

**Montana Water Center  
Montana State University**

**Annual Technical Report  
2018**

## General Information

### Products

2014MT290B

Student Fellowship: Precipitation and topographic controls over montane forest transpiration

Looker, N., Martin, J., Jencso, K., & Hu, J. (2016). Contribution of sapwood traits to uncertainty in conifer sap flow as estimated with the heat-ratio method. *Agricultural and forest meteorology*, 223, 60-71.

<https://doi.org/10.1016/j.agrformet.2016.03.014>

Looker, N., Martin, J., Hoylman, Z., Jencso, K., & Hu, J. Diurnal and seasonal coupling of conifer sap flow and vapor pressure deficit across topoclimatic gradients in a subalpine catchment. *Ecohydrology*, e1994.

<https://doi.org/10.1002/eco.1994>

Hoylman, Z. H., Jencso, K. G., Hu, J., Martin, J. T., Holden, Z. A., Seielstad, C. A., & Rowell, E. M. (2018). Hillslope Topography Mediates Spatial Patterns of Ecosystem Sensitivity to Climate. *Journal of Geophysical Research: Biogeosciences*, 123(2), 353-371. <https://doi.org/10.1002/2017JG004108>

2014MT291B

Student Fellowship: Conditions necessary to maintain chute-cutoff morphology in meandering gravel-bed rivers

MS Thesis: Sawyer, April M., "Flood duration and chute cutoff formation in a wandering gravel-bed river" (2015), University of Montana, Missoula, Montana. <https://scholarworks.umt.edu/etd/4536>

2015MT292B

Assessing the capacity of natural infrastructure to increase water storage, reduce vulnerability to floods, and enhance resiliency to climate change

Doctoral dissertation: Moore, M. A. (2018). Understanding rancher's beliefs and behaviors regarding drought and natural water storage in southwest Montana, Montana State University-Bozeman, College of Letters & Science.

<https://scholarworks.montana.edu/xmlui/handle/1/15094>

Dunham, J. B., Angermeier, P. L., Crausbay, S. D., Cravens, A. E., Gosnell, H., McEvoy, J., ... & Sanford, T. (2018). Rivers are social–ecological systems: Time to integrate human dimensions into riverscape ecology and management. *Wiley Interdisciplinary Reviews: Water*, e1291. <https://doi.org/10.1002/wat2.1291>

McEvoy, J., Bathke, D. J., Burkardt, N., Cravens, A. E., Haigh, T., Hall, K. R., ... & Wickham, E. (2018). Ecological Drought: Accounting for the Non-Human Impacts of Water Shortage in the Upper Missouri Headwaters Basin, Montana, USA. *Resources*, 7(1), 14. <https://doi.org/10.3390/resources7010014>

Crausbay, S. D., Ramirez, A. R., Carter, S. L., Cross, M. S., Hall, K. R., Bathke, D. J., ... & Dunham, J. B. (2017). Defining ecological drought for the twenty-first century. *Bulletin of the American Meteorological Society*, 98(12), 2543-2550. <https://doi.org/10.1175/BAMS-D-16-0292.1>

2015MT298B

Student Fellowship: Environmental DNA to evaluate individual variation in rainbow trout spawning date

MS Thesis: Wilcox, Taylor Matthew, "ENVIRONMENTAL DNA SAMPLING ACROSS EVOLUTIONARY AND SPATIAL SCALES" (2017), University of Montana, Missoula, Montana. 11079.

<https://scholarworks.umt.edu/etd/11079>

Young, Michael K.; Isaak, Daniel J.; McKelvey, Kevin S.; Schwartz, Michael K.; Carim, Kellie J.; Fredenberg, Wade; Wilcox, Taylor M.; Franklin, Thomas W.; Chandler, Gwynne L.; Nagel, David E.; Parkes-Payne, Sharon L.; Horan, Dona L.; Wollrab, Sherry P. 2017. Species occurrence data from the Range-Wide Bull Trout eDNA Project. Fort Collins, CO: Forest Service Research Data Archive. <https://doi.org/10.2737/RDS-2017-0038>.

Wilcox, T. M., Zarn, K. E., Piggott, M. P., Young, M. K., McKelvey, K. S., & Schwartz, M. K. (2018). Capture enrichment of aquatic environmental DNA: A first proof of concept. *Molecular ecology resources*, 18(6), 1392-1401. <https://doi.org/10.1111/1755-0998.12928>

2015MT297B

Student Fellowship: Enhancing Tribal Environmental Health Literacy: Developing a toolkit to improve community understanding of rights and responsibilities regarding water quality.

MS Professional Project: Miranda Margetts, Department of Health and Human Development MSU - Bozeman (2015): Water Quality on Tribal Lands: An overview of laws and policies.

2016MT301B

Impacts of river flow and temperature on salmonfly productivity and terrestrial subsidy

Doctoral dissertation: Anderson, H. E. (2018). Environmental drivers of salmonfly ecology in southwest Montana, Montana State University-Bozeman, College of Letters & Science.

<https://scholarworks.montana.edu/xmlui/handle/1/14861>

Anderson, H. E., Albertson, L. K., & Walters, D. M. (2019). Thermal variability drives synchronicity of an aquatic insect resource pulse. *Ecosphere*, 10(8), e02852. <https://doi.org/10.1002/ecs2.2852>

Anderson, H. E., Albertson, L. K., & Walters, D. M. Water temperature drives variability in salmonfly abundance, emergence timing, and body size. *River Research and Applications*. 1-10. Online early.

<https://doi.org/10.1002/rra.3464>

2016MT307B

Removal of selenium by co-precipitation with microbially induced calcite precipitation

Zambare, N., Lauchnor, E., Gerlach, R., & Pitts, B. (2018). Multi-scale Microscopy of Microbially Induced Calcium Carbonate Precipitation. *Microscopy and Microanalysis*, 24(S1), 1328-1329.

<https://doi.org/10.1017/S1431927618007122>

Zambare, N. M., Lauchnor, E. G., & Gerlach, R. (2019). Controlling the Distribution of Microbially Precipitated Calcium Carbonate in Radial Flow Environments. *Environmental science & technology*.

<https://doi.org/10.1021/acs.est.8b06876>

2016MT306B

Snowpack and soil moisture controls on nitrogen availability in a Rocky Mountain conifer forest

Yano, Y., Qubain, C., Holyman, Z., Jencso, K., & Hu, J. (2019). Snowpack influences spatial and temporal soil nitrogen dynamics in a western US montane forested watershed. *Ecosphere*, 10(7), e02794.

<https://doi.org/10.1002/ecs2.2794>

2017MT318B

Student Fellowship Project: Leaf Water Potential as an Improved Predictor of Drought Induced Conifer Stress

Simeone, C., Maneta, M. P., Holden, Z. A., Sapes, G., Sala, A., & Dobrowski, S. Z. (2018). Coupled ecohydrology and plant hydraulics modeling predicts ponderosa pine seedling mortality and lower treeline in the US Northern Rocky Mountains. *New Phytol*, 10. doi: 10.1111/nph.15499

2017MT319B

Student Fellowship Project: Influence of wood on sediment storage in a low order stream in the northern Rocky Mountains

MS Thesis: Welling, R. (2019). Influence of Large Wood on Sediment Routing in a Mixed Bedrock-Alluvial Stream, University of Montana, Department of Geosciences. <https://scholarworks.umt.edu/etd/11336>

## Information Transfer Program

2014MT291B

Student Fellowship: Conditions necessary to maintain chute-cutoff morphology in meandering gravel-bed rivers  
Sawyer, A., & Wilcox, A. C. (2015, December). Flood duration and chute cutoff formation in a wandering gravel-bed river. In AGU Fall Meeting Abstracts.

2015MT292B

Assessing the capacity of natural infrastructure to increase water storage, reduce vulnerability to floods, and enhance resiliency to climate change

Moore, M., "Understanding Ranchers' Beliefs and Behaviors Regarding Drought and Natural Water Storage in Southwest Montana". Poster Presentation. Montana American Water Resources Association Annual Meeting.

2015MT293B

Nitrifying wastewater biofilms and the influence of emerging contaminants

Lauchnor, E. G., \*K. Bodle. "Role of nitrifying bacteria in fate of triclosan." American Chemical Society National Meeting, Philadelphia, PA, August 20-24, 2016 (oral presentation)

Lauchnor, E. G. Research presentation to Water Policy Interim Committee of MT Legislature on "Pharmaceuticals in wastewater", Bozeman, MT

2015MT295B

Student Fellowship: Climatic and geomorphologic influences on soil development and transport in the Bitterroot and Sapphire Mountains, Montana, USA

Dixon, J., Benjaram, S. S., Quinn, C., & Adams, K. (2018, December). Weathering thresholds and the resilience of soils in mountainous systems. In AGU Fall Meeting Abstracts.

2015MT297B

Student Fellowship: Enhancing Tribal Environmental Health Literacy: Developing a toolkit to improve community understanding of rights and responsibilities regarding water quality.

Margetts, M. and V. Simonds, Environmental Health Literacy and Water Quality Toolkit: Improving knowledge of rights for healthier water in tribal communities. National Congress of American Indians Tribal Leader Scholar Forums, June 2015, St. Paul, Minnesota (Poster Presentation)

Margetts, M., Increasing Environmental Health Literacy in a Native American Community, Report for Guardians of the Living Water Project (written report).

2016MT301B

Impacts of river flow and temperature on salmonfly productivity and terrestrial subsidy

Albertson, L. K.. 2019. An iconic macroinvertebrate in peril? Salmonfly emergence patterns and climate-driven range contraction. Montana Water Center's Water School. Bozeman, MT. Invited presentation.

Albertson, L. K., H. E. Anderson, and D. M. Walters. 2019. Large-scale drivers of resource pulse phenology: Salmonfly emergence patterns differ between human dominated and natural rivers. Montana Aquatic Research Colloquium. Flathead Lake, MT. Presentation.

Albertson, L. K., H. E. Anderson, and D. Walters. 2019. An iconic macroinvertebrate in peril? Salmonfly emergence patterns and climate-driven range contraction. Institute on Ecosystems Rough Cut Seminar Series. Bozeman, MT. Invited presentation.

Albertson, L. K. 2018. Small aquatic insects can teach us big things: Ecological indicators and community facilitators in streams. University of South Dakota Seminar Series, Vermillion, SD. Invited presentation.

2016MT308G

Using weathering geochemistry to understand the sources of base flow water supply in rivers across mountain-basin transitions in the Upper Missouri Watershed

Leuthold, S. J., Ewing, S. A., Payn, R. A., Miller, F., Custer, S. G., & Paces, J. B. (2018, December). Longitudinal Patterns in Stream Stable Isotope Chemistry along a Snowmelt Driven Headwater Suggest Seasonally Dynamic Connectivity between Proximal Streamflow Generation Sources. In AGU Fall Meeting Abstracts.

Ewing, S., Miller, F., Payn, R., Paces, J., & Custer, S. (2018, April). Strontium and uranium isotopes reveal surface water-groundwater interaction as a function of lithology along a mountain stream (Hyalite Canyon, Montana). In EGU General Assembly Conference Abstracts (Vol. 20, p. 11794).

2017MT318B

Student Fellowship Project: Leaf Water Potential as an Improved Predictor of Drought Induced Conifer Stress  
Maneta, M. P., Simeone, C., Holden, Z. A., Sala, A., Sapes, G., & Dobrowski, S. (2018, December). Drought-induced Ponderosa pine seedling mortality controls the extent of the lower tree line in the US Northern Rocky Mountains. In AGU Fall Meeting Abstracts.

Simeone, C., Maneta, M. P., Holden, Z. A., Dobrowski, S., & Sala, A. (2017, December). An Examination of Drought-Induced Hydraulic Stress in Conifer Forests Using a Coupled Ecohydrologic Model. In AGU Fall Meeting Abstracts.

Simeone, C. An examination of drought-induced hydraulic stress in conifer forests using a coupled ecohydrologic model. Poster Presentation. 2017. Annual Meeting Montana Section of the American Water Resources Association.

2017MT312B

Effects of floating treatment wetlands on the abundance and removal of dissolved and nanoparticulate contaminants in waste water lagoons

Colman, B. Emerging contaminant increases wetland methane fluxes by stimulating production and potential trophic cascade. Oral Presentation, 2018 Meeting Montana Section of the American Water Resources Association.

2017MT312B

Exploring Hydrologic Connectivity Between Shallow and Deep Groundwater Flow Systems in Upland Catchments  
Gardner, W. P., Jencso, K., Hoylman, Z. H., & Thiros, N. E. (2018, December). Mountain Water-The Role of Deep Groundwater in Mountain Watersheds. In AGU Fall Meeting Abstracts.

Gardner, P. Exploring Hydrologic Connectivity Between Shallow and Deep Groundwater Flow Systems in Upland Catchments. Oral Presentation. 2017 Meeting Montana Section of the American Water Resources Association.

Gardner, P. Exploring Hydrologic Connectivity Between Shallow and Deep Groundwater Flow Systems in Upland Catchments. Oral Presentation. Montana Institute on Ecosystems, Rough Cut Series Seminar, 2017

2017MT317B

Student Fellowship Project: Estimate Mountain Front Recharge in a Basin and Range Province in Southwest Montana.

Shama, C. Mountain Front Recharge in a Basin and Range Province in Southwest Montana. Poster Presentation. 2017 Annual Meeting Montana Section of the American Water Resources Association.

2017MT314B

Student Fellowship Project: Science to inform restoration: Effects of channel reconstruction on hydraulic exchange and baseflow generation

Brissette, C., Stream restoration effects on storage and baseflow generation, Ninemile Creek, MT. Oral Presentation. 2017. Annual Meeting Montana Section of the American Water Resources Association.

2018MT322B

Student Fellowship Project: Assessing pharmaceuticals in Montana's waste water and drinking water to determine exposure risk, and inform targeted environmental and public health regulatory initiatives to protect Montanan communities

Margetts, M., Assessing pharmaceuticals in Montana's waste water and drinking water. Invited presentation. Montana Water Center, 2018 Fall Water School.

2018MT323B

Identifying seasonal spatial distribution of geothermal groundwater discharge to surface water using UAV-based thermal infrared imaging, LaDuke hot springs, MT

Article: Caldera Chronicles, USGS Yellowstone Volcano Observatory newsletter - [https://volcanoes.usgs.gov/volcanoes/yellowstone/article\\_home.html?vaid=126](https://volcanoes.usgs.gov/volcanoes/yellowstone/article_home.html?vaid=126)

## **Student Support**

Graduate students: 12

Undergraduate: 5

## **Notable Achievements and Awards**

2015MT292B

Assessing the capacity of natural infrastructure to increase water storage, reduce vulnerability to floods, and enhance resiliency to climate change

Best Poster Award. Montana American Water Resources Association Annual Meeting. "Understanding Ranchers' Beliefs and Behaviors Regarding Drought and Natural Water Storage in Southwest Montana". Poster Presentation.

2017MT312B

Exploring Hydrologic Connectivity Between Shallow and Deep Groundwater Flow Systems in Upland Catchments  
Supported Graduate Students' Awards:

First Prize Student Poster, 2017 Annual Meeting of the Montana Section of the American Water Resources Association.

Outstanding Student Presentation Award – Hydrology Section, 2017 Fall AGU meeting.

## Projects

### **Student Research: Microbial reduction of selenium at the Colstrip power plant**

**Project Type:** Annual Base Grant **Project ID:** 2018MT320B

**Project Impact:** The impact of stratigraphy and water chemistry on selenium bioremediation was tested by constructing batch microcosms using biofilm and groundwater samples collected from monitoring wells in three distinct stratigraphic units located near the fly ash disposal ponds at the coal-fired power plant currently managed by Talen Energy in Colstrip, Montana. Three different carbon amendments - methanol, glycerol, and molasses - were tested. 16S sequencing was used to examine microbial communities before and after carbon amendment. In tests using samples from alluvial wells, all carbon amendments stimulated significant reduction of selenium. Molasses-amended microcosms began reducing selenium earlier; however, selenium concentrations leveled off around 100-200 ppb, whereas methanol and glycerol amendments began reduction later, but reduced selenium to below the quantification limit (BQL). Contrastingly, with samples from a coal layer, molasses amendments and a single methanol-amended microcosm reduced selenium to BQL, while glycerol amendments did not reduce selenium. In microcosms using samples from a well screened in interburden, slight selenium reduction occurred in one molasses-amended replicate, but in no other microcosms. Samples from the coal and interburden wells responded unpredictably to methanol and glycerol; duplicates showed differing reduction rates for selenium and/or nitrate. The efficacy of the microbial community in reducing selenium depended on carbon amendment and stratigraphic unit, suggesting areas that are geographically close but hydrogeochemically distinct may respond differently to the same bioremediation treatment. Understanding how microbial community composition and function is influenced by hydrogeochemical parameters and carbon amendments will help to inform in situ selenium remediation strategies.

### **Deciphering the combined effects of artificial and natural water storage structures on late-season flows.**

**Project Type:** Annual Base Grant **Project ID:** 2018MT324B

**Project Impact:** In Montana headwater basins, any current or future changes to the snow accumulation and snowmelt timing directly impacts water availability for aquatic life, urban centers, agriculture, hydropower etc. in the downstream areas. Therefore, hydrologic modelling tools are vital to analyzing and assessing the scale of such impacts. In this study, we calibrated the Tsinghua Hydrological Model based on the Representative Elementary Watershed (THREW) at a research watershed in central Montana called Tenderfoot Creek Experimental Forest (TCEF). In THREW model, the study area is usually divided into multiple Representative Elementary Watersheds (REWs) which are further discretized into several hydrologic zones such as snow, vegetated, bare soil, saturated soil, unsaturated soil, sub-stream network and the main channel. Here, we have collected and processed climatic, remote sensing and soil properties data as inputs to the THREW Model. Based on the data availability, TCEF was divided into nine REWs. Model calibration and water balance adjustment have been done for the past decade. The model simulates the daily discharge with reasonably good accuracy as validated against the observed streamflow at the USGS gauge. The sensitivity of the hydrograph components which include lowflow, rising limb, peak and falling limb to several model parameters were also analyzed. Currently, we are working to extend THREW model to the whole Jefferson River Basin. After calibrating and validating the model using historical data, our goal will be to analyze the impacts of future climate changes on the summer low flow dynamics of the Jefferson River.

### **Effects of floating treatment wetlands on the abundance and removal of dissolved and nanoparticulate contaminants in waste water lagoons**

**Project Type:** Annual Base Grant **Project ID:** 2017MT312B

**Project Impact:** Wastewater effluent represents a critical point source of metal and metalloid contamination to aquatic ecosystems and wastewater lagoons are as the most common wastewater treatment system in the rural United States. Although the fraction of total wastewater metals and metalloids in "dissolved" forms (defined here as < 450 nm) likely drives the potential for negative effects on receiving waters, this broad operational definition lumps truly dissolved solutes (