

Rachel M. Keen

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Last updated: February 2026

RESEARCH INTERESTS

Ecohydrology; grassland / savanna ecology; stable isotope ecology & hydrology; plant ecophysiology

APPOINTMENTS

- 2025 – Present **Postdoctoral Research Fellow**
NSF Earth Sciences Postdoctoral Research Fellowship (EAR-PF)
College of Earth, Ocean, & Atmospheric Sciences, Oregon State University
Mentor: Pam Sullivan
- 2023 – 2025 **Postdoctoral Research Associate**
Dept. of Ecology and Evolutionary Biology, University of Kansas
Kansas Biological Survey & Center for Ecological Research
Co-mentors: Sharon Billings & Pam Sullivan

EDUCATION

- 2019 – 2023 **Ph.D., Biology – Kansas State University**
Advisor: Jesse Nippert
- 2017 – 2019 **M.S., Ecology – Utah State University**
Advisor: Steve Voelker
- 2011 – 2015 **B.S., Biology – Kansas State University**

EXTERNAL GRANTS FUNDED

Title	Role	Agency	Duration	Amount
How does woody plant encroachment alter soil hydrological processes in savanna ecosystems?	PI	NSF (EAR-PF)	6/1/2025 – 5/31/2027	\$180,000

PUBLICATIONS

Peer Reviewed Journal Articles

+indicates graduate or undergraduate student co-author

21. Puthalath, S., Kirk, M.F., **Keen, R.M.**, Flores, A.N., Billings, S.A., Sullivan, P.L. and Nippert, J.B., *In review*. Local and distal processes determine precipitation isotope records in the Great Plains, USA. *Geochimica et Cosmochimica Acta*.
20. **Keen, R.M.**, Sullivan, P.L., Ajami, H., Hirmas, D., Li, L., Flores, A.N., Jarecke, K., Loecke, T., ⁺Klamm, L., ⁺Unruh, M., ⁺Varikuti, V. and Billings, S.A., *In revision*. Quantifying potential nutrient liberation following plant investment in root exudates: variation across soil profiles and ecosystems in the United States. *JGR: Biogeosciences*.
19. Sadayappan, K., Jarecke, K.M., **Keen, R.M.**, Puthalath, S., Dodds, W.K., Kirk, M.F., Sullivan, P.L., Nippert, J.B., Seybold, E.C. and Li, L. 2026. Flow or no-flow: Does discharge regulate water chemistry in intermittent streams? *Water Resources Research*. DOI: 10.1029/2025WR040321
18. Billings, S.A., Sullivan, P.L., Li, L., Hirmas, D.R., Nippert, J.B., Ajami, H., Flores, A.N., Singha, K., **Keen, R.M.**, Markewitz, D., Chorover, J., Ederer, A., Silver, W.L., ⁺Unruh, M., Gerson, J., Hart,

- S.C., Richter, D.D., Hauser, E., McDowell, W.H., Souza, L.F.T., Banerjee, I., Jarecke, K.M., Pachon Maldonado, J.C., Yang, Y., Aronson, E.L., Dere, A., Gallery, R.E., Lohse, K. and White, T., 2025. Contrasting depth dependencies of plant root presence and mass across biomes underscores prolific root-regolith interactions. *AGU Advances*. DOI: 10.1029/2025AV002072
17. Jarecke, K.M., **Keen, R.M.**, Singha, K., Nippert, J.B., Billings, S.A., Zhang, X., Sadayappan, K., Kirk, M.F., Hirmas, D.R., Li, L., Ajami, H., Dumont, M., Flores, A.N. and Sullivan, P.L., 2025. Woody encroachment intensifies deep soil drying at daily, seasonal, and decadal scales. *Ecosystems*. DOI: 10.1007/s10021-025-01008-0
 16. Jarecke, K.M., Zhang, X., **Keen, R.M.**, Dumont, M., Li, B., Sadayappan, K., ⁺Moreno, V., Ajami, H., Billings, S.A., Flores, A.N. and Hirmas, D.R., 2025. Woody Encroachment Modifies Subsurface Structure and Hydrological Function. *Ecohydrology*, 18(2), p.e2731. DOI: 10.1002/eco.2731
 15. ⁺Anhold, C., ⁺Hatley, C., Alcantar-Velasquez, E., **Keen, R.M.**, Sadayappan, K., Jarecke, K., Sullivan, P.L., Nippert, J.B., Li, L., Macpherson, G.L., Kirk, M.F., 2025. Grassland woody encroachment alters subsurface mineral weathering and groundwater composition in a carbonate system. *Chemical Geology*. DOI: 10.1016/j.chemgeo.2024.122522
 14. Jarecke, K., Zhang, X., **Keen, R.M.**, Dumont, M., Li, B., Sadayappan, K., ⁺Moreno, V., Ajami, H., Billings, S.A., Flores, L., Hirmas, D., Kirk, M., Nippert, J.B., Singha, K., Sullivan, P.L., 2024. Woody encroachment modifies subsurface structure and hydrological function. *Ecohydrology*, p.e2731. DOI: 10.1002/eco.2731
 13. **Keen, R.M.**, Sadayappan, K., Jarecke, K., Li, L., Kirk, M.F., Sullivan, P.L., Nippert, J.B., 2024. Unexpected hydrologic response to ecosystem state change in tallgrass prairie. *Journal of Hydrology*. DOI: 10.1016/j.jhydrol.2024.131937
 12. O'Keefe, K., Nippert, J.B., **Keen, R.K.**, McCulloh, K.A., 2024. Contrasting shrub and grass hydraulic responses to experimental drought. *Oecologia*. DOI: <https://doi.org/10.1007/s00442-024-05543-w>
 11. **Keen, R.M.**, Bachle, S., Bartmess, M., and Nippert, J.B., 2024. Combined effects of fire and drought are not sufficient to slow shrub encroachment in tallgrass prairie. *Oecologia*. DOI: 10.1007/s00442-024-05526-x
 10. **Keen, R.M.**, Helliker, B.R., McCulloh, K.A., and Nippert, J.B., 2024. Save or spend? Diverging water-use strategies of grasses and encroaching clonal shrubs. *Journal of Ecology*. DOI: 10.1111/1365-2745.14276
 9. Sadayappan, K., **Keen, R.M.**, Jarecke, K.M., Moreno, V., Nippert, J.B., Kirk, M.F., Sullivan, P.L. and Li, L., 2023. Drier streams despite a wetter climate in woody-encroached grasslands. *Journal of Hydrology*. DOI: 10.1016/j.jhydrol.2023.130388
 8. Dodds, W.K., Ratajczak, Z., **Keen, R.M.**, Nippert, J.B., Grudinski, B., Veach, A., Taylor, J. and Kuhl, A., 2023. Trajectories and state changes of a tallgrass prairie stream and riparian zone after a decade of woody plant removal. *Ecological Applications*, e2830. DOI:10.1002/eap.2830
 6. **Keen, R.M.**, Nippert, J.B., Sullivan, P.L., Ratajczak, Z.R., Ritchey, B., O'Keefe, K. and Dodds, W.K., 2023. Impacts of riparian and non-riparian woody encroachment on tallgrass prairie ecohydrology. *Ecosystems*, 26: 290-301. DOI: 10.1007/s10021-022-00756-7
 7. Tooley, E.G., Nippert, J.B., Bachle, S. and **Keen, R.M.**, 2022. Intra-canopy leaf trait variation facilitates high leaf area index and compensatory growth in a clonal woody encroaching shrub. *Tree Physiology*, 42(11): 2186-2202. DOI: 10.1093/treephys/tpac078
 5. Sullivan, P.L., Billings, S.A., Hirmas, D., Li, L., Zhang, X., Ziegler, S., Murenbeeld, K., Ajami, H., Guthrie, A., Singha, K., Giménez, D., Duro, A., Moreno, V., Flores, A., Cueva, A., Koop, Aronson, E.L., Barnard, H.R., Banwart, S.A., **Keen, R.M.**, Nemes, A., Nikolaidis, N.P., Nippert, J.B., Richter, D., Robinson, D.A., Sadayappan, K., de Souza, L.F.T., Unruh, M., and Wen, H. 2022. Embracing the dynamic nature of soil structure: A paradigm illuminating the role of life in critical zones of the Anthropocene. *Earth-Science Reviews*, 225: 103873. DOI: 10.1016/j.earscirev.2021.103873
 4. **Keen, R.M.**, Volker, S.L., Wang, S.Y.S., Bentz, B.J., Goulden, M., Dangerfield, C., Reed, C.C., Hood, S.M., Csank, A.Z., Dawson, T.E., Merschel, A.G. and Still, C.J. 2022. Changes in tree drought

- sensitivity provided early warning signals to the California drought and forest mortality event. *Global Change Biology*, 28(3): 1119-1132. DOI: 10.1111/gcb.15973
3. O’Keefe, K., Bachle, S., **Keen, R.M.**, Tooley, E.G. and Nippert, J.B. 2022. Root traits reveal safety and efficiency differences in grasses and shrubs exposed to different fire regimes. *Functional Ecology*, 36(2): 368-379. DOI: 10.1111/1365-2435.13972
 2. **Keen, R.M.**, Voelker, S.L., Bentz, B.J., Wang, S.Y.S. and Ferrell, R., 2020. Stronger influence of growth rate than severity of drought stress on mortality of large ponderosa pines during the 2012–2015 California drought. *Oecologia*, 194(3): 359-370. DOI: 10.1007/s00442-020-04771-0
 1. Lavergne, A., Voelker, S., Csank, A., Graven, H., de Boer, H.J., Daux, V., Robertson, I., Dorado-Liñán, I., Martínez-Sancho, E., Battipaglia, G., Bloomfield, K.J., Still, C.J., Meinzer, F.C., Dawson, T.E., Camarero, J.J., Clisby, R., Fang, Y., Menzel, A., **Keen, R.M.**, Roden, J.S., Prentice, I.C., 2020. Historical changes in the stomatal limitation of photosynthesis: empirical support for an optimality principle. *New Phytologist*, 225(6): 2484-2497. DOI: 10.1111/nph.16314

Peer Reviewed Book Chapters

1. Nippert, J.B., Bachle, S., **Keen, R.M.**, Wedel, E.R., 2022. Climate change in grassland ecosystems: Current impacts and potential actions for a sustainable future. In: Grosinsky, B. (ed.) *Climate actions: Local applications and practical solutions*. Boca Raton, Florida, USA: CRC Press.

SCHOLARLY PRESENTATIONS

Oral presentations (presenting-author only) *indicates invited talks, +indicates student authors

20. **Keen, R.M.**, Swemmer, T., Nippert, J., Lerm, R., Sullivan, P.L., 2026. “Bush encroachment: A boon or barrier for groundwater recharge?”
Savanna Science Network Meeting, Kruger National Park, South Africa
19. **Keen, R.M.**, Billings, S.A., Sprenger, M., Li, B., Ajami, H., Amato, M., +Araki, R., Crompton, O., Gimenez, D., Groh, J., Hirmas, D., Koop, A., Nimmo, J.R., Singh, N., Wiekenkamp, I., Wyatt, B.M., Xu, T., Sullivan, P.L., 2024. “Elucidating patterns of preferential flow occurrence across ecosystems and soil profiles to aid in future projections of water storage and fluxes.”
AGU Annual Meeting, Washington D.C., USA
18. ***Keen, R.M.**, Billings, S.A., Sprenger, M., Li, B., Jarecke, K., Kirk, M., and Sullivan, P.L., 2024. “Soil water preferential flow: Broad drivers and consequences for encroached grasslands.”
Kansas Biological Survey (KBS) Ecology Seminar Series, Lawrence, KS, USA
17. **Keen, R.M.**, Sullivan, P.L., Ajami, H., Hirmas, D.R., Li, L., and Billings, S.A., 2024. “Cross-site variability in potential nutrient returns for carbon investment in root exudates.”
Soil Science Society of America (SSSA) Annual Meeting, San Antonio, TX, USA
16. **Keen, R.M.**, Nippert, J.B., Sullivan, P.L., Dodds, W.K., Sadayappan, K., Li, L., and Kirk, M., 2023. “Shrub encroachment decouples ecohydrological linkages and depletes surface water in tallgrass prairie.”
Ecological Society of America (ESA), Portland, Oregon, USA
15. ***Keen, R.M.**, Nippert, J.B. “Interactive grassland drivers: Impacts on shrub encroachment and plant biodiversity in tallgrass prairie.”
Konza Prairie LTER Mid-Site Review, Manhattan, KS, USA
14. **Keen, R.M.**, Nippert, J.B., 2023. “Combined effects of fire and drought are not sufficient to slow bush encroachment.”
Savanna Science Network Meeting, Kruger National Park, South Africa
13. ***Keen, R.M.**, 2023. “Interactive drivers in grassland ecosystems.”
Terrestrial Plant Ecology, St. Edwards University, Austin, TX, USA
12. ***Keen, R.M.**, Nippert, J.B., Sullivan, P.L. and Dodds, W.K., 2022. “Ecohydrological impacts of woody encroachment at Konza Prairie Biological Station.”
LTER All Scientists’ Meeting 2022, Monterey, CA, USA (Invited)

11. **Keen, R.M.**, Tooley, E.G., Bachle, S. and Nippert, J.B., 2022. "Physiological responses of woody-encroached grassland communities to multi-year drought and fire."
Ecological Society of America (ESA), Montreal, Canada
10. **Keen, R.M.**, Nippert, J.B., Swemmer, A.M., Graf, J.A. and Wedel, E.R., 2022. Impacts of afforestation on belowground dynamics in montane grasslands and mesic savannas of the Northern Drakensbergs."
Ecological Society of America (ESA), Montreal, Canada
9. **Keen, R.M.**, Tooley, E.G., Bachle, S. and Nippert, J.B., 2022. "Physiological responses of woody-encroached grassland communities to multi-year drought and fire."
Konza LTER Annual Meeting, Manhattan, Kansas, USA
8. **Keen, R.M.**, Tooley, E.G., Bachle, S. and Nippert, J.B., 2022. "Physiological responses of woody-encroached grassland communities to multi-year drought and fire."
Konza LTER Annual Meeting, Manhattan, KS, USA
7. **Keen, R.M.**, Nippert, J.B., Sullivan, P.L., Ratajczak, Z., Ritchey, B., O'Keefe, K. and Dodds, W., 2021. "Impacts of woody encroachment on watershed-scale water fluxes in tallgrass prairie."
Konza LTER Annual Meeting, Manhattan, KS, USA
6. ***Keen, R.M.**, Wedel, E.R., 2019. "Konza: Life on the tallgrass prairie."
Greenhouse Science Special Education Course, Manhattan High School, Manhattan, KS
5. **Keen, R.M.**, Voelker, S.L., Wang, S.S-Y. and Bentz, B.J., 2019. "Ponderosa pine susceptibility to western pine beetle during the 2012-2015 California Drought."
Intermountain Society of American Foresters (IMSFA) Annual Meeting, Logan, UT, USA
4. **Keen, R.M.** and Voelker, S.L. 2019. "Comparing surviving and dead ponderosa pines following severe drought"
Plants, Soils, and Climate Departmental Seminar, Utah State University, Logan, UT, USA
3. **Keen, R.M.** and Voelker, S.L. 2018. "Ponderosa pine susceptibility to western pine beetle during the 2012-2015 California Drought."
Plants, Soils, and Climate Departmental Seminar, Utah State University, Logan, UT, USA
2. **Keen, R.M.** and Voelker, S.L. 2017. "Increased drought and tree mortality in the western United States: How are ponderosa pine-dominated forests responding to drought?"
Plants, Soils, and Climate Departmental Seminar, Utah State University, Logan, UT, USA
1. **Keen, R.M.**, Leys, B. and McLauchlan, K. 2016. "Linking charcoal data on Konza Prairie to Great Plains historical fire regimes."
PaleoLab Fall Meeting, Kansas State University, Manhattan, KS, USA

Poster presentations ⁺indicates student authors

19. ⁺Manikandan, V., Saha, A., Keen, R.M., 2025. "Unmasking hidden drought and irrigation dependence with an energy-water based index."
Kansas Governor's Water Conference, Manhattan, KS, USA
18. Sadayappan, K., **Keen, R.M.**, Jarecke, K.M., Kirk, M.F., Nippert, J.B., Sullivan, P.L., Li, L., 2024. "Hidden short-term C-Q patterns embedded within long-term C-Q patterns in an intermittent stream."
AGU Annual Meeting, Washington D.C., USA
17. Li, B., Sprenger, M., Wyatt, B.M., Araki, R., Xu, T., Singh, N., Groh, J., Hirmas, D., Koop, A., Ajami, H., Gimenez, D., Wickenkamp, I., **Keen, R.M.**, Amato, M., Crompton, O., Sullivan, P.L., 2024. "Global identification and prediction of preferential flow occurrence in soils."
AGU Annual Meeting, Washington D.C., USA
16. Jarecke, K.M., **Keen, R.M.**, Sadayappan, K., Nippert, J.B., Billings, S.S., Hirmas, D., Li, L., Ajami, H., Flores, A.N., Kirk, M.F., Singha, K., Sullivan, P.L., 2024. "Woody encroachment intensifies soil drying at multiple temporal scales."

AGU Annual Meeting, Washington D.C., USA

15. **Keen, R.M.**, Sullivan, P.L., Dodds, W.K., Ratajczak, Z. and Nippert, J.B., 2023. "Impacts of woody encroachment on grassland water yield"
Capitol Graduate Research Summit, Topeka, KS, USA – winning poster
14. Jarecke, K.M., **Keen, R.M.**, Sadayappan, K., Moreno, V., Bonan, L., Dumont, M., Hirmas, D., Nippert, J.B., Ajami, H., Billings, S.B., Li, L., Flores, A.N., Zhang, X., Singha, K. and Sullivan, P., 2023. "Impacts of woody encroachment on soil hydrology: Insights from root distribution, soil moisture time series, and electrical resistivity imaging."
AGU Annual Meeting, San Francisco, CA, USA
13. Sadayappan, K., **Keen, R.M.**, Jarecke, K.M., Moreno, V., Nippert, J.B., Kirk, M.F., Sullivan, P.L. and Li, L., 2023. "Enhanced carbonate weathering in woody encroached grasslands."
AGU Annual Meeting, San Francisco, CA, USA
12. **Keen, R.M.**, Sullivan, P.L., Dodds, W.K., Ratajczak, Z. and Nippert, J.B., 2022. "Impacts of woody encroachment on grassland water yield"
Research & the State Annual Forum, Kansas State University, Manhattan, KS, USA
11. **Keen, R.M.**, Swemmer, A.M., Graf, J.A., Wedel, E.R., and Nippert, J.B. 2022. "Impacts of afforestation on belowground dynamics in montane grasslands and mesic savannas of the Northern Drakensbergs"
Savanna Science Network Meeting, Kruger National Park, South Africa
10. Sadayappan, K., **Keen, R.M.**, Moreno, V., Sullivan, P.L., Nippert, J.B. and Li, L., 2022. "Woody encroachment increases evapotranspiration and groundwater flow in a prairie grassland."
AGU Annual Meeting, Chicago, IL, USA
9. **Keen, R.M.**, Nippert, J.B., Tooley, E.G. and O'Keefe, K., 2021. "Interactive effects of drought and fire on co-existing woody and herbaceous communities in temperate mesic grasslands"
Joint International Grassland and International Rangeland Congress, Nairobi, Kenya (Virtual)
8. Sadayappan, K., **Keen, R.M.**, Moreno, V., Sullivan, P.L., Nippert, J.B. and Li, L., 2021. "Enhanced carbonate weathering due to woody encroachment."
AGU Annual Meeting, virtual
7. Sadayappan, K., **Keen, R.M.**, Sullivan, P.L., Nippert, J.B. and Li, L., 2020. "Does woody encroachment accelerate carbonate weathering?"
AGU Annual Meeting, virtual
6. **Keen, R.M.**, Voelker, S.L., Bentz, B.J. and Wang, S.S-Y., 2019. Stronger influence of growth rate than severity of drought stress on mortality of large ponderosa pines during the 2012-2015 California drought event"
AGU Annual Meeting, San Francisco, CA, USA
5. Zeglin, L., Dea, H.I., **Keen, R.M.**, Tooley, E.G. and Nippert, J.B., 2019. "Soil carbon cycling changes at depth due to woody encroachment of tallgrass prairie."
AGU Annual Meeting, San Francisco, CA, USA
4. Nippert, J.B., **Keen, R.M.**, Bachle, S., Sandwick, M., Tooley, E.G. and O'Keefe, K., 2019. "Plant physiological responses following experimental drought on intact shrub-grass communities in tallgrass prairie."
AGU Annual Meeting, San Francisco, CA, USA
3. O'Keefe, K., **Keen, R.M.**, Nippert, J.B. and McCulloh, K., 2019. "Hydraulic responses of *Cornus drummondii* to fire frequency and drought in a tallgrass prairie."
AGU Annual Meeting, San Francisco, CA, USA
2. **Keen, R.M.** and Voelker, S.L., 2019. "Ecophysiological comparison of surviving and dead ponderosa pines following the 2012-2015 California drought and western pine beetle outbreak"
Graduate Research Forum, Utah State University, Logan, UT, USA
1. **Keen, R.M.** and Nippert, J.B., 2015. "Water use by riparian trees on Konza Prairie: Do riparian trees use riparian water?"

TEACHING EXPERIENCE

- 2022 – 2025 **Critical Zone Field Camp – Instructor**
Four-day hands-on summer field camp that takes place annually at Konza Prairie Biological Station for students from Oregon State University, University of Texas El Paso, and El Paso Community College; Assisted with teaching plant ecophysiology techniques (gas exchange, source water use), lysimeter maintenance and sample collection, and soil infiltration measurements using a SATURO infiltrometer.
- 2023 **Ecology – Graduate Teaching Assistant**
BIOL 529-A (spring semester); Kansas State University
- 2019–2022 **Plant Physiology Laboratory – Co-Instructor**
BIOL 501 (fall semester); Kansas State University
Included designing / leading indoor (lab) and outdoor (field) activities. Field activities took place at Konza Prairie Biological Station and on campus and focused on using plant physiological measurements to assess ecological questions.
- 2021 **Savanna Ecology – Co-Instructor**
BIOL 495-C (spring semester); Kansas State University
Included designing and preparing materials for full-length lectures, group activities, writing assignments, and exams.
- 2020 **Organismic Biology – Graduate Teaching Assistant**
BIOL 201 (spring semester); Kansas State University

MENTORSHIP EXPERIENCE

- 2023 **Liam Kinghouser*** (University of Kansas)
Undergraduate laboratory technician
Biogeochemical lab skills and basic coding in R
- 2021 **Faith Atkinson*** (Kansas State University)
REU (Research Experience for Undergraduates) student
Independent project: Woody encroachment impacts on grassland soil hydrology
- 2020–2022 **Ryan Donnelly*^** (Kansas State University)
Undergraduate and master's student
Independent project: Diversity in functional traits across grass phylogenetic groups in the Great Plains region
- 2019–2022 **Emmett Tooley*^** (Kansas State University)
Undergraduate and master's student, Kansas State University
*Independent project: Functional traits associated with woody encroachment success of *Cornus drummondii* in tallgrass prairie*

AWARDS

- 2023 KSU Division of Biology John C. Frazier Plant Sciences Award – \$1000
- 2023 State of Kansas Capitol Graduate Research Summit Poster Winner – \$500
- 2022 KSU Research and the State Poster Winner
- 2022 KSU Arts & Sciences Travel Grant (ESA Annual Meeting) – \$500
- 2021 KSU Division of Biology James E. Ackert Award
- 2019–2020 KSU Timothy R. Donoghue Graduate Scholarship – \$10,000
- 2015 KSU Arts & Sciences Student Research Travel Grant (South Africa) – \$350
- 2013–2015 KSU Division of Biology Excellence Scholarship
- 2011–2015 KSU Foundation Scholarship

SERVICE & OUTREACH

- 2021-2022 **NC CASC Grasslands Synthesis Project – Advisory committee member**
North Central Climate Adaptation Science Center Grasslands Initiative
Assisted the Climate & Ecology Working Group by identifying information / resources during the writing phase and providing feedback on written syntheses
- 2020–2022 **Konza Prairie Annual Bison Round-up**
- 2019–2022 **Friends of Hale Library Board Member – Kansas State University**
- 2019–2020 **KAWSE (K-State Office for the Advancement of Women in Science and Engineering) SUCCEED Internal Advisory Board Member**
Designing activities and opportunities for undergraduate and graduate students of all genders to become involved, and succeed, in STEM fields at K-State
- 2019–2020 **Biology Graduate Student Association, Kansas State University**

Journal reviewer:

Hydrological Processes; Earth's Future; Functional Ecology; Ecological Applications: Science of the Total Environment; Oecologia; Rangeland Ecology & Management; African Journal of Range and Forage Science; Journal of Arid Environments; Environmental Problems; Plant & Soil; Catena

RESEARCH EXPERIENCE & TRAINING

- 2019 – 2023 **Graduate Research Assistant, KSU – Plant Ecophysiology**
R programming; stable isotope ($\delta^{13}\text{C}$, $\delta^2\text{H}$, $\delta^{18}\text{O}$) ecology and hydrology; LICOR 6400XT and 6800 gas analyzers; LICOR 600 porometer; PMS pressure chamber; WinRHIZO root image analysis; GeoProbe hydraulic soil corer; METER Saturo Infiltrrometer; Assisted with creating and maintaining (w/ J. Nippert) long-term (10+ years) water stable isotope records ($\delta^{18}\text{O}$, $\delta^2\text{H}$) for precipitation, stream water, and groundwater samples at Konza Prairie Biological Station
- 2016 & 2021 **Phys-Fest I and III – Plant Ecophysiology Workshops**
Graduate student training in plant ecophysiology sampling techniques, including gas exchange, hydraulics, and chlorophyll fluorescence
- 2017–2019 **Graduate Research Assistant, USU – Dendroclimatology**
Collection and preparation of tree cores and cross-sections; alpha cellulose digestions; measurement of tree-ring growth and stable isotopes ($\delta^{13}\text{C}$, $\delta^{18}\text{O}$)
- 2015–2016 **SIMSL Laboratory Manager, KSU – Stable isotope ecology / plant ecophysiology**
Stable Isotope Mass Spectrometry Laboratory
Operation and maintenance of (1) CE1110 elemental analyzer coupled to a Delta Pluss mass spectrometer (Thermo Electron Corporation; $\delta^{13}\text{C}$, $\delta^2\text{H}$, and $\delta^{15}\text{N}$), (2) Picarro WS-CRDS isotopic water analyzer ($\delta^{18}\text{O}$, $\delta^2\text{H}$), and (3) cryogenic vacuum distillation line at the KSU Stable Isotope Mass Spectrometry Laboratory; organized sample processing and invoicing for internal and external clients
- 2015–2016 **Undergraduate Research Assistant, KSU – Paleoecology**
Processing lake sediment samples for charcoal and pollen counts
- 2013–2015 **Undergraduate Research Assistant, KSU – Plant Ecophysiology**
Assisting graduate students with field- and lab work; independent project assessing sources of water use by grassland riparian vegetation