

Quentin D. Read

Using big open data to understand how humans influence the natural world

USDA Agricultural Research Service
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GitHub, StackOverflow: [q dread](#)

Professional appointments

- 2021– **Agricultural Research Service, U.S. Department of Agriculture**, Raleigh, NC (North Carolina State University)
Applied Consulting Statistician, Southeast Area
- 2018-2021 **National Socio-Environmental Synthesis Center**, Annapolis, MD (University of Maryland)
- 2019–2021 Data scientist
- 2018-2020 Postdoctoral fellowship: “Food waste and the environment”
Mentor: Dr. Mary Muth (RTI International, Research Triangle Park, NC)
- 2016-2018 **Michigan State University**, East Lansing, MI
Postdoctoral researcher, Department of Forestry; Ecology, Evolutionary Biology, & Behavior Program
“Intraspecific trait variation and community structure at a continental scale”
Advisors: Dr. Phoebe Zarnetske (MSU) and Dr. Sydne Record (Bryn Mawr College)
Visiting scholar, University of Notre Dame, laboratory of Jason McLachlan

Current roles and responsibilities

- Support USDA researchers by designing experiments, processing and visualizing data, and doing statistical analyses
- Pursue a research program modeling the impacts of the food system on human and natural communities, using techniques from ecology, environmental science, and economics

Education

- 2011-2016 **University of Tennessee**, Knoxville, TN
Ph.D., Ecology & Evolutionary Biology
Dissertation: “Individual variation in plant traits drives species interactions, ecosystem functioning, and responses to global change”
Advisor: Dr. Nathan Sanders
- 2005-2009 **University of North Carolina**, Chapel Hill, NC
B.S. with highest distinction, Environmental Science

Skills and languages

- Data processing, visualizing, and analysis in R, including tidyverse and data.table
- Teaching and training students and researchers in data science and statistics
- Developing R packages
- Bayesian modeling with Stan
- Spatial analysis and modeling with GDAL and R
- Working knowledge of Python and Julia
- Bash scripting
- Creating static webpages with Markdown and Jekyll
- High-performance parallel computing using Linux server
- Using git/GitHub for version control and remote collaborations

- Fluent in spoken and written German; communicate effectively in spoken and written Spanish

Grants

2019 “Connecting local, regional, and continental scale drivers to biodiversity across NEON through the lens of intraspecific trait variation and disturbance.” NSF Macrosystems Biology, NEON-Enabled Science (senior personnel) \$536,800

Publications

OA = open access; * = first author is an undergraduate whom I mentored

- 2022 Mason, R. E., J. M. Craine, N. K. Lany, ... **Q. D. Read**, ... and A. J. Elmore. Evidence, causes, and consequences of a global decline in terrestrial ecosystem nitrogen availability. *Science* 376:eabh3767. DOI:10.1126/science.abh3767
- Read, Q. D.**, K. L. Hondula, and M. K. Muth. 2022. Biodiversity effects of food system sustainability actions from farm to fork. *Proceedings of the National Academy of Sciences* 119, e2113884119. DOI:10.1073/pnas.2113884119. featured in *Anthropocene Magazine*
- Sthapit Kandel, J., G. V. Sandoya, W. Zhou, **Q. D. Read**, B. Mou, and I. Simko. 2022. Identification of quantitative trait loci associated with bacterial leaf spot resistance in baby leaf lettuce. *Plant Disease*. DOI: 10.1094/PDIS-09-21-2087-RE.
- Rewcastle, K. E., J. A. Henning, **Q. D. Read**, R. E. Irwin, N. J. Sanders, and A. T. Classen. 2022. Plant removal across an elevational gradient marginally reduces rates, substantially reduces variation in mineralization. *Ecology* 103, e03546. DOI: 10.1002/ecy.3546.
- 2021 Dahlin, K. M., P. L. Zarnetske, **Q. D. Read**, L. Twardochleb, A. G. Kamoske, K. S. Cheruvilil, and P. A. Soranno. 2021. Linking terrestrial and aquatic biodiversity to ecosystem function across scales, trophic levels, and realms. *Frontiers in Environmental Science*, 9, 217. DOI:10.3389/fenvs.2021.692401.
- Prager, C. M., X. Jing, J. A. Henning, **Q. D. Read**, P. Meidl, S. Lavorel, N. J. Sanders, M. Sundqvist, D. A. Wardle, and A. T. Classen. 2021. Climate and multiple dimensions of plant diversity regulate ecosystem carbon exchange along an elevational gradient. *Ecosphere*. DOI:10.1002/ecs2.3472. (OA)
- Marston, L. T., **Q. D. Read**, S. Brown, and M. K. Muth. 2021. Reducing water scarcity by reducing food loss and waste. *Frontiers in Sustainable Food Systems* 5. DOI:10.3389/fsufs.2021.651476. (OA)
- Read, Q. D.** and M. K. Muth. 2021. Cost-effectiveness of four food waste interventions: is food waste reduction a “win-win?” *Resources, Conservation & Recycling* 168, 105448. DOI:10.1016/j.resconrec.2021.105448.
- Metson, G. S., A. Chaudhary, X. Zhang, B. Houlton, A. Oita, N. Raghuram, **Q. D. Read**, L. Bouwman, H. Tian, A. Uwizeye, and A. J. Eagle. 2021. Nitrogen and the food system. *One Earth* 4:3-7. DOI:10.1016/j.oneear.2020.12.018.
- 2020 Grady, J. M., **Q. D. Read**, S. Record, N. Rüger, P. L. Zarnetske, A. I. Dell, S. P. Hubbell, S. T. Michaletz, A. Shenkin, and B. J. Enquist. 2020. Life history scaling and the division of energy in forests. *bioRxiv* 2020.06.22.163659. DOI:10.1101/2020.06.22.163659. (preprint)
- Read, Q. D.**, S. Brown, A. D. Cuéllar, S. M. Finn, J. A. Gephart, L. T. Marston, E. Meyer, K. A. Weitz, and M. K. Muth. 2020. Assessing the environmental impacts of halving food loss and waste along the food supply chain. *Science of the Total Environment* 712:136255. DOI:10.1016/j.scitotenv.2019.136255. (OA)

- Read, Q. D.**, P. L. Zarnetske, S. Record, J. M. Grady, A. M. Wilson, A. O. Finley, A. M. Latimer, J. K. Costanza, K. D. Gaddis, K. M. Dahlin, M. L. Hobi, S. V. Ollinger, S. L. Malone, and S. Pau. 2020. Beyond counts and averages: relating geodiversity to dimensions of biodiversity. *Global Ecology and Biogeography*. DOI: 10.1111/geb.13061.
- Record, S., K. M. Dahlin, P. L. Zarnetske, **Q. D. Read**, S. L. Malone, K. D. Gaddis, J. M. Grady, J. Costanza, M. L. Hobi, A. M. Latimer, S. Pau, A. M. Wilson, S. V. Ollinger, A. O. Finley, and E. Hestir. Remote sensing of geodiversity as a link to biodiversity. Book chapter in *Remote Sensing of Biodiversity: Using spectral signals to understand the biology and biodiversity of plants, communities, ecosystems and the tree of life*. J. Cavender-Bares, J. Gamon, and P. Townsend, eds. Springer International. DOI: 10.1007/978-3-030-33157-3
- 2019 Muth, M. K., C. Birney, A. Cuéllar, S. M. Finn, M. Freeman, J. N. Galloway, I. Gee, J. A. Gephart, K. Jones, L. Low, E. Meyer, **Q. D. Read**, T. Smith, K. A. Weitz, and S. Zoubek. 2019. A systems approach to assessing environmental and economic effects of food loss and waste interventions in the United States. *Science of the Total Environment* 685:1240-1254. DOI:10.1016/j.scitotenv.2019.06.230. (OA)
- Zarnetske, P. L., **Q. D. Read**, S. Record, K. Gaddis, S. Pau, M. Hobi, S. L. Malone, J. K. Costanza, K. M. Dahlin, A. Latimer, A. M. Wilson, J. M. Grady, S. Ollinger, A. O. Finley. 2019. Towards connecting biodiversity and geodiversity across scales with satellite remote sensing. *Global Ecology and Biogeography*. DOI:10.1111/geb.12887. (OA)
- Henning, J. A., **Q. D. Read**, N. J. Sanders, and A. T. Classen. 2019. Fungal colonization of plant roots is resistant to nitrogen addition and resilient to dominant species losses. *Ecosphere*. DOI:10.1002/ecs2.2640. (OA)
- 2018 Grady, J. M., **Q. D. Read**, S. Record, P. L. Zarnetske., B. Baiser, K. Thorne, and J. Belmaker. 2018. Size, niches, and the latitudinal diversity gradient. *Teaching Issues and Experiments in Ecology*, Vol. 14, Figure Set 1. http://tiee.esa.org/vol/v14/issues/figure_sets/grady/abstract.html (OA)
- Read, Q. D.**, J. M. Grady, P. L. Zarnetske, S. Record, B. Baiser, J. Belmaker, M.-N. Tuanmu, A. Strecker, L. Beaudrot, and K. M. Thibault. 2018. Among-species overlap in rodent body size distributions predicts species richness along a temperature gradient. *Ecography*. DOI:10.1111/ecog.03641. (OA)
- Read, Q. D.**, B. Baiser, J. M. Grady, P. L. Zarnetske, S. Record, and J. Belmaker. 2018. Tropical bird species have less variable body sizes. *Biology Letters* 20170453. DOI:10.1098/rsbl.2017.0453.
- Read, Q. D.**, J. A. Henning, A. T. Classen, and N. J. Sanders. 2018. Aboveground resilience to species loss but belowground resistance to nitrogen addition in a montane plant community. *Journal of Plant Ecology*. DOI:10.1093/jpe/rtx015.
- Welshofer, K. B., P. L. Zarnetske, N. K. Lany, and **Q. D. Read**. 2018. Short-term responses to warming vary between native vs. exotic species and with latitude in an early successional plant community. *Oecologia*. DOI:10.1007/s00442-018-4111-9.
- 2017 **Read, Q. D.**, J. A. Henning, and N. J. Sanders. 2017. Intraspecific variation in traits reduces ability of trait-based models to predict community structure. *Journal of Vegetation Science*. DOI:10.1111/jvs.12555.
- Hendershot, J. N.*, **Q. D. Read**, J. A. Henning, N. J. Sanders, and A. T. Classen. 2017. Consistently inconsistent drivers of patterns of microbial diversity and abundance at macroecological scales. *Ecology*. DOI:10.1002/ecy.1829. (OA)
- Butler, E. E., A. Datta, ..., **Q. D. Read**, ..., and P. B. Reich. 2017. Mapping local

and global variability in plant trait distributions. *Proceedings of the National Academy of Sciences*. DOI:10.1073/pnas.1708984114.

- 2016 **Read, Q. D.**, S. M. Hoban, M. B. Eppinga, J. A. Schweitzer, and J. K. Bailey. 2016. Accounting for the nested nature of genetic variation across levels of organization improves our understanding of biodiversity and community ecology. *Oikos* 125:895-904. DOI:10.1111/oik.02760. *Editor's Choice*.
- Van Nuland, M. E., R. C. Wooliver, A. A. Pfennigwerth, **Q. D. Read**, I. M. Ware, L. Mueller, J. A. Fordyce, J. A. Schweitzer, and J. K. Bailey. 2016. Plant-soil feedbacks: connecting ecosystem ecology and evolution. *Functional Ecology*. DOI:10.1111/1365-2435.12690.
- Yoon, S. A.* and **Q. D. Read**. 2016. Consequences of exotic host use: impacts on Lepidoptera and a test of the ecological trap hypothesis. *Oecologia*. DOI:10.1007/s00442-016-3560-2.
- 2015 Schussler, E. E., **Q. D. Read**, G. Marbach-Ad, K. Miller, and M. Ferzli. 2015. Preparing biology graduate teaching assistants for their roles as instructors: an assessment of institutional approaches. *CBE-Life Sciences Education* 14:1-11. DOI:10.1187/cbe.14-11-0196. (OA)
- 2014 **Read, Q. D.**, L. C. Moorhead, N. G. Swenson, J. K. Bailey, and N. J. Sanders. 2014. Convergent effects of elevation on functional leaf traits within and among species. *Functional Ecology* 28:37-45. DOI:10.1111/1365-2435.12162. *nominated for the British Ecological Society's Haldane Prize for Young Investigators*
- 2013 Gorman, C. E., **Q. D. Read**, M. E. Van Nuland, and others. 2013. Species identity influences belowground arthropod assemblages via functional traits. *Annals of Botany Plants* plto49. DOI:10.1093/aobpla/plto49. *Editor's Choice*. (OA)
- Van Nuland, M. E., E. N. Haag, J. A. Bryant, **Q. D. Read**, and others. 2013. Fire promotes pollinator visitation: implications for ameliorating declines of pollination services. *PloS One* 8:e79853. DOI:10.1371/journal.pone.0079853. (OA)
- 2012 Clark, J. S., B. D. Soltoff, A. S. Powell, and **Q. D. Read**. 2012. Evidence from individual inference for high-dimensional coexistence: long term experiments on recruitment response. *PLoS One* 7:e30050. DOI:10.1371/journal.pone.0030050. (OA)

In review/revision/accepted

- Kamoske, A. G., K. M. Dahlin, **Q. D. Read**, S. Record, S. P. Serbin, S. C. Stark, and P. L. Zarnetske. Towards mapping biodiversity from above: Can fusing lidar and hyperspectral remote sensing predict taxonomic, functional, and phylogenetic tree diversity in temperate forests? *Global Ecology and Biogeography*, in revision.
- Swanwick, R., **Q. D. Read**, S. Guinn, M. Williamson, K. L. Hondula, and A. Elmore. DasyPop: a dasymetric population map based on U.S. Census data and 30-m gridded estimates of impervious surface. *Scientific Data*, in revision.
- Prager, C. M., A. T. Classen, ... **Q. D. Read**, ... and N. J. Sanders. Integrating natural gradients, experiments, and statistical modelling in a distributed network experiment: an example from the WaRM Network. *Perspectives in Plant Ecology, Evolution and Systematics*, submitted.

Teaching and curriculum development

- 2022 Guest lecture on food waste in Agroecology (undergraduate course), University of Maryland
- 2021 Guest lecture on food waste in People, Land and Food (undergraduate course),

George Washington University, Washington, DC

- 2021 Co-designed curriculum for day-long geospatial data analysis workshop for postdocs and grad students; taught introductory lesson and lesson on geospatial statistics with vector data
- 2020 Co-designed and co-taught day-long whirlwind data science class for SESYNC postdoctoral researchers
- 2020 Co-delivered guest lecture on data synthesis in food-energy-water nexus research, Global Stewards graduate seminar, University of Maryland
- 2020 Co-taught SESYNC 2020 [Computational Summer Institute](#), a week-long online data science course
- 2020 Designed and led workshop on best practices for collaboration with GitHub
- 2018 Designed graduate teaching module: “Using NEON data to test macroecological hypotheses”
- 2017 Co-instructor of record, Metacommunity Ecology, MSU
- 2016 Graduate teaching assistant, Models in Biology, UT-Knoxville
- 2015-2016 Graduate teaching assistant, Conservation Biology, UT-Knoxville
- 2015 Designed and led workshop on graphing with R and ggplot2
- 2015 Delivered guest lecture and led mock trial activity, Conservation Biology, UT-Knoxville
- 2014 Designed and led workshops on introductory statistics with R
- 2013-2014 Member of panel developing and reforming curriculum of undergraduate introductory biology courses, UT-Knoxville
- 2013 Guest lecture on climate change and communities, General Ecology, UT-Knoxville
- 2012-2014 Graduate teaching assistant, General Ecology, UT-Knoxville
- 2012 Guest lecture on biogeochemistry, General Ecology, UT-Knoxville
- 2011-2012 Graduate teaching assistant, Introduction to Biodiversity, UT-Knoxville

Mentoring

- 2021 Mentored student team in University of Maryland Data Challenge; team won grand prize in a 75-team competition
- 2020 Remotely mentored two Bryn Mawr College undergraduates on an R package development project, funded by NSF Macrosystems Biology grant
- 2017-2018 Mentored 4 undergraduates through Summer Research Opportunities Program and High Performance Computing Center, MSU
- 2012-2015 Mentored 8 undergraduate field and lab assistants, Rocky Mountain Biological Laboratory
- 2013-2015 Mentored 3 undergraduate lab assistants, UT-Knoxville

Fellowships and awards

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| 2018 | NSF SESYNC postdoctoral immersion fellowship | \$160,000 |
| 2015 | University of Tennessee Science Alliance graduate award | \$3000 |
| 2015 | NSF travel grant to deliver biology education seminar at Notre Dame | \$500 |

2014	Outstanding Outreach and Community Service award, UT-Knoxville Department of Ecology and Evolutionary Biology	
2013	Dr. Jean H. Langenheimer Endowed Graduate Fellowship in the Ecology and Evolution of Plants, Rocky Mountain Biological Laboratory	\$6000
2013	UTK Graduate Student Senate travel award	\$500
2013	Honorable Mention, National Science Foundation Graduate Fellowship	
2012	Dr. Lee R. G. Snyder Memorial Fellowship, Rocky Mountain Biological Laboratory	\$700

Invited talks

2022	“Reducing food waste from farm to fork to benefit biodiversity.” North Carolina State University, Plant & Microbial Biology department seminar, Raleigh, NC
2020	“Reducing food waste to benefit environment and society: how, why, and in what context?” Duke University Program in Ecology seminar series, Durham, NC
2018	“Food waste impacts on biodiversity.” Commission on Environmental Cooperation Food Loss and Waste Measurement Experts Group Meeting, Arlington, VA
2017	“Challenges in the functional trait approach to community ecology (and ways to overcome them).” German Centre for Integrative Biodiversity Research (iDiv), Leipzig, Germany “Intraspecific variation and community assembly.” National Ecological Observatory Network, Boulder, CO (talk co-delivered with John Grady)
2016	“Individual variation in organismal traits: predicting patterns in space and time from local to global scales.” Michigan State University Department of Forestry, Hanover Forest Science Seminar Series, East Lansing, MI
2015	“C3UBE undergraduate biology curriculum reform.” University of Notre Dame, Biology Education Seminar, Notre Dame, IN
2014	“Roots, leaves, and soils facing global change.” Rocky Mountain Biological Laboratory Seminar, Gothic, CO
2014	“Plant traits & interactions altered by warming at different elevations.” Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN

Conference presentations

2019	Read, Q. D. , J. A. Gephart, A. D. Cuéllar, ... and M. K. Muth. “Which supply chain stages should we target to reduce food loss and waste and benefit the environment?” Ecological Society of America-United States Society for Ecological Economics, Louisville, KY
2018	Read, Q. D. , S. Record, K. M. Dahlin, P. L. Zarnetske, and others. “Measuring geodiversity to explain biodiversity: what is the effect of spatial grain and spatial consciousness?” US-International Association of Landscape Ecology, Chicago, IL
2017	Read, Q. D. , J. M. Grady, P. L. Zarnetske, S. Record, and others. “Intraspecific variation reflects drivers of rodent community assembly across the National Ecological Observatory Network.” Ecological Society of America, Portland, OR
2015	Read, Q. D. , N. J. Sanders, and A. T. Classen. “A globally replicated experiment shows that long-term environmental filters constrain plant response to increased temperature and loss of foundation species.” Ecological Society of America,

Software

- 2021 **Read, Q. D.**, A. Yue, I. E. Fluck, B. Baiser, J. M. Grady, P. L. Zarnetske, and S. Record. 2021. Ostats: O-stats, or pairwise community-level niche overlap statistics. R package version 0.1.1. <https://neon-biodiversity.github.io/Ostats/>. DOI:10.5281/zenodo.5706470.
- 2020 Brunson, J. C. and **Q. D. Read**. 2020. ggalluvial: Layered Grammar for Alluvial Plots. R package version 0.12.2.0001. <https://corybrunson.github.io/ggalluvial/>
- 2019 Marchand, P., I. T. Carroll, M. Smorul, R. E. Blake, and **Q. D. Read**. 2019. rslurm: Submit R Calculations to a 'Slurm' Cluster. R package version 0.6.1. <https://sesync-ci.github.io/rslurm>. DOI:10.5281/zenodo.5705430.

Online content

- 2019-2021 Blog posts on the SESYNC Cyberhelp blog (<https://sesync-ci.github.io/blog>)
- “Making a fifty-state USA map, 2021 edition”
 - “Making free maps with R, ggspatial, and Mapbox”
 - “Goodbye %>%, hello := (Using R data.table to speed up my data science)”
 - “How open reproducible methods benefit the research community: a shiny story”
 - “The carbon footprint of R code, and how to reduce it”
 - “Resources to help you learn GitHub Pages”
 - “Tips for a smooth R(Studio) workflow and reproducible R code”
 - "How do I resolve merge conflicts in git/GitHub/GitLab?"
 - "Using the rslurm package to run code in parallel"
 - “ggplot tricks not to forget about”
- 2021 Marchand, P., I. T. Carroll, and **Q. D. Read**. “Introduction to Geospatial Data.” Jul. 2021, SESYNC Cyberhelp online lesson. <https://sesync-ci.github.io/geospatial-packages-in-R-lesson/>
- 2020 **Read, Q. D.** “Advanced git Techniques.” Sep. 2020, SESYNC Cyberhelp online lesson. <https://sesync-ci.github.io/advanced-git-lesson/>
- Read, Q. D.** and I. T. Carroll. “Online Data with R.” Jul. 2020, SESYNC Cyberhelp online lesson. <https://sesync-ci.github.io/online-data-with-R-lesson/>
- Muth, M. K. and **Q. D. Read**. “Effects of COVID-19 meat and poultry plant closures on the environment and food security.” 7 Jul. 2020, RTI Insights blog. <https://www.rti.org/insights/covid-19-effect-meat-supply-chain>
- Blake, R. E., R. Beilinson, N. Motzer, K. L. Hondula, and **Q. D. Read**. “Resources and tips for elevating your team science in an all-virtual world.” Mar. 2020. <https://www.sesync.org/resources-and-tips-for-elevating-your-team-science-in-an-all-virtual-world>

Professional service

- 2020 Peer reviewer of R package for [RopenSci.org: pixelclasser](https://ropensci.org/pixelclasser)
- 2019– Maintainer of the R package *rslurm* (sesync-ci.github.io/rslurm)
- 2019 Review panelist, SESYNC immersion postdoctoral fellowship program

- 2017 Co-organizer of oral session at Ecological Society of America meeting: “Challenges and opportunities for investigating ecological communities across space and time: insights from coordinated research networks.”
- 2013– Peer reviewer for the following journals: *Agriculture, Food Policy, Anthropocene, Journal of Animal Ecology, Science of the Total Environment, Scientific Reports, Biogeosciences, Remote Sensing of Environment, Systematic Biology, Resources Conservation & Recycling* (2×), *Annals of Botany, Molecular Ecology, Energies, Nature Climate Change, Journal of Biogeography, Oikos* (2×), *Ecological Applications, Ecology, Journal of Ecology* (2×), *Global Ecology and Biogeography* (2×), *Plant Ecology, Ecological Monographs, Ecology Letters* (2×), *Annals of Botany Plants, Methods in Ecology and Evolution, Ecography* (2×), *Biotropica, Functional Ecology* (3×), *Journal of Plant Ecology, PeerJ* (2×), *Ecology and Evolution, PLoS One* (3×), *Ecosphere* (3×), *New Phytologist* (2×), *Global Change Biology* (3×)

Community outreach

- 2016– Maintain a personal science blog (blog.quentinread.com)
Answer community programming questions on StackOverflow
- 2021 Interviewed on food waste for SESYNC podcast (anchor.fm/sesync-communications)
- 2018 Organized event and gave presentation on citizen science opportunities, MSU Science Festival
- 2017 Gave public research talk, MSU Biology On Tap
- 2014 Organized and coordinated Darwin Day Tennessee
- 2013 Coordinated advertising for Darwin Day Tennessee
- 2012 Discussed my research and assisted 7th-grade students with climate change projects
- 2011-2015 Volunteered at kids' science education events at the University of Tennessee and the Rocky Mountain Biological Laboratory

Professional training

- 2021 SAS for R Users training course
- 2020 ReproHack reproducible science workshop, SESYNC
- 2019 Google Earth Engine workshop, SESYNC
Ecosystem services valuation workshop, USDA, Washington, DC
- 2018 Data to Motivate Synthesis workshop, SESYNC
- 2018-2020 SESYNC postdoctoral immersion series, including multiday workshops on interdisciplinary techniques, team science, socio-environmental hydrology, land system science, methods in social science, ecology, environmental policy, and public health
- 2014 Structural equation modeling workshop with Dr. Jim Grace, Knoxville, TN
- 2013 Short course: Boreal Forest Ecology, Swedish University of Agricultural Sciences, Umeå, Sweden
- 2012 Short course: Fundamentals of Ecosystem Ecology, Cary Institute of Ecosystem Studies, Millbrook, NY