LAURA E WADKIN

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

EDUCATION AND QUALIFICATIONS

Newcastle University PhD in applied mathematics 'A mathematical framework for stem cells'	2016-2020
Newcastle University MMath Hons Mathematics, 1st	2012-2016
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	
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 $(\pounds7k)$	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. I have ongoing collaborations with ecologists and policy developers at the Forestry Commission and the Department for Environment, Food and Rural Affairs, and with leading stem cell biologists at Newcastle University and two biotechnology companies.

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.

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

Post-doctoral: Models and inference for tree disease. This work centres 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.

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 the 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.

PUBLICATIONS

- \cdot L. E. Wadkin *et al.*, Estimating the effective reproduction number of tree diseases through agent-based models. In preparation (2022).
- · A. Golightly, <u>L. E. Wadkin</u> *et al.*, Accelerating Bayesian inference for stochastic epidemic models using incidence data. In preparation (2022).
- · 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.*, 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.

· 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.

 S. Orozco-Fuentes, I. Neganova, <u>L. E. Wadkin</u> 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.

IN THE MEDIA

- $\cdot\,$ New Scientist Feature 'Tougher action needed to stop oak-killing moth's spread in the UK'
- $\cdot\,$ University press release 'How stem cells move'
- · University press release 'Newcastle's rising stars selected to showcase their research in Parliament'

TALKS HIGHLIGHTS

Invited:

- · Royal Statistical Society 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:

- · 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)

TEACHING AND SUPERVISION

- · Associate Fellow of the Higher Education Academy (D1)
- · 'Exploring the leaky pipeline of women in mathematics', summer project supervisor (2021 & 2022).

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

Study 2: Building on the work of Study 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.

· 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.

 \cdot Lecturer for PHY1032 Introductory Algebra (Semester 119/20)

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 (~ 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.

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

EDI AND OUTREACH

· 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.

· 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.

 \cdot 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.

- \cdot Outreach committee member (2017–2020).
- · Organised Applied Postgraduate Conference (2019).

POSTER PRESENTATIONS

- · 'Barriers for women in UK mathematics academia: their voices' presented at Advanced HE Equality, Diversity 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).

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

COURSES

- \cdot Evidencing Learning and Teaching Skills: D1, Newcastle University, (Semester 2 19/20).
- · ACTION for Impact Training, Newcastle/Durham Universities, 3 day residential (July 2019).
- $\cdot\,$ 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).
- $\cdot\,$ Hands-on Introduction to HPC, ARCHER, two day course (Dec 2016).