Sam J. Leuthold, PhD

Soil Carbon Scientist
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Education

Colorado State University *June 2024*
Fort Collins, CO
PhD Ecology
Dissertation Title: *Isolation, interpretation, and implications of physical soil organic matter fractions in agroecosystems.*

University of Kentucky *May 2021*
Lexington, KY
MS Plant and Soil Sciences
Thesis Title: *Interactive effects of landscape topography and cover crops in Southeastern agroecosystems.*

Montana State University *December 2017*
BS Soil and Water Sciences (Minor: GIS)

Research Positions

Postdoctoral Fellow *July 2024 - Current*
CSU Soil Innovation Lab – AI CLIMATE Initiative
Remote – Chicago, IL
Dr. Francesca Cotrufo

- Led the mid-infrared spectroscopy focus area with the SoIL, increasing the throughput of sample processing and analysis, as well as improving understanding around soil carbon biogeochemistry.
- Collaborated with a multi-intuitional group of scientists to leverage artificial intelligence tools to improve climate smart agricultural approaches.
- Developed and maintained R pipelines for the chemometric analysis and prediction of soil physicochemical properties, including the use of cubist, random forest, memory-based learning, and partial least squares regression statistical tools.
- Managed several employees remotely, providing clear instruction and feedback, and maintaining robust communication.

Graduate Research Assistant (PhD) *June 2021 - June 2024*
CSU Soil Innovation Lab
Fort Collins, CO
Dr. Francesca Cotrufo and Dr. Jocelyn Lavallee

- Performed and oversaw rigorous laboratory analysis of over 1000 soil samples, including physical fractionation, organic and inorganic carbon quantification, mid-infrared absorbance acquisition, and characterization of various physicochemical properties (e.g., soil pH, soil texture, iron and aluminum oxide concentration, etc.).
- Conducted complex data analysis of soil and agronomic data using R, employing methods such as structural equation modeling, random forest machine learning, and mixed linear model approaches.
- Led several research projects focused on advancing understanding of soil carbon dynamics simultaneously by managing employees and collaborating with lab staff, creating robust and realistic timelines and project goals, and keeping organized records of activities and multivariate soil data.
- Designed experiments to investigate novel questions around soil organic carbon and nitrogen dynamics while maintaining statistical rigor and power.
- Led the writing and submission of six peer-reviewed articles over the course of three years to high-impact journals.

Soil Carbon Data Consultant *June 2022 - September 2022*
NDA Redacted
Remote – Fort Collins, CO

- Created and maintained an analysis pipeline for the calculation of soil carbon data, with a focus on flexibility, ease of use for the end user, and transparency around methodology.
- Regularly met with senior staff to discuss vision, results, and modifications for improved product efficacy and accuracy.
- Wrote and maintained thorough documentation around codebase function for future use and adaptation.

Graduate Research Assistant (MS) *January 2019 - June 2021*

Agroecological Nutrient Cycling Lab
Lexington, KY

- Managed and maintained a field study involving cover crops, corn, and soybeans at four locations, including two on-farm experimental sites with a farmer-cooperator. This included the management of multiple field sampling campaigns with > 300 samples per site, and subsequent processing and archiving of sample material.
- Oversaw a diverse team of international interns and college students: assigning tasks, allocating time dedication, and developing strict timelines for actions.
- Constructed and managed a large (3,000+ observations) multivariate environmental dataset, with an emphasis on clarity, transparency, and practicality.
- Researched, applied for, and was granted funding by both private and government funding agencies.
- Led the analysis and writing of three peer-reviewed publications concerning sustainable agricultural practices and soil biogeochemistry over the span of 2.5 years.

Research Associate *November 2016 - August 2018*

Soil Biogeochemistry Lab
Bozeman, MT
Dr. Stephanie Ewing

- Synthesized complex research goals and outcomes for communication to cross-disciplinary teams, including the production of maps, figures, and the results of statistical analyses.
- Presented written and oral results to a diverse group of stakeholders including tribal members, academics, and agricultural producers.
- Requested and was granted funding from an NSF affiliate and produced three peer-reviewed publications, leading one.

Peer Reviewed Publications

*: Publication not yet accepted (i.e., In-prep, in-review, in-revision)

(1*) Todd-Brown, K., Sanderman, J., Amorim, H., Bloom, D., Crow, S., Fang, L., Gallios, G., Ghosh, U., Heckman, K., Hengl, T., Ramakhanna , S., Knadel, M., Konstantinidis, K., **Leuthold, S.J.**, Lin, Y., Safanelli, J., Mancini, M., Maynard, J., Meisel, J., Minai, J., Minarik, R., Minatre, K., Murph, S., Omar Faruk Murad, M., Panday, D., Barrett, L., Ransom, C., Shepherd, K., Sherif, F., Smith, C., van Egmond, F., Viscarra Rossel, R., Zeraatpisheh, M. (In-Prep). Visioning the future of soil spectroscopy. In preparation for submission to Geoderma, Spring 2025.

(2*) **Leuthold, S.J**., Lavallee, J.M., Haddix, M.L., Poffenbarger, H., Castellano, M. (In-prep). Carbon controls on the behavior of mineralized nitrogen. In prep for submission to EGU SOIL, December 2024.

(3*) **Leuthold, S.J.,** Soong, J., Even, R., Cotrufo, M.F. (In-review). Decadal persistence of soil organic matter formed from litter and pyrogenic inputs. In-review at Nature Geosciences, October 2024.

(4) **Leuthold, S.J.,** Lavallee, J.M., Basso, B., Brinton, W.F., Cotrufo, M.F. (2024). Shifts in controls and abundance of particulate and mineral-associated organic matter fractions among subfield yield stability zones. SOIL 10, 307–319.

(5) **Leuthold, S.J.,** Lavallee, J.M., Haddix, M.L., Cotrufo M.F. (2024) Characterizing differences in soil organic matter fractions isolated by various physical separation methodologies. Geoderma. 445, 116870.

(6) Driscoll, A.W., **Leuthold, S.J.,** Choi, E., Clark, S.M., Cleveland, D.M., Dixon, M., Hsieh, M., Sitterson, J., Mueller, N.D. (2022). Divergent impacts of crop diversity on caloric and economic yield stability. Environ. Res. Lett. 17, 124015.

(7) **Leuthold, S.J.,** Haddix, M.L., Lavallee, J., Cotrufo, M.F. (2022). Physical fractionation techniques, in: Reference Module in Earth Systems and Environmental Sciences. Elsevier, p. B9780128229743002000.

(8) Sigler, W.A., Ewing, S.A., Wankel, S.D., Jones, C.A., **Leuthold, S.J.,** Brookshire, E.N.J., Payn, R.A. (2022) Isotopic signals in an agricultural watershed suggest denitrification is locally intensive in riparian areas but extensive in upland soils. Biogeochemistry 158.

(9) **Leuthold, S. J**., Wendroth, O., Salmerón, M. & Poffenbarger, H. (2022) Weather-dependent relationships between topographic variables and yield of maize and soybean. F. Crop. Res. 276.

(10) **Leuthold, S.J.**, Quinn, D.J., Miguez, F., Wendroth, O., Salmerón, M., and Poffenbarger, H. (2021) Topographic effects on soil microclimate and surface cover crop residue decomposition in rolling cropland. Agriculture, Ecosystems, and Environment, 320.

(11) Quinn, D.J., Poffenbarger,H.J., **Leuthold, S.J.** and Lee, C.D. (2021) Corn response to in-furrow fertilizer and fungicide across rye cover crop termination timings. Agron. J.

(12) **Leuthold, S.J.**, Salmerón, M., Wendroth, O., Poffenbarger, H. (2021) Cover crops decrease maize yield variability in sloping landscapes through increased water during reproductive stages. F. Crop. Res. 265.

(13) **Leuthold, S.J.**, Ewing, S.A., Payn, R.A., Miller, F.R., Custer, S.G. (2021) Seasonal connections between meteoric water and streamflow generation along a mountain headwater stream. Hydrol. Process. 35.

(14) Miller, F.R., Ewing, S.A., Payn, R.A., Paces, J.B., **Leuthold, S.J.**, Custer, S.G. (2020) Sr and U isotopes reveal the influence of lithologic structure on groundwater contributions along a mountain headwater catchment (Hyalite Canyon, MT). J. Hydrol.

Professional Presentations

Leuthold, S.J. (2024) Taking SOC a step further: Understanding measurement and function of physical soil organic matter fractions. 3rd Annual Indigo Science and Policy Forum. 16 April, Boston, MA.

Leuthold, S.J., Lavallee, J., Haddix, M., Cotrufo, M.F. (2023). Reconciling conceptual and procedural definitions of soil organic matter. 2023 American Geophysical Union Annual Meeting. 12 December, San Francisco, CA.

Leuthold, S.J., Soong, J., Even, R., Cotrufo, M.F. (2023). Litter decomposition traced over a decade confirms divergent mechanisms of POM and MAOM formation and persistence. 2023 American Geophysical Union Annual Meeting. 12 December, San Francisco, CA.

Leuthold, S.J., Even, R., Haddix, M., Mendez, R., Patterson, E., Cotrufo, M.F. (2023). Advancing an understanding of SOM composition and quantification via DRIFT spectroscopy. 2023 ASA-CSSA-SSSA Annual Meeting. 30 October, St. Louis, MO.

Leuthold, S.J., Lavallee, J.M., Cotrufo, M.F. (2023). Connecting physical SOC fraction indicators to yield variability across scales. 2023 ASA-CSSA-SSSA Annual Meeting. 30 October, St. Louis, MO.

Cotrufo, M.F. and **Leuthold, S.J.** (2023). Insight into molecular, spatial, and temporal dynamics gained via organic matter fractionation. 2023 Ecological Society of America Annual Meeting. 8 August, Portland, OR. (S. Leuthold presenting author).

Leuthold S.J., Even, R., Cotrufo M.F. (2022) Efficient. Rigorous. Effective. Field and laboratory methods for quantifying soil organic carbon across scales. Soil-based climate solutions: science to drive impact meeting. 14 November. Fort Collins, CO.

Leuthold, S.J., Lavallee, J.M., Basso, B., Brinton, W., Cotrufo, M.F. (2022) Relationships between Yield Stability and the Distribution of Soil Organic Matter Among Physical Fractions. 2022 ASA-CSSA-SSSA Annual Meeting. 6 – 9 November, Baltimore, MD.

Canisares, L.P**., Leuthold, S.J.**, Ison, J., Wendroth, O., Poffenbarger, H. (2022) Cover Crops Increased Nitrous Emission in Low-Lying Landscape Positions. 2022 ASA-CSSA-SSSA Annual Meeting. 6 – 9 November Baltimore, MD.

Leuthold, S., Poffenbarger, H. (2020) Understanding and addressing spatial variability in corn yield, University of Kentucky Corn, Soybean, and Tobacco Field Day. 21 June, Princeton, KY (Remote presentation)

Leuthold, S., Poffenbarger, H., Salmeron, M., Wendroth, O., Haramoto, E. (2020) Do cover crops increase or decrease spatiotemporal variability in maize yield? iCROPm 2020. 1 February, Montpellier, France. (H. Poffenbarger presenting author)

Poffenbarger, H., **Leuthold, S.**, Salmeron, M., Wendroth, O., and Haramoto, E. (2020) Corn, complex topography, and cover crops. Kentucky Corn CORE farmer program. 10 January, Versailles, KY.

Leuthold, S., Wendroth, O., Salmeron, M., Haramoto, E., Poffenbarger, H. (2020) Corn, cover crops, and complex topography. Southern ASA Regional Meeting. 2 February, Louisville, KY.

Sigler, W.A., Ewing, S.A., Wankel, S., Jones, C., **Leuthold, S.**, Brookshire, J., Payn, R. (2019) Denitrification patterns across a dryland agroecosystem in the Northern Great Plains, AGU Fall Meeting, 9-13 December. San Francisco, CA.

Poffenbarger, H., **Leuthold, S.** (2019) Cover crops, hillslopes, and corn nitrogen requirements. Tri-State Advanced Soil Health Training. 10 December, Princeton, KY.

Leuthold, S., Wendroth, O., Salmeron, M., Haramoto, E., Poffenbarger, H. (2019) Cover crops response to landscape topography, and the effect on maize yield stability. ASA-CSSA-SSSA Annual Meeting. 10-13 November, San Antonio, TX.

Leuthold, S., Wendroth, O., Salmeron, M., Haramoto, E., Poffenbarger, H. (2019) Cover crop growth varies by landscape position but does not affect spatial variability of maize yield. North Central Soil Fertility Conference, 5-6 November, Des Moines, IA.

Leuthold, S., Poffenbarger, H.J. (2019) Quantifying decomposition rates and nitrogen fixation ability of leguminous cover crops in production fields characterized by complex topography. Southern Cover Crops Council Fall Meeting, July 16-17, Auburn, AL.

Miller, F.R., Ewing, S.A. , Payn, R.A., Paces, J.B., **Leuthold, S.**, Michalek, T., Custer, S. (2018) Sr and U isotopes reveal the influence of lithologic structure and weathering on surface-groundwater interaction along a mountain stream (Hyalite Canyon, MT). Oral presentation HS2.3.3, Isotope and Tracer Methods: Flow paths characterization, catchment response and transformation processes, Goldschmidt Conference, August, Boston MA.

Leuthold, S., Ewing, S.A., Payn, R., Miller, F., Klassen, J., Paces, J., (2017) Using stable liquid water isotopes to understand sources of stream flow generation in a mountainous headwaters catchment. Poster presented at 25th Annual NSF EPSCoR National Conference. 5 - 8 November, Missoula, MT

Awards and Achievements

College of Agricultural Science Outstanding Contributions to Research and Scholarship Award	*May 2024*
Soils and Environmental Health Excellent Peer Reviewer	*December 2023*
School of Global and Environmental Studies Sustainability Leadership Fellow	*August 2023*
Colorado State Recruitment Fellowship Award	*April 2023*
Johnston-Carringer Agronomy Award	*August 2021*
Outstanding Continuing MS Student	*May 2021*
2nd place MS Student Oral Presentation – Southern ASA Regional Meeting	*May 2020*
1st place Graduate Student Oral Presentation – National ASA Nutrient Management Division	*February 2020*
North Central Soil Fertility Outstanding Graduate Student Award	*November 2019*
National Outdoor Leadership School (NOLS) Graduate	*August 2015*