DR. CATHERINE M. HULSHOF, PHD
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RESEARCH INTERESTS

I study the coupling between climate and biodiversity in tropical and temperate mountains across spatial and temporal scales, ranging from climatic-induced shifts in species traits and distributions to the reassembly and altered dynamics of ecological communities. My research group works at the intersection of climate science, data science, geoscience, and ecology to ask:

- How do we monitor long-term climate change in topographically complex regions?
- What climatic processes determine community reassembly across mountain gradients?
- How do climatic and edaphic properties impact the resilience of mountainous areas?

We explore these questions using a combination of long-term biodiversity monitoring data, synthesis of global environmental data, datasets we generate ourselves in the field, and open-source tools.

ACADEMIC APPOINTMENTS

2018 –	Assistant Professor, Department of Biology, Virginia Commonwealth University
2018 –	Research Associate, Smithsonian Institution National Museum of Natural History
2014 – 2017	Assistant Professor, Department of Biology, University of Puerto Rico Mayagüez
2013 – 2014	NSF Postdoctoral Research Fellow, Department of Environmental Science & Policy, University of California Davis

EDUCATION

2013	PhD in Ecology and Evolutionary Biology, Minor in Global Change, Department of Ecology and Evolutionary Biology, University of Arizona
2006	BA in Biology with a double major in Chemistry, University of Pennsylvania

PROFESSIONAL EXPERIENCE

2009 – 2012	NSF Graduate Research Fellow, Department of Ecology and Evolutionary Biology, University of Arizona
2011 – 2012	Research Assistant, Water Resources Research Center, University of Arizona
2009	Grant Writer, Environmental Education Exchange, Tucson, Arizona
2007 – 2008	Research Associate, Conservation International TEAM Network
2002 – 2006	Federal Work-Study, Department of Biology, University of Pennsylvania

COMPETITIVE RESEARCH GRANTS

2021 – 2026	NSF CAREER: Predicting functional trait variation across spatial, temporal, and biological scales ($1.06M)
2016 – 2020	NSF Macrosystems Biology Early Career Award: Climate change and plants on unusual soils ($300K)
2017	NSF EPSCoR Research Infrastructure Improvement Track 4: Image analysis of tropical Lepidoptera – Developing transferable skills for the use of biodiversity collections in the Big Data era ($195K)

2016 – 2017 Puerto Rico Science, Technology, and Research Trust: Digitization of museum Lepidoptera collections for biodiversity conservation ($70K)
2015 – 2017 USFS Endangered Species Grant: The ecology of edaphic endemism ($45K)
2014 – 2016 University of Puerto Rico Mayagüez Internal Competitive Research Grant ($5K)
2010 Institute of the Environment Graduate Dissertation Grant, University of Arizona ($5K)
2008 Latin America Tinker Summer Field Research Grant, University of Arizona ($5K)
2003 – 2005 NSF Research Experience for Undergraduates ($15K distributed over three summer field seasons in Area de Conservación Guanacaste, Costa Rica)

AWARDS & FELLOWSHIPS

2021 VCU College of Humanities & Sciences Excellence in Scholarship Award
2021 rstudio::global(2021) Diversity Scholar
2016 Ecological Society of America Education Scholar
2014 Carl Storm Underrepresented Minority Fellowship
2013 NSF Postdoctoral Research Fellowship in Biology
2012 Ecological Society of America SEEDS Travel Award
2010 Philanthropic Educational Organization Scholar Award National Nominee
2009 NSF Graduate Research Fellowship Program
2009 Ford Foundation Diversity Fellowship Doctoral Program
2008 Organization for Tropical Studies NSF International Research Fellowship
2007 Graduate Diversity Fellowship Award, University of Arizona
2006 Nassau Research Award, University of Pennsylvania
2006 Binns-Williams Research Award, University of Pennsylvania

PUBLICATIONS

* Graduate Student, + Undergraduate Student, ǂ Corresponding Author

Under Review or In Prep (MS available, data deposition in Dryad planned upon publication)

1. * Kusi E, **CM Hulshof**, K Kester. The role of abiotic and biotic factors on hornworm distributions in the United States. *In Prep for Ecological Entomology*.
2. *Richins A, Kester K, **CM Hulshof**. Disturbance disrupts pollinator network stability in a serpentine grassland. *In Prep* for *Ecological Entomology*.
3. Umaña MN, **CM Hulshof**. Trait variation is stable across spatial and temporal scales in a subtropical forest. *In Prep* for *Ecology*.
4. +Samojedny TJ, *Garnica Diaz C, **ǂ Hulshof CM**, Rajakaruna N. Specific leaf area is modulated by ultramafic soils across biogeographical regions. *Under Review. Plant Ecology and Diversity*.
5. **ǂ Hulshof CM**, Umaña MN. Power laws and predicting plant trait variation across spatiotemporally heterogeneous environments. *Revise and Resubmit*. *Ecology Letters*.
6. *Garnica Diaz C, 15 co-authors, **ǂ CM Hulshof**. Global plant ecology of tropical ultramafic ecosystems. *Major Revisions*. *The Botanical Review*.

Peer-reviewed

1. *Richins A, **Hulshof CM**. Deer exclusion regenerates native plant functional responses, but not species richness in an eastern serpentine savannah. *Accepted*. *Frontiers in Conservation Science*.
2. McEntire K, Gage M, Gawne R, Hadfield M, **Hulshof CM**, Johnson M, Levesque D, Segura J, Pinter N. 2021. Understanding drivers of variation and predicting variability across levels of biological organization. *Integrative and Comparative Biology*, icab160.

3. Vargas G, Brodribb T, Dupuy J, González-M R; **Hulshof CM**, Medvigy D, Allerton T, Pizano C, Salgado-Negret B, Schwartz N, Van Bloem S, Waring B, Powers J. 2021. Beyond leaf habit: Generalities in plant function across 102 tropical dry forest tree species. *New Phytologist* 232: 148-161. Data.
4. Waring B, De Guzman M, Du D, Dupuy J, Gei M, Gutknecht J, **Hulshof CM**, Jelinski N, Margenot A, Medvigy D, Pizano C, Salgado-Negret B, Schwartz N, Trierweiler A, Van Bloem S, Vargas G, Powers J. 2021. Soil biogeochemistry across Central and South American tropical dry forests. *Ecological Monographs* 91: e01453. Data.
5. ǂ **Hulshof CM**, Spasojevic MJ. The edaphic control of plant diversity. 2020. *Global Ecology and Biogeography* 29: 1634-1650. Data.
6. ǂ **Hulshof CM**, Waring BG, Powers JS, Harrison SP. 2020. Trait-based signatures of cloud base height in a tropical cloud forest. *American Journal of Botany* 107: 1-9. Data.
7. Swenson NG, **Hulshof CM**, Katabuchi M, Enquist BJ. 2020. Long-term shifts in the functional composition and diversity of a tropical dry forest: a 30-yr study. *Ecological Monographs* 90: e01408. Data.
8. *Wales S, Kreider M, **Hulshof CM**, Atkins J, Fahey RT, Nave LE, Nadelhoffer KJ, Gough CM. 2019. Mechanisms underlying production stability in temperate deciduous forests. *Forest Ecology and Management* 460: 117865.
9. ǂ **Hulshof CM**, Powers JS. 2019 Tropical forest composition and function across space and time: Insights from diverse gradients in Área de Conservación Guanacaste. *Biotropica* 52: 1065-1075.
10. +Echevarria Ramos M, ǂ **Hulshof CM**. 2019. Using digitized museum collections to understand the effects of habitat on wing coloration in the Puerto Rican monarch *Biotropica* 51: 477-483. Data.
11. Wieczynski D, Boyle B, Buzzard V, Duran S, Henderson A, **Hulshof CM**, Kerkhoff A, McCarthy M, Michaletz S, Swenson S, Asner G, Bentley L, Enquist B, Savage V. 2019. Climate shapes and shifts functional biodiversity in forests worldwide. *Proceedings of the National Academy of Sciences* 116: 587-592.
12. *Derroire G, Powers J, **Hulshof CM**, Varela L, Healy J. 2018. Contrasting patterns of leaf trait variation among and within species during tropical dry forest succession in Costa Rica. *Nature Scientific Reports* 8: 285.
13. Agosta SJ, **Hulshof CM**, *Staats E. 2017. Herbivore performance, climate, and leaf traits in regenerating tropical dry forests. *Journal of Animal Ecology* 86: 590-604.
14. Allen K, Dupuy JM, Gei MG, **Hulshof CM**, Medvigy D, Pizano C, Salgado-Negret B, Smith CM, Trierweiler A, Van Bloem SJ, Waring BG, Xu X, Powers JS. 2017. Will seasonally dry tropical forests be sensitive or resistant to future changes in rainfall regimes? Special Issue *Environmental Research Letters* 12: 023001s. Featured in Highlights of 2017.
15. *Buzzard V, **Hulshof CM**, Violle C, Enquist BJ. 2016. Regrowing a tropical dry forest: Functional trait diversity during secondary succession. *Functional Ecology* 30: 1006-1013.
16. ǂ **Hulshof CM**, Swenson N, Weiser M. 2015. Tree height-diameter allometry across the United States. *Ecology and Evolution* 5: 1193-1204.
17. ǂ **Hulshof CM**, Violle C, Spasojevic M, McGill B, Damschen E, Harrison S, Enquist B. 2013. Intra-specific and interspecific variation in specific leaf area reveal the importance of abiotic and biotic drivers of species diversity across elevation and latitude. *Journal of Vegetation Science* 24: 921-931.
18. ǂ **Hulshof CM**, Martinez-Yrizar A, Burquez A, Boyle B, Enquist B. 2013. Functional plant trait variation in tropical dry forests: A review and synthesis. In Tropical Dry forests of the Americas: Ecology, Conservation, and Management (eds. J. Powers and A. Sanchez), CRC Press, New York. pp 129-140.

19. Violle C, Enquist BJ, McGill B, Jiang L, Albert CH, **Hulshof CM**, Jung V, and J Messier. 2012. Viva la variance! A reply to Nakagawa & Schielzeth. *Trends in Ecology and Evolution* 27: 475-476.
20. Violle C, Enquist B, McGill B, Jiang L, Albert C, **Hulshof CM**, Jung V, Messier J. 2012. The return of the variance: intraspecific variability in community ecology. *Trends in Ecology and Evolution* 27: 244-252.
21. ǂ **Hulshof CM**, Swenson NG, Stegen JJ, Enquist CF, Enquist BJ. 2012. Interannual variability of growth and reproduction in the tropical tree Bursera simaruba – The role of allometry and resource variability. *Ecology* 93:180–190.
22. ǂ **Hulshof CM**, Swenson NG. 2010. Variation in leaf functional trait values within and across individuals and species: An example from a Costa Rican dry forest. *Functional Ecology* 24: 217 – 223.

DEPARTMENTAL SEMINARS & SELECTED CONFERENCE PRESENTATIONS
(INVITED)*

2022 * *University of Virginia, Department of Environmental Sciences*
Ecotones are sentinels of climate change at local to continental scales (3/31/22)
* *Trinity University, Department of Biology*
Ecotones are sentinels of climate change at local to continental scales (4/4/22)
* *Iowa State University, Department of Ecology, Evolution and Organismal Biology*
Ecotones are sentinels of climate change at local to continental scales (4/7/22)
2021 * *The University of Washington at St. Louis Tyson Research Center Seminar Series*
Climate change in the tropical wet forest - dry forest transition zone
* *Ekmanianthe Dominican Association of Students of Biology (in Spanish)*
Los ecotonos tropicales y el cambio climático
* *University of Maine, School of Biology and Ecology*
Beyond Big Data: What is the next scientific revolution?
2020 * *Cornell University, Department of Ecology and Evolutionary Biology Seminar Series*
Advancing a trait scaling theory to predict variance in space and time
* *Association for Tropical Biology and Conservation Special Symposium* (cancelled)
2018 *Ecological Society of America Annual Meeting*
Species and trait diversity of an insular tropical Lepidoptera assemblage
* *University of Florida Gainesville, Department of Biology Seminar Series*
How seasonal is seasonal? Wavelet analysis of climatic and functional trait data in seasonal tropical forests
2017 *Congreso de Biodiversidad Caribeña, Santo Domingo, República Dominicana (in Spanish)*
Variabilidad climática y la diversidad funcional en los bosques secos tropicales
* *Research Experience for Undergraduates Blandy Experimental Farm*
The functional trait approach in ecology
2016 *Ecological Society of America Annual Meeting*
Climatic variability and functional diversity in tropical dry forests
2015 * *Association of Tropical Biology and Conservation Symposium*
Trait-based signatures of climate-induced changes in cloud base height in a tropical cloud forest
* *University of Puerto Rico Rio Piedras Seminar Series (in Spanish)*
Variabilidad climática y la diversidad funcional en los bosques secos tropicales
2014 * *Gordon Research Conference Unifying Ecology across Scales*
Caterpillar performance, climate, and leaf traits in a regenerating tropical forest

2011 * *Organization for Tropical Studies, Undergraduate Tropical Ecology Semester Course*
The functional trait approach for testing long-standing ideas in ecology
2009 *Association of Tropical Biology and Conservation Annual Meeting*
Plant functional trait variation across elevation

MENTORING
Mentees current position in italics

Chair

Erick Calderon Morales (PhD, 2021–). Forecasting climate change in tropical forests.
Emelia Kusi (co-chair with Karen Kester, MSc 2019–2021). The effects of abiotic and biotic factors on hornworm distributions. Awarded Department of Biology Outstanding Graduate Student Award. *PhD student, University of Massachusetts*.
Dayneris Aparicio Jimenez (MSc 2018–2020). The effects of wing traits on the recovery of Lepidoptera post-Hurricane Maria. *Community engagement with Cuban and migrant community in Tampa, FL*.
Claudia Garnica Diaz (MSc 2018–2020). Effects of climatic and edaphic factors on plant trait variation across elevation. *PhD student, University of Florida Gainesville*.
Allyson Richins (MSc 2018–2020). Plant-pollinator associations in an eastern serpentine savannah and the effects of overbrowsing. Awarded Rice River Center Research Award. *Ecological Monitoring Field Lead, Great Basin Institute*.
Amelia Mateo Jimenez (MSc 2016–2018). Phenology of a tropical dry forest in Dominican Republic. *Instructor, Universidad Autónoma de Santo Domingo*.

Member

Constance Bolte (PhD, 2018–); Lisa Turner (PhD, 2018–); Tristan Allerton (PhD, 2017–2020); Sequoia Mosby (MSc 2020–); Baron Lin (MSc 2019–2021); Alex Brown (MSc 2019–2021); Shannon Walker (MSc 2018–2020); Elsa Chen (MSc 2018–2020); Maxim Grigri (MSc 2018–2020); Rebecca Dahlberg Piri (MSc 2017–2019); Audrey Kirschner (2018–2019); Shea Wales (2018–2019)

Undergraduate

Eric Escobar-Chena (VCU, 2021–). Recovery of butterflies post Hurricane Maria in Puerto Rico; SEEDS chapter at VCU
Cat Terry (VCU, 2022–). History of Lepidoptera research in Puerto Rico.
Angela Hong (VCU, 2018–2019). Image analysis of butterfly size and color.
Tristan Rivera (VCU, 2018–2019). Plant-insect associations in Puerto Rico.
Luis Velázquez Román (UPRM, 2018). NSF REU Luquillo Long Term Ecological Research Network. The effect of climate change on Puerto Rican butterfly distribution. Presented work at Ecological Society of America Annual Meeting Late-breaking Poster Session. Received NSF REU travel award. *MSc student, University of Puerto Rico Rio Piedras*.
Mariangelí Echevarría (UPRM, 2017). Phenotypic variation in the Puerto Rican monarch. Received Mindlin Foundation Undergraduate Research Award ($5k) for travel and presentation at Association for Tropical Biology and Conservation Annual Meeting in Kuching, Malaysia, July 2018. Co-led butterfly technology exhibit at Feria Para La Naturaleza (the largest science fair

on the island). *MSc student, Boston University*.
Oscar Ojeda Cana (UPRM, 2017). Digitization of Puerto Rican Lepidoptera collections. Co-led butterfly technology exhibit at Feria Para La Naturaleza (the largest science fair on the island).
Andrea Lopez (UPRM, 2015). Urban plant diversity and function. Presented work at the UPRM Undergraduate Biology Research Symposium, May 2016.
Vanessa Buzzard (UA, 2010). Tropical dry forest succession. Published peer-reviewed journal and presented at Ecological Society of America Annual Meeting. *Completed PhD, now research technician, University of Arizona*.

TEACHING

** Indicates new course and curriculum development; in-person unless otherwise noted*

Virginia Commonwealth University, Department of Biology
Ecology, Undergraduate, 3 credits
Fall 2022 79 students, online asynchronous
Fall 2021 235 students, online asynchronous
**EcoCode: Environmental Data Science, Undergraduate, 3 credits*
Fall 2020 9 students, online asynchronous
**Data Science for Biologists, Graduate, 3 credits*
Fall 2020 7 students, online asynchronous
Fall 2019 14 students
Fall 2018 10 students
**Capstone: Envisioning Future Earth with SEEDS, Undergraduate, 2 credits*
Fall 2022 15 students

University of Puerto Rico Mayagüez, Department of Biology
Principles of Ecology, Undergraduate, 3 credits, 30 students
Fall 2017; Spring 2015; Fall 2014
**Quantitative Ecology in R, Graduate, 3 credits, 15 students*
Spring 2016
**Population Ecology in R, Graduate, 3 credits, 15 students*
Fall 2016
Introduction to Biology for Majors, Undergraduate, 3 credits, 50 students
Fall 2015; Fall 2014

Pima Community College, Desert Vista, Tucson, Arizona
Introduction to Biology for Non-Majors, 3 credits, 20 students
Fall 2012

SERVICE

Reviewer

American Naturalist, Annals of Botany, Biotropica, Ecography, Ecology, Ecology Letters, Frontiers in Plant Science, Functional Ecology, Global Ecology and Biogeography, Journal of Animal Ecology, Journal of Biogeography, Journal of Ecology, Journal of Vegetation Science, Nature, Oecologia, Oikos, PLoS ONE, Perspectives in Plant Ecology, Evolution and Systematics; Plant and Soil, Proceedings of the Royal Society B, Science, among others.

NSF Review Panels – Directorate of Biological Sciences:
2016 (2); 2018 (1); 2019 (1); 2020 (1, ad hoc); 2021 (2); 2022 (2)

Alberta Conservation Association Grants in Biodiversity (1)

Faculty Committees

Department of Biology Ad hoc Diversity, Equity, and Inclusion Committee (Fall 2020–): Evaluate existing and consider new strategies for increasing DEI in the Department; developed a mission statement and recommendations for the Department, moving to make the *ad hoc* committee a standing committee.

Department of Biology PhD Prospectus Committee (Fall 2019–): Part of a team of 4 faculty who prepared and submitted a proposal for the creation of a PhD in Biosciences program. Proposal was approved by Dean, Provost, and is now under review by the State Council of Higher Education for Virginia.

Department of Biology Graduate Academic Committee (Spring 2018; Fall 2019; Spring 2020): Reviewed and approved graduate applications; reviewed graduate application requirements, reviewed new graduate course proposals. I advocated for eliminating the Graduate Record Examination (GRE) requirement which was unanimously approved by the department.

Workshops Convened

2019 Explore NEON, Virginia Commonwealth University, 30 participants. Access and analyze NEON data in R.

2018 Data Carpentry R for Ecology, University of Puerto Rico Rio Piedras, 25
Participants. Data management, reproducibility, analysis, and visualizations.

2016 Data Carpentry R for Ecology, University of Puerto Rico Mayagüez, 20 participants. Data management, reproducibility, analysis, and visualizations.

Diversity in STEM

2021 ESA SEEDS, new VCU chapter, faculty advisor (2021–)

2019 Científico Latino Graduate Student Initiative, faculty mentor
2018 Ecological Society of America Annual Meeting SEEDS faculty mentor
2017 ESA SEEDS, new UPRM chapter, faculty advisor (2014–2017)
2010 Women in Science and Engineering mentor

Invited Public Outreach

2021 Henrico County Public Schools Hispanic Heritage Month Keynote (bilingual), Científiques como tú: Innovation Depends on Diversity

2021 Roots and Shoots Puerto Rico Pollinator Week (in Spanish), La diversidad de las mariposas de Puerto Rico

PROFESSIONAL DEVELOPMENT

2021 - 2022 *National Ecological Observatory Network Ambassador Program*
Accelerating scientific discovery, diversity, and inclusion through NEON data.

2021 - 2022 *Institute on Inclusive Teaching, Virginia Commonwealth University*
Strategies for becoming more inclusive instructors and leaders. A sustained, year-long process of design, application, and assessment of these strategies.

2019 *NSF Jumpstart: Reintegrating Biology, Austin, TX*
Explored questions and new developments at the crossroads of modern biology. Resulted in publication (McEntire...Hulshof et al. 2021, *Integrative and Comparative Biology*).

2017 *Data Carpentry Instructor Training, San Juan, PR*
Educational psychology, instructional design, and inclusive pedagogy.

2016 *NEON Data Science Institute, Boulder, CO*
Remote sensing of vegetation using open-source tools and reproducible science approaches.

2016 *Quantitative Undergraduate Biology Education and Synthesis (QUBES) and Ecological Society of America Faculty Mentoring Network 'Scaling Up: Bringing Research Data into Undergraduate Classrooms' program*

PROFESSIONAL AFFILIATIONS

American Geophysical Union
Association for Tropical Biology and Conservation (including Neotropical Chapter)
Association for Women in Science
Ecological Society of America (including Latin American & the Caribbean Chapter)

LANGUAGES

English – native language; Spanish – fluent