

Center for the Management, Utilization,  
& Protection of Water Resources

# ANNUAL REPORT

2017 to 2018

---

CENTER FOR THE  
MANAGEMENT,  
UTILIZATION &  
PROTECTION  
OF WATER  
RESOURCES

---

JUSTIN MURDOCK,  
INTERIM DIRECTOR

---

Annual Report for Fiscal Year  
July 1, 2017 through  
June 30, 2018

[WWW.TNTECH.EDU/WATERCENTER](http://WWW.TNTECH.EDU/WATERCENTER)

## FISCAL YEAR 2017-2018 AT-A-GLANCE

The mission of the Center for the Management, Utilization and Protection of Water Resources (Water Center) is to support state and federal agencies, communities, and industry in solving water quality, biodiversity, and water security problems and advancing scientific understanding of all aspects of water science and engineering through basic and applied research. Water Center researchers study aquatic biodiversity and ecology from genes to ecosystems; address water quality challenges and develop better treatment technologies; and implement state-of-the-art technologies and tools for watershed sciences, modeling and simulation, data acquisition and geospatial analysis. The Water Center provides a strong water resources research infrastructure at Tennessee Tech University by supporting faculty research, training and mentoring of future water professionals, and serving the citizens of the state of Tennessee.

## ACCOMPLISHMENTS/AWARDS

Water Center faculty and associates are recognized nationally for research in aquatic biodiversity, technology development, and water security and sustainability.

Faculty and associate faculty with the Water Center secured approximately \$2.2 million (including indirect costs) from state and federal agencies and private industries to seek solutions to environmental problems. The direct monetary return on the State's investment is \$1.84/State-allocated dollar. This is a 49.5% increase in external matching funds over the previous year.

Water Center researchers produced 13 refereed publications and made 47 presentations.

Environmental engineering Associate Professor Alfred Kalyanapu and Assistant Professor Tania Datta were referenced in a *Herald-Citizen* article titled "Improving Safety at Cummins Falls," published August 6, 2017 (<http://herald-citizen.com/stories/improving-safety-at-cummins-falls.22690>). Datta also earned the 2017 Tennessee Tech University Distinguished Service Learning Award for extraordinary contributions by a faculty member in the area of service learning and was selected as a finalist for the 2017 Outstanding Faculty Award for Professional Service sponsored by Home Instead Senior Care.

Amanda Rosenberger, assistant unit leader of the Tennessee Cooperative Fishery Research Unit and associate professor of biology, won the 2017 award for Outstanding Fisheries and Wildlife Sciences Faculty Member of the Fish and Wildlife Student Organization. Also, Rosenberger's students Kayla N. Key, G. Lindner, and K. Bouska were awarded the Best Student Oral Platform Presentation Award for their paper titled "A Hierarchical Approach to Mussel Conservation: From Niche Modeling to Field Monitoring," presented at the 2017 Freshwater Mollusk Conservation Society 10th Biennial Symposium in Cleveland, Ohio.

Parker Lusk, a senior in Chemical Engineering advised by Professor Holly Stretz, was named as an extraordinary student contributor among the Creative Inquiry Summer Experience awardees at the Tennessee Tech 13th Annual Research and Creative Inquiry Day. His work is on sensors as part of the water-energy-nexus collaboration between the Center for

Energy Systems Research and the Water Center. Lusk was also one of the Posters at the Capitol award winners from that sensors project. The State of Tennessee hosts this event annually in which 61 students are invited to show their undergraduate research and meet the State legislators as well as the Governor. It was also announced that Lusk is the second place winner of the American Institute of Chemical Engineers Annual National Student Conference Materials Engineering Science Division competition, to be held in Pittsburg, Pennsylvania, November 2018.

Civil and environmental engineering student John Brackins, advised by Assoc. Prof. Kalyanapu, was invited to participate in the prestigious National Water Center Innovators Program Summer Institute at the U.S. National Oceanic and Atmospheric Administration's National Water Center at the University of Alabama in Tuscaloosa. Brackins said it was a unique opportunity to work with national leaders in hydrology, modeling and decision support.

Chemical engineering Assistant Professor Laura Arias Chavez won the 2017 Young Membrane Scientist Award from the North American Membrane Society. Xi Zhe Ong, Arias Chavez's master's student, won the Best Poster Award at the Tennessee Tech Water Professionals Conference and second place in the Liquid Separations Category of the Student Poster Competition at the 27th Annual Meeting of the North American Membrane Society. Arias Chavez's other master's student Doug Huttes won a \$500 travel award from the North American Membrane Society for the 2018 annual meeting. Kiana Sealy, an undergraduate research advisee who worked on Arias Chavez's EAGER grant, earned the College of Engineering's SPECTRUM Award for her initiatives and achievements in educational, research, and professional development activities. A poster titled "Utilizing Desalination Brine for Concentration of Orange Juice via Forward Osmosis," written by Arias Chavez and students H.D. White, L.M. Templeton, and S.L. Jones, won the graduate student poster competition in the category of Chemical Engineering at the Tennessee Tech Research and Creative Inquiry Day held April 2018.

## INVESTMENTS FOR THE FUTURE

- Addressing the effects of climate changes on endangered species and water availability.
- Expanding research on the causes and consequences of harmful algal blooms.
- Developing methods for using environmental DNA to detect and enumerate endangered and invasive species in Tennessee waterways.
- Advancing work in remote sensing of aquatic ecosystems using site-based and aerial imaging.
- Furthering outreach through local water resource protection and management projects and student activities like Engineering a Future and the Creative Inquiry and Research Day.

# TABLE OF CONTENTS

## PROGRAMMATIC REPORT

MESSAGE FROM THE INTERIM DIRECTOR ..... 1

### RESEARCH

Benefits to the State of Tennessee ..... 2

Accomplishments and Awards ..... 3

Faculty and Expertise ..... 4

Return on the State's Investment in the Center ..... 5

Center Project Highlights ..... 6

Research Feature ..... 10

Investments for the Future ..... 11

Mission Statement ..... 11

The Center's Strategic Goals ..... 12

### EDUCATION

Enhancing Education and Research ..... 13

### PUBLIC SERVICE

Professional Service ..... 14

Analytical Capabilities ..... 15

Support Staff ..... 16

### PROGRESS

Current Fiscal Year ..... 17

## SUPPORTING MATERIALS

Externally Funded Projects ..... S1

Refereed Publications ..... S3

Publications in Press ..... S4

Presentations ..... S4

Personnel ..... S8

Graduate Student Support ..... S9

Hourly Student Support ..... S10

## BUDGET

Schedule 7 ..... B1

# PROGRAMMATIC REPORT

## MESSAGE FROM THE INTERIM DIRECTOR



*Dear Stakeholders,*

*This past year, the Water Center has continued to grow in both the breadth and depth of its water-related research and supporting activities. We have increased our collaborations with faculty across campus, and increased Center support of undergraduate and graduate student research. This year's projects consist of a wide variety of issues including TWRA-funded investigations of invasive Asian carp in our rivers, TDEC-funded research to remove nutrients from wastewater treatment plants more efficiently, and USDA-funded research to maintain aquatic resource quality in agricultural ecosystems. Water Center faculty have also begun working with multiple state agencies to install a much-needed flood monitoring and early-warning system for Cummins Falls and Window Cliffs state parks. Projects such as these provide a strong base that enables the Center to maintain a leading role in regional and national water resource protection and management.*

*Over the next year, we plan to continue to grow our support of graduate student education, faculty research activities, and community involvement. We will also seek to establish additional connections within the Tennessee Tech community through new collaborations with researchers in our School of Environmental Sciences, and Earth Sciences and Agriculture departments, and other Tennessee Tech centers. We will also strive to increase our support of our state and federal partners to position ourselves to address the most pressing issues facing Tennessee and our region.*

*Thank you for your continued support as we further our mission to improve water resources and better serve the state, national, and global water resource stakeholders.*

*Sincerely,*

A handwritten signature in black ink that reads "Justin N. Muddock". The signature is written in a cursive, flowing style.

*Interim Center Director*

# BENEFITS TO THE STATE OF TENNESSEE

The Water Center's work in water and wastewater research, wildlife and fisheries management, hydrological modeling, sensor development, ecosystem services, and many other areas related to water resource protection is becoming more relevant as environmental issues continue to be pushed to the front of our nation's attention. Additionally, as Tennessee's economy becomes more interlinked with natural resources, the Center's role in meeting state water informational needs is expanding. Specifically, the Water Center has benefited Tennessee by drawing in millions of dollars of externally funded research and providing its citizens with the awareness and knowledge needed to effectively manage the state's precious and imperiled water resources.

Water Center researchers work closely with the Tennessee Department of Environment and Conservation (TDEC) and Tennessee Department of Transportation (TDOT) to assess surface water quality issues. For example, civil and environmental engineering assistant and associate professors Tania Datta and Alfred Kalyanapu are researching nutrient movement within stormwater, and the potential of vegetation swales to infiltrate stormwater runoff from Tennessee's highways.

Center researchers serve as the primary research arm of the Tennessee Wildlife Resources Agency Fisheries Division and the State's greater than \$480 million annual fishing industry and \$21 billion annual outdoor recreation industry, which reaches approximately 900,000 anglers. The work of Mark Rogers and Amanda Rosenberger in the U.S. Geological Survey (USGS) Cooperative Fishery Research Unit at Tennessee Tech, and biology and environmental study professors Brad Cook, Hayden Mattingly, Carla Hurt, Donald Walker, Chris Murray, and Justin Murdock

have helped protect endangered and threatened aquatic species in rivers throughout the state, as well as helped better manage fisheries resources from invasive species such as Asian carp and didymo.

The Water Center recently became part of a multi-state agency and Tennessee Tech initiative to design and build an early-warning flash flood system for Cummins Falls and Window Cliffs state parks to alert staff of flash flood events that endanger park visitors.

This past fiscal year, the Center provided Tennessee Tech with approximately \$167,000 in graduate student support.

Also this past fiscal year, Water Center faculty and associates made 21 presentations to Tennessee agencies or within the state. (For a complete listing of presentation and publication information, see Page S4.)

The Water Center's faculty and associates realize the importance of sharing their research with the citizens of Tennessee. One way they do this is by serving on committees or becoming members of State organizations or active boards. As an example, last fiscal year, our faculty and associates took part in the following committees, organizations or events that benefit the state: Tania Datta and Alfred Kalyanapu served on the Technical Work Group for the Tennessee Water Plan that is being initiated under Governor Haslam. Steven Hayslette served as an Executive Board member (a Southeastern Section Representative) of the Tennessee Chapter of The Wildlife Society. Hayden Mattingly was a federally appointed member of the Bluemask Darter Technical Team of the U.S. Fish and Wildlife Service.

# ACCOMPLISHMENTS AND AWARDS

Water Center faculty and associates are recognized nationally for research in aquatic biodiversity, technology development, and water security and sustainability.

Faculty and associate faculty with the Water Center secured approximately \$2.2 million (including indirect costs) from state and federal agencies and private industries to seek solutions to environmental problems. The direct monetary return on the State's investment is \$1.84/State-allocated dollar. This is a 49.5% increase in external matching funds over the previous year.

Water Center researchers produced 13 refereed publications and made 47 presentations.



Datta



Kalyanapu

Environmental engineering Associate Professor Alfred Kalyanapu and Assistant Professor Tania Datta were referenced in a *Herald-Citizen* article titled "Improving Safety at Cummins Falls," published August 6, 2017 (<http://herald-citizen.com/stories/improving-safety-at-cummins-falls,22690>).

Datta also earned the 2017 Tennessee Tech University Distinguished Service Learning Award for extraordinary contributions by a faculty member in the area of service learning and was selected as a finalist for the 2017 Outstanding Faculty Award for Professional Service sponsored by Home Instead Senior Care.

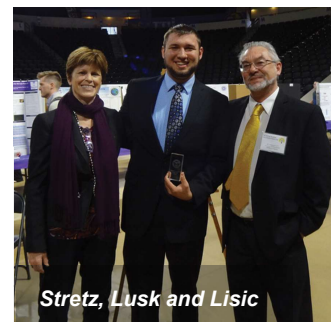
Amanda Rosenberger, assistant unit leader of the Tennessee Cooperative Fishery Research Unit and associate professor of biology, won the 2017 award for Outstanding Fisheries and Wildlife Sciences Faculty Member of the Fish and Wildlife Student Organization. Also, Rosenberger's students Kayla N. Key, G. Lindner, and K. Bouska were awarded the Best Student Oral Platform Presentation Award for their paper titled "A Hierarchical Approach to Mussel Conservation: From Niche Modeling to Field Monitoring," presented at the 2017 Freshwater Mollusk Conservation Society 10th Biennial Symposium in Cleveland, Ohio.



Rosenberger

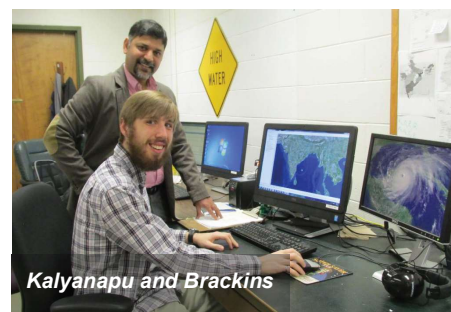
Parker Lusk, a senior in Chemical Engineering advised by Professor Holly Stretz, was named as an extraordinary student contributor among the Creative Inquiry Summer Experience awardees at the Tennessee Tech 13th Annual Research and Creative Inquiry Day. His work is on sensors as part of the water-energy-nexus collaboration between the Center for Energy Systems Research and the Water Center. Lusk was also one of the Posters at the Capitol award winners from that sensors project. The State of Ten-

nessee hosts this event annually in which 61 students are invited to show their undergraduate research and meet the State legislators as well as the Governor. It was also announced that Lusk is the second place winner of the American Institute of Chemical Engineers Annual National Student Conference Materials Engineering Science Division competition, to be held in Pittsburg, Pennsylvania, November 2018.



Stretz, Lusk and Lisic

Civil and environmental engineering student John Brackins, advised by Assoc. Prof. Kalyanapu, was invited to participate in the prestigious National Water Center Innovators Program Summer Institute at the U.S. National Oceanic and Atmospheric Administration's



Kalyanapu and Brackins

National Water Center at the University of Alabama in Tuscaloosa. Brackins said it was a unique opportunity to work with national leaders in hydrology, modeling and decision support.

Chemical engineering Assistant Professor Laura Arias Chavez won the 2017 Young Membrane Scientist Award from the North American Membrane Society. Xi Zhe Ong, Arias Chavez's master's student, won the Best Poster Award at the Tennessee Tech Water Professionals Conference and second place in the Liquid Separations Category of the Student Poster Competition at the 27th Annual Meeting of the North American Membrane Society. Arias Chavez's other master's student Doug Huttes won a \$500 travel award from the North American Membrane Society for the 2018 annual meeting. Kiana Sealy, an undergraduate research advisee who worked on Arias Chavez's EAGER grant, earned the College of Engineering's SPECTRUM Award for her initiatives and achievements in educational, research, and professional development activities. A poster titled "Utilizing Desalination Brine for Concentration of Orange Juice via Forward Osmosis," written by Arias Chavez and students H.D. White, L.M. Templeton, and S.L. Jones, won the graduate student poster competition in the category of Chemical Engineering at the Tennessee Tech Research and Creative Inquiry Day held April 2018.

## RESEARCH

# FACULTY AND EXPERTISE

## Faculty and Associates in *Biodiversity*

**Brian Carver**  
(Biology)

**Dan Combs**  
(Biology)

**Brad Cook**  
(Biology)

**Keith Gibbs**  
(Biology)

**Steve Hayslette**  
(Biology)

**Carla Hurt**  
(Biology)

**Robert Kissell**  
(Biology)

**Hayden Mattingly**  
(Environmental Studies)

**Justin Murdock**  
(Biology)

**Chris Murray**  
(Biology)

**Mark Rogers**  
(Biology and USGS Cooperative  
Fishery Research Unit)

**Amanda  
Rosenberger**  
(Biology and USGS Cooperative  
Fishery Research Unit)

**Donald Walker**  
(Biology)

## Faculty and Associates in *Enabling Technologies and Tools*

**Jeff Boles**  
(Chemistry)

**Tania Datta**  
(Civil and Environmental  
Engineering)

**Sheikh Ghafoor**  
(Computer Science)

**Alfred Kalyanapu**  
(Civil and Environmental  
Engineering)

**Justin Murdock**  
(Biology)

**Chris Murray**  
(Biology)

**Donald Walker**  
(Biology)

## Faculty Associates and Associates in *Water-Energy-Food Nexus*

**Bharat Soni**  
(Vice President, Research  
and Economic Development)

**Laura Arias Chavez**  
(Chemical Engineering)

**Michael Best**  
(Agriculture)

**Tania Datta**  
(Civil and Environmental  
Engineering)

**Brian Leckie**  
(Agriculture)

**Satish Mahajan**  
(Center for Energy  
Systems Research)

**Holly Stretz**  
(Chemical Engineering)

## Faculty and Associates in *Water Security and Sustainability*

**Laura Arias Chavez**  
(Chemical Engineering)

**Joseph Asante**  
(Earth Sciences)

**Dan Dodson**  
(Water Center)

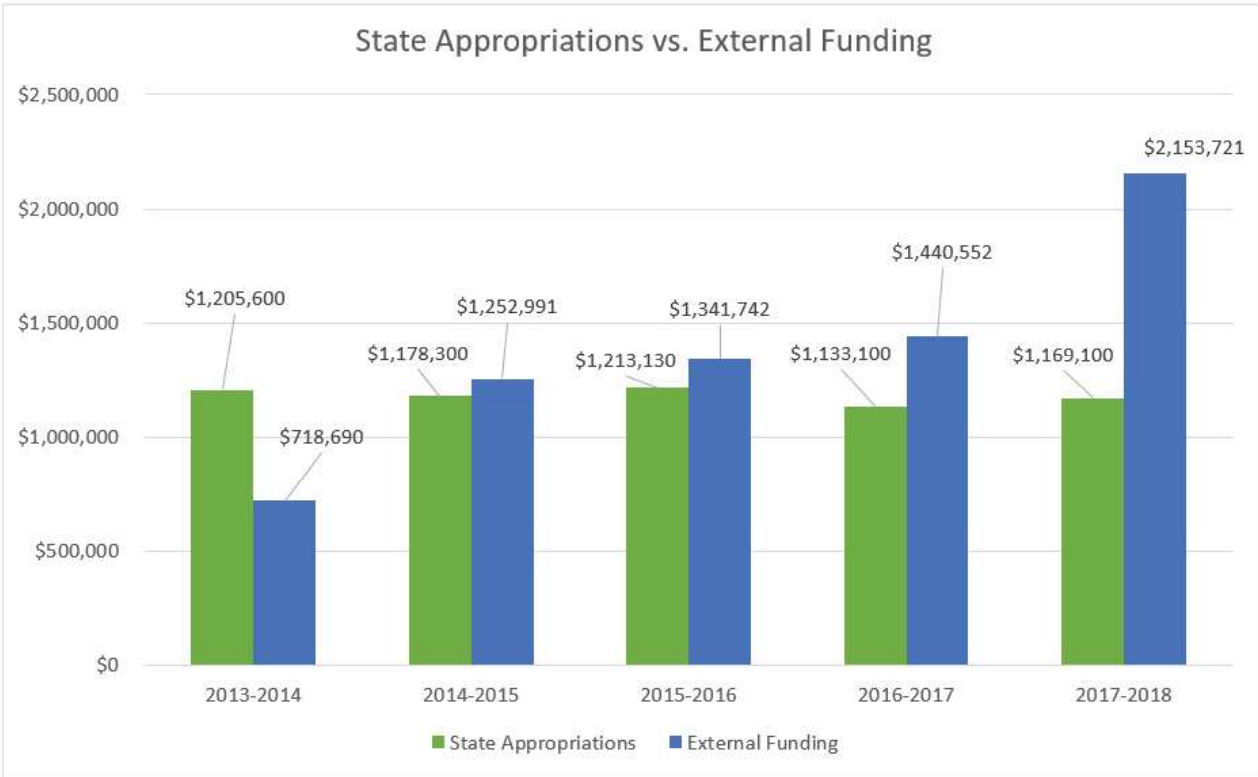
**Justin Murdock**  
(Biology)

**Tania Datta**  
(Civil and Environmental  
Engineering)

**Alfred Kalyanapu**  
(Civil and Environmental  
Engineering)



# RETURN ON THE STATE'S INVESTMENT IN THE CENTER



Note: External funding amount includes indirect costs.

# CENTER PROJECT HIGHLIGHTS

## DRONES



Gathering streamflow information during flooding events is essential to many aspects of watershed management; however, data collection can be very dangerous. Key flood measurements for water and wildlife managers, as well as emergency first responders, are measures of flood magnitudes that exceed the riverbanks and flow into the adjoining floodplains. Unmanned aerial vehicles (commonly known as drones) are becoming more available and less expensive. People have been using drones for various recreational activities, and some have recently started using these for research purposes. In this project, researchers from Tennessee Tech's Water Center and Penn State University are investigating the use of drones in measuring streamflow in rivers and streams, so that streamflow during floods can be measured at a lower risk. The initial tests were conducted on measuring streamflow along the Cumberland, Caney Fork and Obion rivers, in middle and western Tennessee.

## RESEARCH

# CENTER PROJECT HIGHLIGHTS (CONT.)



## FISHERIES

Bighead carp, *Hypophthalmichthys nobilis*, and silver carp, *H. molitrix* (collectively referred to as bigheaded carp), were introduced to the United States in the 1970s and have become established in the Tennessee and Cumberland rivers. Little research has been conducted on bigheaded carp in Tennessee waters. Mark Rogers and his students at the Tennessee Tech USGS Cooperative Fishery Research Unit are using catch data to assess sampling efficiency and spatial variation in densities of bigheaded carp in reservoirs of the Tennessee and Cumberland rivers, and using telemetry data to inform movement among lakes. Bigheaded carp were sampled using electrofishing and gill nets in Summer 2017 and overnight gill net sets in Fall 2017 and Spring 2018. Locks at Tennessee River dams have been outfitted with acoustic telemetry receivers to monitor fish movements. More than 100 silver carp have been implanted with acoustic telemetry transmitters in Kentucky, Tennessee, and Mississippi waters of the Tennessee River. While the project is currently ongoing, average size of bigheaded carp was 668 mm.

The bigheaded carp density data has been used to help inform management decisions for controlling bigheaded carp in Tennessee waters and provide effective methods for sampling bigheaded carp in large impoundments. Movement data will inform movement timing, lock management, and barrier construction strategies to restrict further upstream invasion of these nuisance species.



## RESEARCH

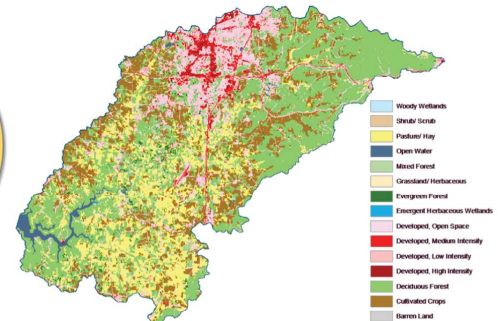
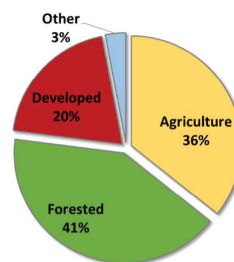
# CENTER PROJECT HIGHLIGHTS (CONT.)



Tania Datta, assistant professor of environmental engineering, and Alfred Kalyanapu, associate professor of environmental engineering, are leading a project to better understand and protect the Falling Water River watershed. This HUC10 watershed is located in Middle Tennessee and is home to two state and three city parks, several natural areas, and a unique karst hydrology, resulting in springs, sinkholes and sinking streams. About 63% of the watershed area is wooded/agricultural, while 24% is urbanized near the City of Cookeville. However, increasing urban development, ongoing recreational activity, and growth in industrial and commercial entities are slowly affecting the health of this watershed. As this watershed is crucial for the Upper Cumberland's growing economy, developing a long-term management strategy is imperative for its protection. To allow for a sustainable management strategy, the Tennessee Tech-led ongoing project is developing effective ways to characterize the watershed using existing data, and is bringing stakeholders together to streamline data collection efforts and decrease duplication of work, as well as facilitate data sharing and encourage collaboration among stakeholders. Geographic Information Systems (GIS) technology allows for data visualization and analysis at the

## WATERSHEDS

watershed level, facilitating a deeper understanding of the spatial relationships between water quality, land use, and the karst hydrology. Therefore, a database and GIS geodatabase are being developed to house data collected from stakeholders and provide online data sharing among stakeholders. Descriptive statistics are being used to determine the spatio-temporal variability of water quality at five-year intervals. Moreover, a hydrologic model and watershed quality index (WQI) tool are being developed to enhance decision-making capabilities, leading to efficient management of watersheds while meeting the needs of urban development. The WQI tool can be used to illustrate the positive or negative effect of land-use changes on water quality, and can be developed to utilize existing GIS data from a variety of sources. The project is funded by the Upper Cumberland Development District and the Tennessee Department of Environment and Conservation, and supported by several local stakeholders. A photo of one of the stakeholder meetings is presented above.



# CENTER PROJECT HIGHLIGHTS (CONT.)

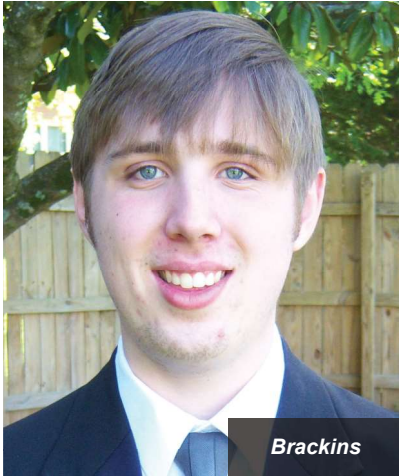


Fully reclaiming industrial wastewaters instead of sequestering or degrading their components could broadly enhance sustainability across society. Laura Arias Chavez, assistant professor of chemical engineering, and her students are assessing how well a hybrid forward osmosis (FO) - reverse osmosis (RO) membrane process could reclaim all components of wastewater associated with production of synthetic fuel via bio-feedstocks. FO performs the first separation while RO regenerates the FO draw solution to ensure the process operates continuously. This dual membrane configuration provides two selective barriers to enhance water quality and maximize its potential reuse. Solute transport

through each of these membranes can also be customized by independently adjusting the pH of the feed (wastewater) solution and the NaCl draw solution. By exploiting the pH-dependency of speciation for different contaminants, wastewater components can be sequestered in different parts of the hybrid system, leading to optimal fractionation. The transport and recovery of hydrocarbons, ammonia, cyanide, nickel, and zinc containing species across commercial and lab-fabricated FO membranes are quantified as a function of pH, recovery, and draw solution concentration. Water flux and solute transport through commercial RO membranes at different pH and draw solute concentrations were also investigated. While fouling does diminish water flux, stable operation can be achieved at modest fluxes of 1 to 3 L m<sup>-2</sup> h<sup>-1</sup> with raw wastewater in the FO stage. Comparing the observed pH dependency of solute transport with that expected for particular compounds (e.g., free cyanide vs. organic cyanides) also provides insight into the specific composition of the wastewater. These preliminary results suggest that the FORO hybrid system could be an effective process for reclamation of industrial wastewater.

INDUSTRIAL  
WASTEWATER

# RESEARCH FEATURE



Civil and environmental engineering student John Brackins, from Franklin, Tennessee, is dedicated to his field of study. This is evidenced by his pursuit of concurrent master's and doctoral degrees on the topic of hurricane storm surges. That determination to advance his studies in water resources resulted in

an invitation to participate in the National Water Center Innovators Program Summer Institute at the U.S. National Oceanic and Atmospheric Administration's National Water Center at the University of Alabama in Tuscaloosa from June 10 through July 28.

"This is a unique opportunity to work with people from a broad range of fields," said Brackins. "I am honored to have been chosen."

The Institute boasts national leaders in hydrology, modeling, and decision support, as well as other graduate students from across the nation and around the globe.

"John began his work four years ago as an undergraduate," said Alfred Kalyanapu, Brackins' advisor and associ-

ate professor in environmental engineering at Tennessee Tech. "His focus is on creating a model that will predict the results of combined storm surge and rainfall-driven flooding from hurricanes. John is hopeful that this research may overlap with the projects he is able to work on at the Summer Institute."

"We will be living on the UA campus for seven weeks," Brackins said. "In the first couple of weeks, we will learn about the National Water Center, then we will pick from a number of the Center's themes for our summer research. The last five weeks will be spent working on those specific projects."

All of the projects are designed to contribute to the National Water Center's goals of enhancing water-related products and decision-support services across the country. This year's project themes are hyper-resolution modeling; groundwater flow modeling with an emphasis on groundwater-surface water interactions; and the computational aspects of hydrologic modeling. All of the projects will be led by experts in these fields from universities across the country. Even the process to become a theme leader was competitive, according to Brackins.

"I'm excited to get to learn from such highly qualified leaders, and from other next-generation researchers," said Brackins, who is also a graduate research assistant in the Water Center.

# INVESTMENTS FOR THE FUTURE

- Addressing the effects of climate changes on endangered species and water availability.
- Expanding research on the causes and consequences of harmful algal blooms.
- Developing methods for using environmental DNA to detect and enumerate endangered and invasive species in Tennessee waterways.
- Advancing work in remote sensing of aquatic ecosystems using site-based and aerial imaging.
- Furthering outreach through local water resource protection and management projects and student activities like Engineering a Future and the Creative Inquiry and Research Day.

## Mission Statement

The mission of the Water Center is to support state and federal agencies, communities, and industry in solving water quality, biodiversity, and water security problems and advancing scientific understanding of all aspects of water science and engineering through basic and applied research. Center researchers study aquatic biodiversity and ecology from genes to ecosystems; address water quality challenges and de-

velop better treatment technologies; and implement state-of-the-art technologies and tools for watershed sciences, modeling and simulation, data acquisition and geospatial analysis. The Center provides a strong water resources research infrastructure at Tennessee Tech by supporting faculty research, training and mentoring of future water professionals, and serving the citizens of the state of Tennessee.

# THE CENTER'S STRATEGIC GOALS

- **Increase recognition of the Center and its faculty through invited presentations, refereed publications, and other promotion initiatives. Produce a minimum of eight refereed publications per year and present at a minimum of 10 professional, regional, national or international meetings per year.**

Related University Strategic Focus Area:

Create Distinctive Programs and Invigorate Faculty

Action Plan:

The Center plans to meet this goal through encouraging refereed publications, continued external funding, focused research, and participation in professional organizations, faculty obtain state, regional and national recognition.

Assessment:

Annual faculty achievement reports contain information on scholarly works.

- **Increase externally funded research, which addresses the diverse water-related problems in Tennessee, the nation and the world. Toward this goal, the Water Center strives to maintain a minimum external funding of 75% of state appropriations.**

Related University Strategic Focus Area:

Create Distinctive Programs and Invigorate Faculty

Action Plan:

Strategic focus areas have been established by Center faculty and faculty associates. A portion of Water Center funds is being invested in selected high-return, research focus areas. Priority for the remaining research funds will be given to projects with potential to secure additional related external funds. The Center annually supports faculty who seek external research funds by: reviewing proposals prior to their being sent off campus; providing travel funds to support PIs in meeting with agency program directors to discuss research opportunities; keeping faculty informed about research opportunities; bringing faculty together to develop interdisciplinary research proposals; and providing essential matching funds and student research support. The Center is working with the

university administration to keep Tennessee's Congressional delegation informed about research findings and new emerging areas of research.

Assessment:

The Water Center will assess its goal of increasing external funding through the expansion of external collaborations. These collaborations will extend into all aspects of improving water quality including expanding initiatives in water-energy-food-nexus projects and sensors and other information technology tools to help society and the community. Collaborative relationships and intellectual capital will also be developed to support the Tennessee Department of Environment and Conservation and the Tennessee Department of Transportation in their environmental efforts throughout the state.

The Water Center annually assesses the external funds received during the State's fiscal year. The Center conducts trend analyses to determine progress toward achieving goals and asserts corrective action when needed.

- **Increase the number of graduate students supported by the Center.**

Related University Strategic Focus Area:

Create Distinctive Programs and Invigorate Faculty

Action Plan:

Currently, the Water Center combines its resources with external funding to support graduate students at the level of \$1,200 per month for master's students. Doctoral students receive \$1,750 per month. The Center will continue to work with academic units and faculty to support up to 12 graduate students annually. Toward improving graduate student enrollment, the Water Center will also focus on sustaining undergraduate student research through offering research opportunities with the Center faculty.

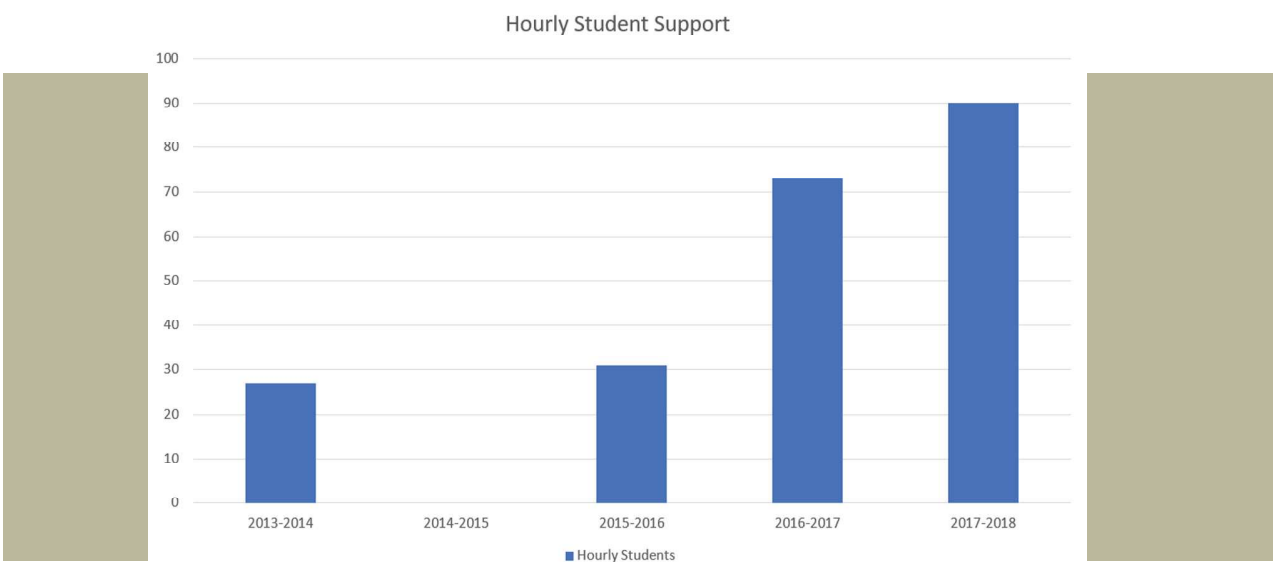
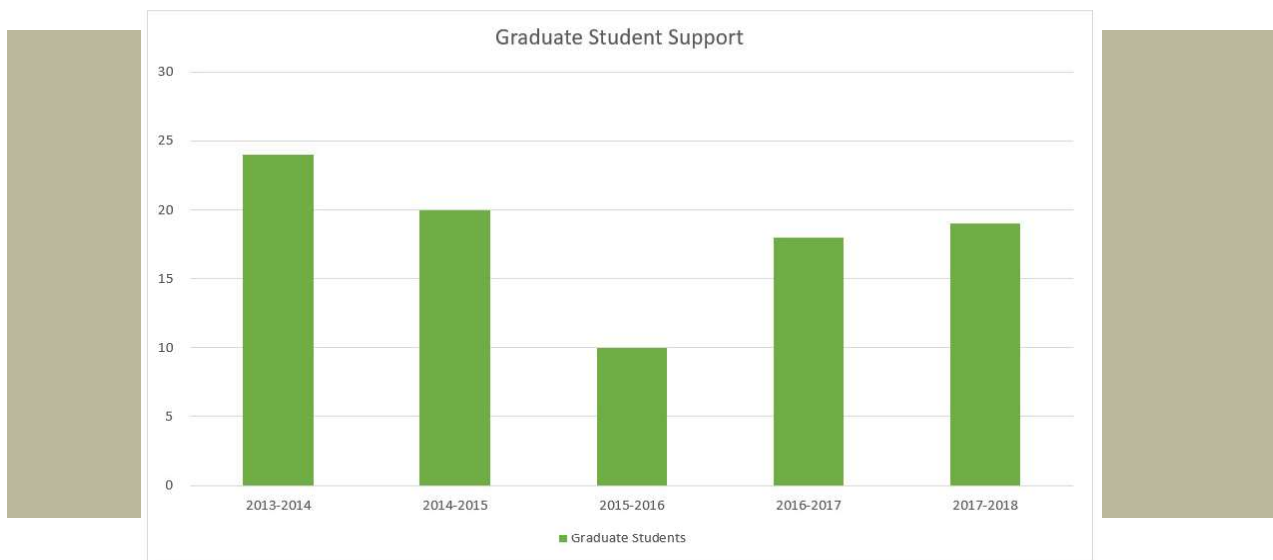
Assessment:

The Center will continue to increase its initiative to support graduate students in their environmental science-/engineering-related research. Annually, the Center will assess how many students have been supported.



# ENHANCING EDUCATION AND RESEARCH

Without students, the Water Center could not continue to engage in its research initiatives. Therefore, the Center strives to ensure that its students are offered the most cutting-edge opportunities in environmental research. This fiscal year, the Center supported 19 graduate research assistants in six different academic majors. The Center also supported 90 students from 18 majors on an hourly basis to work on research and service projects in the field, in laboratories and in the office. Forty-four of those students were supported by the Center appropriations, and 56 were supported through external project funds.



# PROFESSIONAL SERVICE

**Laura Arias Chavez**, assistant professor of chemical engineering, was the newsletter editor for the Association of Environmental Engineering and Science Professor, Session Co-Chair for the 2018 Annual Meeting of the North American Membrane Society, and Session Presider for the 2018 Spring Meeting of the American Chemical Society. She also reviewed proposals for the National Science Foundation.

**Tania Datta**, assistant professor of environmental engineering, served as the Task Force Chair for the Water Environment Federation (WEF) Water Reuse Task Force of the Municipal Water Resource Recovery Design Committee. She also serves on the Technical Work Group for the Tennessee Water Plan that is being initiated under the leadership of Governor Haslam. Datta is an active member of the Literature Review Committee and Municipal Water Resource Recovery Design Committee of the WEF. She served as Judge and Session Moderator for the American Society of Microbiology KY-TN Branch Annual Meeting held in November 2017 and also, along with David Beck, assistant professor in biology, organized a career panel for students in the field of microbiology for that meeting. Datta has reviewed papers for the *Environmental Engineering Science*, *Water Science and Technology*, and American Society for Engineering Education Annual Conference publications. She also co-organized the 2017 Distinguished Kappe Lecture with the University of Tennessee and Vanderbilt University. Datta's outreach activities extended into the community as she led an activity for the 2017 Engineering a Future event, designed to inspire middle school girls to pursue STEM-related career paths.

**Steve Hayslette**, professor of biology, was an active member of the national organization and the Tennessee Chapter of The Wildlife Society (TN-TWS). He also served as an Executive Board member (a Southeastern Section Representative) of the TN-TWS from 2017 through 2018. He was Program Chair for the Spring 2017 TN-TWS meeting and will be Program Chair for the 2018 meeting. Hayslette was the Tennessee Tech faculty liaison for the Tennessee Wildlife Resources Agency (TWRA) Internship program co-sponsored by the University of Tennessee-Knoxville and by the TWRA in 2017 and 2018. Hayslette was a judge for the 13th Annual Tennessee Tech Research and Creative Inquiry Day in April 2018. With Haily Hinson and other Tennessee Tech students, Hayslette conducted 18

animal-related programs for local schools, scouting groups, and other youth organizations.

**Alfred Kalyanapu**, associate professor of environmental engineering, was the President of the Tennessee Section of the American Water Resources Association (TN AWRA), President-Elect of the Computational Hydraulics Committee of the American Society of Civil Engineers (ASCE), member of the Tennessee Infrastructure Report Card Committee of the ASCE, a member of the Tennessee H<sub>2</sub>O Surface Water Subcommittee, and an award reviewer for the American Geophysical Union and the Civil and Environmental Engineering Renaissance Spectrum Awards Committee. He also reviewed articles for the journal *Hydrological Processes* and ASCE *Journal of Hydraulic Engineering*. Kalyanapu also reviewed the Proceedings of the 2017 Environmental and Water Resources Institute (EWRI) World Water Congress and the 2017 TN AWRA Conference.

**Hayden Mattingly**, professor of environmental studies, is an editorial board member and manuscript editor for the *Southeastern Naturalist*. He also reviewed journal manuscripts for the *Transactions of the American Fisheries Society* and *Oecologia*. He was a Technical Session Moderator at the Southeastern Fishes Council Annual Meeting held in Chattanooga in November 2017. He was also a federally appointed member of the Bluemask Darter Technical Team of the U.S. Fish and Wildlife Service and a professional society member of the American Fisheries Society, American Society of Ichthyologists and Herpetologists, Society for Conservation Biology, and Southeastern Fishes Council. Mattingly was also a children's activities volunteer and musical performer at Crossville Waterfest in July 2017 and the entertainment chairperson and musical performer at the St. Thomas Aquinas International Fall Festival in September 2017. He was also a faculty judge at the 2018 Tennessee Tech Research and Creative Inquiry Day and was a musical performer and entertainment coordinator for Volunteer State Community College and Tennessee Tech's Earth Day Festival in April 2018.

**Amanda Rosenberger**, assistant unit leader of the USGS Cooperative Fishery Research Unit and associate professor of biology, was an associate editor for the *Transactions of the American Fisheries Society*.

## PUBLIC SERVICE

# ANALYTICAL CAPABILITIES

The Water Center offers unique analytical capabilities through its state-certified consulting lab including the following services:

- Industrial wastewater treatment process analysis design
- Drinking water and wastewater treatability studies
- Wastewater characterization studies
- Wastewater treatment unit process evaluation using nonstandard analytical techniques including particle size distribution analysis, solids oxygen demand determination, and long-term biochemical oxygen demand
- Aerobic and anaerobic biological wastewater treatment process pilot studies
- Coagulation process optimization using zeta potential measurements
- Activated carbon absorption studies
- Robotic reservoir/stream water quality analysis
- GIS capabilities for field study design

The environmental quality lab continues to support faculty and student research, as well as the surrounding

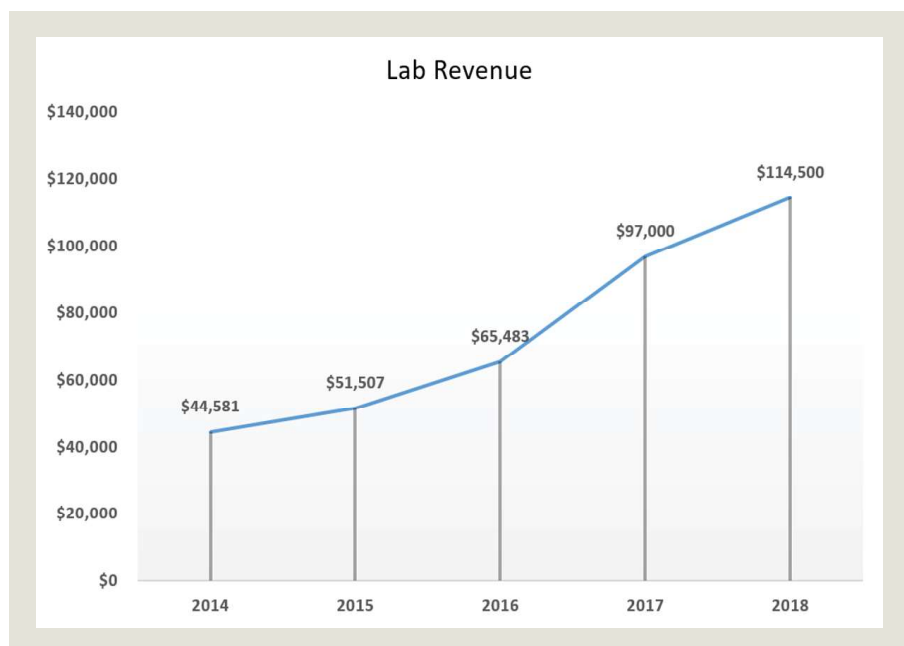
community by offering stand-alone analytical services at a reasonable cost. These include:

- Drinking water regulatory parameters
- Conventional wastewater pollutants
- Metals
- Bacteriological analyses
- Organic analysis, GC and GCMS capabilities to analyze for THMs, HAAs, and semi-volatiles

The Water Center Laboratory also offers field sampling and monitoring capabilities including:

- Composite field sampling for local businesses
- Stream velocity measurements
- Field-dissolved oxygen, pH, temperature, conductivity, and ORP measurements
- GPS position logs of all sampling sites

The lab is managed by Dan Dodson, and is staffed by analysts Phillip Burr and David Hobbs. The quality and reliability of the Water Center Lab has led to steady increase in lab revenue, with the current fiscal year its busiest and most profitable year yet.



# SUPPORT STAFF



*Sandy Garrison,  
Office Manager*



*Karen Warren,  
Financial Associate*



*Amy Hill,  
Editor*



*Dan Dodson,  
Lab Manager*



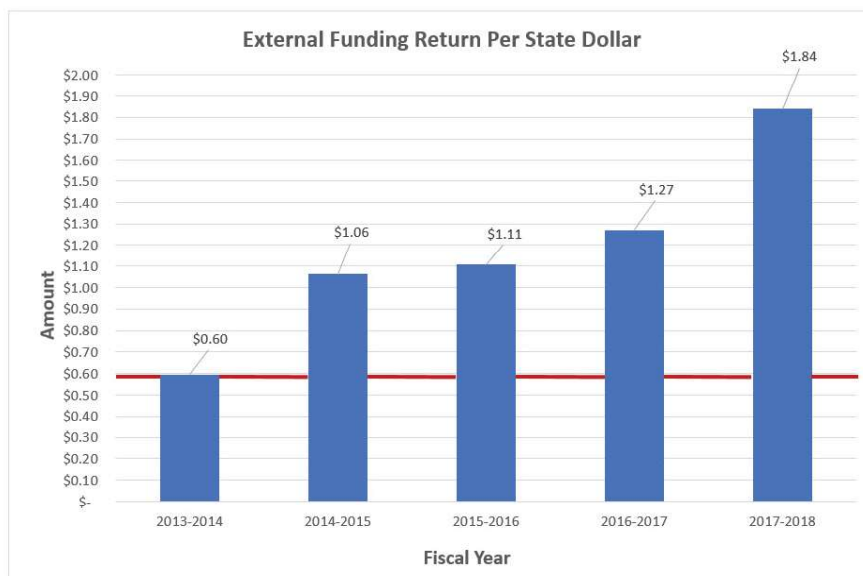
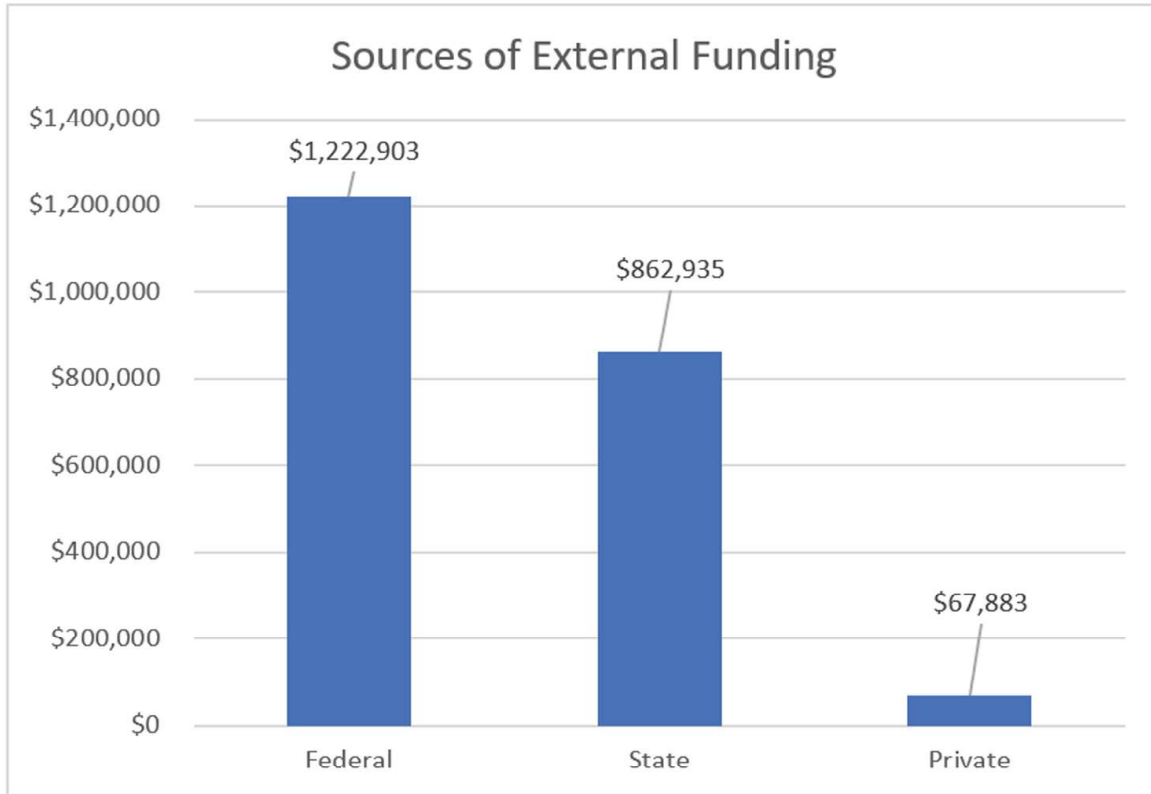
*Phillip Burr,  
Academic Support  
Associate 8  
(lab technician)*



*David Hobbs,  
Lab Support*

Our staff brings years of expertise in their respective areas of work, and they include Sandy Garrison, office manager, and Karen Warren, financial associate, who work with faculty to prepare budgets for grants and are also integral in administering the financial reporting and details required once a grant is earned. Amy Hill, editor, provides editorial, graphic design and poster-printing assistance to faculty and students and also prepares the Center's annual report and updates the website. The Water Center Analytical Laboratory is managed by Dan Dodson, who oversees all of the lab's functions and has also been a principal investigator on funded research. Phillip Burr is an academic support associate, and David Hobbs provides additional lab support. Center staff are recognized across campus for excellence in their respective duties.

# CURRENT FISCAL YEAR



This year, Center researchers partnered with state and federal governmental agencies and private entities to secure in excess of \$2.2 million through externally funded projects. Of this, funding from states' governmental agencies accounted for \$862,935; federal agencies \$1,222,903; and private entities \$67,883. These amounts reflect a \$1.84 return per dollar of State appropriation.

## PROGRESS

### Aquatic Agroecosystems

*J. Murdock/U.S. Department of Agriculture*

**Activation This Year:** \$10,000

**Project Period:** 9/1/2017-8/31/2022

### Avian Occurrence and Habitat Use at Naval Support Activity Mid-South

*S. Hayslette/U.S. Geological Survey*

**Activation This Year:** \$48,459

**Project Period:** 8/9/2017-6/29/2018

### Brook Trout Restoration

*K. Gibbs/National Park Service*

**Activation This Year:** \$5,000

**Project Period:** 8/1/2017-7/31/2018

### Collection of Biological Data at Deer Check Stations

*S. Hayslette/Tennessee Wildlife Resources Agency*

**Activation This Year:** \$2,000

**Project Period:** 7/1/2016-6/30/2021

### Determination of Geomorphological and Landscape Factors Contributing to Diverse Unionoid Mussel

*A. Rosenberger/Missouri Department of Conservation*

**Activation This Year:** \$23,250

**Project Period:** 7/1/2017-6/30/2018

### Determining Bluemask Darter Ecological Requirements at Multiple Spatial Scales to Support Reintroductions in the Calfkiller River System

*H. Mattingly/U.S. Fish and Wildlife Service*

**Activation This Year:** \$30,000

**Project Period:** 7/1/2017-7/1/2022

### Determining the Current Distribution and Potential Spread of Didymo in North Carolina Streams

*J. Murdock/North Carolina Community Foundation*

**Activation This Year:** \$31,508

**Project Period:** 4/19/2018-9/18/2018

### Ecological and Climatic Assessment of Flying Squirrels in East Tennessee

*B. Carver/Tennessee Wildlife Resources Agency/U.S. Fish and Wildlife Service*

**Activation This Year:** \$38,000

**Project Period:** 10/1/2017-6/30/2018

### Endangered Tennessee Bats and Development of WNS Biocontrol Agents

*D. Walker/Tennessee Wildlife Resources Agency*

**Activation This Year:** \$30,000

**Project Period:** 5/15/2017-3/31/2019

### Environmental DNA Detection, Population Status, and Habitat Use of the Pygmy Madtom

*H. Mattingly/Tennessee Wildlife Resources Agency*

**Activation This Year:** \$24,000

**Project Period:** 12/1/2014-10/31/2018

### Evaluating Sport Fisheries

*M.W. Rogers/Tennessee Wildlife Resources Agency*

**Activation This Year:** \$40,000

**Project Period:** 7/1/2017-6/30/2022

### Evaluating Stocked Fisheries

*M.W. Rogers/Tennessee Wildlife Resources Agency*

**Activation This Year:** \$66,000

**Project Period:** 7/1/2017-6/30/2022

### Evaluation of Bush-Type Heirloom Green Beans to Expand Markets for TN Specialty Crop Growers

*B. Leckie/Tennessee Department of Agriculture*

**Activation This Year:** \$20,000

**Project Period:** 11/1/2017-8/1/2020

### Genomic Variation and Species Diversification in Alpheid Snapping Shrimps

*C. Hurt/National Geographic Society*

**Activation This Year:** \$20,000

**Project Period:** 12/1/2017-12/1/2018

### GOALI: Reclaiming Valuable Resources from Industrial Wastewater

*L. Arias Chavez/National Science Foundation*

**Activation This Year:** \$90,738

**Project Period:** 8/15/2016-7/31/2019

### Intern for Propagation of Freshwater Mussels and Fishes in Tennessee

*A. Rosenberger/Tennessee Wildlife Resources Agency*

**Activation This Year:** \$13,062

**Project Period:** 5/16/2018-10/15/2018

### Intern for Propagation of Freshwater Mussels and Fishes in Tennessee (second activation)

*A. Rosenberger/Tennessee Wildlife Resources Agency*

**Activation This Year:** \$7,033

**Project Period:** 5/16/2018-10/15/2018

### Investigation on the Structure of Human Beta Defensin Type 3 in Lipids

*L. Zhang/Burroughs Wellcome Fund*

**Activation This Year:** \$10,825

**Project Period:** 6/1/2018-12/31/2019

**Externally Funded Projects (cont.)  
(Projects Activated in Fiscal Year 2017-2018)**

Linking Diversity Polyphosphate  
*B. Mohr/National Science Foundation Fellowship to Grace McClellan*

**Activation This Year:** \$46,000

**Project Period:** 6/1/2017-5/31/2018

The Origin, Host and Geographic Range of Snake Fungal Disease with an Emphasis on Species

*D. Walker/Tennessee Wildlife Resources Agency*

**Activation This Year:** \$1,500

**Project Period:** 9/1/2016-4/30/2018

The Origin, Host and Geographic Range of Snake Fungal Disease with an Emphasis on Species (second activation)

*D. Walker/Tennessee Wildlife Resources Agency*

**Activation This Year:** \$1,500

**Project Period:** 9/1/2016-4/30/2018

Performance Evaluation of Existing Vegetated Swales for Stormwater Runoff Reduction

*T. Datta/Ensafe Inc. Funded by Tennessee Department of Transportation*

**Activation This Year:** \$271,011

**Project Period:** 1/17/2018-3/11/2020

Prioritizing Fish Reintroduction in Lower Abrams Creek, Great Smoky Mountains National Park

*B. Leckie/Tennessee Wildlife Resources Agency*

**Activation This Year:** \$17,150

**Project Period:** 7/1/2016-6/30/2018

Project INSPIRE: A STEM Teacher Residency

*J. Boles/National Science Foundation*

**Activation This Year:** \$479,644

**Project Period:** 8/15/2014-7/31/2020

Proof-of-Concept GIS-Based Vegetated Swale Algorithm for TDOT Highways (GV-SwATH)

*A. Kalyanapu/Ensafe Inc. Funded by Tennessee Department of Transportation*

**Activation This Year:** \$185,193

**Project Period:** 1/9/2018-3/11/2020

Rangewide Population Status Assessment for the Rare Barrens Darter, *Etheostoma forbesi*

*H. Mattingly/U.S. Fish and Wildlife Service*

**Activation This Year:** \$40,000

**Project Period:** 9/14/2017-7/31/2018

Relative Population Densities, Movement and Spawning Success of Asian Carp

*M.W. Rogers/Tennessee Wildlife Resources Agency*

**Activation This Year:** \$62,760

**Project Period:** 12/1/2016-6/30/2018

Res Insect Resistant Tomatoes

*B. Leckie/NIFA-U.S. Department of Agriculture*

**Activation This Year:** \$300,000

**Project Period:** 6/1/2018-7/31/2021

Spatial Assessment of the Status and Risk to Mussel Concentrations in the Meramec Drainage

*A. Rosenberger/The Missouri Department of Conservation*

**Activation This Year:** \$31,484

**Project Period:** 7/1/2017-6/30/2019

Status of Streamside Salamander in Central Tennessee

*C. Hurt/Tennessee Wildlife Resources Agency*

**Activation This Year:** \$5,834

**Project Period:** 1/1/2018-6/30/2019

Tracking the Sources of Nitrogen Pollutants in TDOT MS4 Stormwater Discharges

*T. Datta/Ensafe Inc. Funded by Tennessee Department of Transportation*

**Activation This Year:** \$170,000

**Project Period:** 9/6/2016-3/31/2018

U.S.-Iraq Higher Education Partnerships Program-Solid Waste Management Improvement in Iraq

*T. Datta/IREX*

**Activation This Year:** \$5,550

**Project Period:** 7/5/2017-2/28/2018

Valley Flame Crayfish, Molecular and Morphological Taxonomy

*C. Hurt/Tennessee Wildlife Resources Agency*

**Activation This Year:** \$4,000

**Project Period:** 1/1/2018-12/31/2018

Water Quality Profile of the Little Black River System to Determine Potential Causes for Decline

*A. Rosenberger/The Missouri Department of Conservation*

**Activation This Year:** \$22,220

**Project Period:** 7/1/2017-6/30/2018

## Refereed Publications

Ahmadisharaf, E.A., A.J. Kalyanapu, and E.-S. Chung. 2017. "Sustainability-Based Flood Hazard Mapping of the Swannanoa River Watershed," *Sustainability*, 9, 1735, doi:10.3390/su9101735.

Bhuyian, Md.N.M., A.J. Kalyanapu, and F. Hossain. 2017. "Evaluating Conveyance-Based DEM Correction Technique on NED and SRTM DEMs for Flood Impact Assessment of the 2010 Cumberland River Flood," *Geosciences*, 7, 132, doi:10.3390/geosciences7040132.

Curtis, W.J., A.E. Gebhard, and J.S. Perkin. 2018. "The River Continuum Concept Predicts Prey Assemblage Structure for an Insectivorous Fish Along a Temperate Landscape," *Freshwater Science*, doi:10.1086/699013.

Dillard, J.G., A.E. Rosenberger, and E. Tracy-Smith. 2018. "Still Hooked: Our First 50 Years," Missouri Chapter of the American Fisheries Society, Columbia. ISBN 978-1-61600-518-4.

Foley, K., A.E. Rosenberger, and F. Mueter. 2018. "Longitudinal Patterns of Juvenile Coho Salmon Distribution and Abundance in Headwater Streams of the Little Susitna River, Alaska," *Transactions of the American Fisheries Society*, 147, 247-264.

Knorp, N.E., and J.N. Murdock. 2017. "Exclusion Size and Material Have Minimal Effects on Stream Benthic Algae and Macroinvertebrate Colonization within Submerged Cages," *Aquatic Ecology*, 54, 545-556.

Laske, S.M., A.E. Rosenberger, M.S. Wipfli, and C.E. Zimmerman. 2018. "Generalist Feeding Strategies in Arctic Freshwater Fish: A Mechanism for Dealing with Harsh Environments," *Ecology of Freshwater Fish*, doi: 10.1111/eff.12391.

Laske, S.M., A.E. Rosenberger, W.J. Kane, M.S. Wipfli, and C.E. Zimmerman. 2017. "Top-Down Control of Invertebrates by Ninespine Stickleback in Arctic Ponds," *Freshwater Biology*, doi:10.1086/690675.

Malone, E.W., J.S. Perkin, B.M. Leckie, M.A. Kulp, C.R. Hurt, and D.M. Walker. 2018. "Which Species, How Many, and From Where: Integrating Habitat Suitability, Population Genomics, and Abundance Estimates Into Species Reintroduction Planning," *Global Change Biology*, doi:10.1111/gcb.14126.

Marshall, R., S.K. Ghafoor, A.J. Kalyanapu, M. Rogers, and T.T. Dullo. 2017. "Performance Improvement of a Two-Dimensional Flood Simulation Application in Hybrid Computing Environments," Proceedings of the Fifth International Symposium on Computing and Networking (CANDAR 17), November 19-22, 2017, Aomori, Japan.

Mikawa, M., T. Datta, Y. Amano, and M. Machida. 2017. "Dominant Characteristics Between *Microcystis aeruginosa* and *Cyclotella* sp. Accompanying Dilution Process in Eutrophic Lake," *Water, Air and Soil Pollution*, 228(5), 174.

Ohemeng-Ntiamoah, J., and T. Datta. 2018. "Evaluating Analytical Methods for the Characterization of Lipids, Proteins, and Carbohydrates in Organic Substrates for Anaerobic Co-Digestion," *Bioresource Technology*, 247, 697-704.

Wellemeier, J.C., J.S. Perkin, J.D. Fore, and C. Boyd. 2018. "Comparing Assembly Processes for Multimetric Indices of Biotic Integrity," *Ecological Indicators*, 89, 590-609.



## Publications in Press

Bouska, K., A.E. Rosenberger, S.E. McMurray, G. Lindner, and K. Key. State-Level Freshwater Mussel Programs: Current Status and a Research Framework to Aid in Mussel Management and Conservation.

Rosenberger, A.E. "Principles of Thermal Ecology: Temperature, Energy, and Life." Written by Andrew Clarke. New York (United States): Oxford University Press. ISBN: 978-0-19-955166-8. The Quarterly Review of Biology.

Zuber, B.C., and H.T. Mattingly. "*Etheostoma forbesi*, Barrens Darter," in George, A.L. (ed.). Conservation Plans for Imperiled Fishes of the Mobile, Tennessee, and Cumberland Rivers. Tennessee Aquarium Institute, Chattanooga, TN.

## Presentations

Allen, S., C. Guy-Baker, T. Datta, and A.J. Kalyanapu. "Developing a Web-Based Geodatabase for Data Sharing and Collaboration within the Falling Water River Watershed," presented at the 27th Tennessee Water Resources Symposium, Montgomery Bell State Park, Tennessee, April 2018.

Allen, S., C. Guy-Baker T. Datta, and A.J. Kalyanapu. "Web-Based Geodatabase for the Characterization and Management of a Karst Watershed," presented at the 27th Tennessee Water Resources Symposium, Montgomery Bell State Park, Tennessee, April 2018.

Arias Chavez, L.H., S.B. Hornsby, P. Ranjan, B.J. Goans, and K.T. Sealy. "Importance of Variability in Surface Morphology of Polyamide Selective Layers on Thin-Film Composite Membranes," presented at the National Meeting of the American Chemical Society, New Orleans, Louisiana, 2018.

Arias Chavez, L.H., A.S. Mohammad, J.J. Biernacki, M.R. Esfahani, and E.M. Languri. "Limitations of the Structural Parameter for Understanding Forward Osmosis," presented at the International Congress on Membranes and Membrane Processes, San Francisco, California, 2017.

Blackburn, A. "Benthic Macroinvertebrate and Periphyton Response to Antimycin During Brook Trout Restoration in a Small Headwater Stream," presented at the Tennessee Tech Research and Creative Inquiry Day, Cookeville, Tennessee, April 9-10, 2018.

Blackburn, A. "Benthic Macroinvertebrate and Periphyton Response to Antimycin During Brook Trout Restoration in a Small Headwater Stream" presented at the 2018 Society for Freshwater Science Conference, Detroit, Michigan, May 20-24, 2018.

Brackins, J.T., A.J. Davis, S.E. Wilson, and A.J. Kalyanapu. "Development of a Hydrologic Modeling System for the Dry Valley Catchment, Putnam County, Tennessee," presented at the 26th Tennessee Water Resources Symposium of the Tennessee Chapter of the American Water Resources Association, Nashville, Tennessee, April 11-13, 2018.

Caudle, J., W.G. Wells, S. Kenney, H.T. Mattingly, and J. Wolak. "Analysis of Microhabitat Preferences of the Mountain Madtom, *Noturus eleutherus*," presented at the Tennessee Tech University Research and Creative Inquiry Day, Cookeville, Tennessee, April 2018.

Caudle, J., S. Kenney, W. Wells, H.T. Mattingly, and J. Wolak. "Water Depth and Substrate Use of *Noturus eleutherus* in the Clinch River, Tennessee," presented at the Southeastern Fishes Council Annual Meeting, Chattanooga, Tennessee, November 2017.

Chilton, J., and A.E. Rosenberger. "Habitat Associations of Endemic Crayfishes in the Meramec River Drainage: The Freckled Crayfish (*Cambarus maculatus*) and Belted Crayfish (*Faxonius harrisonii*)," presented at the Missouri Natural Resources Conference, Osage Beach, Missouri, February 2018.

## Presentations (cont.)

Chilton, J., and A.E. Rosenberger. "The Detectability of Two Rare Crayfish Species in the Meramec River Drainage: The 'Vulnerable' Freckled Crayfish and Belted Crayfish," presented at the Annual Meeting of the American Fisheries Society, Tampa, Florida, August 2017.

Dullo, T., S., Gangrade, R. Marshall, S.R. Islam, S. Ghafoor, S.-C. Kao, and A.J. Kalyanapu. "A Large-Scale Simulation of Climate Change Effects on Flood Regime--A Case Study for the Alabama-Coosa-Tallapoosa River Basin," presented at the 2016 American Geophysical Union Fall Meeting, December 12-16, 2017, San Francisco, California.

Evans, J., and J. Murdock. "Linking Water Depth to Denitrification in Shallow Agricultural Lakes," presented at the Society for Freshwater Science National Meeting, Detroit, Michigan, May 2018.

Guy-Baker, C., T. Datta, and A.J. Kalyanapu. "Toward Development of a Systematic Framework and Watershed Quality Index Tool for Karst Watershed Management," presented at the 27th Tennessee Water Resources Symposium, Montgomery Bell State Park, Tennessee, April 2018.

Hornsby, S.B., B.J. Goans, K.T. Sealy, and L.H. Arias Chavez. "Variability in Morphology of Polyamide Active Layers for Thin Film Composite Membranes," presented at the International Congress on Membranes and Membrane Processes, San Francisco, California, 2017.

Huttes, D.A., X.-Z. Ong, L.M. Templeton, and L.H. Arias Chavez. "Separation of Inorganic Components from Industrial Wastewater via a Hybrid Forward Osmosis--Reverse Osmosis System," presented at the 13th Annual Research and Creative Inquiry Day, Cookeville, Tennessee, 2018.

Huttes, D.A., X.-Z. Ong, L.M. Templeton, H.D. White, and L.H. Arias Chavez. "Separation of Inorganic Components from Industrial Wastewater via a Hybrid Forward Osmosis-Reverse Osmosis System," presented at the 27th Annual Meeting of the North American Membrane Society, Lexington, Kentucky, 2018.

Huttes, D.A., X.-Z. Ong, L.M. Templeton, and L.H. Arias Chavez. "Separation of Inorganic Components from Industrial Wastewater via a Hybrid Forward Osmosis--Reverse Osmosis System," presented at the International Congress on Membranes and Membrane Processes, San Francisco, California, 2017.

Kalyanapu, A.J. "Tennessee Tech's Water Resources Modeling and Simulations," presented to the Environmental Sciences Division at Oak Ridge National Laboratory, September 20, 2017 (invited presentation).

Key, K., A. Rosenberger, G. Lindner, and K. Bouska. "Hierarchical Approach to Mussel Conservation: From Niche Modeling to Field Monitoring," presented at the American Fisheries Society Annual Meeting, August 2017.

Key, K., A. Rosenberger, and C. Krause. "A User-Friendly Tool to Identify Potential Threats to Species on a Landscape Level," presented at the 2017 Organization of Fisheries and Wildlife Information Managers Conference, Chattanooga, Tennessee, October 2017.

Key, K.N., A. Rosenberger, G. Lindner, and K. Bouska. "A Hierarchical Approach to Mussel Conservation: From Niche Modeling to Field Monitoring," presented at the 2017 Freshwater Mollusk Conservation Society 10th Biennial Symposium, Cleveland, Ohio, 2017 (invited presentation and winner of the Best Student Oral Platform Presentation Award).

Litmer, A.R., and C. Murray. "Neutrophil: Lymphocyte Ratios as a Measure of Chronic Stress in Populations of the Hellbender (*Cryptobranchus allegnaiensis*) Across a Habitat Quality Gradient," presented at the Southeast Partners in Amphibian and Reptile Conservation Annual Meeting, Helen, Georgia, 2018.

Litmer, A.R., and C. Murray. "Neutrophil: Lymphocyte Ratios as a Measure of Chronic Stress in Populations of the Hellbender (*Cryptobranchus allegnaiensis*) Across a Habitat Quality Gradient," presented at the Organization of Fish and Wildlife Information Managers, Chattanooga, Tennessee, 2017.

## Presentations (cont.)

Litmer, A.R., and C. Murray. "The Critical Thermal Capacity of Dispersal: Comparative Niche Breadth Among Populations of the Mediterranean Gecko (*Hemidactylus turcicus*)," presented at the Joint Meeting of Ichthyologists and Herpetologists, Austin, Texas, 2017.

Litmer, A.R., and C. Murray. "Neutrophil: Lymphocyte Ratios as a Measure of Chronic Stress in Populations of the Hellbender (*Cryptobranchus allegnaiensis*) Across a Habitat Quality Gradient," presented at the Tennessee Herpetological Society, Murfreesboro, Tennessee, 2017.

Lusk, P., H.A. Stretz, and M.J.M. Wells. "Detection of Lead Contamination in Water Using Fluorescence of Functionalized Gold Nanoparticles," presented at the American Institute of Chemical Engineers Annual National Student Conference, Pittsburgh, Pennsylvania, November 2018.

McClellan, G.E., and T. Datta. "A Look into the Microbial Community of a Wastewater Treatment Facility Undergoing Optimization for Nutrient Removal," presented at the American Society for Microbiology (ASM) KY/TN Conference, Tennessee Tech University, Cookeville, Tennessee, November 10-11, 2017.

McConnell, M.T., and H.T. Mattingly. "Water Quality Analysis of Coliform Bacteria at Selected Sites in the Cumberland River Basin of Middle Tennessee," presented at the Volunteer State Community College Annual Earth Day Celebration, Cookeville, Tennessee, April 2018.

Mohammadzadeh, M., H.A. Stretz, and R. Mu. "IR Fluorescent Probe for Water-Based Agricultural Nutrients," presented at the 255th American Chemical Society National Conference, New Orleans, March 2018.

Mott, R., and A.E. Rosenberger. "Effects of Sublethal Stressors on Topeka Shiner (*Notropis topeka*) Physiology," presented at the Annual Meeting of the American Fisheries Society, Tampa, Florida, August 2017.

Murdock, J., M.A. Locke, R.E. Lizotte, Jr., and J.M. Taylor. "Surface Water Quantity Management Can Improve Water Quality and Nutrient Retention in Agricultural Watersheds," presented at the West Tennessee Water Resources Symposium, February 2018.

Murdock, J., M.A. Locke, R.E. Lizotte, Jr., and J.M. Taylor. "Surface Water Quantity Can Regulate Aquatic Agroecosystem Water Quality and Nutrient Retention," presented at the Tennessee American Water Resources Association Meeting, April 2018.

Murdock, J., K. Henderson, J. Payne, and J. Evans. "Surface Water Availability Can Regulate Water Quality and Nutrient Retention in Aquatic Agroecosystems," presented at the Society for Freshwater Science National Meeting, Detroit, Michigan, May 2018.

Ong, X.-Z., D.A. Huttes, L.M. Templeton, and L.H. Arias Chavez. "Organic Transport and Fouling in Forward Osmosis Separation of Industrial Wastewater," presented at the 13th Annual Research and Creative Inquiry Day, Cookeville, Tennessee, 2018.

Ong, X.-Z., D.A. Huttes, L.M. Templeton, H.D. White, and L.H. Arias Chavez. "Organic Transport and Fouling in the Reclamation of Industrial Wastewater with a Hybrid Forward Osmosis-Reverse Osmosis System," presented at the 27th Annual Meeting of the North American Membrane Society, Lexington, Kentucky, 2018.

Ong, X.-Z., D.A. Huttes, L.M. Templeton, and L.H. Arias Chavez. "Organic Transport and Fouling in Forward Osmosis Separation of Industrial Wastewater," presented at the International Congress on Membranes and Membrane Processes, San Francisco, California, 2017.

Ranjan, P., S.B. Hornsby, and L.H. Arias Chavez. "The Role of Polyamide Morphology in Determining Contact Angle Variability," presented at the International Congress on Membranes and Membrane Processes, San Francisco, California, 2017.

## Presentations (cont.)

Roberts, A., J. Hundley, A. Rosenberger, K.L. Bouska, D. Mosby, B. Simmons, and G. Lindner. "Quantitative Survey of Freshwater Mussels (*Unionoidea*) and Assessment of Sediment Contamination in the Big River, Missouri," presented at the Society of Environmental Toxicology and Chemistry Annual Meeting, November 2017.

Rosenberger, A. "Landscape Ecology of Alaska Fishes," presented for the Institute of Agriculture, University of Tennessee, Knoxville, April 2018.

Schrum, M., A.E. Rosenberger, and S. McMurray. "Identification of the Cause of Mussel Population Collapse, and Current Water Quality and Habitat Suitability Assessment in the Little Black River System, Carter, Ripley, and Butler Counties, Missouri," presented at the Missouri Natural Resources Conference, Osage Beach, Missouri, February 2018.

Stretz, H.A. "Towards Self-Cleaning Chlorine Resistant Water Treatment Membranes," American Institute of Chemical Engineers/Eastman Corp., Kingston, Tennessee, November 2017.

Stretz, H.A., and A. Altalhi, "Montmorillonite-Modified Aromatic Polyamide Membrane Materials with Chlorine Resistance," presented at the American Institute of Chemical Engineers Annual Meeting, Pittsburgh, Pennsylvania, November 2018.

Wells, W., and H.T. Mattingly. "Preliminary Analysis of Age-Class Structure and Longevity for the Endangered Pygmy Madtom, *Noturus stanauli*," presented at the Southeastern Fishes Council Annual Meeting, Chattanooga, Tennessee, November 2017.

West, J.M. "Range-Wide Population Genetic Structure of Rafinesque's Big-Eared Bat, *Corynorhinus rafinesquii*, and Southeastern Myotis, *Myotis austroriparius*," presented to the Biology 1000 class at Tennessee Tech University, Cookeville, Tennessee, November 2018 (invited presentation).

West, J.M., and B.C. Carver. "Range-Wide Population Genetic Structure of Rafinesque's Big-Eared Bat, *Corynorhinus rafinesquii*, and Southeastern Myotis, *Myotis austroriparius*," presented to the Mississippi Bat Working Group, March 1, 2018 (invited presentation).

White, H.D., L.M. Templeton, S.L. Jones, and L.H. Arias Chavez. "Utilizing Desalination Brine for Concentration of Orange Juice via Forward Osmosis," presented at the 13th Annual Research and Creative Inquiry Day, Cookeville, Tennessee, 2018 (winner of the graduate student poster competition in the category of Chemical Engineering).

# Personnel

## Administration and Faculty

Dr. Justin Murdock  
Dr. Tania Datta  
Dr. Alfred Kalyanapu  
Dr. G. Kim Stearman

Interim Center Director, Associate Professor of Biology  
Assistant Professor of Civil and Environmental Engineering  
Associate Professor of Civil and Environmental Engineering  
Professor of Agriculture

## Support Staff

Phillip C. Burr  
Daniel P. Dodson  
Sandy Garrison  
Amy K. Hill  
David Hobbs  
Karen Warren

Laboratory Technician  
Technical Laboratory Manager  
Office Manager  
Editor  
Laboratory Support  
Financial Associate

# Graduate Student Support

## Name

## Major

### Master's Students

Sarah Brown	Biology
Savannah Fernholz	Biology
Jordan Holtsworth	Biology
Valerie Jones	Biology
Phillip Kacmar	Biology
Eric Malone	Biology
William T. Wood	Biology
Douglas Huttes	Chemical Engineering
Alexander Davis	Civil and Environmental Engineering
A. Danielle Kirkpatrick	Civil and Environmental Engineering
Melissa Moffet	Civil and Environmental Engineering
Ryan Wigner	Civil and Environmental Engineering
Samantha Allen	Professional Science Master's-Environmental Studies

### Ph.D. Students

Nowfel Bhuyian	Engineering
John Brackins	Engineering
Tigstu Dullo	Engineering
Grace McClellan	Engineering
Mahdi Mohammadizadeh	Engineering
Juliet Ohemeng-Ntiamoah	Engineering
Haley White	Engineering
Kayla N. Key	Environmental Science
Robert Paine	Environmental Science

# Hourly Student Support

Name	Major
Christopher Rector	Accounting
Mary A. Holden	Agriculture
Erik Koehler	Agriculture
David White	Agriculture-Horticulture
Andrew Moore	Biochemistry
Megan Wharton	Biochemistry
Cory Blackwelder	Biology
Rachel Conradi	Biology
Samuel J. Day	Biology
Jordan Evans	Biology
Savannah Fernholz	Biology
Jesse Flowers	Biology
Emily Geist	Biology
Ryan Hanscom	Biology
Jordan Holtswarth	Biology
Nathaniel Wade Hubbs	Biology
Valerie Jones	Biology
Phillip Kacmar	Biology
Moriah Kitts	Biology
Jacob Leys	Biology
Allison Litmer	Biology
Ashlee Nichols	Biology
Robert Paine	Biology
Isabel R. Papraniku	Biology
Corinne Wellemeier	Biology
Jason Wogsland	Biology
Spencer Womble	Biology
William Wood	Biology
Coty Young	Biology
Eric Malone	Biology/Fisheries and Aquaculture
Benjamin Jones	Cellular and Molecular Biology
Brooks Goans	Chemical Engineering
Stanton Hornsby	Chemical Engineering
Douglas Huttes	Chemical Engineering
Kiana Sealy	Chemical Engineering
Leif Templeton	Chemical Engineering
Haley White	Chemical Engineering
David T. Hobbs	Chemistry
Jacob Barber	Civil and Environmental Engineering
Nd Nowfel M. Bhuyian	Civil and Environmental Engineering
Jacob Blocker	Civil and Environmental Engineering
John Brackins	Civil and Environmental Engineering
Joseph Brockwell	Civil and Environmental Engineering
Bruce Cunningham	Civil and Environmental Engineering
Tyler Darroch	Civil and Environmental Engineering
Alexander Davis	Civil and Environmental Engineering

# Hourly Student Support

Name	Major
Tigstu Dullo	Civil and Environmental Engineering
Hunter Dyer	Civil and Environmental Engineering
Rex S. Gamble	Civil and Environmental Engineering
Christine Guy-Baker	Civil and Environmental Engineering
Chris Kaczmarek	Civil and Environmental Engineering
Danielle Kirkpatrick	Civil and Environmental Engineering
Melissa Moffet	Civil and Environmental Engineering
Juliet Ohemeng-Ntiamoah	Civil and Environmental Engineering
Kyle Pattison	Civil and Environmental Engineering
Jason Randolph	Civil and Environmental Engineering
Abigail Shores	Civil and Environmental Engineering
Rachel Stewart	Civil and Environmental Engineering
Prince Turkson	Civil and Environmental Engineering
Ryan Wigner	Civil and Environmental Engineering
Tyler Wright	Civil and Environmental Engineering
Muzakhir Amanzholov	Computer Science
Jasmin Baniya	Computer Science
Dakota Aaron	Electrical and Computer Engineering
Maria McConkey	Electrical and Computer Engineering
Mahdi Mohammadizadeh	Electrical and Computer Engineering
Reginald Seay	Electrical and Computer Engineering
Christopher Stringer	Electrical and Computer Engineering
Samantha Allen	Environmental Informatics
Czarinna Clay	Environmental Informatics
Mike Bolan	Environmental Science
Elias W. Vaden	Environmental Science
W. Grady Wells	Environmental Science
Matthew Grisnik	Environmental Science/Biology
John Johansen	Environmental Science/Biology
Jedidiah Scott	Environmental Studies
Jeffrey Bess	Manufacturing and Engineering Technology
Fantasia Erdman	Microbiology
Olivia Bowers	Pre-Med Technology
Justin Medley	Research and Economic Development
Xi Zhe Ong	Research and Economic Development
Jason Payne	Research and Economic Development
Joseph Bentley	Wildlife and Fisheries Science
Aden Blackburn	Wildlife and Fisheries Science
Sarah Brown	Wildlife and Fisheries Science
Jennifer Caudle	Wildlife and Fisheries Science
Rebekah Champion	Wildlife and Fisheries Science
Hailey Hinson	Wildlife and Fisheries Science
Tyler Slagle	Wildlife and Fisheries Science
Clayton B. Smullen	Wildlife and Fisheries Science



# Budget

Schedule 7  
CENTERS OF EXCELLENCE/CENTERS OF EMPHASIS  
ACTUAL, PROPOSED, AND REQUESTED BUDGET

Tennessee Technological University      Center for the Management, Utilization and Protection of Water Resources

Expenditures	FY 2017-18 Actual			FY 2018-19 Proposed			FY 2019-20 Requested		
	Matching	Apppr.	Total	Matching	Apppr.	Total	Matching	Apppr.	Total
<b>Salaries</b>									
Faculty	\$143,727	\$181,163	\$324,890	\$92,829	\$208,525	\$301,354	\$97,470	\$218,951	\$316,421
Other Professional	\$62,350	\$147,962	\$210,312	\$98,133	\$167,655	\$265,788	\$103,040	\$176,038	\$279,078
Clerical/ Supporting	\$0	\$62,708	\$62,708	\$52,801	\$88,668	\$141,469	\$55,441	\$93,101	\$148,542
Assistantships	\$414,235	\$201,778	\$616,013	\$115,956	\$105,000	\$300,956	\$121,754	\$194,250	\$316,004
<b>Total Salaries</b>	<b>\$620,312</b>	<b>\$593,611</b>	<b>\$1,213,923</b>	<b>\$359,719</b>	<b>\$649,848</b>	<b>\$1,009,567</b>	<b>\$377,705</b>	<b>\$682,340</b>	<b>\$1,060,045</b>
Fringe Benefits	\$186,925	\$197,141	\$384,066	\$137,705	\$200,000	\$337,705	\$144,590	\$210,000	\$354,590
<b>Total Personnel</b>	<b>\$807,237</b>	<b>\$790,752</b>	<b>\$1,597,989</b>	<b>\$497,424</b>	<b>\$849,848</b>	<b>\$1,347,272</b>	<b>\$522,295</b>	<b>\$892,340</b>	<b>\$1,414,635</b>
<b>Non-Personnel</b>									
Travel	\$130,610	\$29,381	\$159,991	\$86,994	\$30,000	\$116,994	\$91,344	\$31,500	\$122,844
Software	\$0	\$7,265	\$7,265	\$0	\$0	\$0	\$0	\$0	\$0
Books & Journals	\$0		\$0	\$0	\$0	\$0	\$0	\$0	\$0
Other Supplies	\$377,190	\$100,196	\$477,386	\$270,680	\$164,952	\$435,632	\$284,214	\$173,200	\$457,414
Equipment	\$97,373	\$134,347	\$231,720	\$0	\$150,000	\$150,000	\$0	\$157,500	\$157,500
Maintenance	\$0	\$150,652	\$150,652	\$0	\$0	\$0	\$0	\$0	\$0
Scholarships	\$46,000	\$0	\$46,000	\$0	\$0	\$0	\$0	\$0	\$0
Consultants	\$472,088	\$0	\$472,088	\$500,839	\$0	\$500,839	\$525,881	\$0	\$525,881
Renovation	\$0	\$60,343	\$60,343	\$0	\$0	\$0		\$0	\$0
Other (Specify):	\$0	\$0	\$0	\$0	\$0	\$0		\$0	\$0
			\$0			\$0			\$0
			\$0			\$0			\$0
			\$0			\$0			\$0
<b>Total Non-Personnel</b>	<b>\$1,123,261</b>	<b>\$482,184</b>	<b>\$1,605,444</b>	<b>\$858,513</b>	<b>\$344,952</b>	<b>\$1,203,465</b>	<b>\$901,439</b>	<b>\$362,200</b>	<b>\$1,263,639</b>
<b>GRAND TOTAL</b>	<b>\$1,930,498</b>	<b>\$1,272,936</b>	<b>\$3,203,433</b>	<b>\$1,355,937</b>	<b>\$1,194,800</b>	<b>\$2,550,737</b>	<b>\$1,423,734</b>	<b>\$1,254,540</b>	<b>\$2,678,274</b>
<b>Revenue</b>									
New State Appropriation	\$0	\$1,169,100	\$1,169,100	\$0	\$1,194,800	\$1,194,800	\$0	\$1,254,540	\$1,254,540
Carryover State Appropriation	\$0	\$319,046	\$319,046	\$0	\$215,210	\$215,210	\$0	\$0	\$0
New Matching Funds	\$1,930,498		\$1,930,498	\$1,355,937	\$0	\$1,355,937	\$1,423,734	\$0	\$1,423,734
Carryover from Previous Matching Funds	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
<b>Total Revenue</b>	<b>\$1,930,498</b>	<b>\$1,488,146</b>	<b>\$3,418,644</b>	<b>\$1,355,937</b>	<b>\$1,410,010</b>	<b>\$2,765,947</b>	<b>\$1,423,734</b>	<b>\$1,254,540</b>	<b>\$2,678,274</b>

Budget Note: The Center for the Management, Utilization and Protection of Water Resources requests a five percent budget increase for the 2018-2019 fiscal year to accommodate potential increases in salaries and other supplies and equipment expenses.

Interim Center Director and Writer: Justin Murdock  
Editor, Designer and Writer: Amy Hill

Center for the Management, Utilization and Protection of Water Resources

Tennessee Technological University  
P.O. Box 5033  
Cookeville, TN 38505-0001  
Phone: (931) 372-3507  
Fax: (931) 372-6346  
E-mail: [cmupwr@tntech.edu](mailto:cmupwr@tntech.edu)  
[www.tntech.edu/watercenter](http://www.tntech.edu/watercenter)

We express our appreciation to Sandy Garrison, Alfred Kalyanapu, Tania Datta, and our other faculty associates for their assistance in the production of this report.

August 2018

Tennessee Tech is committed to maintaining an inclusive community that recognizes and values the inherent worth of every person; fosters tolerance, sensitivity, understanding, and mutual respect; and encourages each individual to strive to reach his/her own potential. Tennessee Tech believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. As such, Tennessee Tech seeks to develop and foster diversity.

Tennessee Tech is committed to ensuring that all individuals have equal access to its employment opportunities, educational programs, services, and activities. Tennessee Tech views, evaluates, and treats all students, employees and applicants on the basis of their own personal abilities, qualifications, and other relevant characteristics.

Tennessee Tech does not condone and will not tolerate discrimination against any individual on the basis of race, religion, color, creed, sex, age, national origin, genetic information, disability, veteran status, and any other bases protected by federal and state civil rights law.

Tennessee Tech does not condone and will not tolerate retaliation against individuals who oppose illegal discrimination or participate in investigations of illegal discrimination pursuant to Tennessee Tech policies.

The following person has been designated to handle inquiries regarding non-discrimination and affirmative action at Tennessee Tech: Libby Gays, Director of Affirmative Action, Derryberry Hall Room 156, Box 5132, Cookeville, TN 38505-001, 931-372-3039, [equity@tntech.edu](mailto:equity@tntech.edu) The TTU policy on nondiscrimination can be found at [www.tntech.edu/ideaa](http://www.tntech.edu/ideaa).

