

DENIS PATTERSON

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Research Interests

Applied Analysis Dynamical systems, stochastic processes & functional differential equations
Applications Mathematical Biology: Ecology, biological development & epidemiology

Academic Career

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|---------------------|---|
| Aug. 2023– | Assistant Professor , Durham University Department of Mathematical Sciences |
| Nov. 2020–Jun. 2023 | Postdoctoral Research Associate , Princeton University High Meadows Environmental Institute Mentor: Prof. Simon A. Levin |
| July 2018–Oct. 2020 | Postdoctoral Research Associate , Brandeis University Department of Mathematics Mentor: Prof. Jonathan D. Touboul |
| May 2017–May 2018 | Assistant Professor , Dublin City University School of Mathematical Sciences |
| Oct. 2013–Apr. 2018 | PhD in Applied Mathematics , Dublin City University Thesis: <i>Asymptotic Growth in Nonlinear Stochastic and Deterministic Functional Differential Equations</i> Advisor: Prof. John A. D. Appleby |
| 2009–2013 | BSc in Actuarial Mathematics , Dublin City University First class honours |

Publications

* corresponding author, \diamond equal contribution, \dagger alphabetical authorship.

Preprints

[P1] K. Shen, S. A. Levin, **D. D. Patterson***, *Spatial modeling of forest-savanna bistability: Impacts of fire dynamics and timescale separation*, submitted (2025). [\[arXiv\]](#)

Journal Articles

- [J23] **D. D. Patterson**, L. M. Childs, I. J. Stopard, N. Chitnis, S. Serrato-Arroyo and M. A. Greischar *Immunity can impose a reproduction-survival tradeoff on human malaria parasites*, *Evolution*, qpaf238 (2025). [\[Open Access\]](#)
- [J22] L. Xu, **D. D. Patterson**, S. A. Levin and J. Wang, *Global stability and tipping point prediction of the coral reef ecosystem*, *Earth System Dynamics*, Vol. 16, No. 5 (2025). [\[Open Access\]](#)
- [J21] J. D. Touboul, J. Li, **D. D. Patterson**, S. A. Levin, *New challenges in spatial ecology*, *Japanese Journal of Industrial and Applied Mathematics*, Vol. 79 (2025). [\[Open Access\]](#)
- [J20] J. Siu, W. Wu, **D. D. Patterson**, S. A. Levin and J. Wang, *Revealing physical mechanisms of pattern formation and switching in ecosystems via landscape and flux*, *Advanced Science*, 2501776 (2025). [\[Open Access\]](#)

- [J19] Z. Qu[◇], **D. D. Patterson**[◇], L. Childs, C. Edholm, J. Ponce, O. Prosper and L. Zhao, *Mathematical modeling of malaria vaccination with seasonality and immune feedbacks*, PLoS Computational Biology, 21(5): e1012988 (2025). [Open Access]
- [J18] **D. D. Patterson**^{*}, S. A. Levin, A. C. Staver and J. D. Touboul, *Pattern formation in mesic savannas*, Bulletin of Mathematical Biology, Vol. 86, No. 3 (2024). [Open Access]
- [J17] **D. D. Patterson**^{*}, A. C. Staver, S. A. Levin and J. D. Touboul, *Spatial dynamics with heterogeneity*, SIAM Journal on Applied Mathematics, S225-S248 (2023). [arXiv]
- [J16] Z. Qu[◇], **D. D. Patterson**[◇], L. Childs, C. Edholm, J. Ponce, O. Prosper and L. Zhao, *Modeling immunity to malaria with an age-structured PDE framework*, SIAM Journal on Applied Mathematics, Vol. 83, No. 3 (2023), 1098–1125. [arXiv]
- [J15] L. Xu, **D. D. Patterson**, S. A. Levin and J. Wang, *Non-equilibrium early-warning signals for critical transitions in ecological systems*, Proceedings of the National Academy of Sciences, Vol. 120, No. 5 (2023), e2218663120.
- [J14] J. Feng[◇], W. H. Hsu[◇], **D. D. Patterson**, C. S. Tseng, Z. H. Zhuang, H. W. Hsin, Y.T. Huang, A. Faedo, J. L. Rubenstein, J. D. Touboul and S.J. Chou, *COUP-TFI specifies the medial entorhinal cortex identity and induces differential cell adhesion to determine the integrity of its boundary with neocortex*, Science Advances, Vol. 7, No. 27 (2021), eabf6808.
- [J13] L. Xu, **D. D. Patterson**, A. C. Staver, S. A. Levin, J. Wang, *Unifying deterministic and stochastic ecological dynamics via a landscape-flux approach*, Proceedings of the National Academy of Sciences, Vol. 118, No. 24 (2021), e2103779118. [arXiv]
- [J12] J. A. D. Appleby and **D. D. Patterson**[†], *Growth and fluctuation in perturbed nonlinear Volterra equations*, Applied Mathematics and Computation, Vol. 396, (2021) 125938. [arXiv]
- [J11] **D. D. Patterson**^{*}, S. A. Levin, A. C. Staver, J. D. Touboul, *Probabilistic foundations of spatial mean-field models in ecology and applications*, SIAM Journal on Applied Dynamical Systems, Vol. 19, No. 4 (2020), 2682–2719. [arXiv]
- [J10] J. A. D. Appleby and **D. D. Patterson**[†], *Blow-up and superexponential growth in superlinear Volterra equations*, Discrete & Continuous Dynamical Systems Series A, Vol. 38, No. 8 (2018), 3993–4017. [arXiv]
- [J9] J. A. D. Appleby and **D. D. Patterson**[†], *Growth rates of sublinear functional and Volterra differential equations*, SIAM Journal on Mathematical Analysis, Vol. 50, No. 2 (2018), 2086–2110. [arXiv]
- [J8] J. A. D. Appleby and **D. D. Patterson**[†], *Memory dependent growth in sublinear Volterra differential equations*, Journal of Integral Equations and Applications, Vol. 29, No. 4 (2017), 531–584. [arXiv]
- [J7] J. A. D. Appleby and **D. D. Patterson**[†], *Large fluctuations and growth rates of linear Volterra summation equations*, Journal of Difference Equations and Applications, Vol. 23, No. 6 (2017), 1047–1080. [arXiv]
- [J6] J. A. D. Appleby and **D. D. Patterson**[†], *Growth rates of solutions of superlinear ordinary differential equations*, Applied Mathematics Letters, Vol. 71 (2017), 30–37. [arXiv]
- [J5] J. A. D. Appleby and **D. D. Patterson**[†], *Hartman–Wintner growth results for sublinear functional differential equations*, Electronic Journal of Differential Equations, Vol. 2017, No. 21 (2017), 1–45. [arXiv]
- [J4] J. A. D. Appleby and **D. D. Patterson**[†], *On the admissibility of unboundedness properties of forced deterministic and stochastic sublinear Volterra summation equations*, Electronic Journal of Qualitative Theory of Differential Equations, No. 63 (2016), 1–44. [arXiv]

- [J3] J. A. D. Appleby and **D. D. Patterson**[†], *Classification of convergence rates of solutions of perturbed ordinary differential equations with regularly varying nonlinearity*, Electronic Journal of Qualitative Theory of Differential Equations, Proceedings of the 10th Colloquium on the Qualitative Theory of Differential Equations, No. 3 (2016), 1–38. [arXiv]
- [J2] J. A. D. Appleby and **D. D. Patterson**[†], *Subexponential growth rates in functional differential equations*, Discrete and Continuous Dynamical Systems Supplement (2015), 56–65. [arXiv]
- [J1] J. A. D. Appleby and **D. D. Patterson**[†], *On necessary and sufficient conditions for preserving convergence rates to equilibrium in deterministically and stochastically perturbed differential equations with regularly varying nonlinearity*, Recent Advances in Delay Differential and Difference Equations, Springer Proceedings in Mathematics & Statistics 94 (2014), 1–85. [arXiv]

Academic Honours & Awards

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| 2017 | Outstanding Graduate Researcher Award , Dublin City University |
| 2013–2017 | Government of Ireland Postgraduate Scholarship , Irish Research Council |
| 2013 | Student Actuary Prize , Society of Actuaries in Ireland |
| 2012 | Hamilton Award for Mathematics , Royal Irish Academy |

Selected Academic Talks

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| Mar. 2026 | Mathematical Biology Seminar , University of Edinburgh, UK (invited) |
| Oct. 2025 | BioMath Seminar , University of Florida, USA (invited) |
| Oct. 2025 | Mathematical Biology Seminar , University of Leeds, UK (invited) |
| June 2025 | Mathematical Ecology Workshop , Newcastle University, UK (invited) |
| Mar. 2025 | Math Bio Seminar , New Jersey Institute of Technology, USA (invited) |
| Jan. 2025 | Joint Mathematics Meeting , Seattle, USA (invited) |
| Oct. 2024 | SBIDER Seminar , Zeeman Institute, University of Warwick, UK (invited) |
| Apr. 2024 | Models in Population Dynamics, Ecology, and Evolution (MPDEE) '24 , University of Leicester, UK |
| Apr. 2024 | British Applied Mathematics Colloquium , Newcastle University, UK (invited) |
| Apr. 2024 | AMS Spring Sectional Meeting , Howard University, USA (invited) |
| Nov. 2023 | Mathematical Biology Seminar , University of Illinois, USA (invited) |
| Mar. 2023 | AMS Spring Southeastern Sectional Meeting , Georgia Tech, USA |
| Oct. 2022 | International Conference on Mathematical Modeling & Analysis of Populations in Biological Systems VIII , Univ. of Louisiana Lafayette, USA |
| Oct. 2022 | AMS Fall Eastern Sectional Meeting , UMass Amherst, USA (invited) |
| July 2022 | SIAM Conference on the Life Sciences , Philadelphia, USA (invited) |
| July 2022 | Mathematical Models in Ecology & Evolution (MMEE) , University of Reading, UK |
| Apr. 2022 | Joint Mathematics Meeting , online (invited) |
| Apr. 2022 | MathBio Seminar , Arizona State University, USA (invited) |
| Mar. 2022 | MathBio Seminar , Virginia Tech, USA (invited) |
| Mar. 2022 | AMS Spring Eastern Sectional Meeting , online (invited) |
| June 2021 | Society for Mathematical Biology Annual Meeting , online (<i>Cell & Developmental Biology Contributed Talk Prize winner</i>) |
| May 2021 | SIAM Conference on Applications of Dynamical Systems , online |

Teaching Experience

Fellow, Higher Education Academy, UK (FHEA)

Professional award from [Advance HE](#) for experienced educators with substantive teaching responsibilities.

Courses Lectured

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| Winter 2025 | Computational Mathematics (year 2), Durham University | [webpage] |
| Winter '23/24/25 | Advanced Mathematical Biology (year 4/masters), Durham University | [webpage] |
| Summer 2020 | Differential Equations (fully online), Brandeis University | |
| Fall 2019 | Probability, Brandeis University | |
| Spring 2019 | Multivariate Calculus, Brandeis University | |
| Winter 2017 | Simulation for Finance (year 4/masters), Dublin City University | |

Programming & Software

General C++, Python, R, Julia, Hive, SQL, VBA, Git/Github

Math specific MATLAB, Mathematica, FreeFEM++, GeoGebra, \LaTeX ,
XPP/Auto, Matcont, BifurcationKit

Professional Activities & Affiliations

Recent Grants & Research Funding

- 2025 ICMS Research Workshop grant (PI, £21,000)
- 2025 Society for Mathematical Biology Travel Award (PI, \$650)
- 2025 LMS Undergrad Research Bursary – Matthew Black (PI, £2,400)
- 2025 Pascal Fund Award to host a Durham Symposium on Mathematical Biology (co-PI, £5,000)
- 2025 [Collaborate@ICERM](#), “Modeling the Impact of Human Movement on Malaria Immune Dynamics” (co-PI, \$12,000)
- 2024 Biophysical Sciences Institute Flexible Grant – research visit to Cornell University (PI, £1,520)
- 2024 LMS Undergrad Research Bursary – Ewan Green (PI, £2,000)
- 2024 Biophysical Sciences Institute Undergrad Research Bursary – Thomas Shaw (PI, £3,400)
- 2024 Seedcorn Grant from Durham University, “Microbial multiculture coexistence: Metals as resources and toxins” (PI, £10,000)
- 2023 Durham University Research Staff Association Travel Grant (PI, £700)
- 2022 Convergence Accelerator Team Award from the NSF-Simon’s Center for Multiscale Cell Fate Research (UC Irvine) for the project “Developing methodologies for spatial and demographic heterogeneity in malaria immune dynamics” (\$10,500)
- Selected participant in the AMS [Mathematical Research Community](#) “Dynamics of Infectious Diseases”, 2020-2022 (\$3,125)

Workshops & Organizational Activities

- Conference & workshops organized:
 - “Infectious Disease Modeling across scales” funded and hosted by the [American Institute of Mathematics](#), April 2023
 - “Critical Transition Workshop Series”: [Part I](#), [Part II](#), 2022 (virtual), and [Part III](#), 2023 (hosted by Princeton University)

- “Climate & Math Conference”, Brandeis University, May 26th, 2022 (virtual)
- Minisymposia/special sessions organized:
 - “Dynamics and asymptotics in biological media” at the British Applied Mathematics Colloquium (2025), University of Exeter, UK
 - “Nonlinear Systems in Mathematical Biology” at the British Applied Mathematics Colloquium (2024), Newcastle University, UK
 - “Multiscale Approaches to Modeling Ecological and Evolutionary Dynamics” at the AMS Southeastern Spring Sectional Meeting (2023), Georgia Tech, USA
 - “Dynamics of PDEs on heterogeneous domains: Theory & applications” at the Joint Mathematics Meeting (JMM 2023), Boston MA, USA
 - “Vegetation Modeling: Nonlinear PDE approach” at Mathematical Models in Ecology & Evolution Conference (MMEE 2022), University of Reading, UK
 - “Stochastic Networks in Neuroscience and Ecology” at the SIAM Conference on Applications of Dynamical Systems (DS21), Virtual

Reviewing

EPSRC Peer Review College member and reviewer for the following academic journals:

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| • Applied Mathematics and Computation | • Journal of the Royal Society Interface |
| • Applied Mathematical Modelling | • Mathematical Biosciences |
| • Bulletin of Mathematical Biology | • Mathematical Biosciences and Engineering |
| • Chaos: An Interdisciplinary Journal of Nonlinear Science | • Nature Communications |
| • Ecological Modelling | • Nonlinearity |
| • Electronic Journal of the Qualitative Theory of Differential Equations | • Physica D |
| • European Journal of Applied Mathematics | • Proceedings of the National Academy of Sciences |
| • Journal of Difference Equations and Applications | • PLoS Computational Biology |
| • Journal of Nonlinear Science | • SIAM Journal on Applied Mathematics |
| | • Theoretical Population Biology |
| | • Theoretical Ecology |

Outreach and Diversity, Equity & Inclusion Activities

- Deputy Early Career Representative, Mathematical Sciences Departmental Leadership Team (2025-)
- [First Generation Scholars Lead](#), Mathematical Sciences, Durham University (2024-)
- EDI Committee Member & Webmaster, Mathematical Sciences, Durham University (2023-)
- [EEB Scholars Program](#) invited panellist, Fall 2022, Princeton University
- Postdoctoral representative on the *Diversity & Inclusion Climate Committee* and *Outreach Subcommittee* member, Princeton University (2021-2022)
- Speaker for the “MRSEC Pizza Talks” science outreach program at Waltham High School, Fall 2020
- Judge for [SCUDEM](#) 2020, 2021 and 2024 (high school/undergraduate mathematical modeling competition)
- University coordinator for the BITE/DCU Voluntary Math Tuition programme 2017/2018 (math outreach to disadvantaged schools to promote university access through tutoring and mentorship)
- [DCU Access Service](#) tutor 2015/2016 (academic support for disadvantaged university students)

Professional Memberships

- Institute of Mathematics and its Applications (IMA)
- Society for Mathematical Biology (SMB)