Iowa Water Center
Department of Agronomy

Annual Technical Report
2019

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Products

Iowa Water Center Staff:

Miller, Melissa. 2019. Iowa's Watershed Management Authorities. In Wright, J.; Breja, S.; and Hunter, J. (eds). Getting Into Soil and Water 2019. Iowa Water Center. Ames, IA. (non-refereed)

Miller, Melissa, J. Baumann, B. Beldon. Southfork Watershed Alliance. Presented to the Iowa Senate Natural Resource and Environment Committee. Des Moines, Iowa. March 19, 2019.

Allen, James and **M. Miller**. 2019. One Strange Rock: Agricultural production versus soil and water resources. Presented to five sections of Physical Science at Iowa Falls-Alden High School. Iowa Falls, Iowa. May 16, 2019.

Cook, Chad and **M. Miller**. 2019. Connecting Extension and Water Resources Research Institutes to Advance Harmful Algal Bloom Research and Outreach. Presented at University Council on Water Resources/National Institutes for Water Resources Annual Water Resources Conference. Snowbird, Utah. June 13, 2019.

Miller, Melissa, C. Cook, L. Wolfson, R. Power. 2019. Partnering to Mitigate Harmful Algal Blooms across the Midwest and Beyond. Presented for "The Current" Webinar Series. North Central Region Water Network. Madison, Wisconsin. July 10, 2019.

Miller, Melissa, R. Power. 2019. Partnering to Mitigate Harmful Algal Blooms in the North Central Region of the United States. Presented via Skype to the Environmental Protection Agency Region V Harmful Algal Bloom Working Group. Chicago, Illinois. July 18, 2019.

Usher, Emily., **Bates, Hanna**., Ranjan, Pranay, and Emily Zimmerman. 2020. Extending the Agricultural Conservation Planning Framework for NRCS; Readiness Team Progress Report. West Lafayette: Purdue University

Miller, Melissa, et al… **Hanna Bates**. August 2019. Partnering to Mitigate Harmful Algal Blooms. White Paper. North Central Region Water Network. Partnering to Mitigate Harmful Algal Blooms. https://northcentralwater.org/nutrient-and-manuremanagement/habs/

Ackerman, Heidi and **Hanna Bates**. 2019. Fill the Pantry with Iowa SWCS. Poster. 74th Soil and Water Conservation Society Annual Conference, Pittsburgh, PA

Bates, Hanna and Amy Weckle. 2020. "Mitigating Harmful Algal Blooms in the North Central Region." Eastern South Dakota Water Conference. Virtual Conference. October 14, 2020.

Bates, Hanna. 2020. "Fill the Pantry with the Iowa SWCS." 75th Soil and Water Conservation Annual Conference, Virtual Conference. July 27, 2020.

Bates, Hanna. 2019. "Bringing Diverse Perspectives Together to Support Watershed Management in Iowa." 74th Soil and Water Conservation Society Annual Conference, Pittsburgh, PA. July 29, 2019.

Ackerman, Heidi and **Hanna Bates**. 2019. "Holding Successful Meetings and Professional

Development." 74th Soil and Water Conservation Society Annual Conference, Pittsburgh, PA. July 29, 2019.

Wang, E., **Cruse, R.M**., Sharma-Acharya, B., Herzmann, D.E., Gelder, B.K., James, D.E., Flanagan, D.C., Blanco-Canqui, H., Mitchell, R.B. and Laird, D.A. 2020. Strategic switchgrass (Panicum virgatum) production within row cropping systems: Regional scale assessment of soil erosion loss and water runoff impacts. GCB Bioenergy. 12:955–967. doi:10.1111/gcbb.12749

Wang C., Shan L., Liu X., Yang Q., **Cruse R. M**., Liu B., Li R., Zhang H., Pang G. 2020. Impacts of horizontal resolution and downscaling on the USLE LS factor for different terrains. 2020. International Soil and Water Conservation Research. (8): 363 - 372.

Xaobing Liu, Hao Li, Shengmin Zhang, **Richard M. Cruse**, and Xingyi Zhang. 2019. Gully Erosion Control Practices in Northeast China: A Review. Sustainability. MDPI, Open Access Journal, vol. 11(18), pages 1-16, September.

Bharat Sharma Acharya, Humberto Blanco-Canqui, Robert B. Mitchell, **Richard Cruse**, and David Laird. 2019. Dedicated Bioenergy Crops and Water Erosion. Journ. Env. Qual. doi:10.2134/jeq2018.10.0380

Clara Lefèvre, **Richard M. Cruse**, Lucia Helena Cunha dos Anjos, Costanza Calzolari, Nigussie Haregeweyn. 2020. Guest editorial – soil erosion assessment, tools and data: A special issue from the Global Symposium on soil Erosion 2019. International Soil and Water Conservation Research. 8(4): 333-336. ISSN 2095-6339. https://doi.org/10.1016/j.iswcr.2020.11.004.

Flanagan, Dennis C., Larry E. Wagner, **Richard M. Cruse**, and Jeffrey G. Arnold. 2020. Modeling Soil and Water Conservation. In: Jorge A. Delgado, Clark J. Gantzer, and Gretchen F. Sassenrath (eds) Soil and Water Conservation: A Celebration of 75 Years Soil and Water Conservation Society. Pp. 255-269.

104(b) and 104(g) Grant Recipients:

Albright, E., R. Fleck, **G.M. Wilkinson**. 2020. The importance of sediment phosphorus sources in shallow lakes. Iowa Water Conference. April 2020. Online poster gallery.

Albright, E., R. Fleck, **G.M. Wilkinson**. 2020. Spatiotemporal complexity of internal phosphorus loading in reservoirs. American Geophysical Union Fall Meeting. December 2020. Online poster gallery.

Albright, E., R. Fleck, **G.M. Wilkinson**. 2019. Ex situ measurements of gross internal phosphorus loading in shallow lakes. Great Plains Limnology Conference. October, 2019. Ames, IA.

Albright, E., R. Fleck, **G.M. Wilkinson**. 2020. The importance of sediment phosphorus sources in shallow lakes. Environmental Science Graduate Research Symposium. April, 2020. Online conference platform.

Albright, E. 2019. Friends of Green Valley Lake Annual Meeting. Presentation of research findings and discussion of stakeholder concerns. December 2019. Creston, Iowa.

Meppelink, S., **Kolpin, D**., Lane, R., **Iwanowicz, L**., Zhi, H., **LeFevre, G**. 2020. Waterquality data for a pharmaceutical study at Muddy Creek in North Liberty and Coralville, Iowa, 2017-2018. U.S. Geological Survey data release. https://doi.org/10.5066/P9WOD2XB

Zhi, H., **Kolpin, D. W.**, **Klaper, R. D**., **Iwanowicz, L. R**., Meppelink, S. M., **LeFevre, G. H**. 2020. Occurrence and Spatiotemporal Dynamics of Pharmaceuticals in a Temperate-Region Wastewater Effluent-Dominated Stream: Variable Inputs and Differential Attenuation Yield Evolving Complex Exposure Mixtures. Environ. Sci. Technol. 54(20), 12967–12978. https://doi.org/10.1021/acs.est.0c02328

Qian, J., Martinez,A., Marek, R. F., Nagorzanski, M. R., Zhi, H., Furlong, E. T., **Kolpin, D. W**., **LeFevre, G. H**., Cwiertny, D. M. 2020. Polymeric Nanofiber-Carbon Nanotube Composite Mats as Fast-Equilibrium Passive Samplers for Polar Organic Contaminants. Environ. Sci. Technol. 54(11), 6703–6712. https://doi.org/10.1021/acs.est.0c00609

Zhi, H., Mianecki, A. L., **Kolpin, D. W**., **Klaper, R. D.**, **Iwanowicz, L. R.**, **LeFevre**, **G. H.** Tandem field and laboratory approaches to quantify attenuation mechanisms of pharmaceutical and pharmaceutical transformation products in a wastewater effluentdominated
stream. Water Research. In Revision.

Webb, D.T., Zhi, H., **Kolpin, D. W**., **Klaper, R. D.**, **Iwanowicz, L. R.**, **LeFevre, G**. **H**. Municipal Wastewater as a Year-Round Point Source of Neonicotinoid Insecticides that Persist in an Effluent-Dominated Stream. Environmental Science: Processes and Impacts. In Review.

Zhi, H., Webb, D. T., Schnoor, J. L., **Kolpin, D. W.**, **Klaper, R. D.**, **Iwanowicz, L. R**., **LeFevre, G. H.** Modeling risk dynamics of Contaminants of emerging concern in a Temperate-region wastewater effluent-dominated Stream. Written, in final preparation for journal submission.

Bramfeld Meade, E., **Iwanowicz, L. R.**, **Kolpin, D. W., Klaper, R. D.** Transcriptome of Danio rerioembryos exposed to wastewater effluent dominated stream reveals biomarker signatures specific to developmental stage and seasonal changes in emerging contaminants. In Preparation.

Hui Zhi, PhD Dissertation. Department of Civil & Environmental Engineering, University of Iowa. “Quantifying the occurrence, attenuation mechanisms, and implications of contaminants of emerging concern in a temperate-region wastewater effluentdominated stream”

DanielleT. Webb, PhD Dissertation (1 Chapter). Department of Civil & Environmental Engineering, University of Iowa. “Sorption of Neonicotinoid Insecticides and their Metabolites to Granular Activated Carbon: Implications for Exposure, Treatment, and Biotransformation.” Relevant chapter: ‘Municipal Wastewater as a Year-Round Point Source of Neonicotinoid Insecticides that Persist in an Effluent-Dominated Stream.’

Emma Bramfeld Meade, MS thesis(forthcoming). School of Freshwater Sciences, University of Wisconsin—Milwaukee. “Transcriptome of Danio rerio embryos exposed to wastewater effluent dominated stream reveals biomarker signatures specific to developmental stage and seasonal changes in emerging contaminants”

LeFevre, G.H., **Zhi, H., Kolpin, D.W., Klaper**, **R.D.**, **Iwanowicz, L.R.**, **Meade, E.M.,** Meyer, M.T., Lane, R.R., Meppelink. Spatial and Temporal Variability of Complex Pharmaceutical Mixtures and their Impacts in a Temperate-region Wastewater Effluent Dominated Stream. Emerging Contaminants in the Environment Conference, University of Illinois.

LeFevre, G.H. Pharmaceutical Complex Exposure Mixture Occurrence and Dynamics in a

Temperate Region Wastewater Effluent-Dominated Stream: Muddy Creek, Iowa. Iowa Water Conference.

LeFevre, G.H. Invited seminar, Auburn University, Environmental & Ecological Engineering Program. A tale of two Emerging Contaminant Classes: Transformation of Neonicotinoid Insecticides and Pharmaceutical Complex Mixture Evolution in Aquatic Systems.

LeFevre, G.H. Invited seminar, Michigan Tech University, Environmental & Water Resources Engineering Program. Transformation of Emerging Organic Contaminants and Complex Mixture Evolution in Aquatic Systems.

LeFevre, G.H., **Webb, D.T**., **Zhi, H.**, **Kolpin, D.W.**, **Klaper, R.D.**, **Iwanowicz, R.W.** 2020. Treated Municipal Wastewater as a Significant Point-Source of Neonicotinoids to a Small Effluent-dominated Stream: Implications for Aquatic Biota and Human Exposure. 2020 SETAC North America Meeting, Fort Worth, TX (virtual).

Zhi, H., Kolpin, D.W., Iwanowicz., L.R., **Klaper,R.D**., **Meade, E.B.**, Meppelink, S., Powers, M.M., Quin, J. IV, **LeFevre, G.H**. 2020. Pharmaceutical exposures in a temperate region wastewater effluent-dominated stream: Muddy Creek, Iowa. 2020 SETAC North America Meeting, Fort Worth, TX (virtual)

LeFevre, G.H., Zhi, H., Kolpin, D.W., Klaper, **R.**, **Iwanowicz, L.R.**, **Meade, E.B**., Meyer, M.T., Lane, R.F., Meppelink, S.M., Powers, M.M., Quin, J. 2019. Spatial and Temporal Variability of Pharmaceutical Mixtures and Potential Impacts to a Wastewater Effluent-Dominated Stream in Iowa. Division of Environ Chem, 2019 ACS National Meeting, San Diego.

Zhi, H.,LeFevre, G.,Kolpin, D., Meppelink, S.M., **Iwanowicz, L.R.**, **Meade, E.B**., **Klaper, R.,** Meyer, M.T. 2019. Quantifying the occurrence, fate and implications of pharmaceutical mixtures in a temperate-region wastewater effluent-dominated stream, Division of Environ Chem, 2019 ACS National Meeting Orlando.

Meade,E.B.,**Zhi,H.**,**LeFevre,G.H**.,**Kolpin,D.W**.,Meppelink,S.M.,**Iwanowicz,L.R**.,Lane,R.F.,Klaper,R.D. 2020. Society of Environmental Toxicology and Chemistry (SETAC) 41st Annual Meeting (SETACSciCon2). November 15-19, 2020. Platform presentation: The biological impacts of complex pharmaceutical mixtures in a wastewater treatment plant effluentdominated
stream.

Meade,E.B.,Zhi,H.,LeFevre,G.H.,**Kolpin,D.W**.,Meppelink,S.M.,**Iwanowicz,L.R**.,Lane,R.F., **Klaper,R.D**. 2019. Society of Environmental Toxicology (SETAC) North America, Toronto, Canada, November 3-7, 2019. Platform presentation: Transcriptome response of Daniorerio and Promelas pimephales to complex pharmaceutical mixtures in a WWTP effluent-impacted stream.

Meade,E.B.,**Zhi,H.,LeFevre,G.H**.,**Kolpin,D.W**.,Meppelink,S.M.,**Iwanowicz,L.R.,**Lane,R.F., **Klaper,R.D**. 2019. Society of Environmental Toxicology (SETAC) Midwest, LaCrosse, Wisconsin, March 23, 2019. Poster presentation: Using gene expression in zebrafish (Daniorerio) to quantify the biological impacts of exposure to complex mixtures of pharmaceuticals in Muddy Creek, an effluent-dominated stream in Iowa, September 2017 to August 2018.

R. Klaper., UWM Alumni Foundation Master Chats, Emerging contaminants and the

fresh water environment. May 6, 2020. Milwaukee, WI.
Lawrence, Nate, Tenesaca, Carlos G., VanLoocke, A.,Hall, Steven J. 2020. The nitrogen cycle across topography: insights from natural abundance nitrate isotopes. The fall meeting of the American Geological Union; 1-17 December 2020; San Francisco, USA.
Leung, Tania. (Summer 2021). Iron variability across lake types: Dynamics behind cyanobacterial blooms. Expected submission to Harmful Algae (or relevant journal): June 2021
Zhang, Wendong. 2020. The Economics of Agricultural Water Conservation: Four+ New Surveys of Iowa Farmers & General Public, Conservation Learning Group, December 12, 2020.
Zhang, Wendong. 2020. The Costs and Benefits of Agricultural Water Conservation: An Economist's Perspective, Iowa Learning Farms / Iowa Nutrient Research Center Conservation Webinar December 9, 2020.
Zhang, Wendong. (In process). Policy brief that will be published by ISU Center for Agricultural and Rural Development that summarizes the perceptions and valuations for reduction in harmful algal blooms and improvements in water quality in Iowa waterbodies by Iowa citizens and Iowa farmers.
Zhi, Hui., Doctoral dissertation chapter and a manuscript which has been submitted to the journal Water Research and is currently under review.
Zhi, Hui . Society of Environmental Toxicity and Chemistry (SETAC 2019 and 2020) and American Chemistry Society (ACS2019)

Information Transfer Program

IWC's information transfer program is a comprehensive, coordinated effort that promotes the state's water resources research and applied activities. It leverages relationships with other organizations to reach a wide audience.
Products include:
Vast web presence: website, blog, bi-monthly e-newsletter, Twitter, Facebook, YouTube, with continually growing reach.

Iowa Water Conference: Cancelled due to COVID-19 impacts. Three-day virtual event to be held in 2021.

Getting into Soil and Water: ~30 page publication published annually with the Soil and Water Conservation Club at Iowa State University. Articles on current research are written by researchers for the high school teacher and distributed to approximately 1500 Iowans each year.

Presentations: IWC staff and funded faculty/students speak publicly to many audiences, ranging from K-12 students, volunteer organizations, governmental/quasi-governmental committees, and academic communities.
Service on statewide and regional boards/committees: IWC staff represent the Iowa research community on the Iowa Chapter of the Soil and Water

Conservation Society, Iowa Agriculture Water Alliance Advisory Council, Southfork Watershed Alliance, Agricultural Conservation Planning Framework Steering Committee, 2020 International Soil and Water Conservation Society Annual Conference Committee, UCOWR Conference Planning Committee
In addition, IWC is involved with several statewide and multi-state projects, attending/leading meetings across the state with many stakeholders, making the Iowa Water Center a recognized leader for outreach and education in Iowa.

Student support

Undergraduate students- 7
Graduate students- 10
Post-Docs- 2

Notable achievements

Albright, E., The funds provided by the grant allowed us to successfully construct an ex situ sediment core incubation system as well as develop and test a method for measuring phosphorus exchange at the sediment water interface. To our knowledge, we have reported the first direct measurements of internal phosphorus loading for four impaired water bodies across Iowa. Additionally, the grant allowed us to overcome many challenges throughout the 2020 field season and complete a year-long study of internal phosphorus loads in an impaired reservoir (Green Valley Lake).
Albright, E., Best Graduate Oral Presentation. Great Plains Limnology Conference. October, 2019.
Bates, Hanna. 2019 Commendation Award Recipient -Soil and Water Conservation Society.
LeFevre, G., Featured this work on the cover of *Environmental Science & Technology*, the most prestigious environmental chemistry journal.
Leung, T., Received the John Lemish Memorial Scholarship in 2020.
Zhi, Hui. Awarded an Iowa Water Center graduate student research supplement ($4000) to add an additional research component to the work.
Zhi, Hui. The doctoral dissertation with one main chapter supported by this fund will be submitted to the AEESP outstanding doctoral dissertation award

The Economic Benefit of Mitigating Harmful Algal Blooms in Iowa

Project Type: Annual Base Grant
Project ID: 2019IA102B

Project Impact:
We administered a state-wide survey with 854 completed responses from citizens in the State of Iowa in late 2019. In addition to questions on general perception and attitude toward the water quality issues and nutrient reduction in the MARB, the survey included a stated choice experiment to solicit WTPs for various water quality attributes associated with nutrient pollution.

Our preliminary results show that, first, people are willing to pay for improvement in both local and downstream water quality. Second, the WTPs for local water quality improvement are about 35% higher when the downstream water quality information is provided. The annual WTPs for an improvement scenario – 50% reduction in the number of days algal toxin being detected and 25% reduction in nitrate concentration in source water, 50% reduction in the number of days beach closure due to HABs, and 10% increase in lake water clarity – from the status quo are $21.50 ($15.97) per household when the hypoxic zone information is (not) provided. When the size of hypoxic zone is included as one of the attributes, the annual WTP per household for the above scenario plus a 10% reduction in the size of hypoxic zone is $23.11, which is insignificantly different from the total value of local water quality improvement when the size of hypoxic zone is not included. We also find that about two-third of the respondents consider that reducing nutrients in local waterways would also reduce the size of the hypoxic zone.

Denitrification In Agricultural Depressions By Nitrate Isotope Analysis

Project Type: Annual Base Grant
Project ID: 2019IA103B

Project Impact:
Most of the wetlands in the Midwest Corn Belt were drained to allow crop cultivation. Despite drainage, low-lying areas of many fields still experience periodic flooding. Excess moisture in these areas frequently damages crops but may also reduce harmful nitrate (NO3-) export to downstream waters by promoting denitrification. The extent to which drained wetlands either export nitrogen (N) downstream or remove NO3- through denitrification is largely unknown. To help address this uncertainty, we collected soil water samples along a topographic gradient from a cropped depression to adjacent upland. Samples were collected from zero-tension lysimeters following rainfall events and analyzed for NO3- and NH4+ concentration. Sporadically higher NO3- δ15N values in depression samples (as high as 23‰) accompanied by decreasing NO3- concentrations over time indicated that depression soils could potentially remove substantial NO3- via denitrification. However, nitrate removal by depression soils was inconsistent. Following fertilization, high NO3- concentrations (up to 150 mg N l-1) along with δ18O values of 10–20‰ indicated direct leaching of fertilizer NO3- through depressional soils with little removal via denitrification. These results suggest that depressions are leaky sinks for NO3- which can variably remove NO3- via denitrification or export nitrate depending on antecedent conditions. Because drained depressions often produce lower crop yield, these locations could be targeted for alternative management to in increase N use efficiency and reduce downstream N export.

Determining the Effects of Co-nutrient Availability on Harmful Algal Blooms Across Varying Lake Types

Project Type: Annual Base Grant
Project ID: 2019IA104B

Project Impact:
This research aimed to determine the conditions leading to cyanobacterial harmful algal blooms in Iowa's lakes, specifically examining the role of iron during bloom events. This goal draws from the hypotheses that cyanoHAB intensity and duration are greater in artificial lakes in comparison to natural lakes, therefore, nutrient conditions will also vary between lake types. To this end, weekly field samples were collected in collaboration with Iowa Department of Natural Resources (IDNR) during two summer seasons. Field samples were analyzed for total dissolved Fe (defined as the fraction of Fe that passes through a 0.22micron filter). Statistical analysis was conducted to assess the relationship between iron (among other nutrients and physical conditions) and bloom biomass (measured as chlorophyll-a). Based on the results, total dissolved iron concentrations differed among lake types (artificial vs. natural) and among different regions of Iowa. Most of norther Iowa's land surface are composed of sediments from glacial drifts, therefore varying landforms in Iowa can potentially alter nutrient trends in lakes. This may affect variations in cyanoHAB intensity and duration. Further analysis is needed to better understand the dynamics in iron and its influence of cyanoHABs in Iowa's lakes. Findings from this proposed study will help facilitate environmental risk management and develop mitigation strategies to reduce human exposure.

Developing Methods To Measure Internal Phosphorus Loading In Iowa Lakes

Project Type: Annual Base Grant
Project ID: 2019IA106B

Project Impact:
Our project tested our sediment core incubation system and measured dinternal phosphorus loading rates within four shallow lakes. We found that rates varied across the lake bed and sediment phosphorus release could occur under a range of oxygen conditions. Our results indicate that the rate and mechanisms of internal loading at the deep site of a lake can differ from the processes in shallow water sediments. As such, extrapolating measurements only from the deep site to the entire lake bed produces a highly uncertain estimate. Quantifying how internal loading rates vary within an individual water body is important as this understanding can help managers scale measurements of sediment phosphorus release to describe internal loads at an ecosystem level. From February to October of 2020, we surveyed seasonal and spatial variation in internal phosphorus loading in an impaired reservoir. We found substantial variation in phosphorus release rates across seasons and different areas of the lake bed, from shallow sediments to the deep site. All sampling sites had low to moderate sediment phosphorus release in early spring. Since this spring release occurred at all sites along the reservoir, it is likely an important phosphorus source for early algal blooms. Summer release rates varied across sites. Very high rates were observed at the deep site by mid-summer. Identifying points in space and time with high sediment phosphorus release rates will inform site-specific management in this reservoir to mitigate algal blooms. These results also contribute to our broader understanding of reservoir phosphorus cycling.

Quantifying Differential Sorption and Biodegradation of Pharmaceuticals in a Wastewater Effluent-Dominated Stream

Project Type: Annual Base Grant
Project ID: 2019IA105B

Project Impact:
Evolving complex mixtures of pharmaceuticals and transformation products in effluent-dominate streams pose potential impacts to aquatic species; thus, understanding the prominent attenuation mechanisms of pharmaceuticals and transformation products is critical. Herein, we determined the attenuation dynamics of pharmaceuticals and their corresponding transformation products via a combined long-term field study and controlled laboratory experiments. For the field study, we quantified spatiotemporal exposure concentrations of five pharmaceuticals and six associated transformation products via during baseflow conditions at four sites in a temperate-region effluent-dominated stream (upstream, at, and progressively downstream from effluent discharge) 16 times (approximately twice monthly, depending on flows) for 1 year. Concurrently, we conducted photolysis, sorption, and biodegradation batch tests under controlled conditions to determine the major attenuation mechanisms. We observed 10-fold greater attenuation rates in the field compared to batch tests, demonstrating that connecting laboratory batch tests with field measurements to enhance predictive power is a critical need, as batch systems alone that are useful for determining fate processes can poorly approximate in-stream attenuation rates. Sorption was the dominant attenuation process ($t_{1/2} < 7.7$ d) for 5 of 11 compounds in the batch tests, while the other compounds (n=6) persisted in the batch tests and along the 5.1 km stream reach, contributing to the evolving complex mixture exposure conditions with concomitant implications for aquatic and terrestrial biota. Furthermore, both parent and transformation products were mainly derived from point-source release (i.e., effluent discharge) rather than in-stream formation).

Fate and Ecological Impacts of Pharmaceuticals in a Temperate Stream Dominated by Wastewater Effluent

Project Type: National Competitive Grant
Project ID: 2017IA276G

Project Impact:
During this final project period, we completed all the lab and field work described in the original proposal (plus additional). Notably, we completed all of the water sampling and chemical analysis for stream water samples, lab extraction and batch analysis, laboratory fish exposure, the large-scale field deployment experiment of caged fish, and created a transport risk assessment model. Some of the data-intense fish genetics results are still being analyzed (e.g., RNAseq). Multiple publications have been generated, with several more expected from the project, and we plan to leverage this ideal field site into future research. The main findings of this research are that pharmaceutical mixtures in effluent dominated streams generate evolving spatiotemporal complex exposure mixtures for aquatic biota through variable inputs and differential chemical attenuation. Understanding complex exposure mixture evolution is critical due to potential drug-drug interaction effects. Over a multi-year time period, we quantified 109 pharmaceuticals/degradates and their changing concentrations and representation along the stream reach. Laboratory batch tests probed specific mechanisms, and demonstrated sorption drove differential attenuation. Tandem lab/field experiments are necessary because attenuation rates can differ. We assessed ecological risk, and found that pesticides drove risk compared to pharmaceutics under measured and modeled conditions (and the effluent does not pose a risk to downstream drinking water). Our laboratory and in-stream caged fish experiment are working to connect exposure to complex mixtures to effects through analysis of hormones, gene expression, and antibiotic resistant bacteria; ongoing work with new high-resolution mass spectrometry aims to connect non-target detects with effects.