

Ryan M. Mushinski

Associate Professor - Environmental Microbiology
School of Life Sciences | University of Warwick
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Primary Research Focus: Microbial biogeochemistry in terrestrial environments

Lab Webpage: www.ryanmushinski.com

Warwick Webpage: <https://warwick.ac.uk/fac/sci/lifesci/people/rmushinski/>

Google Scholar Index: <https://bit.ly/2xwRDDT>

Education & Training

Post Doc | Microbial Biogeochemistry | Indiana University | 2017 – 2020

Advisors: Richard P. Phillips, Jonathan D. Raff, and Jeffrey R. White

Ph.D. | Ecosystem Science (Biogeochemistry Focus) | Texas A&M University | 2013 – 2017

Dissertation: *Decade-Scale Influences of Org. Matter Removal on Forest Soil Biogeochemistry and Microbial Ecology*

Advisors: Thomas W. Boutton and Terry J. Gentry

B.S. | Biology, *Cum Laude* | Texas State University | 2009 – 2012

Undergraduate Research Concentration: Organometallic Chemistry

Advisor: Todd W. Hudnall

Appointments

Associate Professor | December 2023 – Current

School of Life Sciences, University of Warwick, Coventry, United Kingdom

Assistant Professor | February 2020 – December 2023

School of Life Sciences, University of Warwick, Coventry, United Kingdom

USDA-NIFA Postdoctoral Fellow | June 2019 – February 2020

School of Public and Environmental Affairs, Indiana University, Bloomington, IN, USA

Postdoctoral Research Scientist | June 2017 – June 2019

Integrated Program in the Environment, Indiana University, Bloomington, IN, USA

McMillan-Ward Graduate Research Fellow | August 2014 – May 2017

Department of Ecosystem Science & Management, Texas A&M University, College Station, TX, USA

Graduate Merit Fellow | August 2013 – July 2014

Texas A&M University, College Station, TX, USA

Funded Research Grants as Project Leader (*all amounts are full economic cost*)

A Radical Source Revealed in Soil: Biogenic Nitrous Acid Production and Effects on Carbon and Nitrogen Cycling. NERC Pushing the Frontiers, 2025-2028, £949,774; **PI: Ryan Mushinski**; Co-I's: Gary Bending, James Covington

NitroNexus – An international partnership to explore agronomic soil contributions to nitrogenous atmospheric pollutants. BBSRC International Institutional Partnership Fund, 2024, £24,723, **PI: Ryan Mushinski**; Co-I's: Trevor VandenBoer, Jonathan Raff.

Uncharacterised microbial pathways are key to understanding large fluxes of biogenic reactive nitrogen gases from agronomic soils. BBSRC Responsive Mode, 2023-2026, £724,973; **PI: Ryan Mushinski**

Utilising genomics to better understand soil emissions of reactive nitrogen oxides. NERC Environmental Omics facility, 2022-2023, £11,274; **PI: Ryan Mushinski.**

Development of a multiplexed chamber system for measuring reactive gases. The Royal Society, 2021-2022, £19,902; **PI: Ryan Mushinski**

An isotope ratio mass spectrometer system to enhance analytical capability throughout Warwick University. Warwick's Academic Equipment Fund (Internal), 2022-2023, £276,000;

PI: Ryan Mushinski; Co-I's: Gary Bending, Hendrik Schafer, Kevin Purdy.

Towards a predictive framework for quantifying fluxes of nitrogen oxides in forest soils. United States Department of Agriculture – National Institute of Food & Agriculture, 2019-2021, \$161,500;

PI: Ryan Mushinski

Involvement in Other Funded Projects

Soil-SENSE: Soil greenhouse gas Sensing for Spatial and Temporal Emissions. EPSRC Impact Accelerator Account. 2024-2025. PI: James Covington. **Ryan Mushinski involved as Co-Lead (2% FTE)**

NutriSTORM: Nutrient Soil Stoichiometry Transformation for Optimized Resource Management. DEFRA as part of The Green ERA-Hub. 2024-2027. PI: Gary Bending. **Ryan Mushinski involved as Co-Lead (2.5% FTE)**

Horizontal gene transfer of cyanobacterial carbon fixing machinery: Implications for the rise of modern atmospheric oxygen. NERC Pushing the Frontiers, 2024-2027. PI: Richard Puxty. **Ryan Mushinski involved as specialist (2.4 % FTE)**

Peer-Reviewed Publications (*indicates student supervision)

- [26] *Lazar A, Griffiths RI, Goodall T, Norton LR, **Mushinski RM**, Bending GD. 2024. Regional scale diversity and distribution of soil inhabiting *Tetracladium*. Environmental Microbiome, 19, 111.
- [25] Bending GD, Newman A, Picot E, **Mushinski RM**, Jones DL, Carre IA. **2024**. Diurnal rhythmicity in the rhizosphere – Mechanistic insights and significance for rhizosphere function. Plant Cell, & Environment, 48, 2040-2052.
- [24] *Lazar A, Phillips RP, Kivlin S, Bending GD, **Mushinski RM**. **2024**. Understanding the ecological versatility of *Tetracladium* species in temperate forest soils. Environmental Microbiology 26, e70001.
- [23] Xiao J, Wang D, Banerjee S, **Mushinski RM**, Jin D, Deng Y. **2024**. Response patterns of the microbiome during hexavalent chromium remediation by *Tagetes erecta* L. Science of the Total Environment 935:173413.
- [22] **Mushinski RM**, Zhou Y, Hyodo A, Casola C, Boutton TW. **2024** Interactions of long-term grazing and woody encroachment can shift soil biogeochemistry and microbiomes in savanna ecosystems. Geoderma 441, 116733.
- [21] *Purchase ML, Bending GD, **Mushinski RM**. **2023** Spatiotemporal variations of soil reactive nitrogen oxide fluxes across the anthropogenic landscape. Environmental Science & Technology 57, 16348–16360.
- [20] Hassan S, **Mushinski RM**, Amede T, Bending GD, Covington JA. **2023**. Integrated probe system for measuring soil carbon dioxide concentrations. Sensors 23, 2580.
- [19] Zhang Q, Boutton TW, Hsiao CJ, **Mushinski RM**, Wang L, Bol R, Klumpp E. **2023**. Soil colloidal particles in a subtropical savanna: Biogeochemical significance and influence of anthropogenic disturbances. Geoderma 430, 116282.
- [18] *Lazar A, **Mushinski RM**, Bending GD. **2022**. Landscape scale ecology of *Tetracladium* spp. fungal root endophytes. Environmental Microbiome 17, 40.
- [17] Eagar AC, **Mushinski RM**, Horning AL, Smemo KA, Phillips RP, Blackwood CB. **2021**. Arbuscular mycorrhizal tree communities have greater soil fungal diversity and relative abundances of saprotrophs and pathogens compared to ectomycorrhizal tree communities. Applied and Environmental Microbiology 88, e01782-21.
- [16] Li C, Liu L, Zhang L, Yu Y, **Mushinski RM**, Zhou Y, Xiao X. **2021**. Greater soil water and nitrogen. availability increase C:N ratios of root exudates in a temperate steppe. Soil Biology and Biochemistry 161, 108384.
- [15] **Mushinski RM**, Payne ZC, Raff JD, Craig ME, Pusede SE, Rusch DB, White JR, Phillips RP. **2021**. Nitrogen cycling microbiomes are structured by plant mycorrhizal associations with consequences for nitrogen oxide fluxes in forests. Global Change Biology 27, 1068-1082.
- [14] Beidler KV, Phillips RP, Andrews E, Maillard F, **Mushinski RM**, Kennedy PG. **2020**. Substrate quality drives fungal necromass decay and decomposer community structure under contrasting vegetation types. Journal of Ecology 108, 1845-1859.
- [13] **Mushinski RM**, Phillips RP, Payne ZC, Abney RA, Jo I, Fei S, Pusede SE, Rusch DB, White JR, Rusch DB, Raff JD. **2019**. Microbial mechanisms and ecosystem flux estimation for aerobic NO_y emissions from deciduous forest soils. Proceedings of the National Academy of Sciences 116, 2138-2145.

Peer-Reviewed Publications *cont.*

- [12] **Mushinski RM**, Gentry TJ, Boutton TW. **2019**. Forest organic matter removal leads to long-term reductions in bacterial and fungal abundance. Applied Soil Ecology 137, 106-110.
- [11] Hyodo A, Malghani S, Zhou Y, **Mushinski RM**, Toyoda S, Yoshida N, Boutton TW, West JB. **2018**. Biochar amendment suppresses N₂O emissions but has no impact on ¹⁵N site preference in an anaerobic soil. Rapid Communications in Mass Spectrometry 33, 165-175.
- [10] **Mushinski RM**, Gentry TJ, Boutton TW. **2018**. Organic matter removal associated with forest harvest leads to decade scale alterations in soil fungal communities and functional guilds. Soil Biology and Biochemistry 127, 127-136.
- [9] Zhou Y, **Mushinski RM**, Boutton TW, Wu XB. **2018** Vegetation change alters soil profile $\delta^{15}\text{N}$ values at the landscape scale. Soil Biology and Biochemistry 119, 110-120.
- [8] **Mushinski RM**, Zhou Y, Gentry TJ, Boutton TW. **2018** Bacterial metataxonomic profiling and putative functional behavior associated with C and N cycle processes remain altered for decades after forest harvest. Soil Biology and Biochemistry 119, 184-193.
- [7] **Mushinski RM**, Gentry TJ, Dorosky RJ, Boutton TW. **2017**. Forest harvest alters inorganic nitrogen pool sizes and ammonia oxidizer community composition. Soil Biology and Biochemistry 112, 216-227.
- [6] **Mushinski RM**, Boutton TW, Scott DA. **2017**. Decade-scale changes in forest soil carbon and nitrogen storage are influenced by organic matter removal during timber harvest. Journal of Geophysical Research-Biogeosciences 122, 846-862.
- [5] Ugarte RA, Devarajan D, **Mushinski RM**, Hudnall TW. **2016**. Antimony(V) cations for sequential and selective catalytic transformation of aldehydes into symmetric ethers, α,β -unsaturated aldehydes, and 1,3,5-trioxanes. Dalton Transactions 45, 11150-11161.
- [4] Dorsey CL, **Mushinski RM**, Hudnall TW. **2014**. Metal-free stabilization of monomeric antimony(I): A carbene-supported stibinidene. Chemistry-A European Journal 20, 8914-17.
- [3] Johnson DW, Yum JH, Hudnall TW, **Mushinski RM**, Bielawski CW, Roberts JC, Wang WE, Banerjee SK, Harris HR. **2013**. Characterization of ALD beryllium oxide as a potential high-k gate dielectric for low leakage AlGaN/GaN MOSHEMTs. Journal of Electronic Materials 43,151
- [2] Yum JH, Shin HS, Hill R, Oh J, Lee HD, **Mushinski RM**, Hudnall TW, Bielawski CW, Banerjee SK, Loh WY, Wang WE, Kirsch P. **2012**. A study of capping layers for sulfur monolayer doping on III-V junctions. Applied Physics Letters doi:10.1063/1.4772641.
- [1] **Mushinski RM**, Squires BS, Sincerbox KA, Hudnall TW. **2012**. Amino-acrylamido carbenes: Modulating carbene reactivity via decoration with an α,β -unsaturated carbonyl moiety. Organometallics 31, 4862- 4870.

Research Manuscripts Under Review (*indicates student supervision)

- *Purchase ML, Raff JD, Gale AG, Vaughan A, Bending GD, **Mushinski RM**. Dynamics of Reactive Oxygen Species and Nitrogen Cycling in Soils as a Mechanism for Volatile Reactive Nitrogen Oxide Production. Submitted to *Microbiome*, <https://doi.org/10.1101/2024.11.29.625130>
- *Cole J, Raguideau S, Abbaszadeh-Dahaji P, Hilton S, Muscatt G, **Mushinski RM**, Nilsson RH, Ryan MH, Quince C, Bending GD. Comparative genomic analysis of a metagenome-assembled genome reveals distinctive symbiotic traits in a Mucoromycotina fine root endophyte arbuscular mycorrhizal fungus. Submitted to *New Phytologist*, <https://doi.org/10.1101/2024.11.27.625642>
- *Lazar A, Alberti F, Muscatt G, Mushinski RM, Quince C, Bending GD. Genomic insights into the ecological versatility of Tetracladium spp. Submitted to *BMC Genomics*.

Refereed Proceedings Article

Yum JH, Shin HS, **Mushinski RM**, Hudnall TW, Oh J, Loh WY, Bielawski CW, Bersuker G, Banerjee SK, Wang WE, Kirsch PD, Jammy R. **2013**. A comparative study of gate first and last Si MOSFETs fabrication processes using ALD beryllium oxide as an interface passivation layer, 2013 International Symposium on VLSI Technology, Systems and Application (VLSI-TSA), pp. 1-2. Hsinchu, Taiwan. doi: 10.1109/VLSI-TSA.2013.6545611

Presentations (*presenting author only; *invited*)

- Mushinski RM**, Purchase ML, Phillips RP, Raff JD, Phelps A, Huenupi E, Lau J. **2025**. Periodic Cicada Mass Mortality Events Drive Microbial-Mediated Gas Pulses from Forest Soils. European Geosciences Union 2025, Abstract: EGU25-5842.
- Mushinski RM**, Purchase ML, Lietzke CJ, Gandolfo A, Phillips RP, Raff JD, Huenupi EP. **2023**. They Came from Below: The Microbiology Behind Cicada-Induced Biogeochemical Pulses in Forest Ecosystems. American Geophysical Union 2023, Abstract: B54B-08
- *Mushinski RM. 2022**. Towards a better understanding of nitrogen feedbacks in the wake of global change. University of Manchester, 20 May 2022.
- *Mushinski RM. 2021**. Biogeochemical sources and fates of reactive nitrogen oxides. Warwick's Chemical, Structural, and Synthetic Biology Seminar Series, 7 December 2021.
- *Mushinski RM. 2021**. Using mycorrhizal categories to better define soil nitrogen cycling in temperate forests. Smithsonian ForestGEO Seminar Series, 21 April 2021.
- Mushinski RM**, Raff JD, Phillips RP, Payne ZC, Pusede SE, Rusch DB, White JR. **2019**. A microbiological perspective on forest soil emissions of nitrogen oxides in a changing world. American Geophysical Union 2019, Abstract: A32D-02.
- Mushinski RM**, Phillips RP, Payne ZC, Pusede SE, Rusch DB, White JR, Rusch DB, Raff JD. **2019**. Low nitrate production limits nitrogen oxide emissions in ectomycorrhizal forest soil. Joint Genome Institute's (JGI) User Meeting, Abstract: 104.
- Mushinski RM**, Phillips RP, Payne ZC, Abney RA, Jo I, Fei S, Pusede SE, White JR, Rusch DB, Raff JD. **2019**. Microbial mechanisms and ecosystem flux estimation for aerobic NO_y emissions from deciduous forest soils. SSSA International Soils Meeting, Abstract: 209-2.
- Mushinski RM**, Payne ZC, Rusch DB, White JR, Phillips RP, Raff JD. **2018**. Ammonia-oxidizing archaea are the dominate nitrifiers in two Midwestern (USA) forest types, but do not contribute to nitric oxide production. 2018 Environmental System Science PI Meeting, Abstract: D35.
- Mushinski RM**, Zhou Y, Gentry TJ, Boutton TW. **2017**. The relative abundance of predicted genes associated with ammonia-oxidation, nitrate reduction, and biomass decomposition in mineral soil are altered by intensive timber harvest. Annual Meeting of the American Geophysical Union 2017, Abstract: B14B-03.
- Mushinski RM**, Boutton TW, Gentry TJ, Dorosky RJ. **2016**. Ammonia oxidizing archaea are the predominant nitrifiers in disturbed and undisturbed southern pine forests. Annual Meeting of the American Geophysical Union 2016, Abstract: B12B-03.
- Mushinski RM**, Boutton TW. **2015**. Nitrifying community and N-cycle activity are reduced by increasing forest harvest intensity in surface and subsurface soils in the western gulf coastal plain. Soil Science Society of America Annual Meeting 2015, Abstract: 93694.
- Mushinski RM**, Boutton TW, Gentry TJ. **2015**. Bacterial and archaeal ammonia oxidizers are reduced by increasing timber harvest intensity in surface and subsurface soils of the western Gulf Coastal Plain. Abstracts, 7th Annual Argonne National Laboratory Soil Metagenomics Meeting, Naperville, Illinois, Abstract: 21.
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Professional Affiliations

European Geosciences Union | December 2024 - Current
British Ecological Society | July 2021 - Current
American Society for Microbiology | January 2017 – Current
International Society for Microbial Ecology | June 2016 – Current
Soil Science Society of America | June 2015 – Current
American Geophysical Union | January 2014 – Current
American Chemical Society | March 2010 – Current

Awards

2017 Most Outstanding PhD Student: Dept. of Ecosystem Science, Texas A&M University
2016 1st Place (Oral Presentation): Univ. Houston Ecology & Evolutionary Biology Symposium
2016 Best Oral Presentation: 53rd Annual Soil Survey & Land Resource Workshop
2016 George Bush Presidential Library Foundation Travel Grant
2015 Robert Luxmoore Travel Award, Soil Science Society of America
2014 McMillan-Ward Memorial Graduate Fellowship, Texas A&M University
2013 Texas A&M University/Association of Former Student: Graduate Merit Fellowship
2013 College of Agriculture & Life Sciences Excellence Fellowship, Texas A&M University
2012 NSF Research Experience for Undergraduates, Dept. of Microbiology, Texas A&M University
2012 Alpha Chi Honor Society Induction, Texas State University
2011 Most Outstanding Biology Undergraduate, Dept. of Biology, Texas State University

Teaching

2023-Current Lecturer for **Environmental Biology Field Lab** (Warwick)
2023-2025 Field Course Group Leader for **Central England NERC Training Alliance**
2022 **Fellow of the Higher Education Academy** (UK, Ref: PR234784)
2021-Current Lecturer for **Central England NERC Training Alliance** (University of Birmingham)
2021-Current Module Leader and Lecturer for **Environmental Biology** (University of Warwick)
2020-Current Lecturer for Years 1-3 **Life Sciences** Tutorial (University of Warwick)
2015-2016 Instructor of Record for UG **Fundamentals of Ecology** (Texas A&M University)
2011 **Pedagogy Certificate in Secondary Education** (Texas State University)

Other Academic Activities

Service & Administration

2024-Current Warwick Director – Central England NERC Training Alliance
2023-Current Senior Postgraduate Research Tutor
2022-2025 Member – School of Life Sciences (Warwick) Pump Priming Award Committee
2021-2025 Co-Lead – Environment & Ecology Res.Cluster, School of Life Sciences (Warwick)
2015 President – Ecology Graduate Student Association (Texas A&M University)

Scholarship

Editorial Board Member, *Journal of Sustainable Agriculture and the Environment*

Review College Member, *British Ecological Society*

Have served as content reviewer for:

PNAS; Nature Communications; Science Advances; Atmospheric Chemistry & Physics; Biogeochemistry; Biology and Fertility of Soils; Catena; Geoderma; Pedosphere; Plant Ecology; Soil Biology and Biochemistry

Postdoctoral Fellows Supervised

Deying Wang*, 2023 – Current, University of Warwick

PhD Students Supervised

 (Served as *Primary Supervisor; §Co-Supervisor)

Beth Taylor*, 2025 – Current, University of Warwick

Alannah Vaughn*, 2023 – Current, University of Warwick

Shuaizhi Guo*, 2022 – Current, University of Warwick

Rachel Jackson§, 2022 – Current, University of Warwick (Co-supervised with Gary Bending)

Josh Cole§, 2022 – Current, University of Warwick (Co-supervised with Gary Bending)

Megan Purchase*, 2021-2025, University of Warwick

Jessica Chadwick§, 2020-2024, University of Birmingham (Co-supervised with Iseult Lynch)

Anna Lazar§, 2020-2024, University of Warwick (Co-supervised with Gary Bending)

Masters Students Supervised

Lixian Yang, 2024, *Impact of Tree Species Composition on Sulfur Metabolism in Forests*
Haoqiang Meng, 2023, *Ammonia oxidiser diversity and function across a land-use continuum*
Phoebe Scott, 2022 – 2023, *The spatial distribution of nitrifying bacteria between soil compartments.*
Peggy McGroary, 2022, *Connecting root dynamics to nitrogen cycle rates in woodland soil*
Jingyi Shi, 2021, *Nitrogen gas flux and plant growth along a gradient of nano-fertilizer additions*

Other Academic Activities cont.

Undergraduate Research Projects Supervised

2025

Celine Waez, *Baseline survey of soil chemistry for Warwick's EcoPark*
Daisy Johnson, *Baseline survey of soil microbiology for Warwick's EcoPark*
Josh Lee, *Effect of rooting morphology in wheat on soil nitrogen cycling microbiomes*

2024

Amy Phelps, *Effects of Brood X Periodical Cicada Decomposition on Soil Nitrogen Cycling*
Mia Dempsey, *Understanding the drivers of sulphur cycling in forest ecosystems*
Emily Crellin, *Contrasting Biogeochemical Composition of Intact and Collapsed Peatland*
Benedict Rivera, *Interplay between root architecture and the rhizosphere microbiome*
Anthony Gordon, *Evaluating carbon capture technologies as a mitigation strategy for climate change*

2023

Sali Sawo Jadama, *Effect of Miyawaki forest protocol on soil biogeochemistry*
Ethan Martindale, *Peat depth effects on microbial community activity*
Alex Gale, *Distribution of organic matter fractions across the anthropogenic landscape*

2022

Bhumi Patel, *Investigating mechanisms of reactive nitrogen production in the environment.*
Jocelyn Mitchell, *Do nitrogen cycle microbes co-occur with mycorrhizae in forest soil?*
Duncan Webb, *Does forest tree composition influence the structure of soil microbial communities?*

2021

Kate Arsac, *Does forest tree composition influence the structure of soil microbial communities?*
Alin Petz, *How do antibiotics influence fluxes of nitrogen gases in aquatic ecosystems?*
Tom Power, *Growth and activity of ammonia-oxidizers.*

Other Team Members Supervised

Alex Thorpe, Lab Manager & Senior Research Technician, 2023-2024
Neale Grant, Lab Manager & Senior Research Technician, 2021-2023