

# DENIS PATTERSON



High Meadows Environmental Institute,  
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## Research Interests

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

## Academic Career

Nov. 2020–present **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: *Asymptotic Growth in Nonlinear Stochastic and Deterministic  
Functional Differential Equations*  
Advisor: Prof. [John A. D. Appleby](#)

2009–2013 **BSc in Actuarial Mathematics**, Dublin City University  
First class honours

## Publications

† alphabetical authorship, \* equal contribution

### Preprints

[P1] **D. D. Patterson**, A. C. Staver, S. A. Levin and J. D. Touboul, *Spatial dynamics with heterogeneity*, in revision (2022).

### Peer Reviewed Journal Articles

- [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, accepted (2023).
- [J15] L. Xu, **D. D. Patterson**, S. A. Levin and J. Wang, *New 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.
- [J12] J. A. D. Appleby and **D. D. Patterson**<sup>†</sup>, *Growth and fluctuation in perturbed nonlinear Volterra equations*, Applied Mathematics and Computation, Vol. 396, (2021) 125938.
- [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.
- [J10] J. A. D. Appleby and **D. D. Patterson**<sup>†</sup>, *Blow-up and superexponential growth in superlinear Volterra equations*, Discrete & Continuous Dynamical Systems Series A, Vol. 38, No. 8 (2018), 3993–4017.
- [J9] J. A. D. Appleby and **D. D. Patterson**<sup>†</sup>, *Growth rates of sublinear functional and Volterra differential equations*, SIAM Journal on Mathematical Analysis, Vol. 50, No. 2 (2018), 2086–2110.
- [J8] J. A. D. Appleby and **D. D. Patterson**<sup>†</sup>, *Memory dependent growth in sublinear Volterra differential equations*, Journal of Integral Equations and Applications, Vol. 29, No. 4 (2017), 531–584.
- [J7] J. A. D. Appleby and **D. D. Patterson**<sup>†</sup>, *Large fluctuations and growth rates of linear Volterra summation equations*, Journal of Difference Equations and Applications, Vol. 23, No. 6 (2017), 1047–1080.
- [J6] J. A. D. Appleby and **D. D. Patterson**<sup>†</sup>, *Growth rates of solutions of superlinear ordinary differential equations*, Applied Mathematics Letters, Vol. 71 (2017), 30–37.
- [J5] J. A. D. Appleby and **D. D. Patterson**<sup>†</sup>, *Hartman–Wintner growth results for sublinear functional differential equations*, Electronic Journal of Differential Equations, Vol. 2017, No. 21 (2017), 1–45.
- [J4] J. A. D. Appleby and **D. D. Patterson**<sup>†</sup>, *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.
- [J3] J. A. D. Appleby and **D. D. Patterson**<sup>†</sup>, *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.
- [J2] J. A. D. Appleby and **D. D. Patterson**<sup>†</sup>, *Subexponential growth rates in functional differential equations*, Discrete and Continuous Dynamical Systems Supplement (2015), 56–65.
- [J1] J. A. D. Appleby and **D. D. Patterson**<sup>†</sup>, *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.

## Academic Honours & Awards

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

## Selected Academic Talks

\* postponed or canceled due to the Covid-19 pandemic

- 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 Conference**, 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)
- Mar. 2022 **Program in Applied & Computational Math Seminar**, Princeton University, USA
- June 2021 **Society for Mathematical Biology Annual Meeting**, online (*Cell & Developmental Biology Contributed Talk Prize winner*)
- May 2021 **SIAM Conference on Applications of Dynamical Systems**, online
- Apr. 2021 **Fourth Northeast Regional Conference on Complex Systems**, online
- Mar. 2020 **SIAM Conference on the Life Sciences**, California, USA\*
- Mar. 2020 **SIAM Conference on Mathematics of Planet Earth**, California, USA\*
- Oct. 2019 **International Conference on Mathematical Modeling & Analysis of Populations in Biological Systems VII**, Arizona State University, USA
- Sep. 2019 **Dynamical Systems Seminar**, Boston University, USA (invited)
- May. 2019 **SIAM Conference on Applications of Dynamical Systems**, Snowbird, Utah, USA
- Apr. 2019 **Mathematics and Statistics Seminar**, University of Limerick, Ireland (invited)
- Mar. 2019 **Mathematics Everytopic Seminar**, Brandeis University, USA (invited)
- July 2017 **Equadiff 2017**, Slovak University of Technology in Bratislava, Slovakia
- May 2017 **SIAM UK and Ireland Student Chapter Conference**, National University of Ireland Galway (Best Talk Prize)
- Apr. 2017 **British Applied Mathematics Colloquium**, University of Surrey, UK
- Mar. 2017 **Mathematics and Statistics Seminar**, University of Limerick, Ireland (invited)

## Teaching Experience

**Courses** (as primary instructor)

- Summer 2020 Differential Equations, Brandeis University (fully online)
- Fall 2019 Probability, Brandeis University
- Spring 2019 Multivariate Calculus, Brandeis University
- Winter 2017 Simulation for Finance (graduate course), Dublin City University  
*Theory and simulation of stochastic processes with financial applications*

**Undergraduate Research Projects supervised**

Fall 2021	Oliver Liang (Applied Math, Brandeis), “Collective dynamics of mobile particles”
Fall 2020	Jingman Li & Yuning Liu (Applied Math, Brandeis), “Network epidemic models”
Spring 2020	Hange Zhu* (Applied Math, Brandeis), “Pattern formation in heterogeneous domains”
Summer 2019	Hanyu Song (Applied Math, Brandeis), “Mathematical models of somitogenesis”

\*awarded the Arnold Shapiro Prize in Mathematics for her research and coursework

## Programming/Software

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

**Math specific** MATLAB, Mathematica, XPP/Auto, Matcont, FreeFEM++, GeoGebra, L<sup>A</sup>T<sub>E</sub>X

## Professional Activities & Affiliations

### Workshops & Organizational Activities

- 2022 Convergence Accelerator Team Award (\$10,500) 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”
- Selected participant in the AMS Mathematical Research Community “Dynamics of Infectious Diseases”, 2020-2022 (\$3,125 in personal funding)
- Conference & workshops organized:
  - “Infectious Disease Modeling across scales” funded and hosted by the American Institute of Mathematics (planned for April, 2023)
  - “Critical Transition Workshop Series”: Part I, Part II, 2022 (virtual), and Part III (in person)
  - “Climate & Math Conference”, May 26th, 2022 (virtual)
- Minisymposia/special sessions organized:
  - “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
- Seminar series organized:
  - Brandeis Mathematical Biology Seminar series (2018–2019)
  - DCU Mathematical Sciences Postgraduate Seminar series (2014–2017)

### Reviewing

- Applied Mathematics and Computation
- Applied Mathematical Modelling
- Bulletin of Mathematical Biology
- Chaos: An Interdisciplinary Journal of Nonlinear Science
- Electronic Journal of the Qualitative Theory of Differential Equations
- Journal of Difference Equations and Applications
- Mathematical Biosciences
- Nature Communications
- Nonlinearity
- SIAM Journal on Applied Mathematics
- Proceedings of the National Academy of Sciences

## **Outreach and Diversity, Equity & Inclusion Activities**

- EEB Scholars Program invited panelist, Fall 2022
- Postdoctoral representative on the *Diversity & Inclusion Climate Committee* and *Outreach Subcommittee* member (Princeton University), Fall 2021, Spring 2022 and Fall 2022
- Speaker for the “MRSEC Pizza Talks” science outreach program at Waltham High School, Fall 2020
- Judge for SCUDEM 2020 and 2021 (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**

- American Mathematical Society (AMS)
- Society for Industrial and Applied Mathematics (SIAM)
- Society for Mathematical Biology (SMB)