LAURA E WADKIN

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School of Mathematics, Statistics & Physics ⬦ Newcastle University ⬦ NE1 7RU

iD orcid.org/0000-0001-7355-2023   R^G Laura E Wadkin   in Laura E Wadkin

Interests: Mathematical biology and ecology, agent/individual-based modelling, stochastic modelling

EDUCATION AND QUALIFICATIONS

Newcastle University   2016–2020
PhD in applied mathematics 'A mathematical framework for stem cells'

Newcastle University   2012–2016
MMath Hons Mathematics, 1st

EMPLOYMENT

Newcastle University
Newcastle University Academic Track (NUAcT) Fellow   Sep 2022–Sep 2027
Post-doctoral Research Associate   Feb 2021–Sep 2022
LMS Early Career Fellow   Sep 2020–Feb 2021

GRANTS

LMS Equality Diversity and Inclusion Grant (£1000)   Aug 2025–Dec 2025
Defra Animal and Plant Health Modelling Services   Apr 2024–Apr 2027
Future Proofing Plant Health (FPPH) (led by Fera, co-investigator, £130k)   Sep 2024–Mar 2025
Higher Education Innovation Fund (Principal investigator, £10k)   Oct 2023–July 2024
NERC Knowledge Exchange Fellowship (Principal investigator, £150k)   Sep 2022–Sep 2025
NERC Discipline Hopping for Environmental Solutions (Co-investigator, £25k)   Jan 2022–Feb 2022
London Mathematical Society Early Career Research Fellow Grant (£7k)   Sep 2020–Feb 2021

PRIZES

Newcastle Applied Mathematics PGR Prize   Jun 2020
Smith Institute TakeAIM Awards: 2nd Prize   Feb 2020
Newcastle Applied Mathematics PGR Prize   Jun 2019
ABTA Doctoral Researcher Awards: Honourable mention for doctoral work   May 2019
London Mathematical Society Women in Mathematics Day: best poster   Oct 2018
STEM for BRITAIN Silver Prize, presented in the House of Commons   Mar 2017
IMA Graduation Prize for outstanding achievement   Jun 2016

RESEARCH AND TECHNICAL EXPERTISE

My research expertise is inherently interdisciplinary, using techniques from mathematics (particularly agent-based models and stochastic differential equations) and statistics (including Bayesian inference) to deepen our understanding of a variety of biological and ecological systems. In ecological modelling, I have ongoing collaborations with ecologists and policy makers at the Forestry Commission, Fera Science Ltd, and the Department for Environment, Food and Rural Affairs (Defra). In my cellular modelling work I collaborate with leading stem cell biologists at Newcastle University and with NHS clinicians.

NUAcT (current): *Data-driven models for biological and ecological systems.* I am working across the disciplines of data science, theoretical mathematical modelling, and experimental life sciences, to develop a framework for best harnessing observational data in life systems models, with the power to inform policy and

industrial strategies, considering two central case studies: tree diseases and cellular systems. Work on tree diseases is financially supported by my NERC Knowledge Exchange Fellowship and is in collaboration with Defra and the Forestry Commission. Work on cellular modelling is in collaboration with the Retinal Stem Cell Group at Newcastle University and Prof Francisco Figueiredo at the Newcastle upon Tyne Hospitals NHS Foundation Trust.

Post-doctoral: *Models and inference for tree disease.* This work centred around developing computational lattice models for the spread of tree disease and invasive pests, informed by state-of-the-art Bayesian inference techniques. I collaborated with the governmental Oak Processionary Moth Control Programme to explore the dynamics of the moth spread in the UK.

Early career fellowship: *Spatial modelling of stem cells.* Through this transitional grant I developed an agent-based model to explore the spatial properties of pluripotency transcription factors within growing stem cell colonies.

PhD: *A mathematical framework for human pluripotent stem cell behaviours.* Through collaboration with experimental biologists (Biosciences Institute, Newcastle University), I developed mathematical models of key stem cell behaviours, including their kinematics, colony growth and pluripotency, informed by bespoke experimental image analysis.

PUBLICATIONS

· K. N. Ries, ..., <u>L. E. Wadkin</u>, Voices of women in mathematics Higher Education: the doctoral student experience. In preparation (2025).

> We explore the lived experiences of female PhD students through a series of one-to-one interviews and a subsequent thematic analysis.

· P. Parkinson, ..., <u>L. E. Wadkin</u>, IVCM image analysis for limbal stem cell deficiency: quantitative diagnostics of the corneal epithelium post-transplant recovery. In preparation (2025).

> Using *in-vivo* confocal microscopy images from a pioneering clinical trial, we identify quantitative characteristics associated with corneal limbal stem cell recovery.

· L. E. Wadkin *et al.*, Estimating the effective reproduction number of tree diseases through agent-based models. Ecological Modelling. 489, 110630 (2024).

> We explore three different methods of estimating the reproduction number from an agent-based model of tree disease spread.

· L. E. Wadkin *et al.*, Human stem cells for ophthalmology: recent advances in diagnostic image analysis and computational modelling. Current Stem Cell Reports. 9, 57–66 (2023).

> We review the advances in computational techniques for diagnostic image analysis and the modelling of stem cell systems for applications in ophthalmology.

· A. Golightly, <u>L. E. Wadkin</u> *et al.*, Accelerating Bayesian inference for stochastic epidemic models using incidence data. Statistics and Computing. 33(6), 134 (2023).

> We consider two approaches for marginalising over the latent process in performing inference for stochastic epidemic compartment models using incomplete time course data.

· L. E. Wadkin *et al.*, Quantifying invasive pest dynamics through inference of a two-node epidemic network model. Diversity. 15(4), 496 (2023).

> We show the applicability of a two-node epidemic network model to describing invasive pest dynamics using the case study of the oak processionary moth.

· L. E. Wadkin *et al.*, Inference for epidemic models with time varying infection rates: tracking the dynamics of oak processionary moth in the UK. Ecol. Evol. 12, e8871 (2022).

Using an advanced Bayesian inference scheme we estimate the parameters for a stochastic compartmental SIR model with a time varying infection rate to describe the spread of pests.

· L. E. Wadkin *et al.*, A mathematical modelling framework for the regulation of intra-cellular OCT4 in human pluripotent stem cells. PLOS ONE 16(8), e0254991 (2021).

An application of fractional Brownian motion and the stochastic logistic equation to describe temporal properties of the pluripotency transcription factor OCT4.

· L. E. Wadkin *et al.*, OCT4 expression in human embryonic stem cells: spatio-temporal dynamics and fate transitions. Phys. Biol. 18, 026003 (2020).

An analysis of the spatio-temporal behaviour of the pluripotency transcription factor OCT4, quantifying its intra-cellular self-regulation and spatial correlations within colonies.

· L. E. Wadkin *et al.*, An introduction to the mathematical modelling of iPSCs. Chapter 5 of Induced Pluripotent Stem Cells: Novel Concepts, Elsevier (2020).

A chapter conveying the importance and usefulness of mathematical modelling to achieve a deeper understanding of stem cell biology, introducing key mathematical concepts (random walk theory, differential equations and agent-based modelling) for non-mathematical readers.

· L. E. Wadkin *et al.*, The recent advances in the mathematical modelling of human pluripotent stem cells. SN Applied Sciences 2, 276 (2020).

A review of the recent developments in the mathematical modelling of the key behaviours of pluripotent stem cells, suitable for both biologists and mathematicians.

· S. Orozco-Fuentes, I. Neganova, L. E. Wadkin *et al.*, Quantification of the morphological characteristics of hESC colonies, Sci. Rep. 9, 17569 (2019).

The morphological characteristics of cells within colonies of varying size are quantified, including their packing and size segregations.

· L. E. Wadkin *et al.*, Seeding hESCs to achieve optimal colony clonality, Sci. Rep. 9, 15299 (2019).

A stochastic exponential growth model for colony formation is developed based on experimental data. The average time at which clonality is lost *in-vitro* for different initial seeding conditions is presented as a diagnostic tool for biologists.

· L. E. Wadkin *et al.*, Correlated random walks of human embryonic stem cells *in-vitro*, Phys. Biol. 15, 056006 (2018).

The individual motions of single and pairs of cells from experimental data are analysed. The correlated random walks and super-diffusive behaviour of cells is presented.

University press release, 'How stem cells move' (Jun 18).

· L. E. Wadkin *et al.*, Dynamics of single human embryonic stem cells and their pairs: a quantitative analysis, Sci. Rep. 7, 570 (2017).

Important parameters of the movement of single and pairs of cells, such as velocities, diffusivity and correlation times are extracted from analysis of experimental data.

IN THE MEDIA

· New Scientist Feature 'Tougher action needed to stop oak-killing moth's spread in the UK'

· University press release 'How stem cells move'

· University press release 'Newcastle's rising stars selected to showcase their research in Parliament'

TALKS HIGHLIGHTS

Invited:

- Retreat for Women In Applied Mathematics, 'EDI Roundtable session - experiences of women in maths', ICMS Edinburgh (Feb 25)
- University College London, Mathematical Biology Group Seminar (Jan 24)
- University of Warwick, SBIDER Seminar (Nov 24)
- Society for Mathematical Biology Annual Meeting, 'Cellular differentiation and phenotypic plasticity: methodological advances and biological insights' mini-symposium, South Korea (Jul 24)
- British Applied Mathematics Colloquium, 'Novel ecological methods' mini-symposium (Apr 24)
- University of Southampton, S3RI Seminar (Nov 22)
- University of Sheffield, Mathematical Biology Research Group Seminar (Oct 22)
- Royal Statistical Society (RSS) International Conference, 'Using statistics to track the oak processionary moth invasion in the UK' (Sep 22)
- North East Data Scientists Meeting, 'Data for mathematical models of life systems' (Mar 22)

Contributed:

- Retreat for Women in Applied Maths, 'Experiences of women PhDs'. ICMS Edinburgh (Jan 24)
- RSS International Conference, 'Network model for invasive pests'. Harrogate (Sep 23)
- Society for Mathematical Biology, 'Modelling forest pests'. Columbus, OH, US (Jun 23)
- British Applied Mathematics Colloquium, 'Modelling invasive forest pests'. Bristol (Apr 23)
- IOP Physics Meets Biology Conference, 'Modelling tree disease through UK forests'. Online (Jul 21)
- Society for Mathematical Biology Annual Meeting, 'Modelling tree disease...'. Online (Jun 21)
- British Applied Mathematics Colloquium, 'Mathematical insights into OCT4'. Online (Apr 20)
- British Applied Mathematics Colloquium, 'Modelling of stem cells'. University of Bath (Apr 19)
- British Young Mathematicians Colloquium, 'Modelling of hESCs'. Birmingham University (Apr 19)
- Women in STEM WISDOM event, 'Why study mathematics?' (Jul 18 & online Jul 20)

LEADERSHIP

- Mathematics of Life and Environmental Science Research Group lead (Jul 24–present)
- MSP Women's Network lead (May 24–present)
- BAMC 2024 Co-organiser (Apr 24)
- Applied Mathematics oureach lead (Sep 23–present)
- PI: NERC Knowledge Exchange Fellowship (Sep 22–Sep 25)
- PI: HEIF stem cell project (Sep 23–Jul 24)
- Supervision of five PhD students (three as academic lead) (Sep 22–present)
- Supervision of 3 Summer projects (Jul 20–present)

TEACHING AND SUPERVISION

- Associate Fellow of the Higher Education Academy (D1)
- MSP2815 Mathematical Biology - Module Leader (2025/26–)

  Module leader for our second year Mathematical Biology module, covering discrete and continuous population models, linear stability analysis and predator-prey interactions. Approximately 160 students with 5 contact hours per week.

- 'Exploring the leaky pipeline of women in mathematics', summer project supervisor (2021–23).

  Project 1: Conceptualised and supervised a 6-week undergraduate summer project involving a systematic scoping review into studies which explore the effect of gender on retention in academic mathematics careers using qualitative techniques.

  Project 2: Building on the work of Project 1, conceptualised and supervised a second summer project involving interviewing gender-minority PhD students within the School of Maths, Stats and Physics at Newcastle about their own experiences.

  Project 3: Applying natural language processing techniques to analyse the interview transcripts from Project 2 to deepen our understanding of the lived experiences of women PhD students.

- PARTNERS Summer School lecturer (2019–2021).

  Led lectures over 2-week summer school on Algebra and Functions for non-traditional UG offer holder students enrolled on the PARTNERS Scheme, aimed at bridging the gap between A-Levels and HE. Developed and delivered online materials for Summer 2020.

- Lecturer for PHY1032 Introductory Algebra (Semester 1 19/20)

  Led 5 weeks of lectures for an UG Physics module introducing algebraic concepts (5 contact hours/week including 1 office hour, 80 students). I designed and presented new lecture material to tailor the course to physicists, wrote the mid-semester test and contributed to the writing of the final exam.

  Feedback from mid-semester questionnaire:
  "Frequent examples, pace changes well with difficulty of the content, clear notes."
  "Easy to understand, good handouts."
  "This module section is taught with great clarity."

- Developed MRes mini-module PHY8005 Agent Based Modelling (2018–2021).

  Led a computational research skills module for MRes Physicists ($\sim$10 students). I developed the material based on my academic research (computational agent-based modelling), wrote the lecture notes, delivered the material across several 3 hour interactive workshops, and wrote and marked the final summative assignment. Transferred online for Semester 1 20/21.

- Assistant in MAS1801 Problem Solving (Semester 1 19/20).
- Led MAS2802 Differential Equations problems classes and office hours (Semester 2, 18/19).
- Demonstrating/marking for the school of Mathematics, Statistics and Physics (2016–2021).

EDI, OUTREACH AND CITIZENSHIP

- MSP Women's Network Lead (2024-present).

  Founder and co-lead of the MSP Women's Network, a group to connect, share opportunities, and organise EDI events.

- British Applied Mathematics Colloquium - Organising Committee member (2024).

  Co-organiser for BAMC2024 at Newcastle University, including the organisation of a dedicated EDI focused mini-symposium.

- Applied Mathematics Outreach Lead (2023-present).

  I coordinate outreach activities on behalf of the Applied Mathematics Section, including the Women in Science Doing Outstanding Mathematics and Year 10 Conference annual events.

· Fellowship Committee role (2023-present).

    Reviewing internal applications to various Fellowship opportunities.

· Regular peer-reviewer for various academic journals, including Scientific Reports, Physical Biology, Oikos and AIMS Mathematics (2022-present).

· Project lead exploring the 'leaky pipeline' of women in mathematics (2020–present).

    I develop research activities to deepen our understanding of the barriers to mathematics for gender minorities using qualitative techniques. I support UG summer projects in this area.

· EDI Committee member (2020–present).

    I am an active member of the EDI committee, with a focus on gender equality. I organised an EDI-focused mini-symposium at the BAMC Newcastle (Apr 24) covering accessibility, gender, LGBTQ+ and racial inclusivity, and a Research Retreat for women in MSP (May 24).

· Silver grade STEM ambassador undertaking outreach activities in local schools (2016–2019).

    Volunteering through the STEM Ambassador program I have undertaken a variety of outreach activities in both primary and secondary schools. The activities include: careers talks, mock interviews, assisting in science days and promoting women working in STEM.

· Speaker at WISDOM event for Y9/10 students encouraging women in STEM (2017–present).

    The annual Women In Science Doing Outstanding Mathematics event is for Y9 and Y10 students, showcasing mathematics careers for women. Each year I have participated, presenting a careers talk on my PhD research and attending the networking event.

· Outreach committee member (2017–2020).

· Organised Applied Postgraduate Conference (2019).

POSTER PRESENTATIONS

· 'Exploring the lived experiences of female-identifying mathematics PhD students' presented at Advanced HE Equality, Diveristy and Inclusion Conference (Hull 2023) and the Learning and Teaching Conference (Newcastle University 2023).

· 'Barriers for women in UK mathematics academia: their voices' presented at Advanced HE Equality, Diveristy and Inclusion Conference (Manchester 2022).

· 'Optimising stem cell clonality' presented at LMS Research School: PDEs in Mathematical Biology (ICMS Edinburgh 2019) and ABTA Doctoral Researcher Awards (University College London 2019).

· 'Human embryonic stem cell colony formation' presented at LMS Women In Mathematics Day. Prize for best poster (Newcastle University 2018).

· 'Modelling stem cell colony formation' presented at the UK Conference on Multiscale Biology (Nottingham University 2018), and the Collective dynamics and self-organisation in biological sciences workshop (ICMS Edinburgh 2018).

· 'Mathematical modelling of stem cell colonies' at STEM for BRITAIN competition, presented to MPs in the House of Commons. Won Silver prize (2017).

COURSES

· Newcastle University Educational Practice Skills (2024–2025).

· Newcastle University Policy Academy (2023)

· Evidencing Learning and Teaching Skills: D1, Newcastle University, (Semester 2 19/20).

- ACTION for Impact Training, Newcastle/Durham Universities, 3 day residential (July 2019).
- The Introduction to Learning & Teaching in Higher Education programme, full day course, Newcastle University (Sep 2017).
- The Academy for PhD Training in Statistics:

  Cambridge week: Statistical Inference and Computing (Dec 2016).

  Oxford week: Applied Stochastic Processes and Statistical Modelling (Mar 2017).
- Hands-on Introduction to HPC, ARCHER, two day course (Dec 2016).