstorming ideas for the new website (Sept. 2021 - Sept. 2023).
- Volunteered at the SMB table at the 2023 Annual Meeting at OSU and the Joint Mathematics Meeting 2023 to sell T-shirts, playing cards, and discuss society perks and membership with interested attendees (Jan., July 2023).

To NC State

- Served as Vice President of the Biomathematics Graduate Student Association. In this role, I organized a weekly Biomath Journal Club between students and attended monthly meetings of the University Graduate Student Association (UGSA) (May 2021 - April 2022).
- Served as President of the Biomathematics Graduate Student Association (Aug. 2022 - April 2024). In this role, I:
  - Fundraised nearly $1,000 for the program by collaborating with local businesses and selling merchandise such as Biomath T-shirts and coffee mugs;
  - Organized weekly seminars featuring presentations from students, postdocs, and faculty (both internal and external);
  - Assisted with graduate student recruitment by giving research talks and meeting with students during campus visits;
  - Organized program events such as student birthday celebrations, end-of-semester symposia for class projects, and weekend socials;
  - Attended monthly UGSA meetings.
- Served on the Legislative Affairs and Student Advocacy Committee of the UGSA (May 2021 - April 2022). In this role, I:
  - Assisted in drafting a report on graduate student stipends at NC State. This report was completed while I served as committee chair (Aug. 2023 - May 2024). Besides spanning the better part of two years, this report included median stipend data for all Ph.D programs across the university, the results of multiple independent graduate student surveys, student interviews, and a comparison of NC State to peer institutions and other R1 universities in the Triangle (Duke and UNC Chapel Hill);
  - Delivered two talks to the general UGSA on the stipend report, which was sent by the UGSA President to the Provost, Chancellor, and Board of Trustees;
  - Elected as GSA Committee Chair of the Year (2023-24) for my service.

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-present)
- Society of Industrial and Applied Mathematics (2020-present)
- North Carolina Mosquito and Vector Control Association (2024-present)