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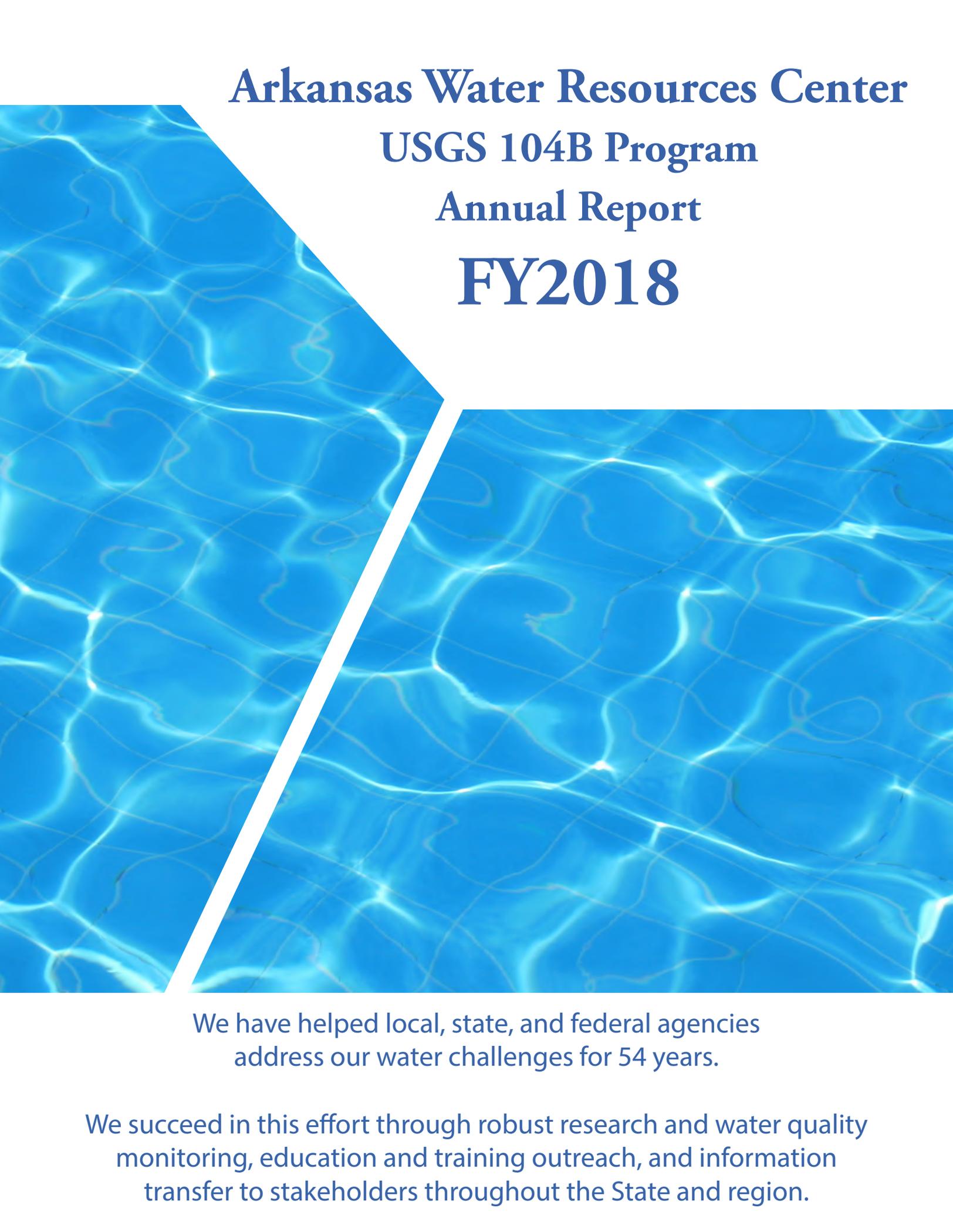
Arkansas Water Resources Center

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Arkansas Water Resources Center
USGS 104B Program
Annual Report
FY2018

We have helped local, state, and federal agencies address our water challenges for 54 years.

We succeed in this effort through robust research and water quality monitoring, education and training outreach, and information transfer to stakeholders throughout the State and region.

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EXECUTIVE SUMMARY

This publication was modified from the FY2018 annual report for the U.S. Geological Survey 104B program.

The Arkansas Water Resources Center (AWRC) is part of a national network of 54 water institutes, which were established by the Water Resources Research Act (WRRRA) of 1964. The 104B program is administered by the U.S. Geological Survey, and it provides equal funding to each institute to address state water resource issues and problems. We have used our 104B base funding to focus on three major activities:

1. facilitate and conduct research and volunteer monitoring;
2. transfer information to water stakeholders and the public; and
3. train the next generation of water scientists and engineers.

Through these activities, we continue to help local, state, and federal agencies understand, manage, and protect water resources within Arkansas.

We give a large portion of our 104B base funding to water research faculty and students throughout the state. Each year we fund a number of faculty research projects, as well as student-led projects with a faculty advisor. We make selections through our proposal peer-review process with participation from our diverse technical advisory committee. This year, we funded two faculty research proposals and two student-centered proposals with faculty advisors, which are listed here:

1. "Do Stream Phosphorus Dynamics Correspond with Biological Condition in the Lake Conway Point Remove Watershed, Arkansas?," Dr. Sally Entrekin, University of Central Arkansas
2. "An In-Situ Approach to Harmful Algal Blooms: Simultaneous Treatment of Cyanobacteria and Cyanotoxins in Natural Water Sources Using Catalytic Nanoparticle-Fiber Nets," Dr. Lauren Greenlee, University of Arkansas
3. "Quantifying Flow Sources and their Impacts on Water Quality in Forested Ozark Streams," Dr. Michelle Evans-White and Allyn Dodd, University of Arkansas
4. "Groundwater and Time Preference Elicitation: Estimating the Value of Market and Non-Market Groundwater Services Over Time," Dr. Kent Kovacs, Kerr Adams, and Grant West, University of Arkansas

This report also includes updated summaries for two projects from FY2017, because these projects required an extension to complete activities.

In order to provide researchers and decision makers with the knowledge and tools they need, we also implemented an extensive information transfer program, including the following activities:

1. held an annual water conference with approximately 160 attendees focused on "The Value of Water" where we showcased the economic and environmental benefits of sustainable water supplies
2. published monthly electronic newsletters, where we highlight research, USGS news and activities, and more, with an open rate (>30%) that exceeds the industry average
3. used social media to share valuable information and engage with a growing number of stakeholders, with 850 followers and counting
4. published technical reports and water-quality datasets, adding to the information base for future research and decision making related to HUC 12 prioritizations and nutrient management plans
5. published fact sheets on hot topics in Arkansas, including harmful algal blooms and a controversial tributary to the Buffalo National River.

We utilize many other outlets as well to communicate with our stakeholders, including through our primary website, our "blog" site, the Arkansas Bulletin of Water Research, and other publications where we highlight our activities and successes.

Student training is also key to the mission of the AWRC and we accomplish this in many ways. For example, funding priorities are given to research proposals that emphasize student support and training. We also provide several training opportunities directly, through various student-oriented programs such as the Freshman Engineering program, Research Experience for Undergraduates program, and hourly positions with the Center. In FY2018, we supported twenty students and one post-doctoral researcher. These students have gone on to successfully establish themselves as college faculty, as graduate research assistants, and as professionals, helping to solve some of our pressing water resource challenges.

WHO WE ARE

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Robert Morgan
Beaver Water District

OUR MISSION

We provide scientific information that improves the understanding and management of water resources.

The mission of the AWRC is three-fold:

- 1) to support water research in Arkansas,
- 2) to train future water scientists and engineers, and
- 3) to share information with stakeholders

Our program goals are to:

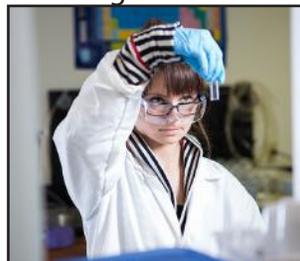
Improve or maintain
resilient water
supplies

Promote healthy
riparian areas and
waterbodies

Support future
scientists through
training

Transfer information
to water resource
stakeholders

Advance sustainable
water use and food
production



104B-FUNDED RESEARCH

Through our 104B proposal review process and with guidance from our technical advisory committee, we funded two faculty research projects and two student research projects with a faculty advisor. These funded projects address critical water resource challenges for Arkansas. Below are brief synopses for each report funded in FY2018, and updates from two FY2017 projects. In addition to these synopses, researchers produced full project reports that we have published in our Arkansas Bulletin of Water Research. We include links to these full reports with each synopsis.

FY2018 Synopses

1 Do Stream Phosphorus Dynamics Correspond with Biological Condition in the Lake Conway Point Remove Watershed, Arkansas?

*Sally Entekin, University of Central Arkansas, Department of Biology
USGS Project #: 2018AR405B*

There is a pressing need for water resource stakeholders in the United States to identify subwatersheds that transport a disproportionately greater amount of nutrients and prioritize these subwatersheds for management activities to reduce downstream eutrophication. This study looked at many levels of nutrient dynamics in streams (concentrations in waters, sediment phosphorus release potentials, and macroinvertebrate communities) across agricultural streams in Arkansas and Michigan.

Results from this study support the notion that streams draining agricultural lands have higher nitrogen and phosphorus (P) concentrations compared to streams draining less agricultural land. This study also showed that macroinvertebrate density generally increased with greater agricultural land use in the watershed, but diversity and richness generally decreased.

An interesting result demonstrated in this study is that P sorption and desorption to streambed sediments can be an important influence on stream nutrient concentrations and transport. For example, when watershed management activities are implemented to reduce nutrient transport to waterways, nutrient concentrations in those waterways might not actually see a reduction, at least not right away. This is a similar but separate issue to legacy P in soils on land. Arkansas streams in this study showed lower P sorption rates and the authors suggest this means that these streams may have greater potential to recovery after management efforts compared to streams with higher sorption (and higher potential desorption) rates.

Water resource managers can use results from this study to better understand how streams might respond to landuse management activities. This can help them decide where management activities might have the most beneficial effect to reduce nutrient transport and downstream eutrophication.



To read the full report associated with this project, click on the short title:
[**Legacy Sediment Bound Phosphorus and Macroinvertebrate Diversity**](#)

2 An In-Situ Approach to Harmful Algal Blooms: Simultaneous Treatment of Cyanobacteria and Cyanotoxins in Natural Water Sources Using Catalytic Nanoparticle-Fiber Nets

Lauren Greenlee, University of Arkansas, Department of Chemical Engineering

Project #: 2018AR403B



Concern about harmful algal blooms is increasing throughout the country as more states are seeing more blooms that could affect drinking water supplies, recreational waters, and even private ponds. Indeed, the Arkansas Water Resources Center has worked with many pond owners this summer who have lost livestock and pets potentially due to cyanobacteria and cyanotoxin contamination of waters. Methods of analysis are generally well-defined, but there is a gap in knowledge about how to best address or remediate waters when blooms and toxins occur.

This research introduced a novel approach to simultaneously treat cyanobacterial blooms and degrade cyanotoxins using nanoparticle technology. They found that titanium dioxide and iron oxide nanoparticles removed cyanobacterial cells from the water column by flocculation, binding them up and deactivating them. They also found that titanium dioxide nanoparticles degraded the common cyanotoxin microcystin-LR through a UV-light-initiated catalyst.

This research is highly valuable because it elucidated mechanisms and limitations of the methods used in the study. The results have already informed method adjustments to try to more effectively treat blooms and toxins using nanoparticle technologies, with minimal to no negative environmental impact. Not only does Arkansas directly benefit from this research, but development of the technology introduced here has the potential to help water resource managers throughout the country to protect water supplies and public health.

To read the full report associated with this project, click on the short title:
[Treatment of Cyanobacteria and Toxins Using Catalytic Nanoparticle-Fiber Nets](#)

3 Quantifying Flow Sources and their Impacts on Water Quality in Forested Ozark Streams

Michelle Evans-White and Allyn Dodd, University of Arkansas, Department of Biological Sciences

Project #: 2018AR404B



Precipitation and groundwater are two dominant flow source inputs to minimally-impacted headwater streams in Arkansas. These stream types are termed Runoff flashy and Groundwater flashy, respectively, based on previous modeling work. Identification of flow sources is important for water managers since the source of water can dictate water and nutrient budgets in streams, with potential impacts on stream ecosystems.

In this study, researchers used water chemistry and hydrologic data to evaluate six minimally-impacted forested streams in the Boston Mountains and Ozark Highlands regions of Arkansas. They measured nutrient and mineral concentrations in the water column and in groundwater and precipitation sources. They used end-member mixing analysis to evaluate relative proportions of each water source (groundwater or precipitation).

This study provided empirical measurements that support previous modeling research. As expected,

Groundwater flashy streams were driven primarily by groundwater inputs, except during storm events when precipitation dominated. Runoff flashy streams were driven by precipitation inputs during base and storm-flow conditions.

Interestingly, Groundwater streams had higher nitrogen and phosphorus concentrations compared to Runoff streams. Also, groundwater inputs actually drove nitrogen concentrations in Runoff streams. These data support previous classifications based on modeling work, but also show that previously held assumptions might need some refinement.

An important take-away from this research is that groundwater nitrogen can influence streams that are classified as Runoff streams. This can have important implications for water managers, as potential landscape changes towards agricultural land use might indirectly increase stream nutrient concentrations via infiltration and groundwater transportation to streams.

To read the full report associated with this project, click on the short title:
[Quantifying Flow Sources and their Impacts on Water Quality](#)

4 Groundwater and Time Preference Elicitation: Estimating the Value of Market and Non-Market Groundwater Services Over Time

Kent Kovacs, Kerr Adams, and Grant West, University of Arkansas, Department of Agricultural Economics and Agribusiness

Project #: 2018AR402B

It is unavoidable to hear about agricultural irrigation without also hearing about the dwindling supplies of water to support it. Even in Arkansas, considered to be relatively “water rich”, there are serious concerns over the sustainability of groundwater supplies that support the majority of crop production in the state.

This study evaluated groundwater depletion from a socio-economic perspective. The researchers surveyed producers in the Mississippi River Valley Alluvial (MRVA) aquifer to understand people’s willingness to pay for different services that groundwater provides, with some services lacking market prices.

Valuating non-market ecosystem services can be extremely difficult, but is paramount to understanding the entire economic picture and deciding on policy actions.

Results show that survey respondents value the provision of water-quality service the most, followed by certainty of supply and agricultural jobs. They were not concerned with wildlife habitat and avoiding subsistence. Respondents also were not interested in the policy alternatives of cap-and-trade or increased investment in surface water infrastructure over the status quo of subsidies for best management practices.

It is interesting to note that the current policies to protect the sustainability of groundwater supplies are not enough, as there continues to be groundwater depletion in the MRVA. Despite this fact, respondents are satisfied with current policies. This research can help water resource managers understand the basis of public opinion and willingness to pay for various services, which will help them figure out effective strategies to communicate with the public and develop new policies to sustain this economically invaluable water resource.



To read the full report associated with this project, click on the short title:
[Estimating the Value of Market and Non-Market Groundwater Services](#)

FY2017 Updated Synopses

1 Combined Application of Nutrient Manipulation and Hydrogen Peroxide Exposure to Selectively Control Cyanobacteria Growth and Promote Eukaryote Phytoplankton Production in Aquaculture Ponds

Amit Sinha, University of Arkansas Pine Bluff, Department of Aquaculture and Fisheries

Project #: 2017AR398B



Algal blooms, and of particular interest, toxin-producing harmful algal blooms (HABs), are increasing in frequency and magnitude in Arkansas and throughout the United States. HABs can be detrimental to many water resource uses such as drinking water supplies, recreation, and aquaculture.

This study looked at the efficacy of a novel approach to managing HABs and toxins in experimental aquaculture ponds, which can be tricky because producers need to selectively control and degrade HABs and toxins, while preserving other algae and aquatic organisms that are food sources for fish.

The researchers found that using a granular H_2O_2 sodium bicarbonate peroxyhydrate (SCP) compound can be effective in targeted degradation of cyanobacteria and their toxins, while avoiding negatively impacting other beneficial algal species and zooplankton. In less than a week, dosing experimental ponds with 2.5 mg/L of the granular H_2O_2 led to significant reductions (by approximately 80%) of cyanobacterial abundance and significantly reduced total microcystins (which was maintained throughout the 6 week experiment). Further, H_2O_2 concentration degraded rapidly and was not detectable 3 days after application.

This research may lead to a highly effective approach to mitigate HABs and toxins without negatively impacting other organisms and fisheries production. This would be extremely valuable to Arkansas, which ranks second among aquaculture producing states in the nation.

To read the full report associated with this project, click on the short title:
[**Mitigating Cyanobacterial Blooms and Cyanotoxins in Hypereutrophic Ponds**](#)

2 Herbicide Mitigation Potential of Tailwater Recovery Systems in the Cache River Critical Groundwater Area

Cammy Willett, University of Arkansas, Department of Crop, Soil, and Environmental Sciences (formerly)

Project #: 2017AR399B



Due to groundwater depletion in intensive agricultural regions, surface water impoundments can help producers bridge their needs with multiple water supplies. But, it is important to understand the quality of water in farm reservoirs, as it may contain herbicides that were agriculturally applied to crops, before that water is reapplied to the landscape.

This study initiated an herbicide monitoring record for seven Arkansas tailwater recovery systems. Four herbicides (clomazone, glyphosate, metolachlor, and quinclorac) were readily detectable and peaked seasonally, reflecting interplay of application timing and precipitation. Clomazone and

quinclorac, common spring-applied rice herbicides, were elevated in spring and summer. Metolachlor was elevated in summer only, reflecting mid-season applications to soybean acres. Glyphosate concentrations

peaked in summer, but were also elevated in spring and fall, reflecting frequent, broad spectrum glyphosate use. Herbicide concentrations were otherwise low in off-season months and mostly below detection.

During the growing season, clomazone, glyphosate, and quinclorac concentrations were higher in ditches than in the linked reservoir. Metolachlor concentrations were similar in magnitude between linked ditches and reservoirs.

The observed spatial and temporal patterns in residual herbicide concentrations will inform best management practices for tailwater recovery systems in Arkansas and the region. For example, recovered tailwater should be cycled through and sourced from the reservoir before reapplication to minimize the risk of sensitive crop exposure to residual herbicides. Also, artificial groundwater recharge strategies should source water from reservoirs and only during winter months to minimize the risk to groundwater supplies.

**To read the full report associated with this project, click on the short title:
[Herbicide Mitigation Potential of Tailwater Recovery Systems](#)**

VOLUNTEER MONITORING

We continued supporting and working closely with Ozarks Water Watch (OWW), a non-profit watershed organization in Northwest Arkansas. There are two volunteer programs of OWW that we were involved with: the Beaver LakeSmart program by serving on the advisory board; and the StreamSmart program by helping train volunteers and analyze water samples.

For the StreamSmart program, we assisted in presenting a formal training workshop related to sample collection and site assessment to volunteers. Through 104B program funding, we also supported this program by analyzing water samples collected by volunteer citizen scientists. During this project year, we analyzed approximately 80 water samples and 560 analytes for the StreamSmart program. OWW uses these data to develop their annual "Status of the Watershed" report that characterizes water quality in the White River Watershed using their volunteer data along with water data from other agencies.

Volunteer monitoring programs can be valuable in many ways. For example, these programs may supplement data collected by professionals in academic or government agencies, provide volunteers with an enhanced understanding and sense of stewardship, and provide public education and outreach. Without support from the Water Center and 104B program funds, these volunteer programs might not be possible.



PUBLICATIONS AND PRESENTATIONS

During FY2018, 104B funding contributed to 34 publications, with most of those being peer-reviewed journal articles, and 21 presentations at local, state, and national conferences. Additionally, one patent is expected related to Amit Sinha's project about the treatment of harmful algal blooms and associated toxins. The dissemination of research results is paramount to our mission. Each of these publications and presentations are listed below.

Publications

AWRC Publications

Journal Articles

- Austin, B.J. S. Entrekin, M.A. Evans-White, J. Kelso, and B.E. Haggard. 2018. Can high volume hydraulic fracturing effects be detected in large watersheds? A case study of the South Fork Little Red River. *Current Opinion in Environmental Science and Health* 3:40-46.
- Austin, B.J., S. Patterson, and B.E. Haggard. 2019 (accepted). Water chemistry during base flow helps inform watershed management: A case study of the Lake Wister Watershed, Oklahoma, USA. *Journal of Contemporary Water Research and Education*.
- Entrekin, S., B.A. Austin, M.A. Evans-White, and B.E. Haggard. 2018. Establishing the linkage among watershed threats, in-stream alterations and biological responses remains a challenge: Fayetteville Shale as a case study. *Current Opinion in Environmental Science and Health*, 3: 27-32.
- Grantz, E., B.E. Haggard, and J.T. Scott. 2018. Censored data can inflate or obscure trends in analyses used for water quality target development. *Environmental Monitoring and Assessment* 190:394.
- Harmel, R., K. King, D. Busch, D. Smith, F. Brigand, and B.E. Haggard. 2018. Measuring edge-of-field water quality: Where we have been and the path forward. *Journal of Soil and Water Conservation* 73:86-96.
- McCarty, J.A., M.D. Matlock, J.T. Scott, and B.E. Haggard. 2018. Risk indicators for identifying critical source areas in five Arkansas watersheds. *Transactions ASABE* 61:1-8.
- Reavis, M.A., and B.E. Haggard. 2018. Mitigating soil phosphorus release using liquid water treatment residuals. *Journal American Water Works Association* 110(12):E36-E43.
- Scott, E., and B.E. Haggard. 2018 (submitted). Evaluating water quality and standard violations at the West Fork of the White River. *Environmental Monitoring*.
- Simpson, Z.P., and B.E. Haggard. 2018. Optimizing the flow-adjustment of constituent concentrations via LOESS for trend analysis. *Environmental Monitoring and Assessment* 190:103.

Fact Sheets

- Austin, B.J., B. Olsen, T. Wentz, and B.E. Haggard. 2018. Algal blooms in Arkansas streams, ponds and lakes. Arkansas Water Resources Center Fact Sheet FS-2018-02.
- Burke, J., A. Sharpley, L. Berry, K. Brye, M. Daniels, E. Gbur, K. VanDevender, S. King, P. Hays, and B. Haggard. 2018. Nutrient concentrations in Big Creek correlate to regional watershed land use. UA Division of Agriculture Fact Sheet FSA9537.
- Daniels, M., B.J. Austin, and B.E. Haggard. 2018. How to sample: collecting water samples is so easy anyone can do it! Arkansas Water Resources Center Fact Sheet FS-2018-01.

Reports

- Austin, B.J., B. Smith, and B.E. Haggard. 2018. Stream water quality to support HUC 12 prioritization in the Lake Wister Watershed, Oklahoma. Final Report to the Poteau Valley Improvement Authority, AWRC Technical Report MSC 385, 35 pp.
- Austin, B.J., J.T. Scott, and B.E. Haggard. 2018. Managing lake fertility within the guidelines of a nutrient management plan and based on algal nutrient limitation. Final Report to the US Forest Service, AWRC Technical Report MSC 386, 14 pp.

eNewsletters

- Scott, E.E. and B.E. Haggard, 2018, Water News, November Newsletter, Arkansas Water Resources Center.
- Scott, E.E. and B.E. Haggard, 2018, Water News, October Newsletter, Arkansas Water Resources Center.
- Scott, E.E. and B.E. Haggard, 2018, Water News, September Newsletter, Arkansas Water Resources Center.
- Scott, E.E. and B.E. Haggard, 2018, Water News, August Newsletter, Arkansas Water Resources Center.
- Scott, E.E. and B.E. Haggard, 2018, Water News, July Newsletter, Arkansas Water Resources Center.
- Scott, E.E. and B.E. Haggard, 2018, Water News, June Newsletter, Arkansas Water Resources Center.
- Scott, E.E. and B.E. Haggard, 2018, Water News, May Newsletter, Arkansas Water Resources Center.
- Scott, E.E. and B.E. Haggard, 2018, Water News, April Newsletter, Arkansas Water Resources Center.
- Scott, E.E. and B.E. Haggard, 2018, Water News, March Newsletter, Arkansas Water Resources Center.
- Scott, E.E. and B.E. Haggard, 2018, Water News, February Newsletter, Arkansas Water Resources Center.
- Scott, E.E. and B.E. Haggard, 2018, Water News, January Newsletter, Arkansas Water Resources Center.

104B-Funded Project Publications

**NOTE: USGS Project ID is shown in brackets at the end of each citation. When applicable, these IDs are also linked to the associated full report published in the Arkansas Bulletin of Water Research.*

Theses and Dissertations

- Dodd, A. 2019. Flow regime influences on stream and riparian soil carbon dynamics in the Ozark Highlands and Boston Mountains of Arkansas. PhD Dissertation. Department of Biological Sciences, University of Arkansas, Fayetteville, AR. [[2018AR404B](#)]
- West, G.H. 2019. Interpreting potential groundwater policies through modelling of market and non-market benefits and costs. PhD Dissertation. Department of Agricultural Economics and Agribusiness, University of Arkansas, Fayetteville, AR. [[2016AR386B](#)]

Journal Articles

- Ivandic, S., W. Zhang, and L.F. Greenlee. 2019 (in preparation). Degradation of MC-LR cyanotoxin with fiber-immobilized TiO₂ Nanoparticles. [[2018AR403B](#)]
- Liang, L., B.R.K. Runkle, B.B. Sapkota, and M.L. Reba. 2019. Automated mapping of rice fields using multi-year training sample normalization. International Journal of Remote Sensing, 40(18): 7252-7271, DOI: 10.1080/01431161.2019.1601286. [[2016AR383B](#)] [[2017AR400B](#)]
- Runkle B.R.K., K. Suvočarev, M.L. Reba, C.W. Reavis, S.F. Smith, Y.L. Chiu, and B. Fong. 2019. Methane emissions reductions from alternate wetting and drying of rice fields detected using the eddy covariance method. Environmental Science & Technology, 53(2): 671-681, DOI: 10.1021/acs.est.8b05535. [[2016AR383B](#)] [[2017AR400B](#)]
- West, G.H., K. Kovacs, and R. Nayga. 2019 (in preparation). How narrative framing about climate change impacts preferences for long-term groundwater management. Climate Policy. [[2018AR402B](#)]
- West, G.H., K. Kovacs, H. Snell, and R. Nayga. 2019 (in preparation). Groundwater and time preference elicitation: Estimating the value of market and non-market groundwater services over time. Water Resources Research. [[2018AR402B](#)]

Other

Sinha, A.K., N. Romano, M. Eggleton, J.H. Howe, and R. Lochmann. 2018. Removing cyanobacteria and associated toxins in aquaculture ponds. Global Aquaculture Alliance, Environmental and Social Responsibility, <https://www.aquaculturealliance.org/advocate/removing-cyanobacteria-toxins-aquaculture-ponds/>. [2017AR398B]

Presentations

AWRC Presentations

- Austin, B.J., B. Smith, and B.E. Haggard. 2018. Subwatershed prioritization of Lake Wister watershed using baseflow water quality monitoring data. In Oklahoma Clean Lakes and Watersheds Conference, Stillwater, OK.
- Austin, B.J., D.R. Lee, and B.E. Haggard. 2019. Occurrence of microcystin in Ozark streams across a nutrient gradient in Northwest Arkansas. In HABs Working Group for South Carolina, online.
- Austin, B.J., D.R. Lee, and B.E. Haggard. 2019. Occurrence of microcystin in Ozark streams across a nutrient gradient in Northwest Arkansas. In National Water Quality Monitoring Conference. Denver, CO.
- Haggard, B.E. 2019. Microcystin is highly variable in Lake Fayetteville. In Lake Fayetteville Watershed Partnership public speaker series, Fayetteville, AR.
- Haggard, B.E. 2018. Illinois River: What, when and where are we now? In Oklahoma State Chapter of the Soil and Water Conservation Society, Grove, OK.
- Haggard, B.E., and B.J. Austin. 2018. Sediment phosphorus release sustains nuisance algal growth in a small impoundment. In University Council on Water Resources (UCOWR) 2018 Annual Conference, Pittsburgh, PA.
- Haggard, B.E., B.J. Austin, and M. Shults. 2019. Variability in microcystin concentrations in a recreational lake during sampling and analysis. In Arkansas Water Resources Center Annual Conference, Fayetteville, AR.
- Henson, E., A.L. Lasater, and B.E. Haggard. 2018. Reducing dissolved phosphorus in stream water may not influence estimation of sediment equilibrium phosphorus concentrations. In Arkansas Water Resources Center Annual Conference, Fayetteville, AR.
- Henson, E., A.L. Lasater, and B.E. Haggard. 2018. Reducing dissolved phosphorus in stream water may not influence estimation of sediment equilibrium phosphorus concentrations. University of Arkansas Honors College Research Conference, Fayetteville, AR.
- Lasater, A.L., B.J. Austin, E.E. Scott, and B.E. Haggard. 2018. Stream discharge monitoring and load estimation for small scale watersheds. In University Council on Water Resources (UCOWR) 2018 Annual Conference, Pittsburgh, PA.
- Ledezma, H.E.O., B. Smith, B.J. Austin, and B.E. Haggard. 2018. Comparison of three methods for measuring chlorophyll in water samples. In Arkansas Water Resources Center Annual Conference, Fayetteville, AR.
- Lee, D., B.J. Austin, and B.E. Haggard. 2018. Microcystin and algal biomass in streams across a land-use gradient in Northwest Arkansas. In Arkansas Water Resources Center Annual Conference, Fayetteville, AR.
- Scott, E.E., B.A. Smith, and B.E. Haggard. 2019. Water quality changes in the West Fork of the White River, upstream to downstream. In Beaver Watershed Alliance Annual Symposium, Fayetteville, AR.

104B-Funded Project Presentations

**NOTE: USGS Project ID is shown in brackets at the end of each citation. When applicable, these IDs are also linked to the associated full report published in the Arkansas Bulletin of Water Research.*

- Dodd, A., E. Pollock, S. Dias, B. Hillebrand, and M. Evans-White. 2019. Relative rain and groundwater contributions to streamflow across two flow regimes in Northern Arkansas. In Society for Freshwater Science Annual Meeting, Salt Lake City, UT. [2018AR404B]
- Ivandic, S., W. Zhang, and L.F. Greenlee. 2019. In situ treatment of cyanotoxins in water sources using fi-

ber-immobilized TiO₂/Fe Nanoparticle Catalysts. In American Institute of Chemical Engineers National Conference, Orlando, FL. [\[2018AR403B\]](#)

Reavis C.W., K. Suvočarev, M.L. Reba, and B.R.K. Runkle. 2018. Comparing eddy covariance and Penman-Monteith methods to estimate evapotranspiration from Mid-South rice production. In American Geophysical Union Fall Meeting, Washington DC. [\[2016AR383B\]](#) [\[2017AR400B\]](#)

Reavis C.W., K. Suvočarev, B.R.K. Runkle, and M.L. Reba. 2018. Utilizing eddy covariance and Penman-Monteith methods to estimate evapotranspiration from Mid-South rice production. In Ameriflux PI meeting, Bloomington IN. [\[2016AR383B\]](#) [\[2017AR400B\]](#)

Runkle, B.R.K., M. Reba, B. Fong, T. Teague, and K. Suvočarev. 2019. Dynamics of CO₂ exchange in US Mid-South cotton production. In Beltwide Cotton Conference, New Orleans, LA. [\[2016AR383B\]](#) [\[2017AR400B\]](#)

Sinha, A.K., W.R. Green, and J. Howe. 2019. Combined application of hydrogen peroxide based algaecide and phosphorus binding compound - A potential strategy to efficiently control cyanobacterial bloom for a prolonged duration. In Associate of the Research Directors, Jacksonville, FL. [\[2017AR398B\]](#)

Sinha, A.K., W.R. Green, L. Howe, A. Surratt, and J. Howe. 2019. Combined application of nutrient manipulation (by phoslock) and hydrogen peroxide based algaecide to control cyanobacterial growth in hypereutrophic ponds. In Aquaculture America, New Orleans, LA. [\[2017AR398B\]](#)

West, G.H. 2018. The influence of resource attributes and climate change narratives on preferences for groundwater management policies: Exploring coalitions of belief using latent class models. In Research and Professional Development Series in the Public Policy PhD Program, Graduate School and International Education, University of Arkansas, Fayetteville, AR. [\[2018AR402B\]](#)

INFORMATION TRANSFER

Annual Conference

We drew in about 160 people for this year's conference on July 23-24 in Fayetteville. The conference theme was "The Value of Water", and we facilitated conversations about how valuable water is to the economy of communities, states, and regions, and the need to be more proactive in management decisions to sustain our water supplies.

Our conference draws in a diverse group of water resource stakeholders including researchers, students, water planners and managers, utilities, consulting firms, government agencies, and others. This year, we welcomed 32 presenters for oral presentations and 22 undergraduate and graduate students for poster presentations.

Session Topics

We opened the conference with a group discussion about the value of water to different stakeholders in Arkansas. Due to unforeseen circumstances, our keynote speakers were unable to be there Monday morning. But, a big thanks to Ryan Benefield, Clell Ford, Nicole Hardiman, and others who pitched in to create a spontaneous discussion session.

The next session covered topics related to microorganisms and how they might respond to changes in water quality. We learned about how microbes can be used directly as bioindicators of pollution, and the potential to use satellite imagery to indirectly detect and monitor harmful algal blooms. We also heard how researchers are trying to track microbes to determine sources of pollution and how microbial biofilms can grow in drinking water distribution lines and release pollutants.

On the afternoon of the first day, we saw presentations on the potential for ecosystem services to attenuate stormwater runoff and nutrient transport, but also the challenges with marketing ecosystem services as nutrient trading regulation in Arkansas moves forward.

Then, to wrap up the first day and start the second day, we heard about water quality issues in the Buffalo National River. There is so much research going on in the Buffalo River watershed from many different organizations, it was great to have everyone come together to share their work and findings.

Then we shifted focus on day two to agriculture. We heard about current issues in water quality, water use, and water availability for surface and groundwater related to irrigation water supplies in the delta.

Finally, the Arkansas chapter of the American Water Resources Association partnered with AWRC for the second year in a row to hold their annual symposium on the afternoon of the second day. The focus of that symposium was "The Value of Citizen Science Programs in Watershed Water-Quality Management". We heard from professionals with the USGS, Arkansas State agencies, and water resource organizations about some of the programs they have going right now in which citizen scientists and the public can participate.

Poster Competitions

The poster session showcased a lot of research from undergraduate and graduate students on a wide variety of water topics. Along with other undergraduate researchers, students in the Ecosystems Services Research Experience for Undergraduates (EcoREU) program presented findings from their summer work. The competition was tight, and the winners walked away with Amazon giftcards.

We want to give a big THANKS to all the presenters, moderators, and sponsors for making this year's conference so fulfilling.

To view the 2018 conference program, click:
[The Value of Water](#)

Undergraduate Student Winners

1st Place

Eleanor Henson, advisors Dr. Brian Haggard and Abbie Lasater, University of Arkansas
Reducing Dissolved Phosphorus in Stream Water May Not Influence Estimation of Sediment Equilibrium Phosphorus Concentrations

2nd Place

Jascha VanBrunt, advisors Dr. Lauren Greenlee and Shelby Foster, University of Arkansas
Characterization of Iron Nickel Oxide Nanoparticles for Surface Optimization for Oxygen Evolution Reaction

Graduate Student Winners

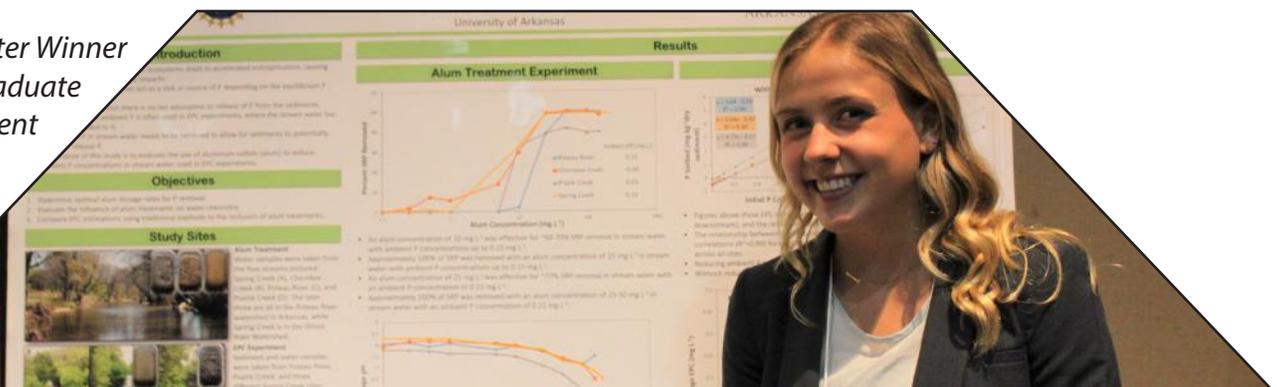
1st Place

Joshua Blackstock, advisor Dr. Phillip Hays, University of Arkansas
Low-Cost, Long-Term Monitoring of Dissolved Gases in Natural Waters

2nd Place

Danielle Braund, advisor Dr. Sally Entekin, University of Central Arkansas
Establishing the Relationships among Land Use, Nutrients, and Aquatic Communities in Headwater Streams

1st Place Poster Winner
Undergraduate
Student



Websites

The AWRC website (arkansas-water-center.uark.edu) is the primary portal for stakeholders to access important and useful water resources information. We continue to improve the usability of the website and the availability of water resources information. The website serves as a platform to provide:

- Immediate electronic availability of almost all AWRC publications
- A warehouse of raw data provided as water-data reports associated with research and monitoring projects
- Information about water research being conducted by the Water Center director, students, and staff, as well as research we fund through the USGS 104B program
- Information about submitting a water sample to the AWRC Water Quality Laboratory
- Information on upcoming conferences and funding opportunities, especially USGS 104B and 104G grants, and other events.

Maintenance of the AWRC website is a critical component of the AWRC's information transfer program.

We also maintain a website (WaterCurrents.uark.edu) devoted to publishing and archiving stories from the electronic newsletters. Housing news articles on a designated website enhances searchability and aesthetic quality of important news and information.

AWRC publication materials are also available on ScholarWorks@UARK (scholarworks.uark.edu), the institutional repository for the University of Arkansas. The benefits of publishing on ScholarWorks include enhanced visibility, availability, and impact of our work as the information is open access and available to users around the world. Approximately 250 publications are available through ScholarWorks including: the Arkansas Bulletin of Water Research, technical reports dating as far back as 1973, and our fact sheets. During FY2018, over 1,600 downloads have been done by users around the globe.

eNewsletters

The AWRC distributed monthly electronic newsletters to several hundred people from local and state agencies, municipalities, academia, non-profit organizations, consulting firms, students, and many other stakeholders. Electronic newsletters continue to be a valuable means of distributing important information related to water resources. The open rate is about 35% on average, much higher than the national average for Mailchimp newsletters.

The Center published news articles on current research being done throughout the State, especially projects funded through the USGS 104B program, activities of the Water Center, the USGS, and other organizations, funding opportunities, and other timely water-related news. The AWRC populates a section of the newsletter for "Upcoming Events" to highlight not only Center-related events and activities, but also those of other local or national organizations such as ADEQ, ANRC, Beaver Watershed Alliance, Illinois River Watershed Partnership, and the US EPA. AWRC also updates a "Jobs" section each month aimed to provide recent graduates or early career people some guidance and examples of current job openings related to water science and engineering.



Social Media

We continue to expand our presence on social media. During this past year, staff utilized Facebook, Twitter, and Instagram to disseminate information about the activities of the Center including funding opportunities, conference materials, and research findings. Facebook followers continue to grow as the Center currently has 850 followers, about 250 more than last year. “Boosting” posts to advertise monthly electronic newsletters continues to increase viewers, where we “reach” up to almost 4,500 people with each post. Social media has been a valuable outlet to network and share ideas and stories among water stakeholders and organizations. We also share posts from other water or water-related organizations about their current news or upcoming events.

Reports, Fact Sheets, and the Arkansas Bulletin of Water Research

We published two technical reports on our website during 2018. Our technical reports include water research and monitoring reports from projects funded by state or local water organizations, as well as reports by scientists not related to the Center to make available valuable information in addition to or in lieu of peer-reviewed articles. Water-data reports are published on our website and provide easy access to years-worth of Center-related water quality monitoring data associated with the data collected for the technical reports. These data reports are available to the public and can be accessed as neatly-organized Microsoft Excel data files.

We also developed and published two fact sheets during the last year. Our fact sheets provide information to stakeholders, especially those who submit water samples to the AWRC Water Quality Lab for analysis. The lab offers analytical “packages” that include parameters of interest for various intended uses. These uses include aquaculture, livestock watering, poultry watering, domestic, and irrigation. Fact sheets are associated with each of the analytical “packages” and describe how a water sample should be collected, and how people can interpret their lab results. Fact sheets on reporting limits, method detection limits, and censored values and on laboratory quality control are also available to allow people to become better informed about the process we go through to produce scientifically defensible water-quality data.

*All of our information transfer activities emphasize the **USGS and the 104B program**. We encourage USGS and 104B research presentations at our conference, we share research results on our website and through our monthly newsletters, we highlight student and faculty work through social media, and we include report articles in the Bulletin.*



The Center produced and published another issue of the Arkansas Bulletin of Water Research, in which all completed 104B projects from FY2018 year were included. The Bulletin was developed to allow anyone conducting research relevant to Arkansas water issues to publish their results, making them available to stakeholders and other researchers throughout the State. The Bulletin is a great avenue to publish results that might not stand alone in a national or international journal, yet are extremely valuable to stakeholders in Arkansas. The Bulletin is also meant to communicate applied research findings that people of various specialties can understand, and we encourage authors to write in a relatively casual way.

STUDENT SUPPORT

Student training is key to the mission of the AWRC and we accomplish this in many ways. For example, 104B program funding priorities are given to research proposals that emphasize student support and training. We also provide several training opportunities directly. This direct student support included:

- We participated in the Ecosystems Services Research Experience for Undergraduates (EcoREU) program, funded by the National Science Foundation, by mentoring students in their research labs on the scientific method.
- We helped train undergraduate students by mentoring them through their freshman engineering research projects or honors projects at the University of Arkansas.
- We supported paid student work where students gained experience in the water quality laboratory and in data organization and analysis.
- We continued with our fifth-annual paid summer internship.

During this past year, 21 students and postdoctoral researchers were trained through participation in research projects and through the AWRC directly. The following table details student support:

Category	Section 104 Base Grant	NIWR-USGS Internship	Total
Undergraduate	10	1	11
Masters	5	0	5
PhD	4	0	4
Post-doc	1	0	1
Total	20	1	21

We funded research by graduate student, Gina Riggio, who was mentored by Dr. Kristen Gibson at the University of Arkansas in Fayetteville, studying how producers could use spent growth mats from hydroponic agriculture to improve nitrogen removal from the wastewater stream. Riggio went on to receive first place in the poster competition at the annual conference of the Universities Council on Water Resources / National Institutes of Water Resources in June 2019.

Annual Report FY2018
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