Benjamin P. Colman Duke Biology, Box 90338 Phone: (919) 660-7262
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Current Position: Research Scientist, Bernhardt Lab, Duke University, NC, studying environmental impacts of engineered and natural nanomaterials in wetland, stream, and terrestrial ecosystems

Research Interests: Effects of global change (N deposition, emerging contaminant release, climate change, sea-level rise) on biogeochemistry, ecosystem ecology, community ecology, and microbial ecology of soils, sediments, and natural waters

Education:

- PhD, University of California, Santa Barbara (UCSB). Dept of Ecology, Evolution, and Marine Biology (EEMB), Soil Microbial Ecology, Advisor: Joshua P. Schimel — 2009
- BA Chemistry, *cum laude*, Carleton College, Northfield, MN — 1999

Awards and Fellowships:

- Sulzman Award, honorable mention, ESA Biogeosciences section — 2008
- Science and Engineering Fellowship, competitive award, UCSB — 2007
- Nancy Brown Environmental Graduate Dissertation Fellowship, competitive award, UCSB — 2007
- Graduate Opportunity Fellowship, UCSB — 2007 to 2008
- Outstanding Symposium Presentation Award, UCSB — 2006
- Fiona Goodchild Mentoring Award, competitive award, UCSB — 2004
- Worster Family Mentoring Award, competitive award, UCSB — 2004
- Kearney Foundation Fellowship, competitive award, Kearney Foundation — 2003 to 2006
- Graduate Opportunity Fellowship, UCSB — 2002 to 2003
- Richard Rammette Award – for excellence in teaching Chemistry, Carleton College — 1999

Professional Experiences:

Research Scientist with Emily Bernhardt, Duke University, Durham, NC
- Continuing focus from postdoctoral work, but with expanded responsibilities for mentoring students, PI status for grant writing, and ability to teach classes at Duke — 2014-present

Postdoctoral Associate with Emily Bernhardt, Duke University, Durham, NC — 2009 to 2014
- Planning, coordinating, and executing interdisciplinary and inter-institutional mesocosm, microcosm, and lab-scale experiments on toxicity and environmental impacts of manufactured nanomaterials in terrestrial and aquatic ecosystems

Graduate researcher with Josh Schimel, UCSB — 2002 to 2009
- Examined the biotic and abiotic controls on C and N cycling in soils from the tropics to the arctic

Research Assistant with Knute J. Nadelhoffer, Ecosystems Center, Marine Biological Laboratory (MBL), Woods Hole, MA — 1999 to 2002
- Determined the fate of simulated elevated anthropogenic N deposition in both a pine and hardwood forest in the northeastern USA using ^{15}N tracers

Research Assistant (Part-Time) with Albert S. Colman and Karl K. Turekian, Geology and Geophysics Dept., Yale University, New Haven, CT — 2000 to 2002
- Devised ion-exchange chromatography method for purifying phosphate for ^{18}O-phosphate measurement without interference from organic matter

Project Aide with David J. Kieber, Chemistry Dept., SUNY-ESF, Syracuse, NY — 1995 to 1998
- Optimized high pressure liquid chromatography method for analyzing photochemical UV light metering system in the lab and on an Antarctic research cruise

Grants:

Awarded:

- National Science Foundation, Acquisition of high-speed sorting flow cytometer for multi-user environmental microbiology research, Wrote section on using flow cytometer to examine microbial stress; $473k

- National Science Foundation and U.S. Environmental Protection Agency, Renewal for the Center for Environmental Implications of Nanotechnology. 2013-2018. Lead PI, M. Wiesner, Duke Engineering, total award $12 million), Co-wrote section on nanotechnology impacts on ecosystems with Emily Bernhardt, (Bernhardt portion ~$600K)

Previously submitted:

- Molecular and enzymatic mechanisms driving the priming effect on soil organic matter under environmental change, submitted to Department of Energy, Lead PI, M. Wallenstein, (Wrote section on microscopic examination of microbial activity and stress using fluorescent probes), not funded

Publications:

In Circulation:

Bone A, Matson CW, **Colman BP**, Yang X, Meyer JN, Di Giulio RT, 2014, "Silver Nanoparticle Toxicity to Atlantic Killifish (Fundulus Heteroclitus) and Caenorhabditis Elegans: A Comparison of Mesocosm, Microcosm and Conventional Laboratory Studies." Environmental Toxicology and Chemistry, November, n/a – n/a. doi:10.1002/etc.2806.

Yelenik S,[#] **Colman BP**,[#] Levine J, Hille Ris Lambers J, A mechanistic study of plant and microbial controls over R* for nitrogen in an annual grassland, PLOS ONE, 9, (8), e106059

Colman BP, Espinasse B, Richardson CJ, Matson CW, Lowry GV, Hunt DE, WIesner MR, Bernhardt ES (2014) Emerging Contaminant or an Old Toxin in Disguise? Silver Nanoparticle Impacts on Ecosystems. *Environmental science & technology* 48:5229–5236

Levard C, Hotze EM, **Colman BP**, Truong L, Yang X, Bone A, Newton K, Brown GE Jr, Tanguay R, Bernhardt ES, Meyer J, Lowry GV, (2013) Sulfidation of Silver Nanoparticles: Natural antidote to their toxicity, *Environmental Science and Technology*, 47, 13440-13448

Ardón MA, Morse JM, **Colman BP**, Bernhardt ES, (2013) Drought-induced saltwater intrusion leads to wetland nitrogen export, *Global Change Biology,* 19, 2976–2985

Colman BP, Arnaout CL, Anciaux S, Gunsch CK, Hochella MF Jr, Kim B, Lowry GV, McGill BM, Reinsch BC, Richardson CJ, Unrine JM, Wright JP, Yin L, Bernhardt ES (2013*)* Low concentrations of silver nanoparticles in biosolids cause adverse ecosystem responses under realistic field scenario. *PLOS ONE,* 8, e57189

Colman BP, Schimel J (2013) Biotic and abiotic drivers of microbial respiration and net N mineralization at the continental scale. *Soil Biology and Biochemistry,* 60, 65-76

Colman BP, Wang SY, Auffan M, Wiesner MR & Bernhardt ES (2012) Antimicrobial effects of commercial silver nanoparticles are attenuated in natural streamwater and sediment. *Ecotoxicology,* 21, 1867-1877

Kim B, Murayama M, **Colman BP**, and Hochella MF Jr (2012) Characterization and environmental implications of nano- and larger tio2 particles in sewage sludge, and soils amended with sewage sludge *Journal of Environmental Monitoring,* 14, 1129-1137

Yin L, **Colman BP**, McGill BM, Wright JP, Bernhardt ES (2012) Effects of silver nanoparticle exposure on germination and early growth of eleven wetland plants, *PLOS ONE,* 7, e47674

Unrine JM,[#] **Colman BP**,[#] Bone AJ, Gondikas AP & Matson CW (2012) Biotic and Abiotic Interactions in Aquatic Microcosms Determine Fate and Toxicity of Ag Nanoparticles: Part 1–Aggregation and Dissolution. *Environmental Science & Technology*, 46, 6925-6933

Bone AJ, **Colman BP**, Gondikas AP, Newton K, Harrold KH, Unrine JM, Klaine SJ, Matson CW, Di Giulio RT, (2012) Biotic and abiotic interactions in aquatic microcosms determine fate and toxicity of Ag nanoparticles: Part 2 –Toxicity and chemical speciation. *Environmental Science and Technology,* 46, 6915-6924

#both authors contributed equally

Lowry GV, Espinasse BP, Badireddy AR, Richardson CJ, Reinsch BC, Bryant LD, Bone AJ, Deonarine A, Chae S, Therezien M, **Colman BP**, Hsu-Kim H, Bernhardt ES, Matson CW & Wiesner MR (2012) Long-Term Transformation and Fate of Manufactured Ag Nanoparticles in a Simulated Large Scale Freshwater Emergent Wetland. *Environmental Science & Technology,* 46, 7027-7036

Yin L, Cheng Y, Espinasse B, **Colman BP,** Auffan M, Rose J, Wiesner M, Liu J, Bernhardt ES, (2011) More than the ions: The effects of silver nanoparticles on *Lolium multiflorum*, *Environmental Science and Technology,* 45, 2360-2367

Bernhardt ES, **Colman BP**, Hochella MF, Cardinale BJ, Nisbet RM, Richardson CJ, Yin L (2010), An ecological perspective on nanomaterial impacts in the environment. *Journal of Environmental Quality* 39, 1954-1965

Hofmockel, KS, Fierer N, **Colman BP**, Jackson R (2010) The abundance and production of amino acids in North American soils *Oecologia,* 163: 1069-1078

Hille Ris Lambers J, Yelenik S, **Colman BP**, Levine J (2010) California annual grass invaders: the passengers, not drivers of change *Journal of Ecology,* 98, 1147-1156

Colman BP, Schimel JP (2010) Understanding and eliminating iron interference in colorimetric nitrate and nitrite analysis *Environmental Monitoring and Assessment,* 165, 633-641

Colman BP, Fierer N, Schimel JP. (2008) Abiotic nitrate incorporation, anaerobic microsites, and the ferrous wheel. *Biogeochemistry,* 91, 223-227

Colman BP, Fierer N, Schimel JP (2007) Abiotic NO_3^- incorporation in soil: is it real? *Biogeochemistry,* 84, 161-169

Fierer N, **Colman BP**, Jackson RB, Schimel JP. (2006) Predicting the temperature dependence of soil CO_2 production: a continental-scale analysis. *Global Biogeochemical Cycles,* 20, GB3026

Pardo LH, Templer PH, Goodale CL, Duke S, Groffman PM, Adams MB, Boeckx P, Boggs J, Campbell J, **Colman B**, Compton J, Emmett B, Gundersen P, Kjønaas J, Lovett G, Mack M, Magill A, Mbila M, Mitchell MJ, McGee G, McNulty S, Nadelhoffer K, Ollinger S, Ross D, Rueth H, Rustad L, Schaberg P, Schiff S, Schleppi P, Spoelstra J, Wessel W (2006) Regional assessment of N saturation using foliar and root $\delta^{15}N$, *Biogeochemistry*, 80 143-171

Nadelhoffer KJ, **Colman BP**, Currie WS, Magill A, Aber JD. (2004) Decadal-scale fates of ^{15}N tracers added to oak and pine stands under ambient and elevated N inputs at the Harvard Forest (USA). *Forest Ecology and Management,* 196, 89-107

Currie WS, Nadelhoffer KJ,**Colman B** (2002) Long-term movement of ^{15}N tracers into fine woody debris under chronically elevated N inputs. *Plant and Soil,* 238, 313-323

In review:

Park S, Chung J, **Colman BP**, Matson CW, Kim Y, Lee B, Kim P, Choi K, Choi J. Toxicity of bare and coated silver nanoparticles in the presence of sediment to the aquatic midge, *Chironomus riparius*

Yang Y, **Colman BP**, Bernhardt ES, Hochella MF Jr., Assessing the size of the impact: nanoparticle and dissolved contaminants in North Carolina's Dan River following a coal ash spill

In preparation:

Colman BP, Baker LF, King RS, Matson CW, Richardson CJ, Bernhardt ES. Duration not dose drives contaminant bioaccumulation

Bryant LB, Hsu-Kim H, **Colman BP**, Espinasse B, Wiesner MR. The effect of manufactured nanomaterials on biogeochemical redox gradients at the sediment-water interface

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Invited Seminars and Talks:

Colman BP (2014) The big deal with little particles in aquatic and terrestrial ecosystems: nanomaterials in the environment, Princeton University, Department of Civil and Environmental Engineering, April 21

Colman BP (2014) The big deal with little particles in aquatic and terrestrial ecosystems: nanomaterials in the environment, University of Wisconsin, Soil Sciences Department, March 27

Colman BP (2013) Environmental impacts of metal and metal oxide nanomaterials, NSF Nanoscale Science and Engineering Grantees Meeting, Arlington, VA, December 4-6

Colman BP (2013) Transport, fate, impacts, and implications of manufactured nanomaterials in terrestrial and aquatic ecosystems, Department of Biology and Marine Biology Seminar Series, October 25

Colman BP (2013) Transport, fate, impacts, and implications of manufactured nanomaterials in terrestrial and aquatic ecosystems, Duke University Program in Ecology Seminar Series, October 18

Colman BP (2013) The transport, fate, and bioavailability of manufactured nanomaterials in terrestrial ecosystems: a critical review, Invited talk, 12th international Conference on the Biogeochemistry of Trace Elements, Athens, GA, June 17

Colman BP (2013) Impacts of manufactured nanomaterials in terrestrial and aquatic ecosystems, Invited Seminar, Cary Institute of Ecosystem Studies, March 21

Colman BP (2010) Nanomaterials in the environment: The effect of realistic silver nanoparticle exposures on terrestrial ecosystem dynamics, Invited Seminar, Civil and Environmental Engineering, Carnegie Mellon University, April 16

Presentations at national meetings:

Colman BP, Fedders A, Richardson CJ, Bernhardt ES (2014) Pulse vs. press disturbance of wetland mesocosms by an emerging contaminant, silver nanoparticles, ESA 99th Annual Meeting, Sacramento, CA, August 10-15

Colman BP, Fedders A, Schwab F, Richardson CJ, Stegemeier J, Lowry GV, Wiesner M, Bernhardt ES (2014) Keepin' it real: the realities of engineered nanoparticles in aquatic ecosystems, Joint Aquatic Sciences Meeting, Portland OR, May 18-23

Colman BP, CJ Richardson, GV Lowry, BK Reinsch, B Espinasse, MR Wiesner, JM Unrine, ES Bernhardt (2012) Increased methane flux from wetlands due to differential toxicity of silver nanoparticle pollution, ESA 97th Annual Meeting, Portland, OR, Aug. 5-10

Colman BP, CJ Richardson, GV Lowry, BK Reinsch, B Espinasse, MR Wiesner, JM Unrine, ES Bernhardt (2011) Differential silver nanoparticle toxicity to microbes and macrophytes leads to carbon dioxide, nitrous oxide, and methane pulses, ESA 96th Annual Meeting, Austin, TX, Aug. 7-12

Colman BP, CJ Richardson, GV Lowry, BK Reinsch, B Espinasse, MR Wiesner, JM Unrine, ES Bernhardt (2011) Short-term fate and toxicity of silver nanoparticles in wetland mesocosms, iCEIN 3rd annual meeting, Duke University May 9-11

Colman BP, ES Bernhardt, C Richardson, CK Gunsch, C Arnaout, B McGill, JP Wright, L Yin (2010) Nanomaterials in the environment: The effect of realistic silver nanoparticle exposures on terrestrial ecosystem dynamics, ESA 95th Annual Meeting, Pittsburgh, PA, August 1-6

Colman BP, N Fierer, J Schimel (2010) Biotic and abiotic drivers of microbial carbon and nitrogen cycling in soils at the continental scale, University Program in Ecology Seminar, Duke University, Feb 12

Colman, BP, M Auffan, CJ Richardson, M Wiesner, ES Bernhardt (2009) Impacts of nanosilver on microbial activity in wetlands and streams, Goldschmidt Conference, Davos, Switzerland, June 21-26

Colman, BP, N Fierer , J Schimel (2008) What drives soil microbial respiration at the continental scale? Ecological Society of America (ESA), 93nd Annual Meeting, Milwaukee,WI, August 3-8

Colman, BP, N Fierer , J Schimel (2007) Is soil microbial ecology predictable: a cross-ecosystem study, Ecological Society of America (ESA), 92nd Annual Meeting, San Jose, California, August 4-10

Colman, BP, N Fierer , J Schimel (2005) Abiotic NO_3^- incorporation in 45 US soils, ESA, 90th Annual Meeting, Montreal, Canada, August 7-12

Colman, BP, N Fierer , J Schimel (2004) Biotic and abiotic controls on C and N cycling in North American soils. ESA, 89th Annual Meeting, Portland, OR, August 2-6

Colman, BP, KJ Nadelhoffer, WS Currie (2001) Decadal scale movements of ^{15}N tracers into bolewood at the Harvard Forest Chronic N Study. ESA, 86th Annual Meeting, Madison, WI, August 5-10, 2001

Teaching:

• Instructor, Duke University, ENV/BIO 564, Biogeochemistry, Grad Course	Spring 2015
• Organizer, Duke University, Biogeochemistry Discussion Group, ORG-GS-UPE299	2010 to present
• Teaching Assistant, University of California, Santa Barbara, EEMB 171: Ecosystem Processes	2004 to 2005
• Field and Laboratory Assistant, Marine Biological Laboratory, Semester in Environmental Science	1999 to 2001
• Laboratory Assistant, Organic Chemistry I and II, Carleton College	1997 to 1999

Invited Lectures:

- Terrestrial Biogeochemistry, Parts I & II (Biogeochemistry, Duke) 2013
- Impact of engineered nanomaterials on microorganisms, plants, and ecosystems (CEINT REUs, Duke) 2011-2014
- Rock weathering, clays, and soil development (Biogeochemistry, Duke) 2011
- Engineered nanomaterial impacts in ecosystems (CEINT REUs, Duke) 2010
- N gas production: nitrification and denitrification (Ecosystem Processes, UCSB) 2005
- Photosynthesis in terrestrial plants (Ecosystem Processes, UCSB) 2005
- Scale in Ecology (Ecosystem Processes, UCSB) 2005
- The history of ecosystem ecology (Ecosystem Processes, UCSB) 2005
- Primary productivity in terrestrial ecosystems (Ecosystem Processes, UCSB) 2004
- Water potential (Ecosystem Processes, UCSB) 2004
- The soil food web (Dos Pueblos High School, Goleta, CA) 2004
- Decomposition: The death history of plants (Ecosystem Processes, UCSB) 2004

Service

Reviewer

Global Change Biology, Biogeochemistry, Nature Communications, Environmental Science and Technology, Applied and Environmental Microbiology, Soil Biology and Biochemistry, Soil Science Society of America Journal, Journal of Environmental Quality, Journal of Hazardous Materials, Environmental Toxicology and Chemistry, Ecotoxicology, Environmental Pollution, and Nanotoxicology

Outreach:

Mesocosm facility tours, Durham, NC 2010-present
Opportunity to discuss concerns over engineered nanomaterial impacts on the environment, and our attempts at testing the fate, transformation, and impact of engineered nanomaterials in terrestrial and freshwater wetland mesocosms. Groups have included science bloggers, undergraduates, regulators, and members of the general public

Nano Days, Museum of Life and Science, Durham, NC 2009-present
Annual opportunity to present the workings of natural ecosystems and the ecosystem of the human microbiome, and engage in discussions about the potential impacts of antimicrobial nanoparticles in these environments

NC Science Festival, Invite a scientist, West Pine Middle School, West End, NC 2014
Talked about how I got into science and led soil texturing hands on activity

Peridoic Table, Museum of Life and Science, Durham, NC 2013
Informal science talk and Q&A about the potential benefits and pitfalls of nanotechnology, presented at the Broad Street Café in Durham, NC

Nano Nights, Museum of Life and Science, Durham, NC 2011
Present the role of aquatic food webs in ecosystems, demonstrate AgNP impacts on different organisms, and discuss their potential impacts in the environment

Tide Pool School, Hollister Ranch Conservancy, CA 2007-2009
Taught 3rd to 10th graders about tide pools and tide pool ecology

Discovery Day, MBL, Woods Hole, MA 2000
Helped design and staff a display on coastal water quality and eutrophication

Council of Visitors, MBL, Woods Hole, MA 2000
Helped lead fieldtrip to Falmouth Wastewater Treatment Plant irrigation-fields

Science Writers Course, MBL, Woods Hole, MA 2000
Led trip for science journalists to the Harvard Forest Long Term Ecological Research experiment in Petersham, MA

Advisory positions:

Founding member of *Biogeochemistry* Review Board 2011-present
Member of NEON Inc. Biogeochemistry working group 2012-present

Students mentored:

- Victoria Green, Undergraduate, Howard Hughes Research Fellow 2014
- Sarah Gubermann, Research Experiences for Undergratuates (REU), Baylor Univ. 2014
- Dana Kazerooni, REU, Virginia Tech 2014
- Emily Rinaldo, Undergraduate Independent Study, Duke 2014
- Abigail McEwen, Masters in Environmental Management Student, Duke 2013-2014
- Elizabeth Yin, Masters in Environmental Management Student, Duke 2012-2014
- David Cutting, REU, Tulane 2012-2013
- Gaurav Sen, Undergraduate Independent Study, Duke 2012
- Tara Soni, REU, MIT 2011
- Kayley Hake, Duke Mentored Research for Undergraduates, Meredith College 2011-2012
- Tyler Bray, Undergrad Independent Study, Duke 2011
- Tammy Stern, Masters in Environmental Management Student, Duke 2010-2011
- Sarah Anciaux, REU, Undergrad, Coe College 2010
- Daniel Kong, Howard Hughes Precollege Program, East Chapel Hill High 2010
- Eddie Liu, Scientifica High School Intern, Durham Academy 2010
- Christine Rheem, Howard Hughes Precollege Program, East Chapel Hill High 2009
- Shona Saxon, Summer Research Assistant, UCSB 2004
- Danielle Shullman, Undergraduate, UCSB 2003
- John Scanlon, Lab assistant, MBL 2001
- Samantha Williams, REU, MBL 2000