



Center for the Management, Utilization and Protection
of Water Resources

WHAT'S INSIDE

- Message from the Director
- Center at a Glance
- Accomplishments/Awards
- Research Spotlights

ANNUAL REPORT

FY2020-21

TENNESSEE TECH

TABLE OF CONTENTS

Message from the Director.....	1	Activation Amount & Numbers of Activations.....	22
Center at a Glance.....	2		
Student Highlights		Externally Funded Projects Activated in Fiscal Year 2020-2021.....	23
Sarah Buer.....	3	Refereed Publications.....	26
Haley Holiman.....	5	Publications in Press.....	28
Chioma Onwuchekwa.....	7	Final Reports.....	28
Lori Nabors.....	8	Presentations.....	29
Nusrat Jannah Snigdha.....	9	Hourly Student Support.....	32
Research Spotlights		Schedule 7.....	34
Unsolved Mystery: Harm's Mill Dam.....	10		
River Chubs: Keynote Species in Southeastern Streams.....	12		
Effect of Process Shear on Reverse Osmosis Membranes and Organic Matter Fouling.....	14		
Enhancing Education & Research			
Students Supported.....	15		
Graduate Students Supported.....	16		
Professional Service.....	17		
Analytical Capabilities.....	18		
Support Staff.....	19		
State Appropriations vs. External Funding.....	20		
Allocation of Appropriations & Sources of External Funding.....	21		

Follow us on
Facebook.

[www.tntech.edu/
watercenter](http://www.tntech.edu/watercenter)



MESSAGE FROM THE DIRECTOR

Last year was an unprecedented one driven largely by the need to traverse living and working during a once-in-a-century pandemic, but we figured it out. Our Water Center community remained well, with people doing their best when things were at their worst. The Center was shut down for about two months, but we maintained program continuity while making the abrupt transition to remote operations and an equally abrupt transition to electronic record keeping. This was done on the fly, but we created new ways to get things done with great technical skill and a creative spirit. Those changes created new efficiencies that stayed with us as we reopened cautiously. We learned how to connect and work from home, and scrounged masks, while our water quality lab made spray disinfectant that was shared across campus.

We all learned to use Zoom and Teams, sometimes from the kitchen table. And faculty leaped into the abyss of online learning with electronic systems that were never designed to accommodate the ensuing information overload. It was difficult, but we got used to it. Astounding multitasking was achieved, the pinnacle of which was

evidenced when a scientist delivered a seminar about European fish communities in English while their children were being home schooled in German. Landscape ecology and snack time occurred simultaneously and were executed flawlessly in two languages.

We fully expected a lapse in new research, but it never happened. The temporal pattern of new proposals changed from a seasonal peak in January into a never-ending flow that lasted from February to the present, and we had a record number of new submissions from a record number of faculty investigators. In fact, we now have so many existing and pending projects that we will need to add at least one new position to handle the workload.

The one truly negative outcome was that nearly every existing research project was delayed. People could not travel to field sites in groups, lab work had to be conducted in isolation, and key supplies and new instruments became unavailable due to supply chain disruptions. It was very hard to get anything done, and many of our students will take longer to graduate. But, many other expenses decreased concurrently

(particularly travel), so we have funding available to get everyone over the finish line.

But best of all, the SARS-CoV-2 virus couldn't touch scientific minds. The flow of new ideas for new research never stopped for a moment, and this was the year that we grew to understand our super power, which is interdisciplinary research. People talk about interdisciplinary approaches, but how often do you see a group of fisheries and wildlife scientists, engineers, chemists, and geologists actually sitting in the same meeting to attack water sustainability problems head on? Most of those meetings had to be virtual, or rarely in very large spaces, but they never stopped and the end result was exciting new research initiatives that are ready once we can fully work together again.

It was an awful year. Our dogs knew that we had quit our jobs to spend more time with them while our cats thought that we were all losers who had been fired. But we persevered, and the lessons learned will take us into a future that is as promising as ever.



CENTER AT A GLANCE 2020-2021

- State appropriation of \$1.22 million
- External grants totaling \$2.3 million
- Forty-two active grants
- Twenty-one new proposals submitted
- Return per state dollar: \$1.91
- Seven staff members
- Four faculty focus area leaders
- Twelve faculty principal investigators
- Forty-four graduate students
- Sixty-six hourly student workers
- Twenty-two peer reviewed publications
- Thirty-five professional presentations

ACCOMPLISHMENTS & AWARDS

Civil and environmental engineering associate professor Tania Datta won the Tennessee Tech Award for Excellence in Creative Inquiry Mentoring.

Civil and environmental engineering associate professor Alfred Kalyanapu was an invited keynote speaker for the International Webinar titled "Role of Civil Engineers for Sustainable Development," held July 14-16, 2020. The webinar was organized by the Department of Civil Engineering & Covid'19 Cell, Mar Baselios Institute of Technology and Science, Nellimattom, Kothamangala, Ernakulam, Kerala, India.

SARAH BUER

STUDENT HIGHLIGHTS



Having access to clean and safe water supplies is one of the most basic needs of everything living on Earth. Unfortunately, it has been discovered that both surface and drinking water sources have been contaminated with small amounts of pharmaceutical compounds, including antidepressants, non-steroidal analgesics (e.g., ibuprofen, acetaminophen, etc.), and hormone-based drugs (e.g., birth control, hormone therapy, etc.). While the

short-term effects of exposure to these pharmaceutical compounds are not considered to be immediately harmful to humans, the full effects of long-term exposure are still not well-understood. Two questions that immediately come to mind on hearing of these contaminants are (1) How do the drugs get into the water in the first place? and (2) How do we get the drugs out again without causing further damage?

As for Question 1, pharmaceuticals enter water systems either through veterinary practices or human consumption. In both humans and animals, pharmaceutical compounds are not completely metabolized, or broken down, by the human body. As a result, a small percentage of these drugs pass through the body and into waterways unchanged. Currently, waste water treatment plants (WWTPs) cannot test or treat the plethora of pharmaceutical compounds making their way into our

SARAH BUER (CONT.)

water systems. Given the number of prescriptions written, as well as the number of over-the-counter medications consumed in the U.S. annually, it is no surprise that WWTPs do not have the technology to detect, let alone treat for, this vast number of contaminants.

Which leads us to Question 2: how do we safely remove these drugs from our water? At Tennessee Tech, we are exploring a method to remove pharmaceuticals from water supplies using photocatalytic degradation, which breaks down pharmaceuticals (as well as bacteria and viruses) by using radiation (the “photo” part of the term) to jump-start a chemical reaction using a catalyst. The photocatalyst – a catalyst that is activated using a very specific wavelength of radiation – we have chosen to use is called titanium dioxide (TiO₂ for short). TiO₂ was chosen primarily because it is abundant, non-toxic, hard to break, is very well-studied, and, most importantly, is environmentally friendly. For titanium dioxide to work, it has to be exposed to UV-C radiation, which is slightly more energetic than the UV that gives you a sunburn, but slightly less energetic than X-rays.

For our experiment, we will test the degradation capabilities of our photocatalytic reactor on acetaminophen, which is one of the most commonly used drugs in the world. Our photocatalytic reactor is similar to 1-liter glass soda bottle filled

with a mixture of water and acetaminophen, with a UV-C lamp directly in the middle. Inside the glass bottle and as close to the edges as possible are rectangular pieces of glass where a thin coating of the TiO₂ photocatalyst has been sprayed and cured onto the surface. Once the UV-C lamp is turned on, the photocatalyst is bombarded with radiation and, since this reaction is happening in water, the TiO₂ photocatalyst interacts with the water molecules (H₂O). The water molecule splits into two parts – a hydrogen atom (H⁺) and a hydroxyl radical (OH[•]). The hydroxyl radical is a more powerful disinfectant than chlorine or ozone. This radical is then free to “attack” the pharmaceutical contaminant, which, given enough time, breaks the drug down into harmless components of carbon dioxide (CO₂) and water.

So, how does all of this translate to the real world? The short answer is: we don’t know... yet. In addition to the experimental method described in previous paragraphs, we are also working to develop a mathematical model to describe this reaction process. This model would not only allow us to predict how long it would take to degrade these contaminants, but would also give us insight as to how large the reactor should be and how much of the photocatalyst would be needed to make the system efficient.

.....

HALEY HOLIMAN

.....

STUDENT HIGHLIGHT



Haley Holiman is pursuing her master's degree under Brad Cohen, assistant professor of biology, this fall. She will be studying the occupancy of secretive marsh birds in western Tennessee. Holiman has always been fascinated with wildlife and spent most of her childhood watching birds and chasing snakes. This led her to seeking her undergraduate degree at Mississippi State University, where she studied wildlife sciences and management. There, she had her first research experience as an intern at the Coastal Research and Extension Center, where she studied marsh birds in the

tidal salt marshes of the Gulf of Mexico. After graduating, she worked various bird-related field jobs, including studying Eastern Bluebirds in Alabama, forest birds in south Texas, and most recently marsh birds in southeastern Louisiana.

Throughout her career, she has grown to fully appreciate these species even more and understand the need for clear conservation and management actions. By completing this program, she hopes that she will gain the skills to conduct applied research that will contribute to the protection and



HALEY HOLIMAN (CONT.)



conservation of non-game bird species. Holiman's current research focuses on the occupancy of marsh birds in Tennessee and the development of new field methods for detecting them. Marsh birds are known for being highly elusive and difficult to detect visually; they also select wetland habitats that are difficult to navigate. Many are listed as species of conservation concern at the state and federal levels. This decline is largely attributed to wetland degradation and loss. Marsh birds are highly selective, and a slight change in water levels or vegetation structure can lead to declining populations. In collaboration with the Tennessee Wildlife Resources Agency, Holiman will be evaluating different management practices on both natural and restored wetlands to determine their effect on marsh bird populations. This includes surveys for vegetation and other wetland-dependent characteristics.

They will also be conducting audio call-back surveys for secretive marsh birds. Marsh birds do not call regularly like most bird species but are known to reliably respond to audio playbacks from a speaker. Along with these surveys, Holiman and the TWRA will also be assessing the use of automated recording units to detect marsh birds. ARUs can be left in the field to record for longer periods of time, cause less disturbance than human observers, and potentially detect more species. However, there are also many limitations to ARUs such as cost, size of audio files and potential device failures. The results from this study should help TWRA have a better understanding of what factors influence marsh bird populations in western Tennessee and establish new protocols to better monitor them.

CHIOMA ONWUCHEKWA

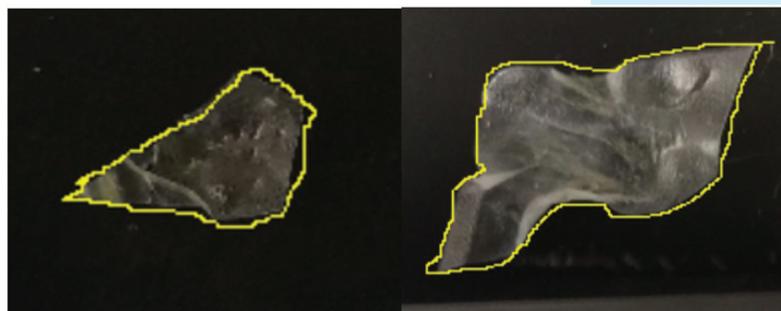
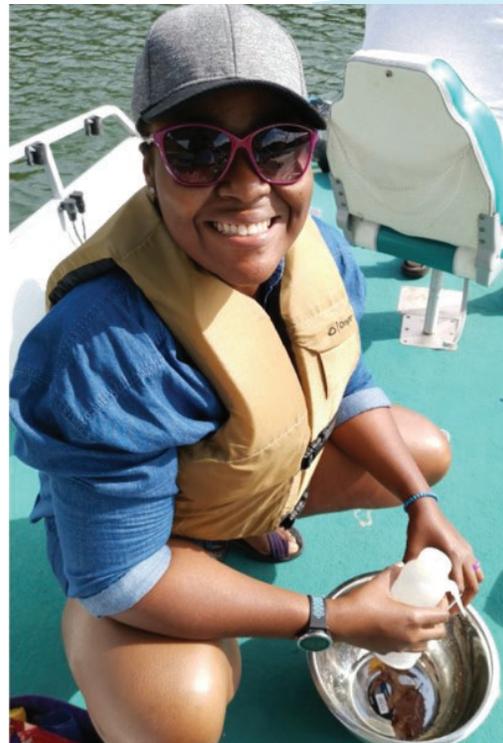
STUDENT HIGHLIGHT

Demand for global plastic production currently exceeds 300 million tons per year, and the world's oceans receive five to 13 million tons year (UNEP, 2016). In the environment, these plastics may undergo some form of weathering from mechanical forces or microorganisms and/or ultraviolet radiation from the sun, resulting in the breaking down of large plastics into smaller plastic particles referred to as microplastics.

Microplastics are plastic fragments are less than 5 mm in diameter and have been found in marine, freshwater, wastewater and terrestrial systems. Microplastics have been ingested by smaller aquatic and terrestrial organisms, resulting in an increase of microplastic pollution in natural food webs. Furthermore, microplastics are everywhere and buoyant, making it easy for them to become widespread chemical pollutants in the environment.

This research aims to quantify and identify the microplastic types and content in select bodies of freshwater and to evaluate the role of the Cookeville Wastewater Treatment Plant in the release of microplastics into the environment. The Water Center has provided unrestricted access to the LUMOS FTIR microscope.

The School of Environmental Studies; the Department of Chemistry; Justin Murdock, associate professor of biology; and Dave Hobbs, Water Center lab analyst; and John Buford and other staff of the Cookeville Wastewater Treatment Plant also provided assistance for the project.



LORI NABORS

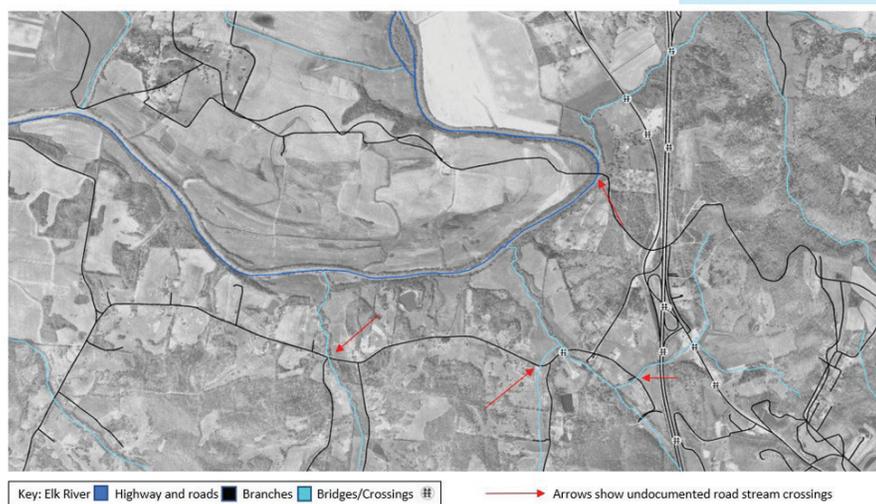
STUDENT HIGHLIGHT

Tennessee has thousands of stream-miles and hundreds of places where roads cross those streams via bridges and culverts. Unfortunately, those sites often have flow restrictions that serve as barriers to fish migration because the crossing blocks the stream. It is possible to re-engineer a crossing to remove the barrier, and strategic removal of a few key barriers within a watershed can open up miles of habitat. But, to do that you need to know where they are, and we don't.

While some are easy to find using existing maps, there are many undocumented crossings that presently must be located by field crews driving around in trucks. This works, but it is inefficient and time consuming and field crews have limited access to private roads. Lori Nabors may have a better way to find them.

Lori is a non-traditional student who has returned to school after raising a family, and has a strong interest in remote sensing and cartography. She is working on a method that highlights undocumented crossings by comparing stream elevations with newly available land elevation data.

The crossings pop up as discontinuities, and even small ones seem to be detectable. While it is a work in progress, she believes that she can map a broad range of undocumented crossings within the Elk River watershed to provide a previously unobtainable visualization that can then be used to identify the key barriers that are a priority for removal so that Tennessee's fishes have more habitat.



NUSRAT JANNAH SNIGDHA

STUDENT HIGHLIGHT

Nusrat Jannah Snigdha obtained her Bachelor of Architecture degree from Bangladesh, recently defended her master's degree thesis, and will be graduating in December 2021 from Tennessee Tech. Despite coming from an entirely different background, her interest in wetland hydrology led her to work with her advisor, associate professor in civil engineering Alfred Kalyanapu, in the USDA/NRCS Wetland Reserve Program (WRP) and pursue a master's degree in civil engineering. She worked on in-situ hydrologic monitoring of wetlands, time-series data analysis, and GIS-based spatial analysis in her graduate research. She assessed the restoration impact of a forested wetland located in Carlisle County, Kentucky, using remote sensing and GIS-based analyses by estimating multiple hydrologic and vegetation indicators. To understand the restoration impact, she analyzed spatiotemporal variability of reliable restoration impact indicators such as evapotranspiration, surface water, visible saturation, plant coverage, and landscape metrics for pre-restoration and current monitoring periods. The analyses performed in this study provided a comprehensive and adaptable methodology to evaluate wetland restoration impact preceding assistance in decision-making for restoration practices. This methodology could also be helpful when available baseline data are inadequate and further implemented as a cost-effective approach to homogeneous wetlands. Snigdha says the graduate research assistantship she had at Tennessee Tech was a rewarding experience. In the future, she intends to apply the expertise she gained here to projects involving the conservation of natural resources.



UNSOLVED MYSTERY: HARM'S MILL DAM

RESEARCH HIGHLIGHT

The Water Center is collaborating with Tennessee Tech history faculty to solve an enduring mystery before the aging and abandoned Harm's Mill Dam on the Elk River can be removed.



Thousands of dams throughout the U.S. impound almost 1 million river kilometers. While many provide useful services, there is a growing

trend for removing dams that no longer serve a purpose or have become unsafe via age, neglect, or abandonment. During the past decade, about 1,000 dams have been removed nationally, greatly benefitting aquatic communities, especially migratory fishes.

One obsolete structure is Harm's Mill Dam on the Elk River, which is a top priority for removal in 2021 or 2022. The original dam was built from wood timbers, and later a concrete dam was constructed in the early 1920s. Both have fallen into disrepair. The concrete dam is undercut and will eventually fail, and the site is potentially dan-

gerous. Paddlers encounter spiky wooden debris left from the original wood dam, and the 1922 concrete dam's construction creates a current pattern just below the structure that water safety experts refer to as "a drowning pool." The remains of the powerhouse

have places where a visitor's misstep could result in a 20-foot fall, and the structure blocks fish passage on a river with exceptional biodiversity. The safety and environmental issues mandate removal.

The removal challenge is not physical, but rather historical, because Harm's Mill Dam is on the National Register of Historic Places. When it was built, it was a regional marvel with a powerhouse whose turbines powered a textile mill, and later nearby towns, when electric power was largely unavailable in the region. Very little of the original structure remains that could be preserved, but



HARM'S MILL DAM (CONT.)



what can be saved is part of the historical knowledge of the site, and documenting that is required prior to removal and ultimate site restoration. But there is a historical twist in that the dam may have once supported a fish ladder.

Fish ladders are now present at many dams throughout the U.S. There are many designs, but all allow migratory fish to circumvent the dam. Although they have been used for almost a century, they were built primarily on coastal rivers for anadromous species such as salmon and herrings, and most are fairly modern. To find a fish ladder constructed in the 1920s in Tennessee is startling and rather like finding a photo of an airplane taken 25 years before the Wright brothers.

Who built it, and why? What species were they trying to protect? Was it voluntary, or was it required by a federal or state agency? Who actually designed it? These are historical

questions that need to be answered to help with the removal process, but they are also of great interest to fisheries scientists. The mystery is complicated by a contradiction. While there are stories and anecdotal reports about several other fish ladders at other dams in the area, no historic photos exist of any structure that looks like a fish ladder. Thus, any information is in yet-undiscovered historical documents.

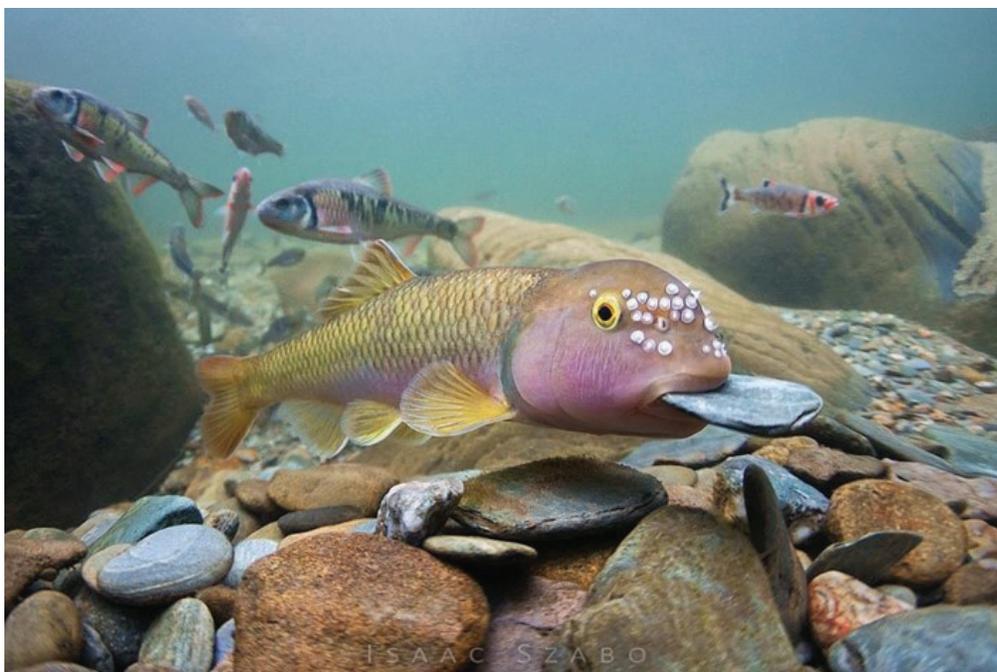
Dr. Troy Smith, his fellow history colleagues, and several students will be taking a deep dive into the history of Harm's Mill Dam to try to answer the many historical questions about the site and hopefully write a new chapter for the environmental history of Tennessee. The results will support dam removal with many benefits to aquatic biodiversity and public safety. If all goes to plan, both dams will be removed entirely, and the site will become a safe public access point for people to enjoy one of Tennessee's most interesting rivers.

.....

RIVER CHUBS: KEYNOTE SPECIES IN SOUTHEASTERN STREAMS

.....

RESEARCH HIGHLIGHT



A male river chub transports stones by mouth to build a spawning mound that he will use along with other so-called nest associates that depend on the existence of river chub spawning mounds for successful reproduction. (Photo credit: Isaac Szabo)

The occurrence, abundance, and diversity of organisms in communities may be driven largely by the presence or behavior of a single keystone species that has a much bigger effect within its community than would be predicted by its biomass alone. Due to the outsized influence of such keystone species, conservation of some communities will be facilitated by identifying keystones whose continued presence is critical

to the persistence of other community members that are the focus of conservation efforts. In freshwater systems, fishes in the genus *Nocomis* (commonly called river chubs) have been identified as potential keystone species due to their reproductive behavior that involves construction of spawning nests made up of individual substrate particles. These nests are used for spawning by many other fishes and distributions of these

RIVER CHUBS (CONT.)

so-called nest associates may indeed be limited by river chub nests. Furthermore, aggregations of spawning fishes on and near river chub nests may present resources to other resident fishes in the form of eggs and small fishes that are easily consumed. Finally, the habitat created through nest construction by river chubs may support different numbers or species of macroinvertebrates, particularly if substrates used for nest construction are relatively rare within a given stream reach. Thus, taking steps to ensure the persistence of river chubs and their ability to construct spawning nests may well benefit many additional freshwater species.

A new research project funded by the Tennessee Valley Authority and the Water Center will examine links between the occurrence of river chubs and the diversity and occurrence of other resident freshwater organisms that likely benefit from the construction of spawning nests by river chubs. Documentation of such linkages has important implications for the conservation of native freshwater biodiversity in many Southeastern watersheds, including the Little Tennessee River system. Research efforts will be led by Joelle Ciriacy, a new graduate student in the Department of Biology. Originally from

Maryland, Joelle finished her undergraduate degree in biology at Lee University in Cleveland, Tennessee. During her time at Lee, Joelle gained valuable field experience in streams of East Tennessee by working with fishes, macroinvertebrates, and hellbenders. The opportunity to continue working in those systems drew Joelle to this project, and she is looking forward to conducting research focused on freshwater biodiversity conservation that can directly inform water resource management decisions.



.....

EFFECT OF WATER VELOCITY RATES ON MALFUNCTION OF REVERSE OSMOSIS MEMBRANES

.....

RESEARCH HIGHLIGHT

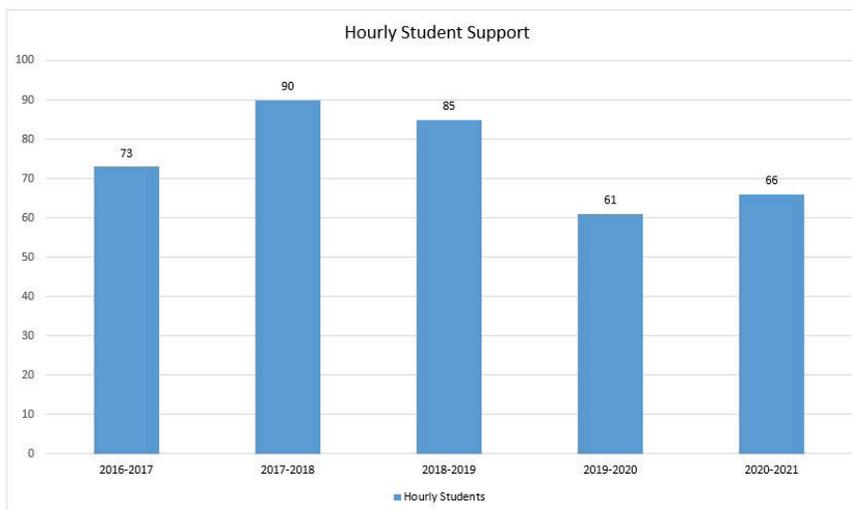
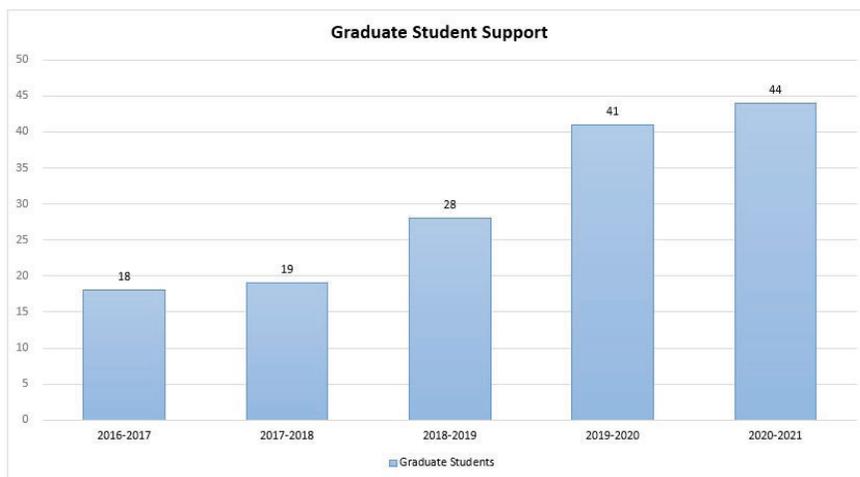
Two undergraduate engineering students, Katie Mealio and Kathryn Slamen, worked in the labs of Holly Stretz, professor of Chemical Engineering and interim chair of the department, in Summer 2021 studying the effect of shear rate — or the change of speed when one layer of fluid passes over another — on a commercial company’s water problem, when reverse osmosis membrane systems become fouled by the accumulation of nonliving natural organic matter found in salty source water and quickly lose efficiency. The students found that very specific shear rates lead to the degradation of organic matter, which will be useful in designing desalination processes to help clean the membranes of energy-robbing foulants. The students are traveling to present this information at a SERMACS conference in Birmingham in November 2021.



Without students, the Water Center could not continue to engage in its research initiatives. Therefore, offering our students the most cutting-edge opportunities in environmental research is important. This fiscal year, the Center supported 44 graduate research assistants. The Center also supported 66 students on an hourly basis to work on research and service projects in the field, in laboratories and in the office.

ENHANCING EDUCATION & RESEARCH

Students Supported



Ph.D.

Name	Major
Peter Blum	ENV
Robert Brown	ENV
Tigstu Dullo	ENGR
Shrijana Duwadi	ENV
Lesta Kocher	ENV
Eric Koehler	ENV
Nicholas Masto	ENV
Collins Owusu	ENGR
Md Bulbul Sharif	ENGR
Dipendra Wagale	ENGR
Spencer Womble	ENV



GRADUATE
STUDENTS
SUPPORTED

Master's

Name	Major
Brittany Bajo	BIOL
Connor Ballard	BIOL
Joseph Brockwell	CEE
Joshua Cary	BIOL
Jennifer Caudle	BIOL
Aaron Coons	BIOL
Julia Coultis	ChE
George Darkwah	CEE
Vinay Dhanvada	CEE
Jack Fetters	BIOL
Thomas Flanagan	BIOL
Wesley Giddens	PSM
Kendell Hamm	BIOL
Cory Highway	BIOL
Abbey Holsopple	BIOL
Frederick Hoogakker	BIOL
Minhazul Islam	CEE
Matthew Keegan	PSM
Maria Kuchla	ChE
Mackenzie Martin	CEE
Morgan Michael	BIOL
Catherine Murphy	ChE
Lori Nabors	PSM
Zishan Onik	CSC
Ashley Padgett	BIOL
Ngernkuakul Phisuthisak	ECE
Dennis Piercy	ChE
Sarah Rhoton	CEE
Anchita Sanan	BIOL
Nusrat Jannah Snigdha	CEE
Tisha Snyder	CP
Victor Wesley	BIOL
Tyler Wright	CEE



PROFESSIONAL SERVICE

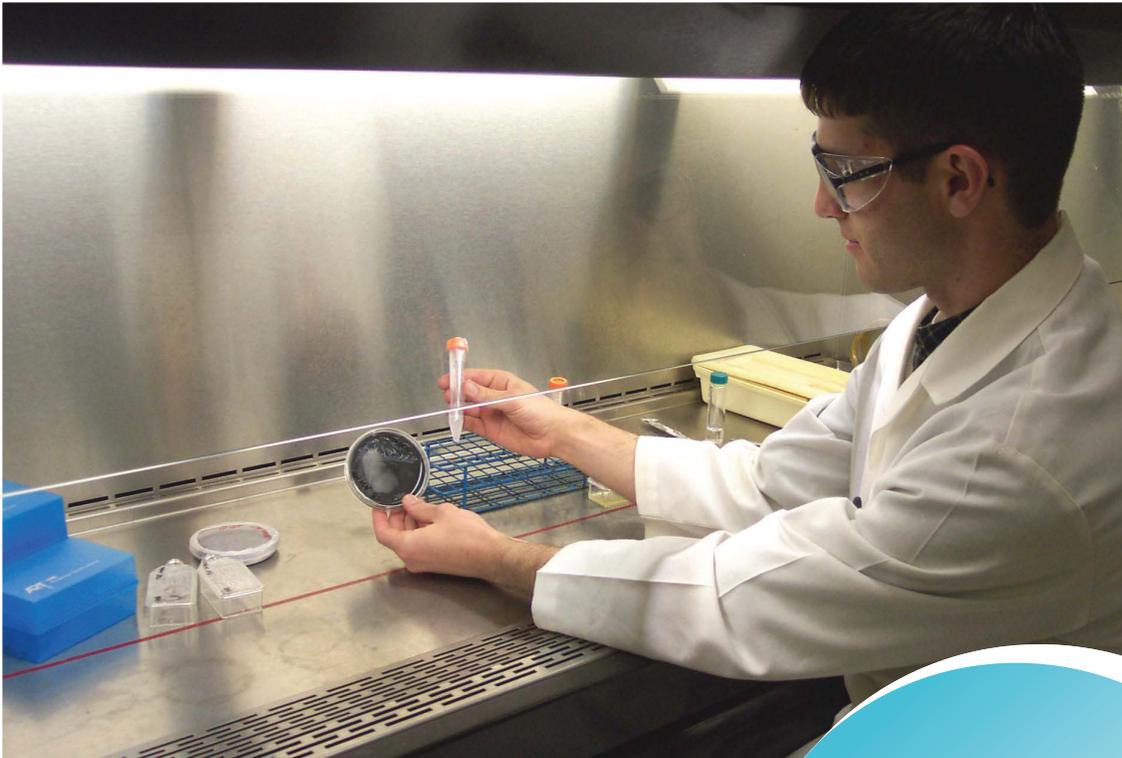
Brad Cohen, assistant professor of biology, published “Putting Duck Folks’ Folklore to the Test: Research to Examine Local Beliefs of Duck Movements in West Tennessee,” along with co-authors A.G. Blake-Bradshaw, N.M. Masto, J.C. Feddersen, and C.J. Highway, in the *Tennessee Wildlife* magazine. Cohen also made private landowner service visits in Humboldt and Lauderdale counties of Tennessee and presented “Why Deer Really Do Get Caught in Headlights” on Interlochen Public Radio, in Michigan.

Tania Datta, associate professor of civil and environmental engineering, was an advisory board member for establishing the Tennessee Water Education and Training Center, being developed by the Tennessee Department of Environment and Conservation, the West Tennessee River Basin Authority, and the University of Tennessee. She served as the chair of the Best Management Practices Working Group and a member of the Benchmarking and Data Analysis Working Group for the Tennessee Nutrient Reduction Strategy Work Group. She is a board member of the Tennessee Caves and Karst Advisory Group and reviews manuscripts for the *Science of the Total Environment*, *Water Science and Technology*, and *Bioresources Technology*. Datta also serves on the College of Engineering Diversity Committee, focusing on increasing women enrollment in engineering.

Alfred Kalyanapu, associate professor of environmental engineering, serves as the committee chair of the American Society of Civil Engineers Computational Hydraulics Committee and a member of the Tennessee American Water Resources Association Executive Committee. He is also an advisory member of the Water Education and Training Center, led by the University of Tennessee Institute of Agriculture and the West Tennessee River Basin Authority.

Hayden Mattingly, professor and director of Environmental Sciences, was an external faculty evaluator for North Carolina State University’s Department of Forestry and Environmental Resources in July 2020. He was also a panel moderator for the Green Solutions Expo, “Beyond Recycling,” online webinar featuring environmental leaders across Tennessee in November 2020. Mattingly also has a professional society membership with the American Fisheries Society and Southeastern Fishes Council. He is a federally appointed member of the Bluemask Darter Technical Team for the U.S. Fish and Wildlife Service. He is also an editorial board member, manuscript editor, and special issue volume co-editor (with Jeffrey W. Simmons) of the journal *Southeastern Naturalist*.

Mark Rogers, associate professor of biology and unit leader of the U.S. Geological Survey Tennessee Cooperative Fishery Research Unit, was the co-editor of the journal *Fisheries Management and Ecology*, president of the Tennessee Chapter of the American Fisheries Society, and vice president-elect of the Southern Division of the American Fisheries Society.



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 non-standard 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
- 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
- GC for THMs and HAAs

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.

ANALYTICAL CAPABILITIES



SUPPORT STAFF

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. Sandy Dodson, administrative associate 3, provides support in preparing travel claims, administering the Motor Pool, and purchasing supplies. 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 leads commercial testing. David Hobbs provides lab support, coordinates student research, and maintains lab safety. Center staff are recognized across campus for excellence in their respective duties.

ADMINISTRATION AND FACULTY

Dr. Jeff Schaeffer
Dr. Tania Datta

Director
Research Focus Area Leader,
Associate Professor of Civil and
Environmental Engineering
Research Focus Area Leader,
Associate Professor of
Environmental Engineering
Research Focus Area Leader,
Associate Professor of Biology

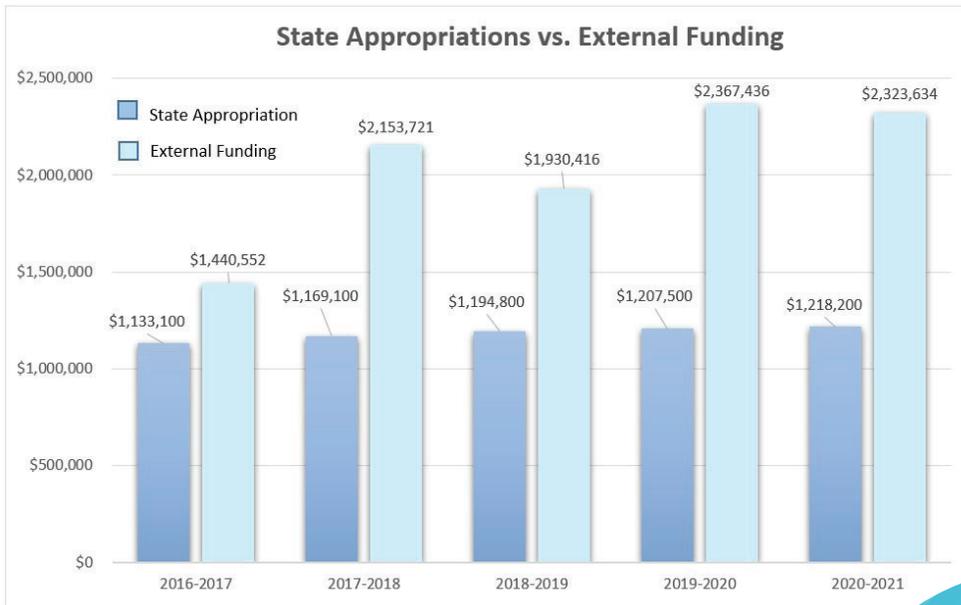
Dr. Alfred Kalyanapu

Dr. Justin Murdock

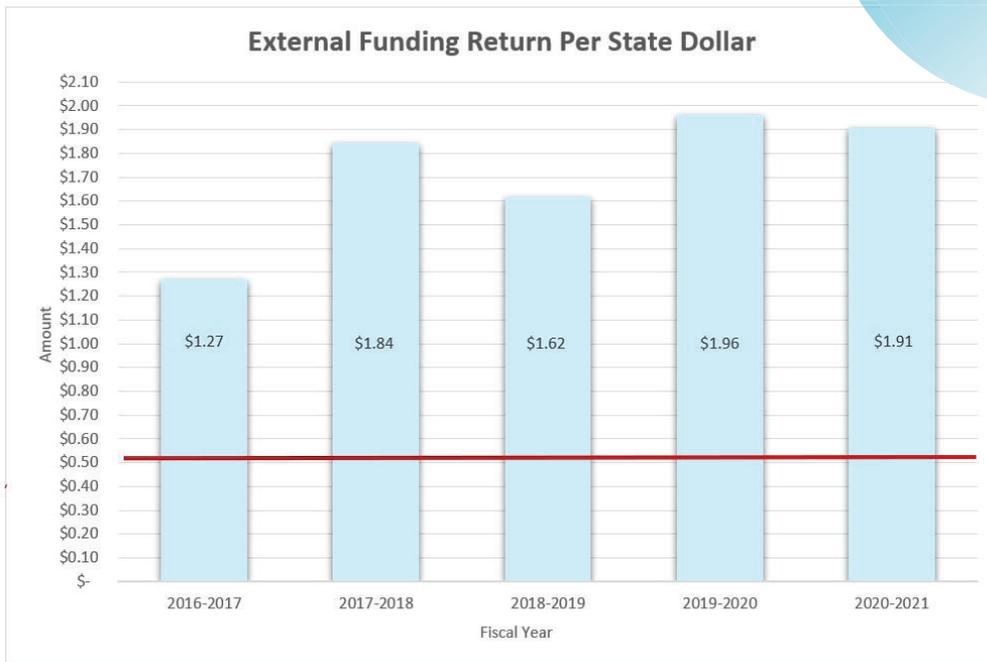
SUPPORT STAFF

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

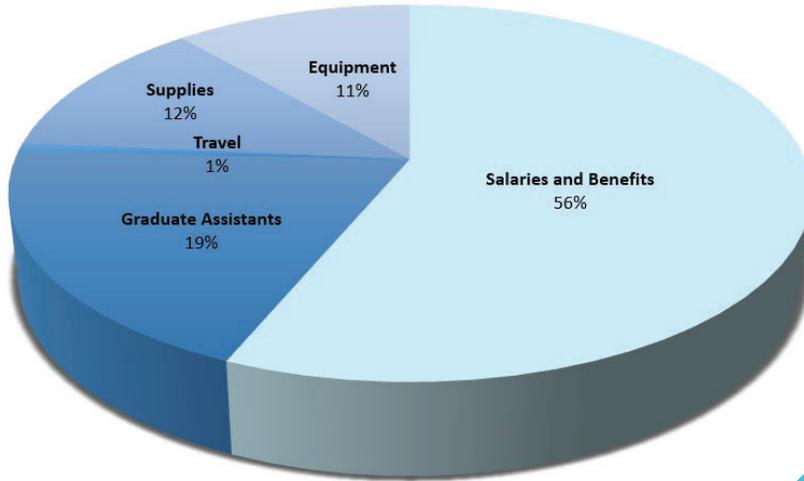
Academic Support Associate
Technical Laboratory Manager
Administrative Associate 3
Office Manager
Editor
Laboratory Support
Financial Associate



STATE
APPROPRIATIONS
VS. EXTERNAL
FUNDING

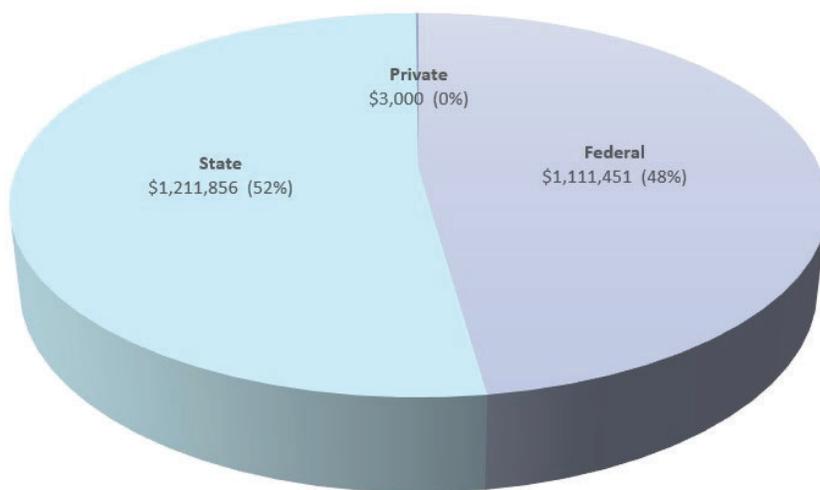


Allocation of Appropriations

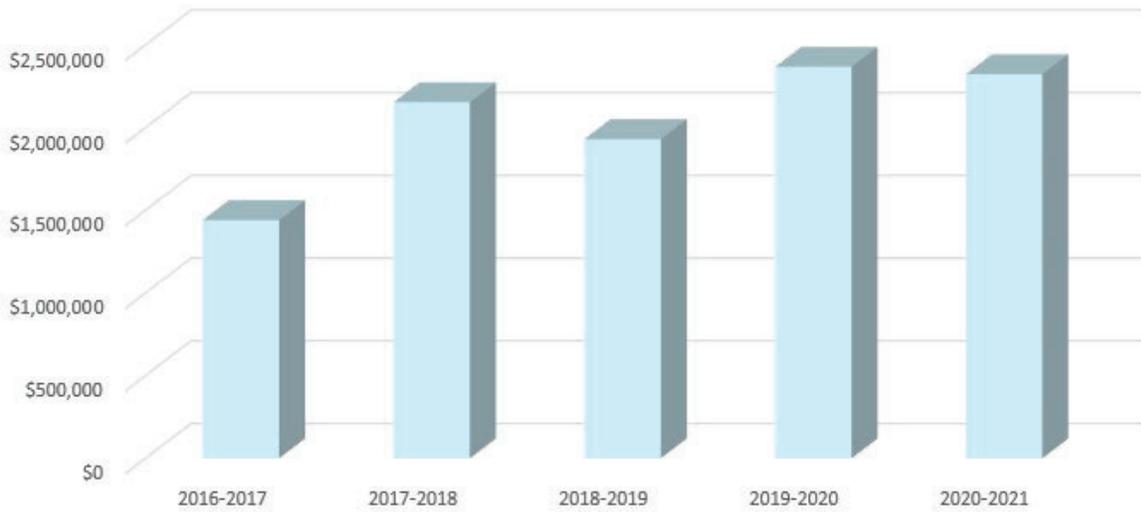


ALLOCATION
OF APPROPRIATIONS
AND SOURCES
OF EXTERNAL
FUNDING

Sources of External Funding

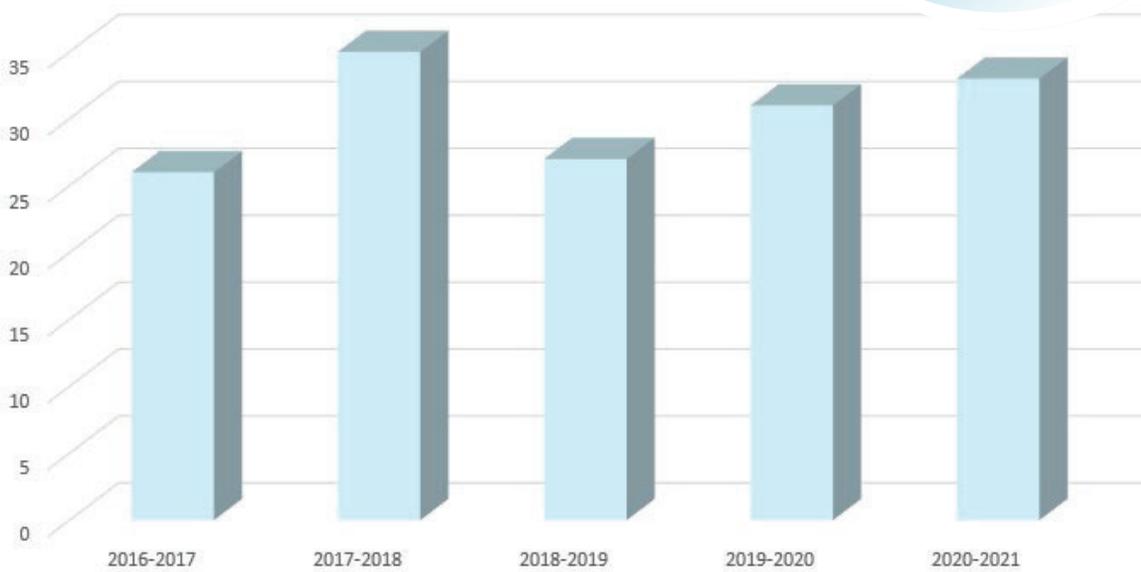


Activation Amount



ACTIVATION
AMOUNT
AND
NUMBERS OF
ACTIVATIONS

Number of Activations



An Interdisciplinary Approach to Understanding the Presence of Antibiotic Resistance and Antibiotic Resistant Bacteria in Urban Karst Groundwater Systems
Tania Datta/Cave Research Foundation
Activation This Year: \$3,000
Project Period: 4/14/2020-10/13/2021

Analysis of Road-Stream Crossings in the Elk River Watershed, AL/TN to Address Threats to Listed and At-Risk Species
Jeff Schaeffer/U.S. Fish and Wildlife Service
Activation This Year: \$36,162
Project Period: 10/1/2020-9/30/2022

A Resurvey of the Mussel Fauna of the Wolf River, Tennessee: Phase 1
Amanda Rosenberger/U.S. Geological Survey
Activation This Year: \$20,754
Project Period: 4/22/2021-1/1/2022

Assessing Biodiversity in Stream-Dwelling Crayfish (*Faxonius durelli/forceps complex*) from the Cumberland Tennessee Watersheds
Carla Hurt/Tennessee Valley Authority
Activation This Year: \$15,000
Project Period: 6/15/2020-12/1/2022

Assessing the Water Quality of the Shatt Al-Arab River in Basra
Tania Datta/International Research and Exchanges Board
Activation This Year: \$26,805
Project Period: 2/15/2021-8/15/2022

Blotchside Logperch Fish Abrams Creek
Amanda Rosenberger/U.S. Department of the Interior/National Park Service
Activation This Year: \$24,975
Project Period: 8/1/2019-11/1/2022

Chestnut Biodiversity Initiative
Carla Hurt/The Nature Conservancy
Activation This Year: \$12,104
Project Period: 9/15/2020-11/30/2022

Collection of Biological Data at Deer Check Stations
Steve Hayslette/Tennessee Wildlife Resources Agency
Activation This Year: \$2,000
Project Period: 7/1/2016-6/30/2021

Compilation and Analysis of Long-Term Nitrogen and Phosphorus Monitoring Data in TN
Tania Datta/Tennessee Department of Environment and Conservation
Activation This Year: \$40,000
Project Period: 8/1/2020-12/31/2021

Completion of a Species Status Assessment Report for the Slabside Pearlymussel
Amanda Rosenberger/
U.S. Geological Survey
Activation This Year: \$33,315
Project Period: 8/14/2020-5/31/2022

Development and Improvement of High-Resolution Flood 2D-GPU Modeling for Titan HPC Environment
Alfred Kalyanapu/UT-Oak Ridge National Lab
Activation This Year: \$37,500
Project Period: 8/16/2018-8/15/2021

Duck River Mussel Surveys
Amanda Rosenberger/Tennessee Wildlife Resources Agency
Activation This Year: \$31,193
Project Period: 7/25/2019-2/25/2021

Evaluating Stocked Fisheries 2017-22 (Three activations)
Mark Rogers/Tennessee Wildlife

EXTERNALLY
FUNDED
PROJECTS
ACTIVATED
IN FISCAL YEAR
2020-2021

Resources Agency
Activation This Year: \$66,000/\$40,000/
\$66,000
Project Period: 7/1/2017-6/30/2022

Evaluation of Nonlinear Interactions
Between Tropic Cyclone Storm Surge
and Rainfall-Runoff
Alice Camuti/National Science Foundation
Activation This Year: \$46,000
Project Period: 8/1/2020-7/31/2025

Evaluation of the Asian Carp Populations in the
Tennessee and Cumberland Rivers
Mark Rogers/Tennessee Wildlife Resources
Agency
Activation This Year: \$439,500
Project Period: 7/1/2018-3/31/2022

Factors Affecting Sanctuary Use by Mallards
Brad Cohen/U.S. Fish and Wildlife Service
Activation This Year: \$27,867
Project Period: 9/1/2019-12/31/2024

Life History, Habitat Use and Genetic
Uniqueness of the Longnose Darter
Percina nasuta in Missouri
Amanda Rosenberger/Missouri Department
of Conservation
Project Period: 7/1/2018-6/30/2021

Life History and Habitat Requirements of
Brawley's Fork Crayfish, *Cambarus williamsi*
Hayden Mattingly/Tennessee Wildlife
Resources Agency
Activation This Year: \$15,000
Project Period: 10/1/2018-6/30/2021

Mallard Use of West Tennessee Wetlands
Brad Cohen/Tennessee Wildlife Resources
Agency
Activation This Year: \$431,125
Project Period: 7/20/2019-7/19/2023

Population Status, Demographic History and
Genetic Health of the Striated Darter
(*Etheostoma striatulum*) in the Duck River
Drainage, Tennessee
Kit Wheeler/Tennessee Wildlife
Resources Agency
Activation This Year: \$11,548
Project Period: 7/15/2020-1/31/2022

Project INSPIRE: A STEM Teacher Residency
(two amendments)
Jeff Boles/National Science Foundation
Activation This Year: \$334,356/\$255,218
Project Period: 8/15/2014-7/31/2021

Quantitative Assess-
ment and Population-
Level Modeling of
Bighead and Silver
Carp Population
Dynamics Across the
Mississippi River
Sub-Basins
Mark Rogers/U.S.
Geological Survey
Activation This Year:
\$94,000
Project Period:
9/1/2020-8/31/2021

Range-Wide Population
Status for the
Striated Darter
Hayden Mattingly/Tennessee Wildlife
Resources Agency
Activation This Year: \$21,000
Project Period: 7/1/2019-6/30/2021

River Chubs as Keystone Species in the Little
Tennessee River Basin
Kit Wheeler/Tennessee Valley Authority
Activation This Year: \$20,000
Project Period: 1/1/2021-9/30/2023

EXTERNALLY
FUNDED
PROJECTS
ACTIVATED
IN FISCAL YEAR
2020-2021
(CONT.)

SG: Phylogenomics and Diversification of the Snapping Shrimp Genus *Alpheus*
Carla Hurt/National Science Foundation
Activation This Year: \$24,762
Project Period: 9/1/2019-8/31/2022

Species Status Assessments for Two Tennessee Crayfishes Proposed for Federal Listing Under the U.S. Endangered Species Act
Hayden Mattingly/U.S. Geological Survey
Activation This Year: \$31,132
Project Period: 8/14/2020-9/30/2021

Tennessee Heelsplitter (*Lasmigona holstonia*)
Distribution and Habitat Use
Amanda Rosenberger/U.S. Geological Survey
Activation This Year: \$3,000
Project Period: 12/21/2018-5/31/2021

Validation and Transferability of Fundamental Niche Models of Mussel Communities and Assessment of Risks to Mussel Populations in Ozark River Drainages

Amanda Rosenberger/Missouri Department of Conservation
Activation This Year: \$21,190
Project Period: 7/1/2018-6/30/2021

Water Quality Assessment for Cumberland River Aquatic Center
Amanda Rosenberger/Tennessee Wildlife Resources Agency
Activation This Year: \$10,000
Project Period: 9/1/2020-8/31/2021

EXTERNALLY
FUNDED
PROJECTS
ACTIVATED
IN FISCAL YEAR
2020-2021
(CONT.)

Bhuyian, Md. N.M., and Kalyanapu, A. (2020). Predicting channel conveyance and characterizing planform using river bathymetry via satellite image compilation (RiBaSIC) algorithm for DEM-based hydrodynamic modeling. *Remote Sensing*, 12(7), doi:10.3390/rs12172799.

Breck, J.E., Simon, C.P., Rutherford, E.S., Low, B.S., Lamberson, P.J., and Rogers, M.W. (2020). The geometry of reaction norms yields insights on classical fitness functions for Great Lakes salmon. *PLoS ONE*, 15(3), e0228990. (<https://doi.org/10.1371/journal.pone.0228990>).

Chamberlain, M.J., Cohen, B.S., Bakner, N.K., and Collier, B.A. (2020). Behavior and movement of wild turkey broods. *Journal of Wildlife Management*, 84, 1139-1152.

Chujo, M., Li, J., Datta, T., Amano, Y., and Machida, M. (2020). A competitive growth model for the simulation of cyanobacterial blooms under eutrophic conditions. *Environmental Engineering Science*, 38(1) 15-23.

Cohen, B.S., Marquardt, D.D., Bakner, N.W., and Collier, B.A. (2020). Daily movements, space use, and habitat selection of GPS-tagged northern bobwhite in Texas. *Wildlife Society Bulletin*, 44, 790-797 (featured on journal cover).

Dullo, T.T., Gangrade, S., Morales-Hernandez, M., Sharif, M.B., Kao, S.-C., Kalyanapu, A.J., Ghafoor, S., and Evans, K.L. (2021). Simulation of Hurricane Harvey flood event through coupled hydrologic-hydraulic models: Challenges and next steps. *Journal of Flood Risk Management*, accepted for publication. Featured in Prevention Web, managed by United Nations Office of Disaster Risk Reduction (<http://www.preventionweb.net/publications/view/76681>).

Ennen, J.R., Kuhajda, B.R., Mitchell, S., Sweat, S.C., Zuber, B.C., Watts, A.V., Mattingly, H.T., and Cecala, K.K. (2020). Assessing the success of conservation efforts for a North American topminnow at risk of extinction from spatially variable mosquitofish invasions. *Freshwater Biology*, 1-10. (<https://doi.org/10.1111/fwb.13652>).

Jennings, C.A., Allen, M., Belcher, C., Bringolf, R., Dennerline, D., Goar, T., Kuklinski, K., Long, J., Mazik, P., Riecke, D., and Rogers, M. (2020). Congratulations on your promotion to management: Considerations for new supervisory biologists. *Journal of the Southeastern Association of Fish and Wildlife Agency*, 103-113.

Kao, Y.-C., Rogers, M.W., Bunnell, D.B., Cowx, I.G., Qian, S.S., Anneville, O., Beard Jr., T.D., Brinker, A., Britton, J.R., Chura-Cruz, R., Gownaris, N.J., Jackson, J.R., Kangur, K., Kolding, J., Lukin, A.A., Lynch, A.J., Mercado-Silva, N., Moncayo-Estrada, R., Njaya, R.J., Ostrovsky, I., Rudstam, L.G., Sandstrom, A.L.E., Sato, Y., Siguayro-Mamani, H., Thorpe, A., Van Zwieten, P.A.M., Volta, P., Wang, Y., Weiperth, A., Weyl, O.L.F., and Young, J.D. (2020). Assessing effects of climate and land-use changes on global lake fisheries production. *Nature Communications*, 11, 2526.

Kinney, D., Bunnell, D.B., Rogers, M.W., Lynch, A.J., Beard, T.D., and Funge-Smith, S. (2020). Inland commercial fisheries in the United States: Carp, catfish, and gaps in national reporting. *Fisheries*.

Lohr, A.K., Martin, J.A., Wann, G.T., Cohen, B.S., Collier, B.A., and Chamberlain, M.J. (2020). Effects of individual recess behaviors on nest and female survival of eastern wild turkeys. *Ecology and Evolution*, 10, 11752-11765.

Lynch, A.J., Bartley, D.M., Beard Jr., T.D., Bunnell, D.B., Cooke, S.J., Cowx, I.G., Funge-Smith, S., Paukert, C.P., Rogers, M.W., and Taylor, W.W. (2020). In Fish: A research network to promote global conservation and sustainable use of inland fish. *Fisheries*, 45(6), 319-326.



REFEREED PUBLICATIONS

Mitchell, K., Barletta, M., Giguere, S., Quandt, J., Osborn, D., Watson, E., Cohen, B., and Miller, K. (2021). Physiologic and blood gas effects of xylazine-ketamine versus xylazine-tiletamine-zolazepam immobilization of white-tailed deer before and after oxygen supplementation: A preliminary study. *Veterinary Anaesthesia and Analgesia*, 48, 356-363.

Morales-Hernandez, M., Sharif, M.B., Kalyanapu, A., Ghafoor, S.K., Dullo, T.T., Gan-grade, Z., Kao, S.-C., Norman, M.R., and Evans, K.J. (2021). TRITON: A multi-GPU source 2D hydrodynamic flood model. *Environmental Modelling and Software* (<https://doi.org/10.1016/j.envsoft.2021.105034>).

Ohemeng-Ntiamoah, J., and Datta, T. (2019). Perspectives on variabilities in biomethane potential test parameters and outcomes: A review on studies published between 2007 and 2018. *Science of the Total Environment*, 664, 1052-1062.

Omori, K., Datta, T., Amano, Y., and Machida, M. (2019). Effects of different types of extracellular polysaccharides isolated from cyanobacterial blooms on the colony formation of unicellular *Microcystis aeruginosa*. *Environmental Science and Pollution Research*, 26(4), 3741-3750.

Peace, A., Frost, P.C., Wagner, N.D., Danger, M., Accolla, C., Antczak, P., Brooks, B.W., Costello, D.M., Everett, R.A., Flores, K.B., Heggerud, C.M., Karimi, R., Kang, Y., Larson, J.H., Mathews, T., Mayer, G.D., Murdock, J.N., Murphy, C.A., Nisbet, R.M., Pecquerie, L., Pollesch, N., Rutter, E.M., Schulz, K.L., Scott, T., Stevenson, L., and Wang, H. (2021). Stoichiometric ecotoxicology for a multi-substance world. *Bioscience*, 71(2), 132-147.

Sullivan, D.J., McEntire, K., Cohen, B.S., Collier, B.A., and Chamberlain, M.J. (2020). Spatial scale and shape of prescribed fires influence use by wild turkeys. *Journal of Wildlife Management*, 84, 1570-1577.

Wakefield, C.T., Martin, J.A., Wightman, P.H., Bond, B.T., Lowrey, D.K., Cohen, B.S., Collier, B.A., and Chamberlain, M. J. (2020). Hunting activity effects on roost selection by male wild turkeys. *Journal of Wildlife Management*, 84, 458-467.

Wakefield, C.T., Wightman, P.H., Martin, J.A., Bond, B.T., Lowrey, D.K., Cohen, B.S., Collier, B.A., and Chamberlain, M.J. (2020). Hunting and nesting phenology influence gobbling of wild turkeys. *Journal of Wildlife Management*, 84, 448-457.

Wells, W.G., Davis, J.L., and Mattingly, H.T. (2020). Evaluation of microhabitat conditions used by *Noturus stanauli* (Pygmy madtom) in the Clinch River, Tennessee. *Southeastern Naturalist*, 19, 537-552.

Wells, W.G., and Mattingly, H.T. (2020). Evaluation of benthic fish communities in the Clinch and Duck rivers as habitat indicators for the endangered Pygmy madtom, *Noturus stanauli*. *Southeastern Fishes Council Proceedings*, 50, 47-59. (<https://trace.tennessee.edu/sfcproceedings/vol11/iss59/8>).



REFEREED PUBLICATIONS

Morales-Hernandez, M., Sharif, M.B., Gangrade, S., Dullo, T.T., Kao, S.-C., Kalyanapu, A., Ghafoor, S.K., Evans, K.J., Madadi-Kandjani, E., and Hodges, B.R. (2020). High performance computing in water resources hydrodynamics. *Journal of Hydroinformatics*.

Paine, R.T., Hurt, C., and Mattingly, H.T. Monitoring a minuscule madtom: Environmental DNA surveillance of the endangered pygmy madtom (*Noturus stanauli* Etnier & Jenkins 1980) in the Duck and Clinch Rivers, Tennessee. *Environmental DNA*.



PUBLICATIONS IN PRESS



FINAL REPORTS



Holmes Jr., R.R., Weston, D., Ballard, C., Bombardelli, F., Kalyanapu, A., Straub, T.D., and Zamani, K. (2021). Surface-Water Hydraulic Model Calibration and Validation Guidelines for Riverine Systems, Report, Task Committee on the Calibration and Validation of Free-Surface Hydraulic Models in Riverine Systems, submitted to the ASCE Computational Hydraulics Technical Committee.

Mattingly, H., Murdock, J., Wheeler, C., and Gibbs, C. (2020). AEDC Bat-Related Aquatic Resources Study 2018 -- Evaluation of Aquatic Resources to Support Bat Foraging Habitat at Arnold Engineering Development Center, Arnold Air Force Base, with an Emphasis on Rare, Threatened, and Endangered Aquatic Species. Annual Interim Performance Report.

Arms, M., Harris, H.T., Wright, T., Kalyanapu, A., and Datta, T. (2021). Watershed-wide stormwater management in an underserved community of Tennessee through community-university partnership. Presented at the virtual 2021 Tennessee Water Resources Symposium.

Blake-Bradshaw, A.G., Masto, N.M., Highway, C.J., Feddersen, J.C., Hagy, H.M., Combs, D.L., and Cohen, B.S. (2020). Mallard response to a gradient of experimental disturbance on waterfowl refuges during winter. Presented at the 74th Conference of the Southeastern Association of Fish and Wildlife Agencies (virtual).

Brown, R., Murdock, J., and Womble, S. (2021). Factors affecting denitrification estimates in restored floodplain wetlands. Presented at the Tennessee AWRA Annual Conference.

Chamberlain, M.J., Cohen, B.S., Bakner, N., and Collier, B.A. (2020). Ecology of eastern wild turkey broods in the southeastern United States. Presented at the National Wild Turkey Conservation Conference, Nashville, TN, USA.

Chamberlain, M.J., Wakefield, C., Wightman, P., Cohen, B.S., Martin, J.A., and Collier, B.A. (2020). Hunting and nesting phenology drive gobbling of eastern wild turkeys. Presented at the National Wild Turkey Federation Conservation Conference, Nashville, TN, USA.

Cohen, B.S., Blake-Bradshaw, A.G., Masto, N.M., Highway, C.D., Combs, D.L., Hagy, H., and Feddersen, J.C. (2020). Using GPS transmitters to evaluate influence of disturbance on mallard movements. Presented at the Mississippi Flyway Council Meeting, Paducah, KY, USA.

Cohen, B.S., Masto, N.M., Blake-Bradshaw, A.G., Highway, C.D., Combs, D.L., Hagy, H.M., and Feddersen, J.C. (2020). Spring migration patterns of mallards captured in Tennessee. Presented at the Mississippi Flyway Migration Committee Meeting (virtual).

Cohen, B.S. (2020). Temporal and spatial characteristics of landscape disturbance affect habitat and animal response. Invited presentation to the University of New York at Geneseo.

Cohen, B.S., Masto, N.M., Blake-Bradshaw, A.G., Highway, C.J., Hagy, H.M., Feddersen, J.C., and Combs, D.L. (2021). Mallard behavior and survival in west Tennessee. Invited presentation to the U.S. Fish and Wildlife Service National Refuge System.

Collier, B.A., Gerrits, A.P., Cohen, B.S., Wightman, P.H., Cantrell, J.R., Ruth, C.R., and Chamberlain, M.J. (2020). Wild turkey hunter movement ecology and turkey-turkey hunter interactions on public lands in South Carolina. Presented at the National Wild Turkey Federation Conservation Conference, Nashville, TN.

Dhanvada, V., Kalyanapu, A., Datta, T., and Adkins, J. (2021). Development of a GIS-based watershed vulnerability assessment tool for the Loosahatchie watershed in Tennessee. Presented at the virtual 2021 Tennessee Water Resources Symposium.



PRESENTATIONS

Duwadi, S., and Murdock, J. (2021). The relation of microbial biomass carbon with denitrification and nutrient retention in restored floodplain wetlands. Presented at the Tennessee AWRA Annual Conference.

Fink, C., Nelson, S.D., Krosnick, S.E., and Cohen, B.S. (2021). Effects of white-tailed deer site use on vegetation structure, composition, and biodiversity in Upper Cumberland region of Tennessee. Presented at the Research and Creative Inquiry Day, Tennessee Tech University, Cookeville, TN.

Garrett, J.E., Highway, C.J., and Cohen, B.S. (2021). The effects of corn ear declination on waterfowl forage availability in unharvested flooded corn fields. Presented at the Research and Creative Inquiry Day, Tennessee Tech University, Cookeville, TN.

Highway, C.J., Blake-Bradshaw, A.G., Masto, N.M., Feddersen, J.C., Hagy, H.M., Combs, D.L., and Cohen, B.S. (2020). Depletion rates of flooded, unharvested corn in western Tennessee. Presented at the 27th Wildlife Society Annual Conference (virtual).

Highway, C.K., Blake-Bradshaw, A.G., Masto, N.M., Feddersen, J.C., Hagy, H.M., Combs, D.L., and Cohen, B.S. (2020). Depletion rates of flooded, unharvested corn in western Tennessee. Presented at the 74th Conference of the Southeastern Association of Fish and Wildlife Agencies (virtual).

Judge, S., Mapes, S., Murdock, J., and Nelson, H. (2021). Marine and freshwater HAB monitoring using the FlowCam. Presented at the North American Lake Management Society Annual Conference.

Kaiser, R., Datta, T., Parekh, R., Agga, G., and Polk, J. (2021). Antibiotic resistant bacteria in urban karst groundwater systems in Bowling Green, Kentucky. Presented at the virtual 2021 Tennessee Water Resources Symposium.

Keever, A.C., Kelly, J.D., Kissell, R.E., and Cohen, B.S. (2021). Estimating abundance of white-tailed deer in Tennessee using harvest data. Presented at the 53rd Annual Conference of the Tennessee Chapter of the Wildlife Society (virtual).

Masto, N.M., Bradshaw, A.G., Highway, C.J., Feddersen, J.C., Link, P., Hagy, H.M., Combs, D.L., and Cohen, B.S. (2020). Pre-breeding migration strategies of mallards wintering in the Mississippi Alluvial Valley. Presented at the 27th The Wildlife Society Annual Conference (virtual).

Masto, N.M., Blake-Bradshaw, A.G., Highway, C.J., Feddersen, J.C., Link, P., Magy, H.M., Combs, D.L., and Cohen, B.S. (2020). Pre-breeding migration strategies of mallards wintering in the Mississippi Alluvial Valley. Presented at the 74th Conference of the Southeastern Association of Fish and Wildlife Agencies (virtual). Awarded "Best Student Poster Presentation"

Masto, N.M., Blake-Bradshaw, A.G., Highway, C.J., and Cohen, B.S. (2020). Field demonstrations for capturing, handling, and banding waterfowl. Presented to Dyer County, TN.

Michael, M., and Murdock, J. (2021). Spatial variation of nutrient uptake in a restored west Tennessee agricultural wetland. Presented at the Tennessee AWRA Annual Conference.

Murdock, J., Brown, R., Womble, S., Duwadi, S., Michael, M., and Kalyanapu, A. (2021). Nutrient recovery trajectories of restored riparian wetlands in agricultural watersheds. Presented at the Tennessee AWRA Annual Conference.

PRESENTATIONS (CONT.)

Murdock, J., Brown, R., Womble, S., Duwadi, S., Michael, M., and Kalyanapu, A. (2021). Nutrient recovery trajectories of restored riparian wetlands in agricultural watersheds. Presented at the Society for Freshwater Science Annual Meeting.

Murdock, J., Brown, R., Womble, S., Duwadi, S., Michael, M., and Kalyanapu, A. (2021). Nutrient recovery across time and space within restored riparian wetlands. Presented at the Society of Wetland Scientist Annual Meeting.

Nelson, H., Chaffin, J., Stanislawczyk, K., Murdock, J., and Judge, S. (2020). Evolution of FlowCam for Cyanobacteria HAB research and monitoring. Presented at the North American Lake Management Society Virtual Conference.

Nelson, S.D., Keever, A.C., Wightman, P.H., Chamberlain, M.J., Collier, B.A., and Cohen, B.S. (2021). Habitat selection of eastern wild turkey broods. Presented at the 82nd Meeting of the Association of Southeastern Biologists (virtual meeting).

Nelson, S.D., Keever, A.C., Wightman, P.H., Bakner, N.W., Collier, B.A., Chamberlain, M.J., and Cohen, B.S. (2021). Resource selection of eastern wild turkey broods. Presented at the 53rd Annual Conference of the Tennessee Chapter of the Wildlife Society (virtual).

Nelson, S.D., Wightman, P.H., Chamberlain, M.J., Collier, B.A., and Cohen, B.S. (2020). Habitat selection of eastern wild turkey broods. Presented at the 27th The Wildlife Society Annual Conference (virtual).

Nelson, S.D., Wightman, P.H., Chamberlain, M.J., Collier, B.A., and Cohen, B.S. (2020). Habitat selection of brooding female eastern wild turkeys: Preliminary findings. Presented at the 52nd Annual Conference of the Tennessee Chapter of the Wildlife Society, Murfreesboro, TN, USA.

Ohemeng-Ntiamoah, J., and Datta, T. (2021). Can microbial acclimation work to avert inhibition during FOG co-digestion? Presented at the 2021 Water Environment Federation Residuals and Biosolids Conference: A Virtual Event, May 11-13, 2021.

Schaeffer, J.S. (2021). Is it time to finally build a water planning tool for the State of Tennessee? Presented at the virtual 2021 Tennessee Water Resources Symposium.

Wood, W.T., and Rogers, M.W. (2020). Abundance and population controls of bigheaded carp in a productive southeastern reservoir. Southern Division of the American Fisheries Society Annual Meeting, Little Rock, Arkansas.

PRESENTATIONS (CONT.)

Name**Major**

Maci Arms	Civil & Environmental Engineering
Marshall Avera	Civil & Environmental Engineering
Justin Baker	Civil & Environmental Engineering
Ryan Bauer	Biology
Joshua L. Bean	Agriculture
Joshua T. Bean	Biology
Sydney Beltran	Earth Sciences
Abby Blake-Bradshaw	Environmental Sciences
Alec Brenner	Civil & Environmental Engineering
Joanna Brown	Interdisciplinary Studies
Gabrielle Burke	Earth Sciences
Joshua Cary	Biology
Jennifer Caudle	Biology
Billy Clanton	Biology
Aaron Coons	Biology
Nathan Colwell	Chemistry
Trevor Crawford	Biology
Ashley Daniel	Interdisciplinary Studies
Kelly Day	Biology
Daniel Drexler	Civil & Environmental Engineering
Hunter Dyer	Civil & Environmental Engineering
Gary Matthew Dziuk	Biology
Kalei Hair	Civil & Environmental Engineering
Ethan Harper	Civil & Environmental Engineering
Hugh Harris	Civil & Environmental Engineering
Parker Hildreth	Biology
Abbey Holsopple	Biology
Ryan Hudson	Biology
Seth Jones	Interdisciplinary Studies
Nicholas Masto	Biology
Keaton Metcalf	Civil & Environmental Engineering
Lindsey Miller	Civil & Environmental Engineering
Cullen Morrow	Civil & Environmental Engineering
Caleb Moses	Biology
Stefan Nelson	Biology
Isaac Nickels	Agriculture
Kester Nucum	Computer Engineering
Ravi Patel	Civil & Environmental Engineering
Dennis Piercy	Chemical Engineering
Devin Rains	Civil & Environmental Engineering
Jonah M. Ralston	Chemistry
Michael L. Rand	Biology
Rachel Reed	Interdisciplinary Studies
Sarah Rhoton	Civil & Environmental Engineering
Mark Rine	Biology
Andrew Rosson	Biology
Austin Sanders	Agriculture
William Schibig	Biology
Tara Schmidt	Biology
Mary Scott	Biology
Alejandro Segoviano-Carril	Civil & Environmental Engineering
Md Bulbul Sharif	Engineering
Isabella Southerland	Chemical Engineering
Jarrett Tallent	Biology



HOURLY STUDENT SUPPORT

Name**Major**

Brandon Tincher	Biology
Katherine Torrance	Biology
Samuel Vesely	Interdisciplinary Studies
Jacob Viamonte	Biology
Emily Vigil	Biology
Adam Walker	Biology
John Micah Westerman	Civil & Environmental Engineering
Effie White	Civil & Environmental Engineering
MacKenzie White	Biology
Kathryn Wilkins	Biology
Alexandra Wilson	Biology
Philip Yankee	Biology



HOURLY STUDENT SUPPORT

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

SCHEDULE 7

	FY 2020-21 Actual			FY 2021-22 Proposed			FY 2022-23 Requested		
	Matching	Appropriations	Total	Matching	Appropriations	Total	Matching	Appropriations	Total
Expenditures									
Salaries									
Faculty	\$80,167	\$30,419	\$110,586	\$107,461	\$5,000	\$112,461	\$112,834	\$5,250	\$118,084
Other Professional	\$285,071	\$294,667	\$579,738	\$113,602	\$287,364	\$400,966	\$119,282	\$301,732	\$421,014
Clerical/ Supporting	\$67,747	\$136,653	\$204,400	\$61,124	\$165,585	\$226,709	\$64,180	\$173,864	\$238,044
Assistantships	\$388,990	\$264,016	\$653,006	\$134,234	\$220,000	\$354,234	\$140,946	\$231,000	\$371,946
Total Salaries	\$821,975	\$725,755	\$1,547,730	\$416,421	\$677,949	\$1,094,370	\$437,242	\$711,846	\$1,149,088
Fringe Benefits	\$369,720	\$318,880	\$688,600	\$159,411	\$285,000	\$444,411	\$167,382	\$299,250	\$466,632
Total Personnel	\$1,191,695	\$1,044,635	\$2,236,330	\$575,832	\$962,949	\$1,538,781	\$604,624	\$1,011,096	\$1,615,720
Non-Personnel									
Travel	\$293,864	\$7,430	\$301,294	\$100,707	\$10,000	\$110,707	\$105,742	\$10,500	\$116,242
Software		\$5,366	\$5,366			\$0			\$0
Books & Journals			\$0			\$0			\$0
Other Supplies	\$896,858	\$70,414	\$967,272	\$313,346	\$135,251	\$448,597	\$329,013	\$142,014	\$471,027
Equipment	\$100,000	\$119,291	\$219,291		\$100,000	\$100,000		\$105,000	\$105,000
Maintenance		\$40,261	\$40,261			\$0			\$0
Scholarships	\$46,000		\$46,000			\$0			\$0
Consultants	\$64,399		\$64,399	\$579,784		\$579,784	\$608,773		\$608,773
Renovation			\$0			\$0			\$0
Other (Specify):			\$0			\$0			\$0
			\$0			\$0			\$0
			\$0			\$0			\$0
			\$0			\$0			\$0
Total Non-Personnel	\$1,401,121	\$242,762	\$1,643,883	\$993,837	\$245,251	\$1,239,088	\$1,043,528	\$257,514	\$1,301,042
GRAND TOTAL	\$2,592,816	\$1,287,397	\$3,880,213	\$1,569,669	\$1,208,200	\$2,777,869	\$1,648,152	\$1,268,610	\$2,916,762
Revenue									
New State Appropriation		\$1,218,200	\$1,218,200		\$1,247,200	\$1,247,200		\$1,268,610	\$1,268,610
Carryover State Appropriation		\$315,153	\$315,153		\$229,270	\$229,270			\$0
New Matching Funds	\$2,592,816		\$2,592,816	\$1,569,669		\$1,569,669	\$1,648,152		\$1,648,152
Carryover from Previous Matching Funds			\$0			\$0			\$0
Total Revenue	\$2,592,816	\$1,533,353	\$4,126,169	\$1,569,669	\$1,476,470	\$3,046,139	\$1,648,152	\$1,268,610	\$2,916,762

Budget Note: The Center for the Management, Utilization and Protection of Water Resources requests a five percent budget increase for the 2021-2022 fiscal year to accommodate potential increases in salaries and other supplies and equipment expenses.

Center Director and Contributor/Editor/Writer:
Dr. Jeff Schaeffer
Designer: 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 | www.tntech.edu/watercenter

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

August 2021

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 basis protected by federal and state civil rights law. Tennessee Tech complies with Title IX and prohibits discrimination on the basis of sex in education programs and activities, admissions or employment. Inquiries regarding non-discrimination and affirmative action may be referred to the Director of Affirmative Action, Derryberry Hall 156, Box 5132, Cookeville, TN 38505-0001, 931-372-3069, equity@tntech.edu. Inquiries regarding Title IX may be referred to Tennessee Tech's Title IX Coordinator, Derryberry Hall 256, 931-372-3112, TitleIX@tntech.edu, or to the U.S. Department of Education Office of Civil Rights, 800-421-8339, OCR@ed.gov.

