

# DENIS PATTERSON



High Meadows Environmental Institute,  
Princeton University,  
Princeton, New Jersey

Office: 104A Guyot Hall  
✉ denispatterson@princeton.edu  
🌐 denispatterson.com

## 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

- [P3] L. Xu, **D. D. Patterson**, S. A. Levin and J. Wang, *New early-warning signals for critical transitions in ecological systems*, submitted (2022).
- [P2] **D. D. Patterson**, A. C. Staver, S. A. Levin and J. D. Touboul, *Spatial dynamics with heterogeneity*, submitted (2022).
- [P1] 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*, arXiv:2112.12721, in revision (2021).

### Journal Articles

- [J11] 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.
- [J10] 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.

- [J9] 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.
- [J8] **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.
- [J7] 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.
- [J6] 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.
- [J5] 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.
- [J4] 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.
- [J3] 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.
- [J2] 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.
- [J1] 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.

### Conference Papers

- [C3] 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.
- [C2] 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.
- [C1] 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 (\$2,125 funding to date)
- Conference/workshops organized:
  - “Infectious Disease Modeling across scales” funded and hosted by the American Institute of Mathematics (planned for April, 2023)
  - “Workshops on Critical Transitions”: Part I and Part II, 2022 (virtual)
  - “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)
  - “Dynamics of PDEs on heterogeneous domains: Theory & applications” at the Joint Mathematics Meeting (JMM 2023)
  - “Vegetation Modeling: nonlinear PDE approach” at Mathematical Models in Ecology & Evolution Conference (MMEE 2022)
  - “Stochastic Networks in Neuroscience and Ecology” at the SIAM Conference on Applications of Dynamical Systems (DS21)
- 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, 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)
- American Association for the Advancement of Science (AAAS)