Matthew E. Craig
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Environmental Science Division and Climate Change Science Institute
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Research Areas
Terrestrial ecosystem ecology, soil carbon, biogeochemistry

EDUCATION

2019	**Ph.D.** Ecology, Evolution, and Behavior (Minor: Geography) Indiana University, Bloomington
2014	**M.S.** Natural Resources and Environmental Sciences University of Illinois, Urbana-Champaign
2011	**B.A.** Biology (Minor: Environmental Studies) Augustana College, Rock Island, Illinois

PROFESSIONAL APPOINTMENTS

2021 – present	Associate Research Scientist, Environmental Sciences Division and Climate Change Science Institute, Oak Ridge National Laboratory
2019 – 2021	Postdoctoral Research Associate, Environmental Sciences Division and Climate Change Science Institute, Oak Ridge National Laboratory
2011	District Forester Assistant, Illinois Department of Natural Resources

PUBLICATIONS

21. **Craig ME**, Walker AP, Iversen CM, Knox RG, Yaffar D, York LM (**2025**) Tree root nutrient uptake kinetics vary with nutrient availability, environmental conditions, and root traits: A global analysis. New Phytologist 246: 2495-2505.

20. Georgiou K, Angers D, Champiny RE, Cotrufo MF, **Craig ME**, Dötterl S, Grandy AS, Lavallee JM, Lin Y, Lugato E, Poeplau C, Rocci KS, Schweizer SA, Six J, Wieder WR. (**2025**) Soil carbon saturation: What do we really know? Global Change Biology 31:e70197.

19. Hogan JA, Lichstein JW, Helmer EH, **Craig ME**, Fricke E, Henrich V, Kannenberg SA, Koven CD, Goldewjik KK, Lapola DM, *et al.* (**In press**) Anthromes and forest carbon responses to global change. Plants, People, Planet.

18. Yaffar D, Brenner J, Walker AP, **Craig ME**, Vaughan E, Marín-Spiotta E, Matos M, Rios S, Mayes MA (**2025**) The Freundlich isotherm equation best represents phosphate sorption across soil orders and land use types in tropical soils of Puerto Rico. Biogeochemistry 168: 27.

17. **Craig ME**, Harman-Ware AE, Cope KR, Kalluri UC (**2024**) Intraspecific variability in plant and soil chemical properties in a common garden plantation of the energy crop Populus. PLOS ONE 19: e0309321.

16. Cusack DF, Reed S, Andersen KM, Cinoğlu D, **Craig ME**, Dietterich LH, Hogan JA, Holm JA, Nottingham AT, Ostertag R, *et al.* (**2024**) Tropical forests and global change: biogeochemical responses and opportunities for cross-site comparisons, an organized INSPIRE session at the 108th Annual Meeting, Ecological Society of America, Portland, Oregon, USA, August 2023. New Phytologist 241: 1922–1926.

15. Beidler KV, Benson MC, **Craig ME**, Oh Y, Phillips RP (**2023**) Effects of root litter traits on soil organic matter dynamics depend on decay stage and root branching order. Soil Biology and Biochemistry 180:109008.

14. Weintraub-Leff SR, Hall SJ, **Craig ME**, Sihi D, Wang Z, Hart SC (**2023**) Standardized data to improve understanding and modeling of soil nitrogen at continental scale. Earth's Future 11: e2022EF003224.

13. **Craig ME**, Geyer KM, Beidler KV, Brzostek ER, Frey SD, Grandy AS, Liang C, Phillips RP (**2022**) Fast-decaying plant litter enhances soil carbon in temperate forests but not through microbial physiological traits. Nature Communications 13:1-10.

12. Lin G, **Craig ME**, Jo I, Wang X, Zeng DH, Phillips RP (**2022**) Mycorrhizal associations of tree species influence soil nitrogen dynamics via effects on soil acid-base chemistry. Global Ecology and Biogeography 31:168-182.

11. **Craig ME**, Mayes MA, Sulman BN, Walker AP (**2021**) Biological mechanisms may contribute to soil carbon saturation patterns. Global Change Biology 27:2633-2644.

10. Terrer C, Phillips RP, Hungate BA, Rosende J, Pett-Ridge J, **Craig ME**, van Groenigen KJ, Keenan TF, Sulman BN, Stocker BD, Reich PB, Pellegrini AFA, Pendall E, Zhang H, Evans RD, Carrillo Y, Fisher JB, Jackson RB (**2021**) A global tradeoff between plant and soil carbon storage under elevated CO_2. Nature 591: 599-603.

9. Keller AB, Brzostek ER, **Craig ME**, Fisher JB, Phillips RP (**2021**) Root-derived inputs are major contributors to soil carbon in temperate forests, but vary by mycorrhizal type. Ecology Letters 24:626-635.

8. Mushinski RM, Payne ZC, Raff JD, **Craig ME**, Pusede SE, Rusch DB, White JR, Phillips RP (**2021**) Nitrogen cycling microbiomes are structured by plant mycorrhizal associations with consequences for nitrogen oxide fluxes in forests. Global Change Biology 27:1068-1082.

7. Walker et al. (**Craig ME** one of 61 co-authors) (**2021**) Integrating the evidence for a terrestrial carbon sink caused by increasing atmospheric CO_2. New Phytologist 229:2413-2445.

6. **Craig ME**, Lovko NL, Flory SL, Wright JP, Phillips RP (**2019**) Impacts of an invasive grass on soil organic matter pools vary across a tree-mycorrhizal gradient. Biogeochemistry 144:149-164.

5. Zak DR, Pellitier PT, Argiroff WA, Castillo B, James TY, Nave LE, Averill C, Beidler KV, Bhatnagar J, Blesh J, Classen A, **Craig ME**, Fernandez C, Gundersen P, Johansen R, Koide R, Lileskov E, Lindahl B, Nadelhoffer K, Phillips RP, Tunlid A (**2019**) Exploring the role of ectomycorrhizal fungi in soil organic matter dynamics. New Phytologist 223:33-39.

4. **Craig ME**, Turner BL, Liang C, Clay K, Johnson DJ, Phillips RP (**2018**) Tree mycorrhizal type predicts within-site variability in the storage and distribution of soil organic matter. Global Change Biology 24:3317-3330.

3. **Craig ME**, Fraterrigo JM (**2017**) Plant–microbial competition for nitrogen increases microbial activities and carbon loss in invaded soils. Oecologia 184:583-596 **(*highlighted student paper*)**.

2. **Craig ME**, Pearson SM, Fraterrigo JM (**2015**) Grass invasion effects on forest soil carbon depend on landscape-level land use patterns. Ecology 96:2265-2279.

1. Hager SB, **Craig ME** (**2014**) Bird-window collisions in the summer breeding season. PeerJ 2:460.

RESEARCH GRANTS AWARDED

Visiting Faculty Program, DOE Office of Workforce Development for Teachers and Scientists (WDTS). Summer 2025 (**co-PI**)

- *Tree composition effects on soil carbon resilience to press and pulse drought conditions*

Center for Bioenergy Innovation (CBI)-High Risk High Reward Project, $722,768 over 2 years, 2025-2026 (**Task lead**)

- *Identifying plant trait and genomic targets for enhanced soil carbon sequestration*

Free Air CO_2 Enrichment Model Data Synthesis (FACE-MDS) project, $1,050,000 over 3 years, 2024-2026 (**co-PI**)

- *Understanding coupled carbon and nitrogen cycle responses in elevated CO_2 experiments through the lens of forest stand and measurable soil organic matter pool dynamics.*

ORNL TES-SFA renewal, $41,500,000 over 5 years, 2023-2028 (**Task lead**)

ORNL Laboratory Directors Research and Development, $495,000, 2023-2024 (**Co-Investigator**)

- *Selecting belowground processes for durable soil carbon*

ORNL Laboratory Directed Research and Development, Seed Fund, $190,000, 2022 (**Contributor**)

- *Optimizing plant traits for bioenergy and soil carbon storage*

Indiana University Research and Teaching Preserve Grant, $2,000, 2018 (**PI**)

National Science Foundation, DDIG, $20,275, 2017-2019 (**co-PI**)

- *Where plant litter ends and soil carbon begins: The role of microbial physiology in stabilizing soil organic matter*

Indiana University Research and Teaching Preserve Grant, $500, 2014 (**PI**)

Smithsonian Tropical Research Institute, CTFS-ForestGEO Research Grant, $14,999, 2014-2016 (**PI**)

- *A new framework for quantifying drivers of soil carbon dynamics within and among forests*

Garden Club of America of Downer's Grove Research Grant, $2,500, 2012 (**PI**)

Augustana College Student Summer Research Grant, $3,500, 2010 (**co-PI**)

TEACHING

Associate Instructorships:
Biology of the Senses, Indiana University, 2019

General Ecology, Indiana University, 2013-2018 (6 semesters)

Ecology, Augustana College, 2011

Guest lectures:
Soil organic matter formation and decomposition, Ecosystem Ecology, Indiana University, 2018

Mutualism, competition, and predation, General Ecology, Indiana University, 2018

Primary production and nutrient limitation, General Ecology, Indiana University, 2016

Nutrient cycling, General Ecology, Indiana University, (5 times from 2014 – 2018)

Designing Observational Studies, Research in Field Biology, Augustana College, 2012

Other relevant teaching experience:
Optimal Foraging Theory, Field Ecology, Indiana University, 2017

Biology Summer Institute, Indiana University, 2014 – 2016, 2018

Structural Equation Modeling, EcoLunch Statistics Workshop, co-led with A. Strauss, 2016

Teacher Training Workshop, Indiana University, (1-week workshop; 2013)

Laboratory Proctor, General Botany, Augustana College, 2010

Laboratory Proctor, Organic Chemistry, Augustana College, 2009

MENTORING

Postdocs:
Daniela Yaffar de la Fuente
- *Soil and root phosphorus dynamics in tropical forests*

Visiting Faculty:

Mali Hubert, DOE Visiting Faculty Program
- *Drought effects on soil carbon*

Interns and undergrads independent research (*student authorship on a peer-reviewed publication):
Sarah Lynne Northop, DOE Visiting Faculty Program
- *Variation in soil properties with tree community composition in a drought-prone forest*

Jacelyn Stone, DOE Visiting Faculty Program
- *Effects of drought on soil respiration across a range of soil traits*

Dana Frankenstein, Science Undergraduate Laboratory Internships, ORNL
- *Root metabolite effects on soil carbon stabilization*

Abubakir Siedahmed, GEM Fellowship, ORNL
- *Developing user interface for the Multi-Assumption Architecture and Testbed*

Parker Calloway, Science Undergraduate Laboratory Internships, ORNL
- *The effects of phenolic acids on soil nitrogen in a bioenergy crop system*

Julius Hain, Independent Study, BIOL-X490*
- *Soil extracellular enzyme responses to plant invasion*

Robin Johnson, Master's research
- *Mycorrhizal colonization of invasive plant roots along nutrient gradients*

Peyton Joachim, Independent Study, BIOL-X490
- *Invasive plant effects on earthworm community composition*

Nadia Lovko, Independent Study, BIOL-X490*
- *Invasive plant effects on soil organic matter pools along a tree-mycorrhizal gradient*

High school student internship:
Mari Walter-Bailey, Internship Program, Bloomington High School South

Field and lab experience:
Corben Andrews, Madison Barney, Tommmy Beresky, Dan Du, Kelly Fox, Cara Grabowski, Matt Hamilton, Emma Hand, Samuel Incardona, Peyton Joachim, Robin Johnson, Yuejong Lee, Joey Maddon, Emily McGrath, Brindin Parrot, Rebecca Pronschinske, Naomi Reibold, Mari Walter-Bailey, Rachel Zeunik

HONORS, AWARDS, AND FELLOWSHIPS

Floyd Plant and Fungal Biology Summer Fellowship, Indiana University, (5 awards; 2014-2019)

Best Student Talk; Soil Health Session at International SOM Symposium in Fall 2017 (£250)

Alfred Parson Mower Fellowship, Indiana University, 2017 ($1,500)

Highlighted Student Paper, *Oecologia*, 2017

Blatchley Nature Study Club Fellowship, Indiana University, 2017 ($500)

Best Student Talk in Biogeosciences for presentation given at ESA in August 2016 ($250)

Louise Constable Hoover Fellowship, Indiana University, 2016 ($1,000)

Spaeth and Boggess Graduate Scholarship in Forestry, University of Illinois, 2012 ($1,000)

Odell Soil Science Fellowship 2011-2012, University of Illinois

SERVICE AND OUTREACH

Professional service:
Joint special collection for New Phytologist and Plants, People, Planet, Anthromes and terrestrial carbon: From the deep past to net-zero, Guest Editor, 2023-2024

NSF-NEON Technical Working Group Member, Terrestrial Biogeochemistry, 2020 – present

Internal Technical Reviewer, Oak Ridge National Laboratory, 2020 – present

Ecosystem Science meeting, planning committee, Oak Ridge National Laboratory, 2020 – present

Local Emergency Squad member, Oak Ridge National Laboratory, 2020 – present

Anthromes, CO_2, and Terrestrial Carbon: From the Deep Past to Net-Zero, Co-organizer, 2023

Integrated Ecosystem Experiments Workshop, ORNL, Co-organizer, 2022

Concerned Scientists at Indiana University, 2018 – 2019

Invited talk, Blatchley Nature Study Club in Noblesville, Indiana, 2018

EcoLunch committee member and co-chair, EEB, Indiana University, 2016 – 2019

Graduate Recruitment Week Planning Committee, Indiana University, 2014 – 2019

Midwestern Ecology and Evolution Conference, planning committee, 2015

Jim Holland Summer Enrichment Program Instructor, 2014-2017

University of Illinois Representative, Coweeta LTER graduate committee, 2012 – 2013

Reviewer

Grants: U.S. Department of Energy, Earth System Science program, proposal review panelist; Czech Science Foundation, ad hoc reviewer.

Manuscripts: Nature, Global Change Biology, Nature Geosciences, Science Advances, Ecological mongraphs, Soil Biology & Biochemistry, Biological Reviews, New Phytologist, Journal of Ecology, Ecological Indicators, Geoscientific Model Development, Biogeochemistry, Biogeosciences, Plant and Soil, Scientific Data, Land Degradation and Development

Professional society membership:
Ecological Society of America, 2013 – present

American Geophysical Union, 2016, 2019

SELECTED PRESENTATIONS

Oral (*denotes invited talk):

***Craig ME**. Soil carbon responses to organic inputs: A simple problem with complicated answers. Biology Department, Syracuse University. April 2024.

***Craig ME**, Walker AP, Iversen CM, Norby R, Yang X, York LM. Root-soil interactions and model-informed data gaps in tropical forests. Talk given at ESA in Portland, OR, USA. August 2024.

***Craig ME**, Walker AP, Abramoff R, Mayes M. The Multi-Assumption Architecture and Testbed (MAAT) for soil carbon science. Talk given at the ESS-PI meeting in Bethesda, MD, USA. May 2023.

Craig ME, Sulman BN, Mayes MA, Abramoff RZ, Walker AP. Microbe-mineral interactions determine the relationship between organic inputs and soil carbon accumulation. 107th Annual Ecological Society of America meeting, Montréal, Québec. August 2022.

Craig ME, Mayes MA, Sulman BN, Walker AP. Microbial control over soil carbon saturation. 105th Annual Ecological Society of America meeting. August 2020.

Craig ME, Beidler KV, Phillips RP. Microbial growth dynamics form a poor link between litter quality and mineral-associated organic matter formation. American Geophysical Union Fall Meeting, San Francisco, CA. December 2019.

Craig ME, Beidler KV, Phillips RP. Soil carbon formation and decay along an experimental litter chemistry gradient. 104th Annual Ecological Society of America meeting, Louisville, KY. August 2019.

Craig ME, Geyer KM, Brzostek ER, Phillips RP. Linking mycorrhizal associations with microbial growth and soil organic matter properties across temperate forests. 103rd Annual Ecological Society of America meeting, New Orleans, LA. August 2018.

Craig ME, Lovko NL, Flory SL, Wright JP, Phillips RP. Tree community modulates the effects of an invasive grass on soil organic matter pools. 6th International Symposium on Soil Organic Matter, Rothamsted Research, Harpenden, UK. September 2017. *(**Awarded Best Student Talk**)*

Craig ME, Turner BL, Bourg N, McShea B, Phillips RP. Higher carbon-to-nitrogen ratios in soils dominated by ectomycorrhizal-associated trees do not equate to greater soil carbon storage. 101stAnnual Ecological Society of America meeting, Ft Lauderdale, FL. August 2016. *(**Awarded Best Student Talk for Biogeosciences Section of ESA**)*

Craig ME, Pearson SM, Fraterrigo JM. Grass invasion differentially affects carbon cycling across an urban-rural gradient in Southern Appalachian forests. 98th Annual Ecological Society of America meeting, Minneapolis, MN. August 2013.

Posters:

Craig ME, Walker AP, Iversen CM, Knox RG, Yaffar D, York LM. A global analysis to understand environmental and interspecies variation in tree root nutrient uptake kinetics. Ecological Society of America meeting, Long Beach, CA. August 2024.

Craig ME, Sulman BN, Mayes MA, Walker AP. Probing structural differences in contemporary soil carbon models. 106th Annual Ecological Society of America meeting. August 2021.

Craig ME, Turner BL, Liang C, Bourg N, McShea B, Phillips RP. Toward a Simple Framework for Understanding the Influence of Litter Quality on Vertical and Horizontal Patterns of Soil Organic Matter Pools. American Geophysical Union Fall Meeting, San Francisco, CA. December 2016.

Craig ME, Phillips RP. Do mycorrhizal associations influence landscape-scale soil C dynamics? A spatially explicit approach. 100th Annual Ecological Society of America meeting, Baltimore, MD. August 2015.

Craig ME, Pearson SM, Fraterrigo JM. Variation in carbon cycling impacts of an invasive grass (*Microstegium vimineum*) across an urban-rural gradient in Southern Appalachian forests. Long-Term Ecological Research – All Scientists Meeting. Estes Park, CO. September 2012.

SELECTED WORKSHOP ATTENDANCE

"Southeast Decarbonization Workshop" sponsored by Oak Ridge National Laboratory and Georgia Tech; Atlanta, GA; November 2023

"Anthromes, CO_2, and Terrestrial Carbon: From the Deep Past to Net-Zero", conference hosted by Oak Ridge National Laboratory and New Phytologist; Potomac, MD; April 2023

"NGEE Arctic ELM ModEx workshop", virtual attendance at DOE-sponsored workshop, Oct 2022.

"Integrated Ecosystem Experiments Workshop", Virtual workshop hosted by Oak Ridge National Laboratory, March 2022

"Summit on Decarbonization of the Ag Sector", Virtual workshop hosted by Oak Ridge National Laboratory, September 2021

"New Advances in Land Carbon Cycle Modeling", Virtual Training Course, Center for Ecosystem Science and Society, Northern Arizona University, July 2020

"Fungal Communities and Soil Carbon Storage", sponsored by the Energy Institute at the University of Michigan and the Beyond Carbon Neutral Program; Ann Arbor, MI; May 2018

DATASETS

Craig ME (2025) Data for "Tree root nutrient uptake kinetics vary with nutrient availability, environmental conditions, and root traits: A global analysis". Next-Generation Ecosystem Experiments (NGEE) Tropics, ESS-DIVE repository. Dataset. doi:10.15485/2524531

Craig ME, Brzostek ER, Geyer KM, Liang C, Phillips RP (2021) Data for "Fast-decaying plant litter enhances soil carbon in temperate forests, but not through microbial physiological traits". The Carbon-Nutrient Economy of the Rhizosphere: Improving Biogeochemical Prediction and Scaling Feedbacks From Ecosystem to Regional Scales, ESS-DIVE repository**.** Dataset. doi:10.15485/1835182

Craig ME, Walker AP (2021) Microbial biomass in soils receiving varying levels of organic inputs - A data compilation. *Oak Ridge National Laboratory, TES SFA, U.S. Department of Energy, Oak Ridge, Tennessee, U.S.A.* https://doi.org/10.25581/ornlsfa.021/1768047

Craig ME, Walker AP (2021) Biological mechanisms may contribute to soil carbon saturation patterns: modeling archive. *Oak Ridge National Laboratory, TES SFA, U.S. Department of Energy, Oak Ridge, Tennessee, U.S.A.* https://doi.org/10.25581/ornlsfa.022/1768048