Indiana Water Resources Research Center
Purdue University

Annual Technical Report
2018

General Information

Products

O'Reilly, K.E., and W.M. Conard. October 2017. Microplastics in Aquatic Ecosystems: Tiny Plastics, Big Problem? Youtube Video. Available at: https://www.youtube.com/watch?v=n_O42Cs9sbg

Usher, E.M., Lu, J., Wade, E.R., and Prokopy, L.S. (2019). Big Pine Creek Watershed Farmer and Landowner 2018 Survey Descriptive Results. West Lafayette: Purdue University

http://waterworks.indiana.edu/

Data collected by the continuous flow monitoring system funded by this grant is publicly available online at: https://stormcentral.waterlog.com/SiteDetails.php?a=415&site=2904&pa=LillyCenter

Wilkins B.P., (2019), Deciphering Soil Nitrogen Biogeochemical Processes Using Nitrogen and Oxygen Stable Isotopes, PhD. Dissertation. doi:10.25394/PGS.8014592.v1.

Xia, X. H., S. L. Li, F. Wang, S. B. Zhang, Y. T. Fang, J. H. Y. Li, G. Michalski, and L. W. Zhang (2019), Triple oxygen isotopic evidence for atmospheric nitrate and its application in source identification for river systems in the Qinghai-Tibetan Plateau, Science of the Total Environment, 688, 270-280, doi:10.1016/j.scitotenv.2019.06.204.

Information Transfer Program

None

Student Support

30 undergraduate students
6 masters students
7 Ph.D. students
Post-doc researchers

Notable Achievements and Awards

As a direct result of her involvement with this research and research essay describing her findings, one undergraduate student working on the project was nominated by Ball State University for a Barry Goldwater Scholarship (did not win at the national level) but was awarded the prestigious national Mary T. Carothers Summer Environmental Studies Scholarship.

Projects

Assessment of nutrient sources and usage during harmful algae blooms (HAB) and algae eutrophication events using stable isotopes: Implications for water quality in the Wabash River

Project Type: Annual Base Grant **Project ID:** 2018IN410B

Project Impact: Most of the research objectives detailed in the original proposal were successfully completed. We (undergraduate researchers) demonstrated the increase growth rate of 5 strains of cyanobacteria algae at elevated temperature compare to room temperature under the same nutrient and light flux. We detected a small isotope effect occurred in one of the strains suggesting a switch from N uptake to N fixation at elevated temperatures. We (undergraduate researcher) developed a new method for analyzing NO3- isotopes using Ti3+ reduction in acidic solution. This method is faster, more inexpensive and efficient that previous methods. We (graduate student) used stable isotope analysis to determine in situ denitrification in tile drain runoff from agricultural field in the Midwest. The elevated ?15N and ?18O values of nitrate that has undergone denitrification suggest that this simultaneous enrichment could be used for assessing in stream/river denitrification. The multiple isotope approach was used to assess sources of nitrate in river systems on the Tibetan Plateau. Water samples (~600) were collected during three Wabash sampling blitz campaigns (Spring, Fall 2018 and Spring 2019). These are being stored frozen for analysis. About 100 of the Wabash blitz samples were analyzed for ?15N and ?18O values of nitrate. Many of these values were highly elevated, suggesting that the nitrate in the river has undergone significant denitrification either prior into arriving at the river or in situ on sediment particles and sediment. We also completed several isotope computers models related to N chemistry and deposition that will be presented in October.

Communicating the State of Indiana Water Resources

Project Type: Annual Base Grant **Project ID:** 2017IN406B

Project Impact: The results of this work are an up-to-date web portal for obtaining information, data and insight into the current state of surface and groundwater resources in Indiana that can be used by land managers, agency personnel and legislators to inform short term and long-term water management decisions.

Effects of land use type on abundance and type of microplastic pollution – a contaminant of emerging concern in Indiana rivers

Project Type: Annual Base Grant **Project ID:** Effects of land use type on abundance and type of microplastic pollution – a contaminant of emerging concern in Indiana rivers

Project Impact: We hypothesized that microplastic concentration would increase with human land use, especially urbanization. However, in our study, land use did not significantly influence microplastic concentration or types in Indiana waterways, suggesting that proximity to humans does not necessarily dictate microplastic distribution in rivers. We further hypothesized that the microplastic type ‘signature’ would vary as a result of human influence. Instead, we found that microplastic fibers were dominant and ubiquitous across the sites we sampled, suggesting that microplastics may predominantly be transported through atmospheric deposition. Further, as “integrators” of watershed and airshed processes, rivers reflect multiple pathways of microplastic pollution where local signals of contaminants may be obscured by broader processes. The sources, pathways, and transport of microplastics remain poorly understood. Our study suggests that atmospheric transport and deposition of fibers may be a hidden source of particulate pollution for inland waters. Further, an emerging public health concern is contaminants that adsorb to the surface of microplastics that may be transferred up the food web (and potentially to humans via fish consumption) or degrade municipal water quality. While recent legislation has banned the use of plastic microbeads in cosmetics (Microbead-Free Waters Act of 2015, H.R. 1321), microplastics will continue to exist in and impact our waterways due to their multiple sources, mobility, and persistence (Free et al. 2014).

Effects of viruses on the development of harmful algal blooms

Project Type: Annual Base Grant **Project ID:** 2017IN405B

Project Impact: An algal virus PBCV-1 was isolated in this study and it specifically infected an algal species Chlorella. The algal infection was confirmed with a TEM analysis. New qPCR primers were developed to quantify PBCV-1 virus and validated with plaque assay. The growth and decay of algal cells was not significantly affected by the exposure of various nutrient loading, but the better correlation between qPCR results and algal numbers indicated that qPCR can be used to quantitively and quickly evaluate the interactions between viruses and algae during viral infection of algal cells. The results will improve accuracy of quantification of algal viruses and fundamental understanding of effects of viruses on algal growth. The study will also help the development of control strategies for HABs, which is still one of the most costly and challenging environmental problems in the world.

Estimating watershed residence times in artificially-drained agricultural landscapes and relation to nutrient concentrations

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

Project Impact: We studied the relationship between nitrate concentrations and a proxy of watershed travel times derived from water stable isotope ratio variability in the Wabash Sampling Blitz study area. Streams that show low stable isotope variability over repeat sampling are assumed to have longer watershed travel times. We hypothesized that drainage areas with high likelihood of tile drain usage would tend to have shorter travel times and this hydrologic 'short-cut' could result in higher nitrate concentrations. Examining the 111 drainage areas that are over 50% agricultural land use and that we have sufficient data for, we do not find a correlation between percent tile drained area and isotopic travel time proxy, indicating multiple processes influencing hydrologic flow paths, perhaps including shallow groundwater flow paths. The percent tile drained area was significantly correlated with percent agricultural area in the drainages. There is however a significant correlation between nitrate concentrations and both percent tile drainage and isotopic travel time proxy. Together, they explain 53% of the variance in nitrate concentrations, with about 5% attributable to the isotope travel time proxy (10% of 53%). We also characterized seasonal and antecedent moisture relationships with nitrate concentrations in the study area. Higher nitrate was observed in the spring and during wet conditions. We estimated that groundwater in this region has approximately 1.2 +/- 1.2 mg/L nitrate using samples collected during dry, fall, base-flow conditions. This study provides new context to examine the role of water travel time on nutrient dynamics in artificially-drained landscapes in order to inform decisions regarding nutrient mitigation efforts.

Evaluation of sub-lethal effects of neurodegenerative cyanotoxins on predator-prey interactions in a freshwater fish

Project Type: Annual Base Grant **Project ID:** 2018IN409B

Project Impact: Cyanobacteria are prevalent blue-green algae in Midwestern freshwater systems that serve as important environmental and economic resources. Evidence indicates that some secondary metabolites produced by cyanobacteria disrupt central nervous system function, and reduce growth, survival, and reproduction of affected aquatic organisms, but the effects of these neural disruptors on the behavior of affected organisms is unknown. In this project we evaluated the potential effects of toxin-induced behavioral and CNS alterations on fish in real-world ecological contexts. Our findings are as follows: • Exposure to two neurodegenerative cyanotoxins (DABA and BMAA) significantly reduces foraging success of larval fish (fathead minnows). Analysis of prey-strike behavior indicates that this outcome may be due to changes in the ability to detect or recognize prey. • Exposure to DABA (and likely BMAA) is associated with impaired anti-predator escape behavior, and impaired locomotor function. • Effects of exposure are evident during the embryonic stage (5 days after being laid), manifested as decreased activity. • The lowest observed effects concentration for both DABA and BMAA was a nominal exposure concentration of 5 ug/L. • Long-term deficits due to developmental exposure (i.e., at 6 months of age) are more pronounced in cognitive ability than locomotor performance; fish show some recovery of locomotor impairment (i.e., swimming performance) ~2 months after exposure.

Examining Anthropogenic Impacts on the Wabash River System

Project Type: Annual Base Grant **Project ID:** 2017IN404B

Project Impact: Nutrients introduced into the Wabash River are carried down the river, typically spiraling through ecosystems in the form of additional body mass or available food resources. This additional nutrient loading and has the potential to substantially impact all associated downstream watersheds. While our study focused mostly on a small stretch of the Wabash River near Terre Haute, it is clear that the largest impacts on the ecosystem are agricultural rather than industrial. Additionally, our research shows that 'invasive species' are not just limited to those that have a visible imprint on the landscape and that it is highly feasible that the introduction of new species to an environment, such as Asian Carp, has the potential to cascade additional microscopic species throughout aquatic ecosystems.

Quantification of tributary nutrient transport and HABs in Lake Wawasee, Indiana's largest natural lake

Project Type: Annual Base Grant **Project ID:** 2018IN408B

Project Impact: Hourly transmissions of data from the Turkey Creek continuous flow monitoring system have been utilized to guide the Lilly Center for Lakes & Streams' sampling efforts. The system allows the sampling team to prepare appropriately for field conditions. Along with stream flow, the team can check the stream's air and water temperatures, water depth, and speed of the water directly from the Lilly Center. Staff can also easily identify and initiate targeted sampling of high flow events as they are happening, the data from which are key to understanding irregular influxes of nutrient and sediment that may not be observed during a regular sampling schedule. Additionally, this sensor is the first step towards the automation of the collection of flow data in the 12 streams across Kosciusko County the staff monitors biweekly. The successful installation of the continuous flow monitoring system in Turkey Creek has acted as a pilot for the fundraising and installation of two more monitoring systems now installed around Lake Wawasee, and two more yet to be installed. Interested citizens, government officials, and partner watershed organizations have access to these data online and can use them to better understand lake levels, manage the outflowing dam, and mitigate flooding. Comprehensive inflow and outflow stream coverage, coupled with the Lilly Center's regular stream water quality, nutrient and sediment sampling, will enable more precise watershed management for the reduction of erosion and runoff that negatively impact lake health.

Water and nutrient recovery from aquaculture effluents through vegetable production

Project Type: Annual Base Grant **Project ID:** 2016IN394B

Project Impact: We constructed the phosphorus (P) removal structure for greenhouse wastewater treatment based on the estimated volume of wastewater and installed in HLA greenhouse. The structure contains 92 kg of a mine drainage treatment residual and P soring material in a tank (84 L). A plastic tray constructed under the bench captured all leachate from the pots placed on the bench. The leachate flows via gravity into the wastewater reservoir tank through a series of gutters. Inflow samples (before filtration) and outflow samples (post filter) were taken every 2 days for analysis of nutrients and metals. The volume of water treated was also measured for determining loads. Thus far, the P removal structure has received a P loading of about 2,700 mg P/kg media from approximately 28,000 L of water for over a year. During this period, the P removal efficiency of the structure has removed nearly 100% of all of the P received, of which concentration ranged from 1 to 40 mg/L. Nearly 100% of Cu and Mn were also removed. We are still conducting this greenhouse trial to observe a breakthrough of this structure This result will help properly size the structure to process a given volume/P amount of wastewater from the greenhouse facility. This technology will mitigate nutrient load from greenhouse facility to the Wabash River Watershed, potentially reducing the prevalence of harmful algal blooms in the Gulf of Mexico and contribute to improving water quality in Indiana and beyond.

WaterWorks: A game to teach water systems thinking

Project Type: Annual Base Grant **Project ID:** 2017IN403B

Project Impact: Fresh water is used increasingly beyond sustainable levels. With IWRRC seed funding, we created an online open-access water game to teach players about the processes by which water gets cleaned and is used in

the home and then gets returned to the natural environment. Correctly understanding these different processes is important to effectively manage an increasingly scarce resource and localized contamination threats. You can play the game here: http://waterworks.indiana.edu/