Andrew D. Steen

Assistant Professor
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Expertise and interests

Geomicrobiology of aquatic systems, particularly microorganism-organic matter interactions, microbial extracellular enzymes, novel bioinformatic techniques, environmental applications of high-performance computing

Education and Professional Experience

2019-present	Assistant Professor, Departments of Microbiology and Earth and Planetary Sciences, University of Tennessee, Knoxville
2014-2019	Assistant Professor, Department of Earth and Planetary Sciences, University of Tennessee, Knoxville
2012-2014	Research Assistant Professor, Department of Microbiology, 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

Funding

2019-2022	**Lead PI**: "GP-IMPACT: ICE-AGE: Integrating Continuous Experiential Activities for Geoscience Education." NSF Improving Undergraduate STEM Education initiative. *$390,424.*
2019-2022	**Co-I:** "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. *$3,320,280*. Lead PI: Karen Lloyd.
2019	**Co-I:** "Diversity of functional genes in deeply branching uncultured microbes". XSEDE computational resource allocation. *1,6000 node-hours of TACC resource, est. value $415*
2019	**Sole PI:** Funded invitation to NSF Ideas Lab workshop (Invitation-only workshop meant to generate proposals for the "Harnessing the Data Revolution (HDR): Institutes for Data-Intensive Research in Science and Engineering – Ideas Labs (I-DIRSE-IL)" solicitation)
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*.
2017	**Co-I:** "Proposal for a workshop: Microorganisms and Organic Carbon in the Marine Subsurface". NSF/Center for Dark Energy Biosphere Investigations (C-DEBI). *$22,800*. Lead PI: Doug LaRowe.
2016	**Sole PI:** "Does hydroxyl radical liberate bioavailable organic carbon in subsurface sediments?" Center for Dark Energy Biosphere Investigations (C-DEBI), *$78,094*.

2016 **Senior personnel:** "GP-IMPACT: Engagement of Students and Faculty at Community Colleges to Enhance Recruitment to 4-Year Geoscience Programs". NSF-ICER. *$415,988*. Lead PI: Larry McKay.

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

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 total contribution*

2014-2016 **Co-I:** "Organic matter degradation pathways and cell specific enzyme activities in uncultured microorganisms found in deep sediments of the Baltic Sea, IODP Leg 347" with Karen Lloyd (lead PI, UT Microbiology). NSF Division of Ocean Sciences. *$362,095 total award; $117,994 to Steen*

2014-2017 **Co-I:** "Collaborative Research: Marine priming effect – molecular mechanisms for the biomineralization of terriginous dissolved organic matter in the ocean." with Alison Buchan (lead PI; UT Microbiology), Aron Stubbins (Skidaway Institute of Oceanography), Robert Spencer (Woods Hole Research Center). NSF Division of Ocean Sciences. *$997,364 total; $162,383 to Steen*.

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

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

Publications

†Undergraduate or high school students

Preprints

Senter, J.K., T.M. Royalty, A.D. Steen, A. Sadovnik (submitted). Unaligned Sequence Similarity Search Using Deep Learning. Available at arXiv: https://arxiv.org/abs/1909.06929

Published papers and manuscripts in press

35. Mahmoudi, N, SM Hagen, TC Hazen, **AD Steen** (accepted for publication). Patterns in extracellular enzyme activity and microbial diversity in deep-sea Mediterranean sediments. *Deep-Sea Research Part I*.
34. Royalty, T, **A.D. 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.
33. Royalty, T, **A.D. Steen** (2019). Quantitatively Partitioning Microbial Genomic Traits among Taxonomic Ranks across the Microbial Tree of Life. In press, *mSphere*. 4(4):e00446-19.
32. Ziervogel, K., S.B. Joye, S. Kleindienst, S.Y. Makin, U. Passow, **A.D. 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.
31. **Steen, A.D.**, R.T. Kevorkian, J.T. Bird, N. Dombrowski, B.J. Baker, S.M. Hagen†, K.H. Mulligan†, J.M. Schmidt, A.T. Webber†, T.M. Royalty, M.J Alperin (2019). Kinetics and identities of extracellular peptidases in subsurface sediments of the White Oak River Estuary, NC. *Applied and Environmental Microbiology*. 85(19):e00102-19.

30. **Steen, A.D.**, A. Crits-Christoph, P. Carini, K.M. DeAngelis, N. Fierer, K.G. Lloyd, J.C. Thrash (2019). High proportions of bacteria and archaea across most biomes remain uncultured. *ISME Journal*. DOI: 10.1038/s41396-019-0484-y
29. Sala, M.M., J. Piontek, S. Endres, A.M. Romaní, S. Dyhrman, **A.D. Steen** (2019). Extracellular enzymes in aquatic environments: exploring the link between genomic potential and biogeochemical processes. *Frontiers in Microbiology*. 10:1463.
28. Lang, S.Q., M.R. Osbourn, **A.D. Steen** (in press). 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.
27. Bird, J.T., E.D. Tague, L. Zinke, J.M. Schmidt, **A.D. Steen**, B. Reese, I.P.G. Marshall, G. Webster, A. Weightmann, H.F. Castro, S.R. Campagna, K.G. 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
26. Quigley, L.M.N, A. Edwards†, **A.D. 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
25. Lloyd, K.G., **A.D. 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
24. Matzek, L., M. Tipton, A. Farmer, **A.D. Steen**, K. Carter (2018). Understanding electrochemically activated persulfate and its application to ciprofloxacin abatement. *Environmental Science and Technology* 52(10): 5875-5883.
23. Mullen, L.†, Malcolm X Shabazz Aquatic Geochemistry Team†, K. Boerrigter†, N. Ferriero, J. Rosalsky, A.v.B. Barrett, P.J. Murray, **A.D. 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
22. Mahmoudi, N., S.R. Beaupré, **A.D. 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
21. **Steen, A.D**, L.N.M 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
20. Michalska, K., **A.D. Steen**, G. Chhor, M. Endres, A.T. Webber, J. Bird, K.G. Lloyd, A. Joachimiak (2015). New aminopeptidase from "Microbial Dark Matter" Archaeon. *FASEB Journal.* DOI: 10.1096/fj.15-272906
19. **Steen, A.D**., J.P. Vazin†, S.M. Hagen†, K.H. Mulligan†, and S.W. Wilhelm (2015). Substrate specificity of aquatic extracellular peptidases assessed by competitive inhibition assays using synthetic substrates. *Aquatic Microbial Ecology* 75(3) 271-281.
18. Cardman, Z., C. Arnosti, A. Durbin, K. Ziervogel, C. Cox, **A.D. 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.
17. **Steen, A.D**. 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
16. Arnosti, C., C. Bell, D. Moorhead, R.L. Sinsabaugh, **A.D. Steen**, M. Stromberger, M. Wallenstein, M.N 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
15. Lloyd, K., M. K. May†, R.T. Kevorkian, and **A.D. 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"**

14. Arnosti, C., and **A.D. 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
13. **Steen, A.D**., B.B. 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
12. Lloyd, K.G., L., Schreiber, D.G. Petersen, K. Kjeldsen, M.A. Lever, **A.D. Steen**, R. Stepanauskas, M. Richter, S. Kleindienst, S. Lenk, A. Schramm, B.B. Jørgensen (2013). Predominant Archaea in marine sediments degrade detrital proteins. *Nature* 496: 215-218.
11. **Steen, A.D**., and C. Arnosti (2013). Extracellular peptidase and carbohydrate hydrolase activities in an Arctic fjord (Smeerenburgfjord, Svalbard). *Aquatic Microbial Ecology* 69: 93-99.
10. **Steen, A.D**., 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.
9. **Steen, A.D.** 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.
8. Arnosti, C, **A.D. Steen**, K. Ziervogel, S. Ghobrial, and W.H. Jeffrey (2011). Latitudinal gradients in degradation of marine dissolved organic carbon. *PLOS ONE* 6(12): e28900. DOI:10.1371/journal.pone.0028900
7. **Steen, A.D**., and C. Arnosti (2011). Long lifetimes of β-glucosidase, leucine aminopeptidase, and phosphatase in Arctic seawater. *Marine Chemistry* 123(1-4) 127-132.
6. **Steen, A.D**, 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
5. Ziervogel, K., **A.D. Steen**, and C. Arnosti (2010). Changes in the spectrum of extracellular enzyme activities in seawater following aggregate formation. *Biogeosciences* 7: 1007-1015.
4. Robador, A., V. Bruchert, **A.D. 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.
3. **Steen, A.D.**, P. Gururaj, J. Ma, N.V. Blough, C. Arnosti (2008). Fluorescence anisotropy as a means to determine extracellular polysaccharide hydrolase activity in environmental samples. *Analytical Biochemistry* 383(2): 340-342.
2. **Steen, A.D.**, L.J. 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.
1. **Steen, A.D.**, C. Arnosti, L. Ness, and N.V. 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.

Abstracts, invited talks and posters

[*]invited; [†]Undergraduate students; [§]High school students or teachers

[*]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, P 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.

*Royalty, TM, and 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/.

*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).

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).

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)

*Steen, AD (2018). Work-life balance is essential and also totally impossible. C-DEBI Professional Development Webinar. Online.

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).

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, MXSHS 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, MXSHS 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).

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

Royalty, T and 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).

McKay, LD, SP Horn, SK Drumheller, CD Sumrall, KN Ellis, AD Steen (2018). Engaging community college transfer students in experiential learning at the University of Tennessee. SE GSA meeting (Knoxville, TN).

[*]Royalty, T and 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).

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

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).

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

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

Steen, A.D. L. N. M. Quigley, A. Stubbins, R. G. Spencer, and A. Buchan (2017). Towards a more mechanistic understanding of the aquatic priming effect. ASLO Aquatic Sciences Meeting (Honolulu, HI).

Barrett, AV, 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).

[*]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? 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, J 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)

[*]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.

Drumheller, SK, TA Gates, LR Brett† and 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)

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

Mahmoudi N, S Beaupre, AD Steen and 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 (ISME; Montreal)

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

Steen, AD and 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)

[*]Steen, AD (2015). Beyond Vmax and Km: How details of enzyme function influence geochemical cycles. AGU Fall Meeting (San Francisco, CA)

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

*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, Czech Republic).

*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, A.D., P.J. Murray, N. Ferriero, MXSHS Aquatic Geochemistry Team, J. Rosalsky, K.G. Lloyd (2015). Activities of extracellular peptidases across environments: Do diverse aquatic environments share similar tastes? ASLO Aquatic Sciences Meeting, Granada, Spain.

Steen, A.D., P.J. Murray, N. Ferriero, MXSHS Aquatic Geochemistry Team, J. Rosalsky, K.G. 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, A. D. 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, A.D., L. Mach, 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, A.D., K. Michalska, G. Chhor, M. Endres, J. Vazin, K. Lloyd, S.W. Wilhelm, A. Joachimiak (2014). Strategies to assess the biochemical properties of extracellular hydrolases in aquatic environments. Goldschmidt Meeting, Sacramento CA.

Michalska, K., A. D. Steen, G. Chhor, K. Fayman, M. Endres, G. Babnigg, K. 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, A.D. 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, A.D., R.T. Kevorkian, E. Deas†, and K.G. Lloyd (2013). Activities of extracellular peptidases in sediments of the White Oak River Estuary, NC. C-DEBI Annual Meeting, Monterrey, CA.

Lloyd, K.G., M. May†, R. Kevorkian, and A.D. Steen (2013). A meta-analysis reveals methodological biases in quantitative methods for marine subsurface microbiology. Goldschmidt Conference, Florence, Italy.

Arnosti, C., Z. Cardman†, A.D. Steen, K. Ziervogel, and 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, J.P, A.D. Steen, and S.W. 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, A.W., A. Buchan, A.D. Steen, and S.W. 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, A.D., J. P. Vazin†, A. W. Webber†, P. J. Gainer, S. W. Wilhelm (2013). Leucyl aminopeptidase is not enough: what do extracellular peptidase activity measurements tell us? ASLO Aquatic Sciences meeting, New Orleans, LA.

Steen, A.D., R. Cory, P. Lee, D.M. 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, A.P., J. P. Vazin†, A. Buchan, A. D. Steen, and S. W. 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, A.D. (2011). Dynamics of marine extracellular enzymes: What we can (and can't) learn from using nonstandard substrates. Uppsala University, Sweden.

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

Steen, A.D., 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.**

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

Ziervogel, A.D. 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, A.D. Steen, K. Ziervogel, S. Ghobrial, and W.H. Jeffrey (2010). Latitudinal gradients in degradation of marine dissolved organic carbon. ASLO Aquatic Sciences Meeting, Santa Fe, NM.

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

Steen, A.D. and 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., A.D. Steen, K. Ziervogel, S. Ghobrial, and W.H. Jeffrey (2009). Latitudinal gradients in microbial enzyme activities: Implications for DOC cycling in changing oceans. Gordon Research Conference in Chemical Oceanography, Tilton, NH.

Steen, A.D., and 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., A.D. Steen, and 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, A.D., K. Ziervogel, S. Ghobrial, and 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, A.D. Steen, and C. Arnosti (2009). Temperature sensitivity of extracellular enzymatic hydrolysis in Arctic and temperate marine sediments. ASLO Aquatic Sciences, Nice, France.

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

Arnosti, C., L. Hamdan, and A.D. 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, A.D., 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, A.D., and C. Arnosti (2005). The influence of marine polymer gels on the activity of extracellular enzymes. ASLO Ocean Sciences, Salt Lake City, UT.

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

Steen, A.D., C. Arnosti, and N.V. 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.

Software products

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

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 Advisees:

(current)	Taylor Royalty (PhD), Computational methods to describe form and function of microbial communities
(current)	Christopher S. Cook (MS), Methods analysis for extracellular enzyme assays in soils, sediments, and natural water media
(current)	Lauren A. Mullen (MS), 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)

2017 Abigail V. Barrett (MS), Controls on microbial extracellular enzymes in northeast Pennsylvania and eastern Tennessee fresh waters

2016 Jenna M. Schmidt (MS), Microbial extracellular enzymes in marine sediments: Methods development and potential activities in the Baltic Sea deep biosphere.

2012-present Committee member for: 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).

2012-present Major undergraduate advisor for: 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, Cameron Fang.

Teaching

Developed/redeveloped from scratch the following curricula:

- FYS 129: Mountains and Oceans
- GEOL 456 / 558: Global Climate Change
- GEOL 301: Methods in Geoscience
- GEOL 590 / MICR 593 / LFSC 590: Reproducible Data Analysis for Environmental Science
- GEOL 660: Seminar in Geochemistry: Organic Matter on the Earth and Elsewhere

Taught the following classes in Earth and Planetary Sciences:

- FYS 129: Mountains and Oceans (1 time)
- GEOL 103: The Earth's Environments (3 times)
- GEOL 301: Field Methods in Geology (1 time)
- GEOL 590: Reproducible Data Analysis for Environmental Science (1 time)
- GEOL 456 / 558: Global Climate Change (3 times)
- GEOL 660: Seminar in Geochemistry (1 time)

Taught the following short courses and independent studies:

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"

Service

2018-2019 Director of Environmental Studies Concentration.

2014-2018 Assistant Director of Environmental Studies Concentration.

2018 Co-organized and co-taught a 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-present 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

2016-present Review panelist, undisclosed funding bodies.

2016-present Proposal committee member for Ph.D. students in UT-Knoxville Departments of Chemistry and Microbiology.

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

2012-present Collaborating with students and teachers at Malcom X Shabazz High School 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.

2009-present Reviewer for the National Science Foundation, NASA, DfG (German national science foundation), 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*, *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 Society of Limnology and Oceanography
- Geochemical Society
- Geological Society of America