Andrew D. Steen

Assistant Professor
Department of Microbiology
Department of Earth and Planetary Sciences
University of Tennessee, Knoxville

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Expertise and interests

Geomicrobiology of aquatic systems, microorganism-organic matter interactions, metaanalyses, data science for microbial ecology

Education and Professional Experience

2014-present Assistant Professor, University of Tennessee, Knoxville
- 2014-2020: Department of Earth and Planetary Sciences
  - 2018-2019: Director of Environmental Studies concentration
  - 2014-2018: Assistant Director of Environmental Studies concentration
- 2020-present: Departments of Microbiology and Earth and Planetary Sciences

2012-2014 Research Assistant Professor, University of Tennessee, Knoxville
2009-2011 Postdoctoral Associate, Center for Geomicrobiology, Aarhus University, Denmark
2009 Ph.D., Marine Sciences, University of North Carolina at Chapel Hill
2005 M.S., Marine Sciences, University of North Carolina at Chapel Hill
2000 Sc.B. with honors in Chemistry, Brown University

Federal Funding

2019-2022 **Steen, AD,** C Coleman-King, S Drumheller-Horton, K Rearden: "GP-IMPACT: ICE-AGE: Integrating Continuous Experiential Activities for Geoscience Education." NSF Improving Undergraduate STEM Education Grant 1911565. *$390,424.*

2019-2022 Lloyd, KG, J Cliff, R Hettich, TC Onstott, **AD Steen**, T Vishnivetskaya: "Using culture-independent methods to link active compound-specific carbon degradation to greenhouse gas production and recycling in natural populations of permafrost microbes". Department of Energy Biological and Environmental Research Grant DE-SC0020369. *$3,320,280, $555,016 to Steen*.

2017 LaRowe, DA, **AD Steen**: "Proposal for a workshop: Microorganisms and Organic Carbon in the Marine Subsurface". NSF/Center for Dark Energy Biosphere Investigations (C-DEBI). *$22,800*.

2016 McKay, LD, SP Horn; **AD Steen** as senior personnel: "GP-IMPACT: Engagement of Students and Faculty at Community Colleges to Enhance Recruitment to 4-Year Geoscience Programs". NSF-ICER. *$415,988, $24,952 to Steen*.

2014-2016 Lloyd, KG, **AD Steen**: "Organic matter degradation pathways and cell specific enzyme activities in uncultured microorganisms found in deep sediments of the Baltic Sea, IODP Leg 347". NSF Division of Ocean Sciences grant OCE-1431598. *$362,095 total award, $117,994 to Steen.*

2014-2017 A Buchan, **AD Steen**, A Stubbins, RG Spencer: "Collaborative Research: Marine priming effect – molecular mechanisms for the biomineralization of terrigenous dissolved organic matter in the ocean." NSF Division of Ocean Sciences grant OCE-1357242. *$997,364 total; $162,383 to Steen*.

2013-2014 **Steen, AD**: "Novel Peptidases in Subsurface Sediments: Activities and Substrate Specificities": NSF/Center for Dark Energy Biosphere Investigations (C-DEBI). *$49,970.*

2013-2014 KG Lloyd, **AD Steen**: NSF/Center for Dark Energy Biosphere Investigations (C-DEBI): "Comparative metagenomics of deep subsurface microbial communities". *$148,422 total, $32,460 to Steen.*

Competitive Funding from Other External Sources

2019 **Co-I:** "Diversity of functional genes in deeply branching uncultured microbes". XSEDE computational resource allocation. *1,600 node-hours at Texas Advanced Computing Center plus support from project specialist.*

2015 **AD Steen**: "Enzyme lability of sedimentary organic carbon". Deep Carbon Observatory. *$22,688*.

Competitive Internal Funding

2018 **Lead PI:** "High performance computing approaches to identify novel genetic potential in uncultured microorganisms across the tree of life." Joint Institute for Computational Sciences Collaborative Grant. *In-kind grant of computational and technician resources. Approximate equivalent value of $20,000*.

2018-2019 **Lead PI:** "Novel pathways for microcystin degradation in aquatic environments." UTK Multidisciplinary SEED grant. *$66,010*.

2015 **Lead PI:** "Root mark analysis utilizing citizen science." UT Outreach Incentive Grant, *$2000.*

2014 **Lead PI:** SARIF award: "Request for a High-Performance Liquid Chromatography system with fluorescence and photodiode-array detectors for environmental science". UTK SARIF award (internal) *$23,808.*

Publications

†Undergraduate or high school students or teachers under my supervision

*Graduate students or postdocs under my supervision

Published papers and manuscripts in press

41. CJ Paradis, JI Miller, J-W Moon, SJ Spencer, LM Lui, JD Van Nostrand, D Ning, **AD Steen**, LD McKay, AP Arkin, J Zhou, EJ Alm, TC Hazen (2022). Sustained ability of a natural microbial community to remove nitrate from groundwater. *Groundwater*. 60(1) 99-111. DOI: 10.1111/gwat.13132
    As a member of the lead author's dissertation committee, I provided input on the design of the experiments and on the text of the dissertation chapter which became this manuscript.
40. *Schmidt, JM, *TM Royalty, KG Lloyd, **AD Steen** (2021). Potential activities of organic carbon degrading extracellular enzymes in deep subsurface sediments of the Baltic Sea. *Frontiers in Microbiology* 12:702015. DOI: 10.3389/fmicb.2021.702015
    I was lead author Jenna Schmidt's Masters' advisor. I designed the project and wrote much of the manuscript.
39. Fullerton KM, MO Schrenk, M Yücel, E Manini, M Basili, TJ Rogers, D Fattorini, M Di Carlo, G d'Errico, F Regoli, M Nakagawa, C Vetriani, F Smedile, C Ramírez, H Miller, SM Morrison, J Buongiorno, GL Jessen, **AD Steen**, M Martínez, JM de Moor, PH Barry, D Giovannelli, KG Lloyd (2021). Effect of tectonic processes on biosphere-geosphere feedbacks across a convergent margin. *Nature Geoscience*. DOI: 10.1038/s41561-021-00725-0
    I created a model of cell abundances in Earth's crust which was necessary for calculations that the manuscript conclusions were based on.
38. **Steen AD**, S Kusch, H Abdulla, N Cakić, S Coffinet, T Dittmar, J Fulton, V Galy, K-U Hinrichs, A Ingalls, B Koch, E Kujawinski, Z Liu, H Osterholz, D Rush, M Seidel, J Sepúlveda, SG Wakeham. Analytical and computational advances, opportunities, and challenges in marine biogeochemistry in an era of "omics" (2020). *Frontiers in Marine Science*. 7:718 DOI: 10.3389/fmars.2020.00718

I led the preparation of this review, including designing the overall form of the review, soliciting contributions from subject-matter experts, and rewriting the text into a cohesive unit.

37. Murray, AE, J Freudenstein, S Gribaldo, R Hatzenpichler, P Hugenholtz, P Kämpfer, KT Konstantinidis, CE Lane, RT Papke, DH Parks, R Rosselló-Móra, MB Stott, IC Sutcliffe, JC Thrash, SN Venter, WB Whitman, SG Acinas, RI Amann, K Anantharaman, J Armengaud, BJ Baker, RA Barco, HB Bode, ES Boyd, CL Brady, P Carini, PSG Chain, DR Colman, KM DeAngelis, MA de los Rios, P Estrada-de los Santos, CA Dunlap, JA Eisen, D Emerson, TJG Ettema, D Eveillard, PR Girguis, U Hentschel, JT Hollibaugh, LA Hug, WP Inskeep, EP Ivanova, H-P Klenk, W-J Li, KG Lloyd, FE Löffler, T Makhalanyane, DP Moser, T Nunoura, M Palmer, V Parro, C Pedrós-Alió, AJ Probst, THM Smits, **AD Steen**, ET Steenkamp, A Spang, FJ Stewart, JM Tiedje, P Vandamme, M Wagner, FP Wang, BP Hedlund, A-L Reysenbach (2020). A roadmap for naming uncultivated microorganisms. *Nature Microbiology*. DOI: 10.1038/s41564-020-0733-x

    I provided edits on this "consensus statement".

36. LaRowe, DA, S Arndt, J Bradley, E Estes, A Hoarfrost, SM Lang, KG Lloyd, N Mahmoudi, W Orsi, SS Walter, **AD Steen**, R Zhao (2020). The fate of organic carbon in marine sediments - new insights from recent data and analysis. *Earth Science Reviews*. 204: 103146

    I contributed text on my area of expertise to this review. More importantly, with lead author Doug LaRowe, I was co-PI of the grant that funded the workshop that produced this review, and I handled much of the organization and logistics for the workshop, which was held in Knoxville.

35. Mahmoudi, N, †SM Hagen, TC Hazen, **AD Steen** (2020). Patterns in extracellular enzyme activity and microbial diversity in deep-sea Mediterranean sediments. *Deep-Sea Research Part I*. DOI: 10.1016/j.dsr.2020.103231

    Lead author Nagissa Mahmoudi and I planned this manuscript together when she was a postdoc with Terry Hazen. I acted as undergraduate student Shane Hagen's day-to-day advisor on enzyme assays and wrote a substantial fraction of the manuscript text.

34. *Royalty, TM, **AD Steen** (2019). Theoretical and simulation-based investigation of the relationship between sequencing effort, microbial community richness, and diversity in binning metagenome-assembled genomes *mSystems*. 4(5):e00384-19

    I was lead author Taylor Royalty's Ph.D. advisor. I conceived the project and contributed substantially to all stages of the project completion.

33. *Royalty, TM, **AD Steen** (2019). Quantitatively Partitioning Microbial Genomic Traits among Taxonomic Ranks across the Microbial Tree of Life. *mSphere*. 4(4):e00446-19

    I was lead author Taylor Royalty's Ph.D. advisor. I conceived the project and contributed substantially to all stages of the project.

32. Senter, JK, *TM Royalty, **AD Steen**, A Sadovnik (2019). Unaligned Sequence Similarity Search Using Deep Learning. 2019 IEEE International Conference on Bioinformatics and Biomedicine (BIBM), San Diego, CA: 1892-1899

    I conceived this project and encouraged Amir Sadovnik, a deep learning expert with no prior bioinformatics experience, to participate. I contributed to all stages of the project.

31. Ziervogel, K, SB Joye, S Kleindienst, SY Makin, U Passow, **AD Steen**, C Arnosti (2019). Polysaccharide hydrolysis in the presence of oil and dispersants: insights into potential degradation pathways of exopolymeric substances (EPS) from oil-degrading bacteria. *Elementa: Science of the Anthropocene*. 7(1), p.31

    I performed statistical analyses for this project.

30. **Steen, AD**, *RT Kevorkian[1], JT Bird, N Dombrowski, BJ Baker, †SM Hagen, †KH Mulligan, *JM Schmidt, †AT Webber, *TM Royalty, MJ Alperin (2019). Kinetics and identities of extracellular

[1] As a post-baccalaureate technician, prior to his joining the Microbiology department as a graduate student.

peptidases in subsurface sediments of the White Oak River Estuary, NC. *Applied and Environmental Microbiology*. 85(19):e00102-19

I conceived this project, organized students to perform field and lab work, performed the bulk of the data analysis and all of the writing.

29. **Steen, AD**, A Crits-Christoph, P Carini, KM DeAngelis, N Fierer, KG Lloyd, JC Thrash (2019). High proportions of bacteria and archaea across most biomes remain uncultured. *ISME Journal*. 13(3126-3130). DOI: 10.1038/s41396-019-0484-y **Selected as one of 20 "Best of the ISME Journal 2019" papers**

    I organized the co-authors, defined the organization of the manuscript, and wrote the bulk of the text.

28. Sala, MM, J Piontek, S Endres, AM Romaní, S Dyhrman, **AD Steen** (2019). Extracellular enzymes in aquatic environments: exploring the link between genomic potential and biogeochemical processes. *Frontiers in Microbiology*. 10:1463

    This is an introduction to a Frontiers in Marine Sciences "Research Topic", similar to a special issue. I helped to organize the Aquatic Sciences session the Research Topic came from, served as a Guest Editor for the Research Topic, and helped to write the introduction.

27. Bird, JT, ED Tague, L Zinke, *JM Schmidt, **AD Steen**, B Reese, IPG Marshall, G Webster, A Weightmann, HF Castro, SR Campagna, KG Lloyd (2019). Uncultured microbial phyla suggest mechanisms for multi-thousand-year subsistence in Baltic Sea sediments. *mBio* 10 (2) e02376-18; DOI: 10.1128/mBio.02376-18

    A key component of this manuscript was observations of extracellular enzyme activities in subsurface environments. I advised the Jenna Schmidt, the Masters' student who performed the enzyme assays, and contributed to data analysis and writing the text.

26. *Quigley, LMN[2], A Edwards, **AD Steen**, A Buchan (2019). Characterization of the interactive effects of labile and recalcitrant organic matter on microbial growth and metabolism. *Frontiers in Marine Science*. 10:493. DOI: 10.3389/fmicb.2019.00493

    I served as co-advisor to Lauren Quigley, who performed the experiments and analyzed the data. I contributed to project design and to writing the manuscript, and was co-PI on the NSF grant that funded this work.

25. Lloyd, KG, **AD Steen**, J Ladau, J Yin, L Crosby (2018). Phylogenetically novel uncultured microbial cells dominate Earth microbiomes. *mSystems* 3(5) e-00055-18; DOI: 10.1128/mSystems.00055-18

    I performed the data analysis on this meta-analysis of publicly-available data, and was closely involved in writing the manuscript.

24. Matzek, L, M Tipton, A Farmer, **AD Steen**, K Carter (2018). Understanding electrochemically activated persulfate and its application to ciprofloxacin abatement. *Environmental Science and Technology* 52(10): 5875-5883

    I performed an HPLC analysis of ciprofloxacin that was key to this work.

23. *Mullen, L, †Malcolm X Shabazz Aquatic Geochemistry Team, †K Boerrigter, †N Ferriero, †J Rosalsky, *AvB Barrett, †PJ Murray, **AD Steen** (2018). Potential activities of freshwater exo- and endo-acting extracellular peptidases in East Tennessee and the Pocono Mountains. *Frontiers in Microbiology*. 9:368. DOI: 10.3389/fmicb.2018.00368

    I was lead author Lauren Mullen's Master's advisor. I also initiated the Malcolm X Shabazz Aquatic Geochemistry Team, the collaboration with high school students that provided much of the data for this project.

22. Mahmoudi, N, SR Beaupré, **AD Steen**, and A Pearson (2017). Sequential bioavailability of sedimentary organic matter to heterotrophic bacteria. *Environmental Microbiology* 19(7): 2629-2644. DOI: 10.1111/1462-2920.13745

[2] Co-advised with Dr. Alison Buchan as primary advisor.

I hosted Nagissa Mahmoudi in my lab when she was a postdoc with Ann Pearson at Harvard. I advised her on experimental design and data interpretation for extracellular enzyme assays.

21. **Steen, AD**, *LNM Quigley and A Buchan (2016). Evidence for the priming effect in a planktonic estuarine microbial community. *Frontiers in Marine Science* 3:6. DOI:10.3389/fmars.2016.00006

    In close collaboration with Alison Buchan, I designed this experiment, performed some parts of the experiment, advised Lauren Quigley on the rest of the experiments, and assisted with data analysis and manuscript writing.

20. Michalska, K, **AD Steen**, G Chhor, M Endres, AT Webber, J Bird, KG Lloyd, A Joachimiak (2015). New aminopeptidase from "Microbial Dark Matter" Archaeon. *FASEB Journal.* DOI: 10.1096/fj.15-272906

    This manuscript was a structural and functional characterization of a peptidase from an uncultured Archaeon. I performed the functional analysis, including experimental work, data analysis and writing the relevant text.

19. **Steen, AD**, †JP Vazin, †SM Hagen, †KH Mulligan, and SW Wilhelm (2015). Substrate specificity of aquatic extracellular peptidases assessed by competitive inhibition assays using synthetic substrates. *Aquatic Microbial Ecology* 75(3) 271-281

    I designed this experiment, performed many of the experiments, advised three undergraduate students on performing the rest of the experiments, and wrote the manuscript with input from Steve Wilhelm.

18. Cardman, Z, C Arnosti, A Durbin, K Ziervogel, C Cox, **AD Steen**, A Teske (2014). Verrucomicrobia Are Candidates for Polysaccharide-Degrading Bacterioplankton in an Arctic Fjord of Svalbard. *Applied and Environmental Microbiology* 80(12): 3749-3756.

    I collected field samples for this project.

17. **Steen, AD** and C Arnosti (2014). Picky, hungry eaters in the cold: A polar pelagic microbial community ignores an abundant carbon source. *Frontiers in Microbiology* DOI:10.3389/fmicb.2014.00527

    I designed this project, performed the experiments and data analysis, and wrote the manuscript in collaboration with Carol Arnosti.

16. Arnosti, C, C Bell, D Moorhead, RL Sinsabaugh, **AD Steen**, M Stromberger, M Wallenstein, MN Weintraub (2014). Extracellular enzymes in terrestrial, freshwater, and marine environments: New perspectives on system variability and common research needs. *Biogeochemistry* DOI:10.1007/s10533-013-9906-5

    I contributed some text and the sole figure in this review.

15. Lloyd, K, M K May, RT Kevorkian, and **AD Steen** (2013). Meta-analysis of quantification methods shows archaea and bacteria to be similarly abundant in the subseafloor. *Applied and Environmental Microbiology* 79(24): 7790-7799. **Selected by editors as an "Article of Significant Interest"**

    I performed the bulk of the data analysis and assisted with writing this meta-analysis paper.

14. Arnosti, C, and **AD Steen** (2013). Patterns of extracellular enzyme activities and microbial metabolism in an Arctic fjord of Svalbard and in the northern Gulf of Mexico: Contrasts in carbon processing by pelagic microbial communities. *Frontiers in Microbiology* 4:318 DOI:10.3389/fmicb.2013.00318

    I assisted with field work, lab work, and data analysis for this manuscript.

13. **Steen, AD**, BB Jørgensen, and B Aa Lomstein (2013). Abiotic racemization kinetics of amino acids in marine sediments. *PLOS ONE* 8(8) e71648. DOI:10.1371/journal.pone.0071648

    This was the central project of my postdoctoral work. I assisted in field work and performed lab work, data analysis, and wrote the bulk of the manuscript.

12. Lloyd, KG, L, Schreiber, DG Petersen, K Kjeldsen, MA Lever, **AD Steen**, R Stepanauskas, M Richter, S Kleindienst, S Lenk, A Schramm, BB Jørgensen (2013). Predominant Archaea in marine sediments degrade detrital proteins. *Nature* 496: 215-218

This manuscript, which proposed an environmental function for a group of ubiquitous marine sediment Archaea, was initially rejected from Science and Nature due to the lack of experimental confirmation of bioinformatic-based predictions. I designed and carried out extracellular enzyme assays that supported the bioinformatic predictions. With those assays, the manuscript was accepted at Nature.

11. **Steen, AD**, and C Arnosti (2013). Extracellular peptidase and carbohydrate hydrolase activities in an Arctic fjord (Smeerenburgfjord, Svalbard). *Aquatic Microbial Ecology* 69: 93-99.

    With Carol Arnosti, I designed this experiment, performed field and lab work, analyzed data, and wrote the manuscript.

10. **Steen, AD**, K Ziervogel, S Ghobrial, and C Arnosti (2012). Functional variation among polysaccharide hydrolyzing microbial communities in the Gulf of Mexico. *Marine Chemistry* 138-139: 13-20

    With Carol Arnosti, I designed this experiment, performed field and lab work, analyzed data, and wrote the manuscript.

9. **Steen, AD** and K Ziervogel (2012). Comment on the review by German et al (2011) "Optimization of hydrolytic and oxidative enzyme methods for ecosystem studies" [Soil Biology & Biochemistry 43: 1387-1397]. *Soil Biology and Biochemistry* 48: 196-197

    I wrote this technical comment with input from Kai Ziervogel.

8. Arnosti, C, **AD Steen**, K Ziervogel, S Ghobrial, and WH Jeffrey (2011). Latitudinal gradients in degradation of marine dissolved organic carbon. *PLOS ONE* 6(12): e28900. DOI:10.1371/journal.pone.0028900

    I identified a way to quantify the qualitative analyses in this manuscript, which is based on a large data set collected by Carol Arnosti and her lab members.

7. **Steen, AD**, and C Arnosti (2011). Long lifetimes of β-glucosidase, leucine aminopeptidase, and phosphatase in Arctic seawater. *Marine Chemistry* 123(1-4) 127-132

    With Carol Arnosti, I designed this experiment, performed field and lab work, analyzed data, and wrote the manuscript.

6. **Steen, AD**, K Ziervogel, and C Arnosti (2010). Comparison of multivariate microbial datasets with the Shannon index: An example using enzyme activity from diverse marine environments. *Organic Geochemistry* 41(9): 1019-1021

    With Carol Arnosti, I designed this experiment, performed field and lab work, analyzed data, and wrote the manuscript.

5. Ziervogel, K, **AD Steen**, and C Arnosti (2010). Changes in the spectrum of extracellular enzyme activities in seawater following aggregate formation. *Biogeosciences* 7: 1007-1015

    I contributed statistical analyses to this work.

4. Robador, A, V Bruchert, **AD Steen**, and C Arnosti (2010). Temperature induced decoupling of enzymatic hydrolysis and carbon remineralization in long-term incubations of Arctic and temperate sediments. *Geochimica et Cosmochimica Acta* 74(8): 2316-2326

    I participated in field work, performed supporting experiments and data analysis, and contributed to the text.

3. **Steen, AD**, P Gururaj, J Ma, NV Blough, C Arnosti (2008). Fluorescence anisotropy as a means to determine extracellular polysaccharide hydrolase activity in environmental samples. *Analytical Biochemistry* 383(2): 340-342

    With Carol Arnosti and Neil Blough, I designed this experiment, performed field and lab work, analyzed data, and wrote the manuscript.

2. **Steen, AD**, LJ Hamdan, and C Arnosti (2008). Dynamics of dissolved carbohydrates in the Chesapeake Bay: Insights from enzyme activities, concentrations, and microbial metabolism. *Limnology and Oceanography* 53(3): 936-947.

    With Carol Arnosti, I designed this experiment, performed field and lab work, analyzed data, and wrote the manuscript.

1. **Steen, AD**, C Arnosti, L Ness, and NV Blough (2006). Electron paramagnetic resonance spectroscopy as a novel approach to measure macromolecule-surface interactions and activities of extracellular enzymes. *Marine Chemistry* 101: 266-276

With Carol Arnosti and Neil Blough, I designed this experiment, performed field and lab work, analyzed data, and wrote the manuscript.

Book Chapter

Lang, SQ, MR Osbourn, **AD Steen** (2019). Carbon in the Deep Biosphere: Forms, Fates, and Biogeochemical Cycling. In *Whole Earth Carbon: Past and Present*, eds. B Orcutt, I Daniel, R Dasgupta. Cambridge: Cambridge University Press. Selected by CHOICE360, a publishing unit of the American Libraries Association, as an Outstanding Academic Title of 2020.

Software product

*Cook, CS and AD Steen. ezmmek. An R package to easily analyze enzyme kinetics data from fluorogenic substrate proxies. Available on CRAN: https://cran.r-project.org/web/packages/ezmmek/index.html

Submitted manuscripts and preprints

*Royalty, TM, **AD Steen**. Functional redundancy in ocean microbiomes controls trait stability. bioRxiv. DOI: https://doi.org/10.1101/2021.06.18.448980 (in revisions).

*Royalty, TM, **AD Steen**. A quantitative measure of functional redundancy in microbial ecosystems. bioRxiv DOI: https://doi.org/10.1101/2020.04.22.054593 (in revisions).

Publications from lab members on which I am not an author

I encourage students in my lab to make scientific contributions wherever they are able. Consequently, my lab members occasionally earn authorship on papers on which I am not an author. The following is a list of additional publications on which my students have earned authorship while in my lab.

3. Ash, K, I Almilla, Y Li, DC Joyner, DE Williams, PJ McKay, *BM Green, C Iler, SE DeBlander, FK Murdoch, C Swift, TC Hazen (2021). Coding-complete genome sequence of a SARS-CoV-2 variant obtained from raw sewage on University of Tennessee-Knoxville campus. *Microbial Resource Announcements*. Accepted for publication.

Brianna joined the lab in August of 2020, just as the campus COVID-19 wastewater sampling initiative was ramping up. She volunteered to assist with lab work for this effort, in addition to her planned research project on permafrost soil geomicrobiology.

2. Herbert, LC, Q Zhu, AB Michaud, K Laufer-Meiser, CK Jones, N Riedinger, †ZS Stooksbury, RC Aller, BB Jørgensen, LM Wehrmann (2021). Benthic iron flux influenced by climate-sensitive interplay between organic carbon availability and sedimentation rate in Arctic fjords. *Limnology and Oceanography* 66(9). https://doi.org/10.1002/lno.11885

Zachery performed particle size analysis as part of his undergraduate research project. Since he was skilled at that protocol, he measured particle sizes for my colleague Laura Wehrmann's work.

1. Gladstone NS, *TM Royalty, EM Carter, ML Niemiller (2020). *Eurycea lucifuga* (Cave salamander). Diet. (Field note). *Herpetological Review* 51(2).

While helping fellow grad student Nick Gladstone with research on cave ecology, Taylor helped to document a cave salamander engaging in previously unknown feeding behavior.

Invited seminars and talks

Steen, AD (2022). Title TBD. Department of Geology and Geological Engineering weekly seminar (Oxford, MS).

Steen, AD (2022). 'It's evolution, Jim, but not as we know it': Adaptation and filtering as drivers of microbial evolution in deep marine sediments. High Pressure Structural Biology and Extreme Biophysics (Ithaca, NY).

Steen, AD, *TM Royalty, *Schmidt, JM, KG Lloyd (2022). Do deep marine sediments host unusually stable enzymes? 66th Annual Biophysical Society meeting (San Francisco, CA).

Steen, AD, J Senter, *TM Royalty, A Sadovnik (2019). Linking metagenomes to organic geochemistry: How to deal with hypothetical and poorly-annotated genes. Hanse-Wissenschaftskolleg Workshop on Marine Organic Biogeochemistry (Delmenhorst, Germany).

Steen, AD (2018). Work-life balance is essential and also it can't possibly exist. C-DEBI Professional Development Webinar (online). Archived at https://www.darkenergybiosphere.org/outputs-resources/professional-development-webinar-series/

Steen, AD (2017). Tracing the carbon cycle through biomolecules. DCO Global Carbon Cycles Workshop (Moscow).

Steen, AD (2017). How heterotrophic microorganisms access sedimentary organic matter: A few known knowns, and plenty of known unknowns. American Chemical Society Spring Meeting.

Steen, AD (2016). Heterotrophic organisms in deep marine sediments: or, What to do when you're hungry but you're 100,000 years late for dinner. ORION (Oak Ridge amateur astronomy and science club) monthly meeting (Oak Ridge TN)

Steen, AD (2016). Bioavailability of organic carbon in deep sediments. School of Marine and Atmospheric Sciences weekly seminar, SUNY – Stony Brook.

Steen, AD (2016). Bioavailability of organic carbon in deep sediments. Marine Science Program weekly seminar, University of South Carolina (Columbia, SC)

Steen, AD. How to make recalcitrant organic matter bioavailable: or, What silverware do you use when you're 10^2-10^6 years late for dinner? (2016) C-DEBI Annual Meeting (Marina, CA).

Steen, AD (2015). The revolution in marine dissolved organic matter chemistry and what it means for geomicrobiology. USC/Agouron International Geobiology Course. (Catalina Island, CA).

Steen, AD (2015). Using peptidase biochemistry to better understand protein degradation in aquatic environments. Massachusetts Institute of Technology Chemical Oceanography-Geobiology weekly seminar; Woods Hole Oceanographic Institution Chemical Oceanography weekly seminar.

Steen, AD (2015). Extracellular enzymes in the environment: What do we really know? China-US Workshop on Biogeochemistry and Climate Change. Institute of Applied Ecology – Chinese Academy of Sciences (Shenyang, China); Shenyang Agricultural University (Shenyang, China) and Inner Mongolia University (Hohhot, China).

Steen, AD (2015). Beyond V_{max} and K_m: How details of enzyme function influence geochemical cycles. AGU Fall Meeting (San Francisco, CA).

Steen, AD (2015). Microbial carbon oxidation in marine sediments: A biochemical perspective. Second Deep Carbon Observatory Early Career Scientist Workshop (Ponta Delgada, Azores).

Steen, AD (2011). Dynamics of marine extracellular enzymes: What we can (and can't) learn from using nonstandard substrates. Uppsala University, Sweden.

Steen, AD (2011). Biological influence on dissolved organic matter reactivity. Skidaway Institute of Oceanography, Skidaway Island, GA.

Steen, AD (2011). Biological influence on dissolved organic matter reactivity. Technical University of Denmark (DTU), Copenhagen, Denmark.

Steen, AD and C. Arnosti (2004). Measurement of extracellular enzyme activities in aquatic environments. U.S. Naval Research Laboratory, Washington, DC.

Conference abstracts, invited talks and posters

†Undergraduate or high school students or teachers under my supervision

*Graduate students or postdocs under my supervision

*Oduwole, I, †M Hibbs, *TM Royalty, KG Lloyd, **AD Steen** (2021). Distribution of genomic novelty among Earth's environments in phylogenetically diverse uncultured microbes. American Geophysical Union Fall Meeting (New Orleans, LA).

Buongiorno, J, EK Phillips, †M Stokes, C Coleman-King, **AD Steen** (2021). Outcomes and lessons learned from a partnership with East Tennessee Freedom Schools to involve K-12 students in authentic microbial ecology research. American Geophysical Union Fall Meeting (New Orleans, LA).

†Stokes, MH, *B Green, A Abramov, T Vishnivetskaya, K Sipes, KG Lloyd, **AD Steen** (2021). Extracellular enzyme activities and mineralogy of thawing permafrost soils near Ny Ålesund, Svalbard. American Geophysical Union Fall Meeting (New Orleans, LA).

*Royalty, TM, **AD Steen** (2021). Functional redundancy in ocean microbiomes controls trait stability. American Geophysical Union Fall Meeting (New Orleans, LA).

Steen, AD, *TM Royalty, *JM Schmidt, KG Lloyd (2021). Long enzyme lifetimes in subsurface sediments. American Geophysical Union Fall Meeting (New Orleans, LA).

*Royalty, TM, **AD Steen** (2021). Trait Contribution Evenness—A functional redundancy metric for community-aggregated traits in microbial communities. U.S. Department of Energy Office of Biological and Environmental Research 2021 Biological System Sciences Division Principal Investigators' Meetings (Online)

*Royalty, TM, **AD Steen** (2020). Trait Contribution Evenness – A functional redundancy metric for community-aggregated traits in microbial communities. American Geophysical Union Fall Meeting (online).

Coleman-King, C, **AD Steen**, K Rearden, S Drumheller-Horton (2020). Making rocks matter: Utilizing critical and culturally responsive experiential learning in teacher education. International Conference on Urban Education (online).

Lloyd, KG, K Sipes, T Vishnivetskaya, **AD Steen**, TC Onstott, R Liang, Z Garvin, RL Hettich, R Giannone, J Clift, J Bradley, J Boike, S Wetterich, A Abramov, E Rivkina (2020). Arctic Microbial Permafrost Degradation. DOE Genomic Sciences Program Annual Principal Investigator Meeting (Washington, DC).

Sontag, P, K Dawson, †PJ Murray, **AD Steen** (2020). Influence of Biogeochemistry on Lead Availability in New Jersey Sediment: Development of Point-of-Use Trace Metal Sensor with Insights from Newark Biogeochemistry Teams. Ocean Sciences Meeting (San Diego, CA).

Steen, AD, C Burdyshaw, SE Sawyer, *TM Royalty, KG Lloyd, RG Brook (2019). Diversity of functional genes in deeply branching uncultured microbes. AGU Fall Meeting (San Francisco, CA).

*Royalty, TM, **AD Steen** (2019). Quantitatively partitioning microbial genomic traits among taxonomic ranks: implications for subsurface microbial communities. C-DEBI Networked Speaker Series (online). Archived at https://www.darkenergybiosphere.org/outputs-resources/networked-speaker-series/nss-taylor-royalty/.

†Fang, C, *TM Royalty, **AD Steen** (2019). Analysis of positive selection on extracellular enzymes. UT-Knoxville EURēCA Undergraduate Research Symposium (Knoxville, TN)

†Klibisz, A, *CS Cook, **AD Steen** (2019). The Potential of Oxidized Organic Sulfur as an Electron Acceptor for Organic Matter Respiration. UT-Knoxville EURēCA Undergraduate Research Symposium (Knoxville, TN)

†Lonergan, A, K Fullerton, KG Lloyd, **AD Steen** (2019). Extracellular enzyme activity in hot springs in Panama. UT-Knoxville EURēCA Undergraduate Research Symposium (Knoxville, TN) and Southeastern Biogeochemistry Symposium (Columbia, SC)

†Smith L, *TM Royalty, **AD Steen** (2019). Discerning the Relative Abundance of Extracellular DNA in Estuarine Sediments Using Spectrophotometery. UT-REU Microbial Community Interactions and Functions Poster Session (Knoxville, TN)

†Miles, M, *TM Royalty, **AD Steen** (2019). The role of sulfonate in the sulfur and carbon cycles of estuarine sediments. UT-Knoxville EURēCA Undergraduate Research Symposium (Knoxville, TN)

†Stooksbury, ZS, **AD Steen** (2019). Geological controls on biological carbon oxidation in the White Oak River Estuary, NC. UT-Knoxville EURēCA Undergraduate Research Symposium (Knoxville, TN) and Southeastern Biogeochemistry Symposium (Columbia, SC)

†Ajuwon, F, †Malcolm X Shabazz Aquatic Geochemistry Team, †PJ Murray, KG Lloyd, AD Steen (2018). Breakdown of organic matter in freshwater: The role and nature of extracellular peptidases. AGU Fall Meeting (Washington, DC).

*Mullen, LA, *TM Royalty, †Z Stooksbury, C Arnosti, **AD Steen** (2018). Activities of extracellular enzymes in sediments of the White Oak River estuary and Kongsfjord, Svalbard. AGU Fall Meeting (Washington, DC).

*Royalty, TM, **AD Steen** (2018). Simulation-based approaches to characterize the effect of sequencing depth on the quantity and quality of metagenome-assembled genomes. AGU Fall Meeting (Washington, DC).

Steen, AD, *LA Mullen, *TM Royalty, C Arnosti (2018). Activities of heterotrophic microorganisms and their extracellular enzymes in Kongsfjorden, Svalbard. AGU Fall Meeting (Washington, DC).

Steen, AD (2018). Understanding the reactivity of proteinaceous OM as a property of microbial community metabolism. Gordon Research Conference on Organic Geochemistry (Plymouth, NH). **Invited.**

†Guidry, ME, *TM Royalty, **AD Steen** (2018). Protein Extraction from Sediment for Proteomic Analysis. UT-REU Microbial Community Interactions and Functions Poster Session (Knoxville, TN).

Sontag, PT, †H Ofori, †Malcolm X Shabazz Aquatic Geochemistry Team, **AD Steen** (2018). Examining Influence of Raritan River-Bay Dissolved Organic Matter (DOM) and Extracellular Enzymes on Methylmercury (MeHg) in Phytoplankton. 10th Annual Sustainable Raritan Conference and Awards Ceremony (New Brunswick, NJ).

†Ajuwon, FA, †PJ Murray, P Sontag, **AD Steen** (2018). Understanding the process of organic matter remineralization and its possible link to cycling of contaminants in estuaries. Southeast GSA (Knoxville, TN).

*Mullen, LA, †Malcolm X Shabazz Aquatic Geochemistry Team, †K Boerrigter, †N Ferriero, J Rosalsky, †PJ Murray, **AD Steen** (2018). Potential activities of freshwater endo- and exo-acting extracellular peptidases in East Tennessee and the Pocono Mountains. Southeast GSA (Knoxville, TN).

*Royalty, T, **AD Steen** (2018) Evaluating the sensitivity of subsurface microbial metagenome assembled genome properties as a function of metagenomic shotgun sequencing depth. Southeast GSA (Knoxville, TN).

*Royalty, T, **AD Steen** (2018) Evaluating the sensitivity of subsurface microbial metagenome assembled genome properties as a function of metagenomic shotgun sequencing depth. Southeast Biogeochemistry Symposium. (Tallahassee, FL).

†Stooksbury, Z, *LA Mullen, **AD Steen** (2018). Potential activities of extracellular glycosyl hydrolases, peptidases, alkaline phosphatase, and sulfatase in sediments of the White Oak River, NC. Southeast Biogeochemistry Symposium. (Tallahassee, FL).

†Montes, D, †F Ajuwon, †E Uyoh, †W Aviles, †E Mends, †H Oyibo, †K Duarte, †D Akinawande, †S Nelson, †L Mozee, †E DeLima, †S Wellington, †N Ferriero, †PJ Murray, *L Mullen, PT Sontag, KG Lloyd, **AD Steen** (2018). Activities of extracellular enzymes in the Raritan Bay, NJ. SE GSA Meeting (Knoxville, TN).

Buchan A, *LMN Quigley, BS O'Banion, RGM Spencer, A Stubbins, **AD Steen** (2018). Geo-metabolomics of a saltmarsh: Combining in situ, bulk, genomic, transcriptomic and DOMeomic data streams to understand microbial transformations of terrestrially derived organic matter. DOE Joint Genome Institute Annual Genomic of Energy & Environment User Meeting (San Francisco, CA).

[*]Royalty, T, **AD Steen** (2018). Evaluating the sensitivity of subsurface microbial metagenome-assembled genome properties as a function of metagenomic shotgun sequencing depth. SE GSA meeting (Knoxville, TN).

[*]Royalty, T, **AD Steen** (2017). A Sensitivity Analysis on Metagenome-Assembled Genome Response to Sequencing Depth: How Much Sequencing Is Enough? C-DEBI Annual Meeting (Marina, CA).

Drumheller, SK, CD Sumrall, TA Gates, **AD Steen**, SP Horn, LD McKay (2017). Including citizen and student scientists in actualistic taphonomic research: The good, the bad, and the smelly. GSA Annual Meeting (Seattle, WA).

[*]Quigley, LNM, **AD Steen**, A Edwards, A Buchan. Evidence for species-specific degradation of recalcitrant organic matter in the presence of labile organic compounds. ASM Microbe 2017 (New Orleans, LA).

[†]Souder, RA, [*]LA Mullen, **AD Steen** (2017). Hydroxyl radicals may help heterotrophic microbes mineralize recalcitrant organic matter. Southeastern Biogeochemistry Symposium (Athens, GA).

Steen, AD, [*]LNM Quigley, A Stubbins, RG Spencer, A Buchan (2017). Towards a more mechanistic understanding of the aquatic priming effect. ASLO Aquatic Sciences Meeting (Honolulu, HI).

[*]Barrett, AvB, [†]Malcolm X Shabazz Aquatic Geochemistry Team, [†]PJ Murray, **AD Steen** (2017). Environmental controls on protein degradation pathways in freshwaters of eastern Tennessee and northeastern Pennsylvania. ASLO Aquatic Sciences Meeting (Honolulu, HI).

[†]Boerrigter, KA, **AD Steen**, J Rosalsky, [†]N Ferriero, [†]PJ Murray (2016). Study of Various Peptidases and Their Effects on Freshwater Bodies. AGU Fall Meeting (San Francisco, CA).

Mahmoudi, N, SR Beaupre, **AD Steen**, A Pearson (2016). Investigating the bioavailability and degradation of sedimentary organic matter in Guaymas Basin using the IsoCaRB system. C-DEBI Annual Meeting (Marina, CA).

Mahmoudi, N, SR Beaupre, **AD Steen**, A Pearson (2016). Sequential bioavailability of sedimentary organic matter to heterotrophic bacteria. Gordon Research Conference (GRC) Organic Geochemistry (Holderness, NH).

Mahmoudi, N, SR Beaupre, **AD Steen**, A Pearson (2016). Investigating microbial C cycling in sediments using the IsoCaRB system. American Society for Microbiology (ASM) Microbe Meeting (Boston, MA).

McKay, L.D., SP Horn, KA Affholter, C Cropper, SK Drumheller-Horton, KN Ellis, K Fristoe, J Jones, CS Hadjiharalambous, AC Lee, **AD Steen**, CD Sumrall (2016). Engaging community college transfer students in Tennessee to improve recruitment, retention and success in 4-year geoscience programs. Geological Society of America Annual Meeting (Denver, CO).

Steen, AD, [†]JP Vazin, [†]KH Mulligan, [†]SM Hagen, SW Wilhelm (2016). What we talk about when we talk about peptidases: Quantifying the substrate specificies of aminopeptidases in fresh and estuarine water. 5th International Enzymes in the Environment Conference. (Bangor, Wales)

Drumheller, SK, TA Gates, [†]LR Brett, **AD Steen** (2016). Root marks in the classroom: A student science approach to actualistic taphonomic research. Society of Vertebrate Paleontology Annual Meeting (Salt Lake City, UT)

Mahmoudi N, S Beaupre, **AD Steen,** A Pearson (2016). IsoCaRB: A novel bioreactor system to characterize microbial carbon cycling and the lability of natural organic matter. 16th International Symposium on Microbial Ecology (Montreal)

[*]Schmidt, JM, **AD Steen** (2016). Potential activities of organic carbon degrading extracellular enzymes in Baltic Sea sediments. Southeastern Biogeochemistry Symposium (Knoxville, TN)

Steen, AD, [*]JM Schmidt (2016). The nature and function of microbial enzymes in subsurface marine sediments. Ocean Sciences Meeting (New Orleans, LA)

†Murray, PJ, †N Ferriero, J Rosalsky, KG Lloyd and **AD Steen** (2016). How do high school students respond to opportunities to collaborate with authentic scientific researchers in at-risk environments? Ocean Sciences Meeting (New Orleans, LA)

*Schmidt, JM, **AD Steen** (2015). Potential activities of extracellular enzymes in the deep subsurface sediments of the Baltic Sea basin. GSA Annual Meeting. Published in GSA Abstracts with Programs, 47 (7).

Steen, AD (2015). How to use extracellular enzyme biochemistry to better predict the effect of increasing CO_2 on microbe-organic matter interactions. Goldschmidt 2015 (Prague).

Steen, AD, †PJ Murray, †N Ferriero, †Malcolm X Shabazz Aquatic Geochemistry Team, J Rosalsky, KG Lloyd (2015). Activities of extracellular peptidases across environments: Do diverse aquatic environments share similar tastes? ASLO Aquatic Sciences Meeting, Granada, Spain.

Steen, AD, †PJ Murray, †N Ferriero, †Malcolm X Shabazz Aquatic Geochemistry Team, J Rosalsky, KG Lloyd (2015). Involving at-risk high school student populations in environmental research: A case study using extracellular enzyme assays. ASLO Aquatic Sciences Meeting, Granada, Spain.

Lloyd, KG, J Bird, **AD Steen**, J Buongiorno, S Jungbluth, IODP Leg 347 Shipboard Science Party (2015). Insights from the first deep subsurface single cell genomes and development of digestR, a new tool for metagenomic analysis. C-DEBI NSF Site Visit, Los Angeles, CA.

Steen, AD, *L Mach (now LNM Quigley), A Buchan (2014). The marine priming effect: Stimulation of detrital organic matter remineralization by addition of labile organic carbon in an estuarine microbial community. Joint Aquatic Sciences Meeting, Portland, OR.

Steen, AD, K Michalska, G Chhor, M Endres, †JP Vazin, KG Lloyd, SW Wilhelm, A Joachimiak (2014). Strategies to assess the biochemical properties of extracellular hydrolases in aquatic environments. Goldschmidt Meeting, Sacramento CA.

Michalska, K, **AD Steen**, G Chhor, K Fayman, M Endres, G Babnigg, KG Lloyd, R Jedrzejczak, A Joachimiak (2014). Towards understanding microbial life in marine sediments – Structure and specificity of a novel aminopeptidase. 23rd Congress of the International Union of Crystallography. Montreal, Canada.

Arnosti, C, L D'Ambrosio, **AD Steen**, A Teske (2014). Site- and depth-related contrasts in enzymatic capabilities of microbial communities: Exploring links between microbial community function and composition. ASLO Ocean Sciences Meeting, Hawaii.

Steen, AD, RT Kevorkian, E Deas, KG Lloyd (2013). Activities of extracellular peptidases in sediments of the White Oak River Estuary, NC. C-DEBI Annual Meeting, Monterrey, CA.

Lloyd, KG, M May, R Kevorkian, **AD Steen** (2013). A meta-analysis reveals methodological biases in quantitative methods for marine subsurface microbiology. Goldschmidt Conference, Florence, Italy.

Arnosti, C, Z Cardman, **AD Steen**, K Ziervogel, A Teske (2013). Functional contrasts and functional redundancy in Arctic bacterial communities in the oxic water column and anoxic sediments. Goldschmidt Conference, Florence, Italy.

†Vazin, JP, **AD Steen**, SW Wilhelm (2013). What's for Dinner? The Study of Substrate Specificities of Extracellular Peptidases in the Tennessee River to Determine Microbe Consumption Options. Exhibition of Undergraduate Research and Creative Achievement. Knoxville, TN. ***Winner of UT "EUReCA" Undergraduate Research Award.**

†Webber, AW, A Buchan, **AD Steen**, SW Wilhelm (2013). Effects of viral lysis on carbon cycling in marine microbial communities: tracking size fractions of released dissolved organic carbon. Exhibition of Undergraduate Research and Creative Achievement. Knoxville, TN. ***Winner of UT "EUReCA" Undergraduate Research Award.**

Steen, AD, †JP Vazin, †AW Webber, PJ Gainer, SW Wilhelm (2013). Leucyl aminopeptidase is not enough: what do extracellular peptidase activity measurements tell us? ASLO Aquatic Sciences meeting, New Orleans, LA.

Steen, AD, R Cory, P Lee, DM McKnight, J Mikucki (2012). Fluorescence spectroscopy and biogeochemical analyses suggest chemosynthetic supply of reactive DOM to Lake Bonney. AGU Fall Meeting, San Francisco, CA.

[†]Webber, AP, [†]JP Vazin, A Buchan, **AD Steen**, SW Wilhelm (2012). Effects of viral lysis on carbon cycling in marine communities: Assaying extracellular enzymes and tracking size fractions of released dissolved organic carbon. ASM KY-TN Branch meeting, Maryville, TN.

Steen, AD, C Arnosti (2011). Peptidase activity in an Arctic fjord: high aminopeptidase activity in cold water. Enzymes in the Environment workshop, Bad Nauheim, Germany, July 2011 ***Winner of Outstanding Poster award.**

Ziervogel, **AD Steen**, M Piehler. (2011). Formation and abundance of organic gel-like particles in Bogue Sound, NC. 11th International Estuarine Biogeochemistry Symposium, Morehead City, NC.

C Arnosti, **AD Steen**, K Ziervogel, S Ghobrial, WH Jeffrey (2010). Latitudinal gradients in degradation of marine dissolved organic carbon. ASLO Aquatic Sciences Meeting, Santa Fe, NM.

Ziervogel, K, **AD Steen**, S Ghobrial, C Arnosti (2010). Advective flow over permeable sandy sediments enhances extracellular enzyme activities in overlying waters. ASLO Ocean Sciences meeting, Portland, OR.

Steen, AD, C Arnosti (2009). Extracellular enzymatic activity in the water column: A comparison among polar, temperate, and subtropical environments. International Meeting on Organic Geochemistry, Bremen, Germany.

Arnosti, C, **AD Steen**, K Ziervogel, S Ghobrial, WH Jeffrey (2009). Latitudinal gradients in microbial enzyme activities: Implications for DOC cycling in changing oceans. Gordon Research Conference in Chemical Oceanography, Tilton, NH.

Steen, AD, C Arnosti (2009). Extracellular enzymatic activity in the water column: A comparison among polar, temperate, and subtropical environments. Chemical Oceanography in a Changing World, Savannah, GA. ***Winner of Best Student Poster award**.

Ziervogel, K, **AD Steen**, C Arnosti (2009). Enhanced extracellular enzyme activity in marine snow and in the surrounding water: Consequences for carbon cycling in coastal waters. Chemical Oceanography in a Changing World, Savannah, GA.

Steen, AD, K Ziervogel, S Ghobrial, C Arnosti (2009). Microbial turnover of high molecular weight dissolved organic matter: Where are the roadblocks? ASLO Aquatic Sciences, Nice, France.

Robador, A, V Brüchert, **AD Steen**, and C Arnosti (2009). Temperature sensitivity of extracellular enzymatic hydrolysis in Arctic and temperate marine sediments. ASLO Aquatic Sciences, Nice, France.

Steen, AD, C Arnosti (2008). Degradation rates of extracellular enzymes in polar and subtropical seawater: Implications for bioavailability of high molecular weight organic carbon. ASLO Ocean Sciences, Orlando, FL. ***Winner of Outstanding Student Talk award**.

Robador, A, V Brüchert, **AD Steen**, C Arnosti (2008). Temperature sensitivity of bacterial carbohydrate hydrolysis in Arctic and temperate marine sediments. Aquashift workshop, Konstanz, Germany.

Arnosti, C, L Hamdan, **AD Steen** (2007) Contrasting dynamics of high molecular weight dissolved organic carbon in the Chesapeake Bay and coastal ocean: Insights from enzyme activities, carbohydrate inventories, and microbial metabolism. Ocean Carbon and Biogeochemistry Summer Workshop. Woods Hole, MA.

Steen, AD, L Hamdan, C Arnosti (2007). PowerBars vs. Cardboard: Small structural differences determine the fate of polysaccharides in an estuary. ASLO Aquatic Sciences, Santa Fe, NM.

Steen, AD, C Arnosti (2005). The influence of marine polymer gels on the activity of extracellular enzymes. ASLO Ocean Sciences, Salt Lake City, UT.

Steen, AD, C Arnosti, NV Blough (2004). Electron paramagnetic resonance spectroscopy used to measure polysaccharide hydrolysis and macromolecule-surface interactions in aquatic environments. Gordon Conference in Organic Geochemistry, Holderness, NH.

Steen, AD, C Arnosti, NV Blough (2003). A novel approach to measuring macromolecule-surface interactions and extracellular enzyme activities in sediments. Hedges Symposium: New Approaches in Marine Organic Biogeochemistry; Friday Harbor, WA.

Honors and awards

2013 & 2014	Excellence in Reviewing award, Biogeochemistry (top 25 reviewers)
2013	Trainee on UNOLS Chief Scientist Training Cruise, $1500
2011	Outstanding Poster Award (researchers under age 35), Enzymes in the Environment: Activity, Ecology, and Applications Workshop, Bad Nauheim, Germany
2009	Best Student Poster Award, Symposium on Chemical Oceanography in a Changing World, Savannah GA
2008	Outstanding Student Talk award, Ocean Sciences meeting, Orlando, FL
2013	ASLO Early Career Travel Grant, *$500*
2011	FEMS Young Scientist Meeting Grant, *$550*
2006	EPA Star Fellowship (3 years PhD Fellowship including full stipend and tuition), value approx. *$160,000*
2004	Agouron Institute scholarship to attend USC Wrigley Institute Geobiology summer course, *value approx. $4000*

Student & postdoc mentorship

Major Graduate Student and Postdoc Advisees:

2021-present	Jacob Perez (PhD, Geology): Biogeochemical consequences of enzyme-clay interactions in thawing permafrost.
2021-present	Iyanu Oduwole (PhD, Genome Science and Technology): Analysis of genes for secreted enzymes in uncultured microbes.
2020-present	Brianna Green (MS, Geology): Microbe-organic matter interactions in thawing permafrost
2020-present	Taylor Royalty (Postdoctoral associate): Functional redundancy in microbial ecosystems
2017-2020	Taylor Royalty (PhD, Geology): Theoretical and empirical methods relating metabolism diversity with microbial phylogenetics, community diversity, and organic geochemistry
2018-2020	Christopher S. Cook (MS, Geology): Effects of enzyme assay protocol on microcystin and other organic matter degradation studies
2018-2020	Lauren A. Mullen (MS, Geology): Effect of temperature on heterotrophic processes: A case study comparing temperate and Arctic sediments
2018-2019	Lauren Krausfeldt (Postdoctoral associate; with Steven Wilhelm, UT-K Microbiology)
2015-2017	Abigail V. Barrett (MS, Geology): Controls on microbial extracellular enzymes in northeast Pennsylvania and eastern Tennessee fresh waters
2014-2016	Jenna M. Schmidt (MS, Geology): Microbial extracellular enzymes in marine sediments: Methods development and potential activities in the Baltic Sea deep biosphere.

Graduate student committee memberships:

Ashley Berg (Ph.D., Earth and Planetary Sciences), Kathleen Brannen (Ph.D., EPS), Walt Doty IV (MS, EPS), Chanda Drennen (Ph.D., EPS), Aaron Goemann (MS, EPS), Miles Henderson (Ph.D., EPS), Jordan Bird (Ph.D., Microbiology), Lauren Mach Quigley (Ph.D., Microbiology), Charles Paradis (Ph.D., EPS), Jessica Stevens (Ph.D., Biosystems Engineering and Soil Science), Joshua Stough (Microbiology), Andrew Putt (Ph.D., EPS), Samantha Gwizd (Ph.D., EPS), Helena Pound (Ph.D., Microbiology), Isis Fukai (Qualifying Exam committee, Ph.D., Bredesen Center), Katie Hughes (Ph.D., Microbiology), Grace Sarabia (Ph.D., Chemistry), Eric Fussell (CRP, Ph.D., Chemistry), Caleb Garrett (CRP, Ph.D., Chemistry), Diana Ramirez (Ph.D., Microbiology), Jill Walton (Ph.D.,

Microbiology), Allison Rogers (Ph.D., EPS), Jennifer Bailey (Ph.D., Microbiology), Sayli Mulay (Ph.D., Microbiology), Ethan Sweet (Ph.D., Earth and Planetary Sciences)

Undergraduate advisees:

Logan Brett, Andrew Crowley, Shane Hagan, Drew Mather, Lauren Mullen, Katherine Mulligan, Rebecca Pinals, Gabrielle Rimmer, Shannon Ryan, Austen Webber, Jasmine Vazin, Josh Gurka, Daniel Shyles, Aaron Souder, Patrice Dansby, Rebecca Craft, Zachery Stooksbury, Andrew Lonergan, Maryn Miles, Kaelyn Gurka, Adam Klibisz, Cameron Fang, James Dallas Dunn, Murray Stokes, Mattie Hibbs.

Teaching

Classes developed or totally overhauled:

- FYS 129: Mountains and Oceans
- GEOL 456 / 558: Global Climate Change
- GEOL 301: Methods in Geoscience
- GEOL 660: Seminar in Geochemistry: Organic Matter on the Earth and Elsewhere
- MICR 475 / 575: Reproducible Data Analysis

Classes taught:

- FYS 129: Mountains and Oceans (x1)
- GEOL 103: The Earth's Environments (x3)
- GEOL 301: Field Methods in Geology (x1)
- GEOL 590: Reproducible Data Analysis for Environmental Science (x2)
- GEOL 456 / 558: Global Climate Change (x3)
- GEOL 660: Seminar in Geochemistry (x1)
- MICR 475 / 575: Reproducible Data Analysis (x1)

Short courses and independent studies taught:

Fall 2017	2-day course: Software Carpentry
Spring 2016	Independent study: "Introduction to organic geochemistry"
Spring 2014	Independent study: "Aquatic extracellular enzymes: Theory and practice"
Spring 2011	1-day course: "Basics of the R Statistical Platform"

Post-baccalaureate laboratory technicians supervised:

2014-2015	Austen Webber. Now employed as a microbiologist at a craft brewing company.
2015-2018	Lauren Mullen. Joined the lab as a Masters' student after working as a technician, graduated Spring 2020. Now employed as an environmental microbiologist in industry.

Leadership Positions

2021-present	Founder of East Tennessee Freedom School Aquatic Ecology Team, an initiative to involve middle school and high school students in authentic environmental science research.
2018-2019	Director of Environmental Studies Concentration.
2014-2018	Assistant Director of Environmental Studies Concentration.
2018	Co-organized and co-taught Software Carpentry workshop (2-day workshop for scientists to learn better coding & data analysis skills, taken by 36 students from all around the University)
2017-2019	Collaboration with Girl Scouts of the Southern Appalachians to develop climate science and geomicrobiology-related activities for Cadette-level Girl Scouts.

2016-2017 Guest associate editor, *Frontiers in Microbiology* Research Topic: Extracellular enzymes in aquatic environments: exploring the link between genomic potential and biogeochemical consequences. Published as an ebook at https://www.frontiersin.org/research-topics/4814/extracellular-enzymes-in-aquatic-environments-exploring-the-link-between-genomic-potential-and-bioge

2012-present Co-founder of the Malcom X Shabazz High School Aquatic Biogeochemistry Team in Newark, NJ to study carbon degradation pathways in water bodies near Newark. To date ~70 students have participated in this program. These data have formed the core of one paper (Mullen et al, 2018) and four presentations at international (AGU) and regional meetings.

Service to the Scientific Community

2019 Co-organizer of C-DEBI workshop, "Microorganisms and Organic Carbon in the Marine Subsurface".

2015 Blogger for 2015 Goldschmidt meeting. Posts were published as part of the European Association of Geochemistry's blog, http://blog.eag.eu.com/.

2009-present Reviewer for funding agencies including the National Science Foundation (USA), NASA, DfG (German national science foundation), FWF (Austrian Science Fund), FONDECYT (Chilean national science foundation), *Applied and Environmental Microbiology*, *Aquatic Geochemistry*, *Aquatic Microbial Ecology*, *Biogeosciences*, *Biogeochemistry*, *Environmental Geotechnics, Environmental Microbiology, FEMS Microbiology Ecology, Frontiers in Marine Science, Frontiers in Microbiology, Geochimica et Cosmochimica Acta*, *Geoderma, ISME Journal*, *Limnology and Oceanography*, *Marine Chemistry*, *Marine Drugs*, *Marine Environmental Research*, *PLOS ONE*.

2011-present Poster judge at meetings of the Association for the Sciences of Limnology and Oceanography.

2005-2006 President, UNC Marine Science Graduate Action Group

Professional society memberships

- American Society for Microbiology
- American Geophysical Union
- American Chemical Society
- Black Microbiologists Association (Affiliate member)

Field experience

2022 Expedition leader: 2 week expedition to Svalbard for permafrost sampling.

2018 Expedition participant: MPI-Bremen / Center for Geomicrobiology 2-week expedition to Svalbard for fjord sediment sampling.

2012 Cruise participant: NSF/UNOLS Chief Scientist Training Program cruise, R/V Hugh R. Sharp. 5-day cruise plus 2-day classroom component.

2012 Cruise participant: R/V Savannah, 8 days, offshore North and South Carolina, USA.

2012-present Led sampling at the White Oak River estuary, NC, USA, 1-3 times per year.

2010 Expedition organizer: MPI-Bremen / Center for Geomicrobiology expedition to Svalbard. 3 weeks at sea and at AWIPEV base, Ny Ålesund.

2005 Course participant: Agouron International Geobiology Course (6 week summer course, including one-week field camp in the Canadian Rockies).

2004-2008 Expedition participant: Four, 2 to 4-week expeditions to Svalbard, including 2-8 day expeditions on M/V Farm and sample processing/experimental work at AWIPEV base, Ny Ålesund.

2003 Cruise participant: R/V Cape Henlopen, 5 days, Chesapeake Bay and offshore Virginia, USA.

Participation in workshops

2019 Hanse-Wissenschaftskolleg Workshop on Marine Organic Biogeochemistry, Delmenhorst, Germany.

2018 Gordon Research Conference on Organic Geochemistry, Holderness, NH.

2016 Center for Dark Energy Biosphere Research Annual Meeting, Marina, CA, USA.

2015 Deep Carbon Observatory Early Career Scientist Workshop, Ponta Delgada, Azores, Portugal.

2014-2021 Southeastern Biogeochemistry Symposium (annual), various locations, USA.

2013 Center for Dark Energy Biosphere Research Annual Meeting, Marina, CA, USA.

2011 Emerging Issues Seminar: Microbial Carbon Pump in the Ocean, San Juan, Puerto Rico, USA.

2009 Enzymes in the Environment Workshop, Bad Neuheim, Germany.

2009 Chemical Oceanography in a Changing World; Savannah, GA.

2005 Gordon Research Conference on Organic Geochemistry; Holderness, NH.

2003 Symposium on Cold-Adapted Microbes; Bremen, Germany.

2003 Hedges Symposium: New Approaches in Marine Organic Biogeochemistry; Friday Harbor, WA, USA.