Dr. Stephen Beckett

Research Scientist I

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updated: 15 November 2020

Research interests

Virus-microbe ecology, marine microbiology, mathematical modelling with application to biology, inference and analysis of networks, dynamics of biological systems, epidemics, complex systems.

Employment

Georgia Institute of Technology — **August 2015 – present**
Research Scientist I. **School of Biological Sciences.** — **February 2019 – present**
Postdoctoral Fellow. **School of Biological Sciences.** — **August 2015 – February 2019**
Atlanta, GA, USA

- Mentor: Joshua Weitz.
- Evaluating viral and grazer impact on phytoplankton communities.
- Developing size-structured trait-based models of virus-host dynamics

Microsoft Research Cambridge — **May – August 2011**
Research Intern. **Computational Ecology and Environmental Science.** — **Cambridge, UK**

Education

University of Exeter — **September 2011 – July 2015**
Ph.D. in Biological Sciences. — **Exeter, UK**

- Thesis: **Nestedness and modularity in bipartite networks**
- Advisor: Hywel Williams.

University of York — **September 2010 – August 2011**
MRes. Mathematics in the Living Environment. — **York, UK**

- Thesis: **Predicting global leaf phenology**
- Advisors: Matthew Smith (Microsoft Research) and Jon Pitchford.
- Project: **Repellent pheromone laying behaviour in Pharaoh's ants** with Luke Westwood.
- Advisors: Elva Robinson and Jon Pitchford.

University of Leeds — **September 2007 – July 2010**
BSc (Hons). Geography & Mathematics. — **Leeds, UK**

Honours and Awards

2018. Climate Change Fellow at Georgia Institute of Technology.
2013. Travel grant from the Society of General Microbiology to attend Autumn conference.
2011-2015. Research & Knowledge Transfer PhD studentship from the University of Exeter.
2010-2011. Partially funded masters studentship from Natural Environment Research Council.

Software

weighted-modularity-LPAwbPLUS: Improved community detection in weighted bipartite networks
Repository: https://github.com/sjbeckett/weighted-modularity-LPAwbPLUS
Description: Quantifying modularity of weighted bipartite networks as described in Beckett, 2016.

FALCON: a software package for analysis of nestedness in bipartite networks
Repository: https://github.com/sjbeckett/FALCON
Description: Assessing nestedness in bipartite networks, described in Beckett *et al.* 2014.

Publications (* = *Joint lead authors*, † = *undergraduate research mentee)*

Published:

Chande A., Lee S., Harris M., Nguyen Q.†, **Beckett S.J.**, Hilley T., Andris C., Weitz J.S. Real-time, interactive website for US-county-level COVID-19 event risk assessment. *Nature Human Behaviour.* (paper code)

Mruwat N., Carlson M.C.G., Goldin S., Ribalet F., Kirzner S., Hulata Y., **Beckett S.J.**, Shitrit D., Weitz J.S., Armbrust E.V., Lindell D. **2020.** A single-cell polony method reveals low levels of infected *Prochlorococcus* in oligotrophic waters despite high cyanophage abundances. *The ISME Journal.* (paper)

Weitz J.S., **Beckett S.J.**, Coenen A.R., Demory D., Dominguez-Mirazo M., Dushoff J., Leung C-Y., Li G., Măgălie A., Park S.W., Rodgriguez-Gonzalez R.A., Shivam S., Zhao C.Y. **2020.** Modeling Shield Immunity to Reduce COVID-19 Epidemic Spread. *Nature Medicine 26: 849-854.* (paper code)

Benedetto B., Coenen A.R., **Beckett S.J.**, McGillicuddy Jr. D.J., Weitz J.S., Karl D.M. **2019.** The ecological and biogeochemical state of the North Pacific Subtropical Gyre is linked to sea surface height. *Journal of Marine Research 77: 215-245.* (paper)

Talmy D., **Beckett S.J.**, Taniguchi D.A.A., Brussaard C.P.D., Weitz J.S., Follows, M.J. **2019.** An empirical model of carbon flow through marine viruses and microzooplankton grazers. *Environmental Microbiology 21(6): 2171-2181.* (paper)

Talmy D.*, **Beckett S.J.***, Zhang A.B.†, Taniguchi D.A.A., Weitz J.S., Follows M.J. **2019.** Contrasting Controls on Microzooplankton Grazing and Viral Infection of Microbial Prey. *Frontiers in Marine Science 6:182.* (paper summary)

Beckett S.J., Weitz J.S. **2018**. The Effect of Strain Level Diversity on Robust Inference of Virus-Induced Mortality of Phytoplankton. *Frontiers in Microbiology 9:1850.* (paper code summary)

Weitz J.S., **Beckett S.J.**, Brum J.R., Cael B.B., Dushoff J. **2017**. Lysis, lysogeny and virus–microbe ratios. *Nature 549(7672): E1–E3.* (paper code)

Beckett S.J., Weitz J.S. **2017**. Disentangling niche competition from grazing mortality in phytoplankton dilution experiments. *PLOS one 12(5): e0177517.* (paper code)

Beckett S.J. 2016. Improved community detection in weighted bipartite networks. *Royal Society Open Science 3: 140536.* (paper code summary)

Cowley L.A., **Beckett S.J.**, Chase-Topping M., Perry N., Dallman T.J., Gally D.L., Jenkins C. **2015**. Analysis of whole genome sequencing for the *Escherichia coli* O157:H7 typing phages. *BMC Genomics 16: 271.* (paper)

Beckett S.J., Boulton C.A., Williams H.T.P. **2014**. FALCON: a software package for analysis of nestedness in bipartite networks. *F1000Research 3: 185 [v1 ;ref status: indexed, http://f1000r.es/3z8].* (paper code)

Watts A.J.R., Lewis C., Goodhead R.M., **Beckett S.J.**, Moger J., Tyler C.R., Galloway T.S. **2014**. Uptake and retention of microplastics by the shore crab *Carcinus maenas. Environmental Science & Technology 48(15): 8823-8830.* (paper press)

Beckett S.J., Williams H.T.P. **2013**. Coevolutionary diversification creates nested-modular structure in phage-bacteria interaction networks. *Interface Focus 3: 20130033.* (paper cover image)

In review:

Beckett S.J., Dominguez-Mirazo, M., Lee, S., Andris C., Weitz J.S. Spread of COVID-19 through Georgia, USA. Near-term projections and impacts of social distancing via a metapopulation model. *In review.* (preprint code)

Muratore D., Boysen A.K., Harke M.J., Becker K.W., Casey J.R., Coesel S.N., Mende D.R., Wilson S.T., Aylward F.O., Eppley J.M., Visolova A., Peng S., Rodgriguez-Gonzalez R.A., **Beckett S.J.**, Armbrust E.V., DeLong E.F., Karl D.M., White A.E., Zehr J.P., Van Mooy B.A.S,

Dyhrman S.T., Ingalls A.E., Weitz J.S. Community-scale Synchronization and Temporal Partitioning of Gene Expression, Metabolism, and Lipid Biosynthesis in Oligotrophic Ocean Surface Waters. *In review.* (preprint)

In preparation:

Beckett S.J.*, Demory D.*, Coenen A.R., Casey J.R., Follett C.L., Dugenne M., Connell P., Carlson M.C.G., Hu S.K., Wilson S.T., Muratore D., Rodriguez-Garcia R.A., Peng S., Becker K.W., Mende D.R., Armbrust E.V., Caron D.A., Lindell D., Follows M.J., White A.E., Ribalet F., Weitz J.S. Nonlinear feedbacks and diel population dynamics of cyanobacteria, viruses, and grazers in the North Pacific Subtropical Gyre. *In preparation.*

Conference Organisation

Co-convenor and moderator at *2018 Ocean Sciences Meeting* for the session: *A Matter of Life and Death: The Role of Microbial Interactions in Mediating Biogeochemical Cycles*. Co-lead with David Talmy (UTK), Kyle Mayers (SOTON) and Elizabeth Harvey (UGA). Portland, USA (2018).

Organiser for the *4th Postdoctoral Research Symposium at Georgia Tech.* Acquired $8,500 in funds for awards to outstanding presenters, organised sessions, reviewed abstracts and coordinated the symposium. I also convened the symposium. Atlanta, USA (2017).

Presentations

Invited Talks

Quantifying the ecological relevance of grazing and viral lysis in marine microbial communities. University of Illinois at Chicago, IL (USA), March 2020.

Computational Marine Microbiology: Linking cellular interactions to population dynamics and ecosystem function. Marine Biological Association, Plymouth (UK), June 2019.

Diel with it: Data-model comparisons of diel ecological oscillations around station ALOHA. *Simons Collaboration on Ocean Processes and Ecology Annual Meeting 2018,* Simons Foundation, NYC (USA), December 2018.

Quantifying the ecological relevance of viral lysis in complex microbial communities. Marine Biological Association & SAHFOS, Plymouth (UK), December 2017.

Estimating viral impacts on marine phytoplankton. *Microbial Dynamics seminar,* Georgia Institute of Technology, Atlanta (USA), October 2017.

Coevolved nestedness and modularity in model phage-bacteria infection networks. *Disease group seminar*, University of Exeter, Penryn Campus (UK), October 2013.

Contributed Talks

Centre for Microbial Dynamics and Infection at Georgia Tech: Quantifying the ecological relevance of grazing and viral lysis in marine microbial communities. Atlanta, GA (USA), March 2020.

Physics of Living Systems seminar at Georgia Tech: Quantifying the ecological relevance of grazing and viral lysis in marine microbial communities. Atlanta, GA (USA), February 2020.

5th Postdoctoral Research Symposium at Georgia Tech: Viral Lysis vs. Grazing: Perspectives on Phytoplankton Mortality. Atlanta, GA (USA), September 2018.

Aquatic Viral Workshop 9: Viral Lysis vs. Grazing: Perspectives on Phytoplankton Mortality. Lincoln, NE (USA), June 2018.

ASLO 2017 Aquatic Sciences Meeting: Robustness and biases in estimating viral-induced plankton mortality. Honolulu, Hawai`i (USA), March 2017.

Aquatic Viral Workshop 8: Towards Modifying the Modified Dilution Method: Robustness and Biases in Estimating Viral-Induced Plankton Mortality. Plymouth (UK), July 2016.

Living systems: from interaction patterns to critical behavior: Can coevolution drive phage-bacteria network structure? San Servolo Island, Venice (Italy), September 2015.

Student Conference on Complexity Sciences: The usage of nestedness for the analysis of bipartite networks. Brighton (UK), August 2014.

Mathematical Models in Ecology and Evolution: Coevolved Nestedness and Modularity in model Phage-Bacteria Infection Networks. York (UK), August 2013.

Posters (only presented posters shown)

Ocean Sciences Meeting 2020: **Beckett S.J.**, Demory D., Coenen A.R., Casey J.R., Follet C.L., Dugenne M., Connell P., Carlson M.C.G., Hu S.K., Muratore D., Wilson S.T., Rodriguez-Gonzalez R.A., Peng S., Becker K.W., Mende D.R., Armbrust E.V., Caron D., Lindell D., Follows M.J., White A., Ribalet F., Weitz J.S. A day in the life of *Prochlorococcus*: Diel ecological oscillations of cyanobacteria, viruses and grazers in the North Pacific Subtropical Gyre. San Diego, CA (USA), February 2020.

Simons Collaboration on Ocean Processes and Ecology Annual Meeting 2019: **Beckett S.J.**, Demory D., Coenen A.R., Casey J.R., Follet C.L., Dugenne M., Connell P., Carlson M.C.G., Hu S.K., Muratore D., Wilson S.T., Rodriguez-Gonzalez R.A., Peng S., Becker K.W., Mende D.R., Armbrust E.V., Caron D., Lindell D., Follows M.J., White A., Ribalet F., Weitz J.S. Estimating *Prochlorococcus* loss rates in north Pacific surface waters associated with viruses, grazers and "other". NYC (USA), December 2019.

Simons Collaboration on Ocean Processes and Ecology Annual Meeting 2018: **Beckett S.J.**, Demory D., Coenen A.R., Muratore D., Casey J., Follet C.L., Dugenne M., Wilson S.T., Follows M.J., White A.E., Ribalet F., Weitz J.S.. Diel with it: Data-model comparisons of diel ecological oscillations at Station ALOHA. NYC (USA), December 2018.

Ocean Sciences Meeting 2018: **Beckett S.J.**, Weitz J.S. The Effect of Strain Level Diversity on Inference of Grazing and Viral-Induced Mortality. Portland, OR (USA), February 2018.

Suddath Symposium: The Chemical Ecology of Microbiome Interactions: **Beckett S.J.**, Weitz J.S. Mortality in a bottle: nonlinear feedbacks and biases when inferring viral-induced lysis of plankton. Georgia Tech. (USA), January 2018.

Simons Collaboration on Ocean Processes and Ecology Annual Meeting 2017: **Beckett S.J.**, Weitz J.S. Mortality in a bottle: nonlinear feedbacks and biases when inferring viral-induced lysis of plankton. NYC (USA), December 2017.

Simons Collaboration on Ocean Processes and Ecology Annual Meeting 2016: **Beckett S.J.**, Lindell D., Caron D., Weitz J.S. Theoretical ecology at sea: interpreting mortality rate measurements. NYC (USA), December 2016.

NAKFI conference: Discovering the Deep Blue Sea: Research, Innovation, Social Engagement: **Beckett S.J.**, Weitz J.S. Competition, diversity and disease: implications for plankton mortality rates. Irvine, CA (USA), November 2016.

3rd Postdoctoral Research Symposium at Georgia Tech: **Beckett S.J.**, Weitz J.S. Towards Modifying the Modified Dilution Method: Robustness and Biases in Estimating Viral-induced Plankton Mortality. Atlanta, GA (USA), September 2016.

School of Biology retreat: **Beckett S.J.**, Weitz J.S. Towards Modifying the Modified Dilution Method: Robustness and Biases in Estimating Viral-induced Plankton Mortality. Helen, GA (USA), August 2016.

Viruses of Microbes 2016: **Beckett S.J.**, Weitz J.S. Towards Modifying the Modified Dilution Method: Robustness and Biases in Estimating Viral-induced Plankton Mortality. Liverpool (UK), July 2016.

Simons Collaboration on Ocean Processes and Ecology Annual Meeting 2015: **Beckett S.J.**, Wigington C.H., Weitz J.S. Diel or no diel? Effectiveness of the dilution method for determining host mortality rates due to viruses. NYC (USA), December 2015.

Uncertainty in Interaction Networks: **Beckett S.J.**, Williams H.T.P. Coevolved nestedness and modularity in phage-bacteria infection networks. Bath (UK), June 2013.

Cambridge Networks Day: **Beckett S.J.**, Williams H.T.P. Coevolved nestedness and modularity in phage-bacteria infection networks. Cambridge (UK), May 2013.

Modelling Biological Evolution 2013: Recent Progress, Current Challenges and Future Directions: **Beckett S.J.**, Williams H.T.P. Coevolved nestedness and modularity in phage-bacteria infection networks. Leicester (UK), May 2013.

Viruses of Microbes 2012: **Beckett S.J.**, Williams H.T.P. Towards trait-based models for aquatic virology. Brussels (Belgium), July 2012.

Teaching experience

Guest lectures: (1) Predator-prey dynamics and evolutionary ecology **(2)** Evolutionary ecology and adaptive dynamics. "*Foundations of Quantitative Biosciences*". October/November 2017, October/ November 2018, October 2019. School of Biological Sciences, Georgia Institute of Technology. **(3)** Predator-prey dynamics and evolutionary ecology. "*Special Topic: Physics of Living Systems*". February 2018. School of Physics, Georgia Institute of Technology.

Seminars: Professional development seminar focussing on the review process for the Quantitative Biosciences Graduate Program. May 2019. Georgia Institute of Technology.

Workshop: Instructor for Georgia Tech. Quantitative Biosciences Workshop 2020: Epidemics.

Teaching assistant: multiple courses including "*Introduction to Ecology*" and "*Modelling for Biosciences*". 2012-2015. Biosciences, University of Exeter.

Professional community service

Mentorship

Co-mentored with **Joshua Weitz** at the Georgia Institute of Technology:

1) Quan Nguyen, Undergraduate Researcher in Chemical and Biomolecular Engineering (2020 –)
- – Developing interactive COVID-19 situation and risk dashboards for Georgia and Europe.
- – Research contributed to the manuscript "Real-time, interactive website for US-county-level COVID-19 event risk assessment."

2) Robert Morgan, Undergraduate Researcher in Biological Sciences (2019 – 2020)
- – Visualization of and interactive tutorials for ecological models. Supported Robert in applying for a President's Undergraduate Research Awards at Georgia Tech.

3) GuanLin Li, PhD candidate in Quantitative Biosciences (2018 – 2019)
- – Timeseries inference and evolutionary dynamics of virus-microbe systems.

4) Adam Zhang, Undergraduate Researcher in Mathematics (2017 – 2018)
- – Research contributed to the manuscript: "Contrasting controls on microzooplankton grazing and viral infection of microbial prey".
- – Adam completed a Data Science Internship at UPS and is now an Analyst at Variant.

5) Daniel Muratore, PhD candidate in Quantitative Biosciences (2017 – 2019)
- – Microbial oceanographic modelling.
- – Game theoretic models of microbial ecology and data analysis of multiple time-series.

6) Ashley Coenen, PhD candidate in Physics (2016 –)
- – Inferring ecological community structure from population dynamics.

7) Charles Wigington, PhD in Bioinformatics (2016 – 2017)
- – Quantifying relationships of oceanic virus-to-microbe ratios.
- – Charles is now a Data Scientist at Insulet Corporation.

8) Shengyun Peng, PhD in Bioinformatics (2015 – 2018)
- – Investigating virus-host infection from single cell and genomic perspectives.
- – Shengyun is now a Data Scientist with Adobe.

Scientific peer review

Reviewer for: Nature Communications, The ISME Journal, PLOS Computational Biology, Limnology and Oceanography, FEMS Microbiology Ecology, Ecology Letters, Methods in Ecology and Evolution, PLOS ONE, IEEE Access, Network Science, Viruses, Communications Biology, Molecular Ecology, Journal of Biological Physics, Applied Network Science, BMJ Open, Frontiers in Genetics, Physica A: Statistical Mechanics and its Applications, Axios Reviews, Concurrency & Computation: Practice & Experience, Europhysics Letters, Evolutionary Bioinformatics, Knowledge and Information Systems, IEEE Transactions on Computational Social Systems.

Memberships
Association for the Sciences of Limnology and Oceanography (ASLO); International Society for Viruses of Microorganisms (ISVM); National Postdoctoral Association (NPA)

Outreach

- Collaboration with Mary Wang (Georgia Tech.) and Science.Art.Wonder to promote science through art (ongoing).
- Collaborative work contributing to interactive COVID-19 event risk map dashboards for regional areas in multiple countries (implementation ongoing).
- Interactive data visualisation of COVID-19 metrics in Georgia as an interactive Rshiny app.
- Data Visualisations of COVID-19 spread in Georgia, showing time-lapses for recorded cases and deaths. April 2020.
- Hosted the science communication Twitter account @biotweeps (audience of over 18,000) for a week in March 2019, where I talked about modelling and marine viruses.
- Collaboration with Emily Madsen (Georgia Tech.) and Science.Art.Wonder to promote science via art. December 2018-April 2019. Atlanta Science Festival and Clough Art Crawl.
- Collaboration with ceramic sculptor RJ Sturgess (Georgia State) and Science.Art.Wonder to promote science through art at the Atlanta Science Festival. December 2017 - March 2018.
- Educator supporting a massive open online course (MOOC) run by the University of Exeter and FutureLearn titled "*Climate Change: Challenges and Solutions*". Engaged with learners online and via weekly feedback videos. 2014.
- Run "Phage on toast" where I occasionally blog about my research and research experiences. Over 1000 visitors from 64 countries. (2013 – present).

Media

- **Beckett S.J.**, Weitz J.S. 2020. Georgia's Reopening Depended on Missing Data. *Slate* (Medical Examiner column). May 2020.

Press

- **WDAF-TV Kansas City -** Thanksgiving plans this year may be changing due to COVID-19
- **WHBQ-TV Memphis -** Researchers develop new risk calculation tool for COVID-19 exposure
- **KSNV News 3 Las Vegas -** Tool shows risk of catching COVID-19 in group settings
- **KADN News15, Lafayette & Acadiana -** COVID-19 Risk Assessment Map
- **MetroLab/Government Technology:** Mapping Tool Visualizes COVID Risk of Different-Size Events. October 2020 Innovation of the month.
- **Business Insider:** A 'cuckoo' graph with no sense of time or place shows how Georgia bungled coronavirus data as it reopens
- **WABE:** Social Distancing Reduced Virus Spread By 50% In Georgia, Study Finds
- **GaTech College of Sciences:** Science Inspiring Art

Other service

- Reviewer for President's Undergraduate Research Awards at Georgia Tech. Atlanta (2019).
- Judged at the *12th Annual Undergraduate Research Spring Symposium*, Georgia Tech. Atlanta, USA (2017).
- Lead GitHub demonstrations within the Weitz group at Georgia Tech to improve and aid the production of reproducible computational science (2015, 2016).
- Helped run the Exeter Climate Change Exhibit at *Transformational Climate Science* conference. Exeter, UK (2014).
- Session chair at *Mathematical Models in Ecology and Evolution*. York, UK (2013).

Laboratory Experience

- *Mortality Workshop*. Technion-Israel Institute of Technology, Haifa, Israel (Sept., 2019).

References

Prof. **Joshua Weitz**
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