

# SARAH E. CRUMP

NSF Postdoctoral Fellow

[Paleogenomics Lab](#), Ecology and Evolutionary Biology  
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## EDUCATION

2019 | **PhD** in Geological Sciences, University of Colorado Boulder

2010 | **BA** in Geology (Environmental Studies concentration), Carleton College, *Magna cum Laude*

## RESEARCH APPOINTMENTS

2021–present | NSF Postdoctoral Fellow, UC Santa Cruz

2019–2020 | Postdoctoral Research Associate, INSTAAR, CU Boulder

2016–2020 | Visiting Research Associate, Trace and Environmental DNA Lab, Curtin University

2014–2019 | Graduate Research Assistant, INSTAAR, CU Boulder

## HONORS & FELLOWSHIPS

2021–2023 | NSF EAR Postdoctoral Fellowship (co-funded by BIO)

2014–2019 | NSF Graduate Research Fellowship

2017 | J. Hoover Mackin Award, Quaternary Geology & Geomorphology, GSA

2014–2015 | Geological Sciences Graduate Student Fellowship, CU Boulder

2013 | Dean's Fellowship, CU Boulder

2010 | Phi Beta Kappa, Carleton College chapter

2010 | Distinction in Major, Carleton College

2010 | Distinction in Senior Integrative Exercise, Carleton College Geology Department

2010 | Jefferson Natural Sciences Teaching Award, Carleton College

2009–2010 | Duncan Stewart Fellow, Carleton College Geology Department

2009 | Patricia V. Damon Scholar, Carleton College

## PUBLICATIONS

### *Manuscripts in Review*

Miller, G.H., Axford, Y., Briner, J.B., Bueltmann, H., **Crump, S.E.**, Francis, D., Frechette, B., Gorbey, D.B., McFarlin, J., Raberg, J.H., Reynolds, M.K., Sepúlveda, J., Thomas, E.K., deWet, G., Wolfe, A., *in revision*, Stratified lacustrine interglacial sediment preserved beneath Laurentide and Greenland ice sheets confirm Arctic Amplification during past episodes of peak summer insolation, *Journal of Quaternary Science*.

Gorbey, D.B., Thomas, E.K., **Crump, S.E.**, Hollister, K.V., Reynolds, M.K., Raberg, J.H., de Wet, G., Sepúlveda, J., Miller, G.H., *in review*, Southern Baffin Island precipitation isotopes modulated by summer and fall precipitation during the past 5,800 years, *Journal of Quaternary Science*.

Young, N.E., Briner, J.P., Miller, G.H., Lesnek, A.J., **Crump, S.E.**, Pendleton, S.L., Schwartz, R., Schaefer, J.M., in review, Pulsebeat of early Holocene glaciation in Baffin Bay from high-resolution beryllium-10 moraine chronologies, *Quaternary Science Reviews*.

### **Publications**

Raberg, J., Harning, D.J., **Crump, S.E.**, de Wet, G., Blumm, A., Kopf, S., Geirsdóttir, A., Miller, G.H., Sepúlveda, J., 2021, Revised fractional abundances and warm-season temperatures substantially improve brGDGT calibrations in lake sediments, *Biogeosciences*. DOI: 10.5194/bg-18-3579-2021

**Crump, S.E.**, Fréchette, B., Power, M., Cutler, S., de Wet, G., Raynolds, M.K., Raberg, J., Briner, J.P., Thomas, E.K., Sepúlveda, J., Shapiro, B., Bunce, M., and Miller, G.H., 2021, Ancient plant DNA reveals High Arctic greening during the Last Interglacial: *Proceedings of the National Academy of Sciences*. DOI:10.1073/pnas.2019069118

**Crump, S.E.**, 2021, Sedimentary ancient DNA as a tool in paleoecology: *Nature Reviews Earth and Environment*. DOI:10.1038/s43017-021-00158-8

Capo, E., Giguet-Covex, C., Rouillard, A., Nota, K., Heintzman, P., Vuillemin, A.... **Crump, S.E.** ...Coolen, M.J.L., Epp, L.S., Domaizon, I., Alsos, I.G., Parducci, L., 2021, Lake sedimentary DNA research on past terrestrial and aquatic biodiversity: Overview and recommendations: *Quaternary*, v. 3. DOI:10.3390/quat4010006

Larsen, D.J., **Crump, S.E.**, and Blumm, A., 2020, Alpine glacier resilience and Neoglacial fluctuations linked to Holocene snowfall trends in the western US: *Science Advances*, v. 6, no. 47. DOI:10.1126/sciadv.abc7661

**Crump, S.E.**, Miller, G.H., Young, N.E., Briner, J.P., and Pendleton, S.L., 2020, Glacier expansion on Baffin Island during Early Holocene cold reversals: *Quaternary Science Reviews*, v. 241. DOI:10.1016/j.quascirev.2020.106419

Young, N.E., Briner, J.P., Schaefer, J.M., Miller, G.H., Lesnek, A.J., **Crump, S.E.**, Thomas, E.K., Pendleton, S.L., Cuzzone, J., Lamp, J., Zimmerman, S., and Caffee, M., 2020, Reply to Carlson (2020) comment on “Deglaciation of the Greenland and Laurentide ice sheets interrupted by glacier advance during abrupt coolings”: *Quaternary Science Reviews*, v. 240. DOI: 10.1016/j.quascirev.2020.106329

Young, N.E., Briner, J.P., Miller, G.H., Lesnek, A.J., **Crump, S.E.**, Thomas, E.K., Pendleton, S.L., Cuzzone, J., Lamp, J., Zimmerman, S., Caffee, M., and Schaefer, J.M., 2020, Deglaciation of the Greenland and Laurentide ice sheets interrupted by glacier advance during abrupt coolings: *Quaternary Science Reviews*, v. 229. DOI:10.1016/j.quascirev.2019.106091

Larsen, D.J., **Crump, S.E.**, Abbott, M.B., Harbert, W., Blumm, A., Wattrus, N.J., and Heberger, J.J., 2019, Paleoseismic evidence for climatic and magmatic controls on the Teton fault, WY: *Geophysical Research Letters*. DOI:10.1029/2019GL085475

**Crump, S.E.**, Miller, G.H., Power, M., Sepúlveda, J., Dildar, N., Coghlan, M., and Bunce, M., 2019, Arctic shrub colonization lagged peak postglacial warmth: Molecular evidence in lake sediment from Arctic Canada: *Global Change Biology*, v. 25, p. 4244-4256. DOI:10.1111/gcb.14836

Pendleton, S.L., Miller, G.H., Lifton, N., Lehman, S.J., Southon, J., **Crump, S.E.**, Anderson, R.S., 2019, Rapidly receding Arctic Canada glaciers revealing landscapes continuously ice-covered for more than 40,000 years: *Nature Communications*, v. 10. DOI:10.1038/s41467-019-08307-w

- Anderson, R.S., Anderson, L.S., Armstrong, W.H., Rossi, M.W., **Crump, S.E.**, 2018, Glaciation of alpine valleys: the glacier–debris-covered glacier–rock glacier continuum: *Geomorphology*, v. 311, p. 127–142. DOI:10.1016/j.geomorph.2018.03.015
- Crump, S.E.**, Anderson, L. S., Miller, G. H. and Anderson, R. S., 2017, Interpreting exposure ages from ice-cored moraines: a Neoglacial case study on Baffin Island, Arctic Canada: *Journal of Quaternary Science*, v. 32, p. 1049–1062. DOI:10.1002/jqs.2979
- Pendleton, S.L., Miller, G.H., Anderson, R.S., **Crump, S.E.**, 2017, Episodic Neoglacial expansion and rapid 20<sup>th</sup> century retreat of a small ice cap on Baffin Island, Arctic Canada, and modeled temperature change: *Climate of the Past*, v. 13, p. 1527–1537. DOI:10.5194/cp-13-1527-2017
- Titus, S.J., **Crump, S.**, McGuire, Z., Horsman, E., and Housen, B., 2011, Using vertical axis rotations to characterize off-fault deformation across the San Andreas fault system, central California: *Geology*, v. 39, p. 711–714. DOI:10.1130/G31802.1

## RESEARCH GRANTS

- 2019 | National Geographic Society: Support for Women & Dependent Care grant (\$3,980)
- 2018 | CU Nature, Environment, Science & Technology Studio for the Arts grant (\$2,500)
- 2017 | NSF Arctic System Science grant #1737712 (proposal co-author and named Postdoc; \$2,290,769 total budget)
- 2017 | National Geographic Society: Early Career Grant (\$5,000)
- 2017 | Charles A. & June R.P. Ross Research Fund, Geological Society of America (\$3,643)
- 2016 | NSF Geography & Spatial Sciences Doctoral Dissertation Research Improvement grant (\$15,999)
- 2016 | NSF GRFP Graduate Research Opportunities Worldwide – Australia (\$5,000 + \$12,000AUD)
- 2015 | Dean’s Graduate Student Research Grant, University of Colorado (\$9,995)
- 2015, 2016 | Spetzler Research Grant, CU Geological Sciences (\$4,000)
- 2015 | Geological Society of America graduate student grant (\$1,875)
- 2014, 2017 | Beverly Sears Student Research Grant, University of Colorado (\$2,000)
- 2014 | Arctic Institute of North America Grant-in-Aid (\$1,000)
- 2014 | Sigma Xi Grant-in-Aid of Research (\$1,000)
- 2013 | Mentorship Grant, CU Geological Sciences (\$1,000)

## TEACHING EXPERIENCE

- Fall 2020 | Instructor, *Global Change: An Earth Science Perspective* (GEOL 1060), CU Boulder
- 2014–2017 | Tutor, Geology tutoring room, CU Boulder
- 2013–2014 | Instructor, *Introduction to Geology Laboratory* (GEOL 1030), CU Boulder
- Spring 2015 | Field trip teaching assistant, *Principles of Geomorphology* (GEOL 4241), CU Boulder
- Summer 2014, 2015 | Field Geology Instructor, CU Science Discovery Summer Camp
- 2010–2011 | Naturalist Instructor, Widjiwagan Outdoor Learning Program, Ely, MN

Fall 2009 | Teaching Assistant, Plate Tectonics, Carleton College

Spring 2009 | Teaching Assistant, Geology in the Field, Carleton College

Spring 2008 | Teaching Assistant, Introduction to Geology, Carleton College

*Guest Lectures:*

- Abrupt events in early Earth history (GEOL 1060, CU Boulder), November 2019
- Indirect evidence of global warming (GEOL 1060, CU Boulder), September 2019
- Greenhouse gases and Earth's Climate (GEOL 1010, CU Boulder), June 2018
- Forests and Climate in the Earth System (GEOL 1060, CU Boulder), November 2017
- Ancient DNA in lake sediment (GEOL 4070, CU Boulder), November 2017
- Ozone 101 (GEOL 1060, CU Boulder), December 2015
- Cosmogenic radionuclide dating lecture and lab, Geomorphology (GEOL 4241, CU Boulder), January 2015

## MENTORING EXPERIENCE

*Graduate student mentees:*

- Matthew Power, MSc Student, Curtin University, Australia (committee member, *sedaDNA*)

*Undergraduate research student mentees:*

- Halle Bender, BSc student, UC Santa Cruz (*sedaDNA*)
- Aria Blumm, BA student, Occidental College (lake sediment coring, FTIRs analyses)
- Maanav Jhatakia, BA student, CU Boulder (FTIRs sediment analyses)
- Anna Todd, BA student, CU Boulder (cosmogenic radionuclide lab prep)
- Sara Constantine, BA student, CU Boulder (cosmogenic radionuclide lab prep)

## UNIVERSITY AND PROFESSIONAL SERVICE

2020 | Justice, Equity, Diversity, & Inclusion (JEDI) Committee member, INSTAAR, CU Boulder

2020 | Seminar committee member, INSTAAR, CU Boulder

2019 | Postdoctoral representative, INSTAAR Directorate, CU Boulder

2018–2019 | Graduate student representative, INSTAAR Directorate, CU Boulder

2017–2019 | Values & Ethics Committee member, CU Boulder Office of the Chancellor

2017–2019 | Student Representative, Geological Society of America (GSA) Quaternary Geology & Geomorphology Division

2017–2019 | Student Advisory Committee member, Geological Society of America

Fall 2013 | Annual Meeting Student Committee member, Geological Society of America

**Conference session organizer for:** AGU 2019 (“B530: Mapping Biodiversity Through Space and Time”); GSA 2018 (“T56: From Alpine Glaciers to Ice Sheets”)

**Reviewer for:** NSF; GSA graduate student grants; *Scientific Reports*, *Geophysical Research*

*Letters, Scientific Data, Environmental DNA, Arctic, Antarctic, and Alpine Research, Thalassas, Journal of Mountain Science, Biodiversity Data Journal.*

## SELECTED OUTREACH ACTIVITIES

2020–present | Skype a Scientist volunteer (virtual)

2017–2019 | Social media co-manager, GSA Quaternary Geology & Geomorphology Division

2016–2018 | President, Women in Science and Engineering (WiSE), CU Boulder

December 2018 | Team Leader, AGU Congressional Visits Day, Washington, D.C.

October 2018 | Career Center invited speaker (topic: Student and Early Career Research Grants), GSA Annual Meeting

July 2018 | Volunteer, Girls on Rock outdoor science program, Gore Range, Colorado.

April 2018 | Guest instructor, Limnology field camp, Nunavut Arctic College Environmental Technology Program, Iqaluit, Baffin Island, Canada

March 2017 | Volunteer scientist, Science Teen Café, CU Science Discovery, Boulder, CO

2015–2016 | Grant committee member, WiSE, CU Boulder

Spring & Fall 2014 | Volunteer scientist, Earth Explorers 501(c)3 nonprofit, Boulder, CO

2006–2010 | Volunteer teacher and Program Director, Kids for Conservation environmental education program, Carleton College

2009–2010 | Volunteer tutor and Program Director, Northfield Middle School English Language Learner STEM tutoring program, Northfield, MN

## INVITED TALKS

April 2021 | “Lessons for a warming world: Late Quaternary insights from sedimentary ancient DNA and glacial history,” University of Utah (virtual)

April 2021 | “Ancient DNA in lake sediment reveals High Arctic greening during the Last Interglacial,” University of Wyoming Quaternary Conversations (virtual)

Dec 2020 | “Lessons from the past: What alpine rocks and sediments can tell us about the future of the western high country,” Science Writers Association of the Rocky Mountains meeting (virtual)

June 2020 | “Ancient DNA in lake sediment reveals High Arctic greening during the Last Interglacial,” AMQUA 2020 (virtual)

Nov 2019 | “Back to the (warmer) future: Insights from ancient plant DNA in lake sediment,” Appalachian State University, Boone, NC

Jan 2019 | “Climate-driven changes to the Arctic landscape during the early Holocene,” Carleton College, Northfield, MN

## SELECTED CONFERENCE ABSTRACTS

**Crump, S.E.**, Power, M., Fréchette, B., de Wet, G., Raynolds, M.K., Raberg, J.H., Allentoft, M., Bunce, M., Miller, G.H., Patterns of postglacial vegetation establishment clarified by lacustrine sedaDNA from Baffin Island, Arctic Canada: EGU General Assembly, virtual.

- Crump, S.E.,** Fréchet, B., Miller, G.H., Power, M., de Wet, G., Thomas, E.K., Sepúlveda, J., Briner, J.P., and Bunce, M., 2020, Ancient DNA in lake sediment reveals High Arctic greening during the Last Interglacial: AGU Fall Meeting, virtual.
- Crump, S.E.,** Fréchet, B., Miller, G.H., Power, M., de Wet, G., Thomas, E.K., Sepúlveda, J., Briner, J.P., and Bunce, M., 2019, Vegetation response to climate warming across multiple interglacials inferred from High Arctic lake sediment: AGU Fall Meeting, San Francisco, CA.
- Crump, S.E.,** Young, N.E., Pendleton, S.L., Miller, G.H., Anderson, R.S., and Briner, J.P., 2019, Expansion of Baffin Island glaciers during early Holocene cold events: GSA Annual Meeting, Phoenix, AZ.
- Crump, S.E.,** Gorbey, D., Raberg, J., Power, M., de Wet, G., Florian, C.R., Thomas, E.K., Miller, G.H., Sepúlveda, J., and Bunce, M., 2019, Deciphering dynamic vegetation histories by integrating bulk geochemistry, leaf wax compounds, and ancient DNA in lake sediment from Arctic Canada: INQUA Congress, Dublin, Ireland.
- Crump, S.E.,** Montes, Z., and de Saillan, N., 2018, Engaging the public in climate research through multi-media communication efforts: An example from the Canadian Arctic: AGU Fall Meeting, Washington, D.C.
- Crump, S.E.,** Power, M., Miller, G.H., Sepúlveda, J., Dildar, N., Coghlan, M., and Bunce, M., 2018, Arctic shrub colonization lagged postglacial climatic optimum: Molecular evidence in lake sediment from Baffin Island, Arctic Canada: International Paleolimnology Association–International Association of Limnogeologists Joint Meeting, Stockholm, Sweden.
- Crump, S.E.,** Power, Matthew, Miller, G.H., Sepúlveda, J., Coghlan, Megan, and Bunce, M., 2018, The paleoecological potential of ancient DNA in lake sediment: Preliminary results from Baffin Island: 48th International Arctic Workshop, Boulder, CO.
- Crump, S.E.,** Sepúlveda, J., Bunce, M., de Wet, G.A., Walker, D., Thomas, E., Reynolds, M., Raberg, J., Miller, G.H., 2017, The PACEMAP project – Predicting Arctic Change through Ecosystem Molecular Proxies: Arctic Change Meeting, Quebec City, Canada
- Crump, S.E.,** Sepúlveda, J., Bunce, M., and Miller, G.H., 2017, Molecules in the mud: Combining ancient DNA and lipid biomarkers to reconstruct vegetation response to climate variability during the Last Interglacial and the Holocene on Baffin Island, Arctic Canada: AGU Fall Meeting, New Orleans, LA.
- Crump, S.E.** and Larsen, D.J., 2017, Evidence of Younger Dryas glacier activity in the Teton Mountain Range, Wyoming: GSA Annual Meeting, Seattle, WA.
- Crump, S.E.,** Miller, G.H., Young, N.E., Briner, J.P., Pendleton, S.L., 2017, Early Holocene glacier chronologies from Baffin Island, Arctic Canada: 47th International Arctic Workshop, Buffalo, NY.
- Crump, S.E.,** Miller, G.H., Bunce, M., 2016, A Holocene paleoecological record from ancient DNA preserved in lake sediments on Baffin Island, Arctic Canada: AGU Fall Meeting, San Francisco, CA.
- Crump, S.E.** and Larsen, D.J., 2016, Exposure dating of major landslides along the Teton fault, WY: Preliminary results and implications for paleoseismicity: GSA Annual Meeting, Denver, CO.
- Crump, S.E.,** Miller, G.H., Bunce, M., 2016, Envisioning a warmer Arctic: Exploring the use of ancient DNA preserved in interglacial lake sediments on Baffin Island: 46th International Arctic Workshop, Boulder, CO.

**Crump, S.E.**, Florian, C.R., Miller, G.H., Geirsdottir, A., Zalzal, K., 2015, A tale of two lakes: Catchment-specific responses to Late Holocene cooling in northwest Iceland: AGU Fall Meeting, San Francisco, CA.

**Crump, S.E.**, Anderson, L.S., Miller, G.H., and Anderson, R.S., 2015, Interpreting the moraine record of debris-covered glaciers: A Neoglacial case study on Baffin Island, Arctic Canada: 45th International Arctic Workshop, Bergen, Norway.

**Crump, S.E.**, and Miller, G.H., 2014, Constraining the Timing of Neoglaciation: Moraine Exposure Ages from Baffin Island, Arctic Canada: AGU Fall meeting, San Francisco, CA.

**Crump, S.E.**, and Miller, G.M., 2014, Constraining the timing and duration of early Holocene and early Neoglacial advances on Baffin Island, Arctic Canada: 44th International Arctic Workshop, Boulder, CO.

## OTHER PUBLICATIONS

**Crump, S.E.**, 2019, Deconvolving climatic and non-climatic controls on Holocene glacier and ecological change on Baffin Island, Arctic Canada. CU Boulder PhD Thesis. 230 pp.

**Crump, S.E.**, 2018, A Quest for Old, Cold Mud: Sediments from frigid lakes on Baffin Island tell the story of climate change over the past 10,000 years. *Scientific American*: <https://blogs.scientificamerican.com/observations/a-quest-for-old-cold-mud/>

**Crump, S.E.**, 2010, Paleomagnetic data from the Rinconada fault in central California: Evidence for off-fault deformation. Carleton College Undergraduate Thesis. 49 pp.

## MEDIA COVERAGE

April 2021 | *Arctic Today / Nunatsiaq News* article on Crump et al., 2021 (PNAS): <https://www.arctictoday.com/ancient-plant-dna-and-pollen-found-under-baffin-island-lake-show-a-greener-arctic/>

April 2021 | *l'Aquilon* article on Crump et al., 2021 (PNAS): <https://www.aquilon.nt.ca/Article/Faire-parler-l-ADN-des-plantes-prehistoriques-202104151638/default.aspx#article>

December 2020 | *Jackson Hole News and Guide* article on our study of glacier history in the Teton Range: [https://www.jhnewsandguide.com/news/environmental/sediment-suggests-teton-glacier-longer-lived-than-thought/article\\_7a68193a-36aa-5a10-ac66-b331790a964f.html](https://www.jhnewsandguide.com/news/environmental/sediment-suggests-teton-glacier-longer-lived-than-thought/article_7a68193a-36aa-5a10-ac66-b331790a964f.html)

December 2019 | *Science Magazine* article on sedimentary ancient DNA featuring our Baffin Island work: <https://www.sciencemag.org/news/2019/12/dna-recovered-arctic-lakes-holds-clues-our-future-world>

February 2019 | *Colorado Arts & Sciences Magazine* piece on ancient DNA and other Arctic research: <https://www.colorado.edu/asmagazine/2019/02/05/cu-boulders-geoscientists-ranked-worlds-best-showcase-rock-it-science>

October 2018 | Colorado Public Radio segment on CU NEST art/science collaborations: <http://www.cpr.org/news/story/forget-stem-at-cu-boulder-the-nest-program-bridges-painters-and-petri-dishes>

September 2018 | USAPECS Polar Film Festival featuring our Baffin Island field film: <http://usapecs.wixsite.com/usapecs/polar-research>

April 2018 | Curtin University piece on Baffin Island ancient DNA research:

<https://research.curtin.edu.au/story/?postid=46856>

December 2017 | Association for Women in Science Magazine feature on CU WiSE leadership:  
[http://magazine.awis.org/publication/?m=46591&l=1#{%22issue\\_id%22:%22482829%22,%22page%22:0}](http://magazine.awis.org/publication/?m=46591&l=1#{%22issue_id%22:%22482829%22,%22page%22:0})

October 2017 | *CU Boulder Today* feature on Baffin Island fieldwork:  
<https://www.colorado.edu/today/2017/10/18/beyond-boulder-digging-arctic-mud-answers-climate-change>

October 2017 | *GlacierHub* story on ice-cored moraine research (Crump et al., 2017, JQS):  
<http://glacierhub.org/2017/10/31/aging-ice-cored-moraines-canadian-arctic/>

## **SHORT COURSES, WORKSHOPS, & CERTIFICATIONS**

- 2021 | Preparing for an Academic Career, Earth Educators Rendezvous (virtual)
- 2020 | Arctic Data Center Training (National Center for Ecological Analysis & Synthesis; virtual)
- 2020 | Sedimentary Ancient DNA Cyberinfrastructure Workshop (NSF-funded; virtual)
- 2019 | Engaged Scientist Workshop: Communication tools for effective outreach (CU Boulder)
- 2019 | CU WiSE SciComm Symposium Writing Workshop
- 2019 | Paleo to Policy Workshop (UC Davis Bodega Marine Laboratory)
- 2017 | Communicating Science Conference (ComSciCon) Rocky Mountain West
- 2016 & 2017 | CU WiSE Science Communication Symposium (organizer & participant)
- 2014 | Urbino Summer School in Paleoclimatology (Urbino, Italy)
- 2007–2015 | Wilderness First Responder (Wilderness Medical Institute/NOLS)
- 2013 | NSF Arctic Field Training (CH2Mhill Polar Services)
- 2013 | Polar Bears: A Guide to Safety (CH2Mhill Polar Services)

## **PROFESSIONAL ORGANIZATIONS**

- American Geophysical Union (2014–present)
- Geological Society of America (2014–present)
- National Association of Geoscience Teachers (2021–present)
- Association for Women in Science (2016–2019)

## **FIELD EXPERIENCE**

- 2014–2021 | Nine field campaigns in Grand Teton National Park, WY; lake sediment coring, landslide and moraine boulder sampling for exposure dating.
- 2013–2019 | Seven field seasons on Baffin Island, Arctic Canada; lake sediment coring, instrumenting lake catchments, moraine boulder sampling for exposure dating, glaciological data collection.
- 2007–2009 | Various field trips in MN, WI, MI, and CA; Carleton College.
- 2007–2010 | Wilderness canoe guide in northern MN and Canada; YMCA Camp Menogyn

## COMPUTER AND LABORATORY SKILLS

- Lake sediment analyses: (ancient) environmental DNA, bulk geochemistry, algal pigments, lipid biomarkers (brGDGTs)
- Experience with qPCR, high-throughput sequencing, HPLC, mass spectrometry, FTIRS
- Cosmogenic  $^{10}\text{Be}$  sample prep and wet chemistry (lab co-manager, 2014–2019)
- Programming languages: R, Matlab
- Adobe Creative Suite (Illustrator, Photoshop)