

Fiscal Year July 1, 2015 through June 30, 2016

Annual Report

Center for the Management,
Utilization & Protection
of Water Resources

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Programmatic Report

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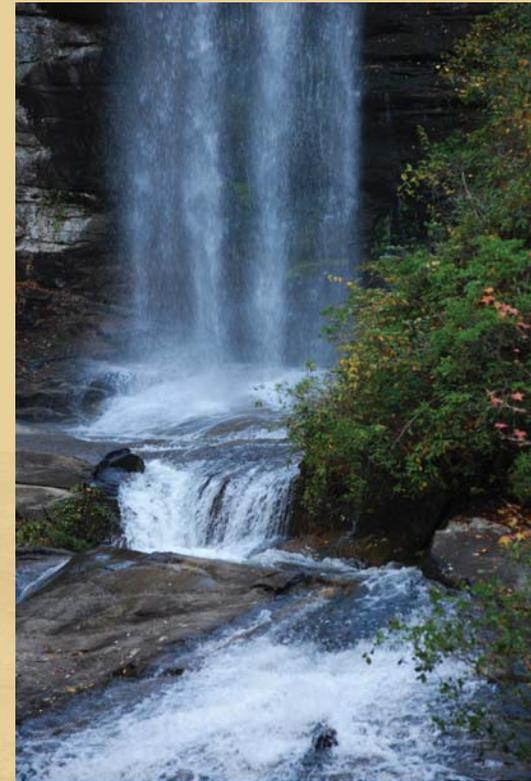


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Programmatic Report



I. Introduction

The Center for the Management, Utilization and Protection of Water Resources (CMUPWR) has been undergoing changes to its infrastructure and mission aimed at making it more productive and efficient at targeting relevant water-research areas that are earning funding in today's research marketplace. Now focusing its efforts in biodiversity and sustainability, enabling technologies and tools, water security and sustainability, and the water-energy-food nexus—which are emerging as leading topics among federal agencies and in water resource conferences—the CMUPWR is aligning faculty from across campus to better reach these areas. The following list encompasses the new research focus areas and the faculty working in them:

a. Biodiversity and Sustainability

Dr. Phil Bettoli, Biology
Dr. Brian Carver, Biology
Dr. Brad Cook, Biology
Dr. Carla Hurt, Biology
Dr. Robert Kissell, Chair, Biology
Dr. Hayden Mattingly, Biology
Dr. Justin Murdock, Biology (thrust leader)
Dr. Joshua Perkin, Biology
Dr. Mark Rogers, TN Cooperative Fishery Research Unit
Dr. Donald Walker, Biology

b. Enabling Technologies and Tools (including GIS, experimental infrastructure and support, computational simulations, and visualization and virtual reality)

Ms. Yvette Clark, Water Center (GIS Capabilities)
Dr. Alfred Kalyanapu, Civil Engineering (thrust leader)
Dr. Ehsan Languri, Mechanical Engineering (Modeling)
Mr. Kevin Liska and the iCube staff (Virtual Reality)

c. Water Security and Sustainability

Dr. Tania Datta, Water Center/Civil and Environmental Engineering (thrust leader)
Mr. Dan Dodson, Water Center
Dr. Alfred Kalyanapu, Civil and Environmental Engineering
Dr. Justin Murdock, Biology

d. Water-Energy-Food Nexus

Dr. Bharat Soni, Vice President for Research and Economic Development (thrust leader)
Dr. Laura Arias-Chavez, Chemical Engineering
Dr. Michael Best, Agriculture
Dr. Ehsan Languri, Mechanical Engineering
Dr. Brian Leckie, Agriculture
Dr. G.K. Stearman, Water Center/Agriculture
Dr. Milad Esfahani, post-doc

The Center's vision is to enhance water security and biodiversity and explore the water-energy-food nexus to provide knowledge that will ensure a sustainable future. Its mission is to

- research and develop innovative solutions to current knowledge and technology barriers associated with safe and sufficient water resources and biological diversity and sustainability
- develop transformational technologies and tools that encompass water-energy-food interactions
- through global outreach, support industry and state/federal agencies and communities in water security, biological diversity and associated sustainability programs
- support academic programs through student and faculty development and laboratory infrastructure access
- promote economic and rural community development regionally and in the State of TN.

II. Deliverables

- a. **Improving the Student Experience:** The CMUPWR supports undergraduate and graduate students from a variety of fields by providing them with hands-on research experiences led by qualified faculty. Through these experiences, students earn valuable hands-on research and analytical skills, public-speaking skills, and networking opportunities by presenting their findings at professional conferences. Several CMUPWR students earned awards and recognitions for their efforts at presenting their research this fiscal year. Please see Section IVa below.
- b. **Transform Technology:** The CMUPWR continuously seeks ways to improve its faculty's access to the latest technology. Whether through improving its Environmental Quality Lab (EQL) capabilities or encouraging its faculty's use of the iCube virtual reality technology available on campus, the CMUPWR promotes constant technological advancement in the pursuit of its mission.
- c. **Expanding Financial Resources and Modernize Infrastructure:**
One of the CMUPWR's main focuses is to increase external funding received by its faculty. By exploring and growing networking and interdisciplinary collaboration opportunities, the CMUPWR plans to further that intent and build new leads that will grow funding successes.

III. Collaborative Efforts (Internal and External)

Bharat Soni, the Vice President for Research and Economic Development, is establishing interdisciplinary teams from across campus to work toward the CMUPWR's new research focus areas. He is gathering faculty from a wide array of departments, ranging from biology to civil engineering, to make the CMUPWR more effective in earning funding by focusing on water research areas that are relevant in today's arena. The fruits of these teams should be revealed in increased external funding.

The CMUPWR has initiated and developed an excellent collaborative relationship with the Environmental Science Division at Oak Ridge National Laboratory (ESD/ORNL). In this respect, two symposia, one at ORNL and one at TTU, were organized to promote exchange of research ideas between researchers. We have made significant progress in linking researchers on both entities and are exploring collaborative sponsored research program proposals.

IV. Faculty Awards, Service and Productivity

a. Faculty and Student Recognition and Awards

The Environmental and Water Resources Institutes of the American Society of Civil Engineers recently awarded third place in the undergraduate division to environmental engineer Alfred Kalyanapu's student John Brackins, a junior civil engineering student from Franklin, TN.

His paper is titled "Using ADCIRC and HEC-FIA Modeling to Predict Storm Surge Impact on Coastal Infrastructure." According to Kalyanapu, this is the first time a student from



Alfred Kalyanapu, environmental engineer (left), and his student John Brackins

Tennessee Tech has been a winner at the Congress.

Environmental engineer Tania Datta's student Oluwadare Oladapo received first prize among all other posters from the Department of Civil and Environmental Engineering during Tennessee Tech University's Research and Creative Activities Day. He also received the College of Engineering Eminence Award.

Datta's student Amirsalar Rabbani Esfahani received third prize at the Student Poster Competition during the 2015 Kentucky/Tennessee Water Professional Conference. Datta's student Grace McClellan received the Sigma Xi Grants-in-Aid research award during the October 2015 grant cycle. McClellan also received a one-time Albert A. Cannella Engineering Memorial Scholarship. Datta's other student Rachel Stewart earned a Tennessee Tech URECA! Grant for summer research in Datta's lab.

b. University, Professional and Community Service Activities

• University and Department Services

Tania Datta, environmental engineer, is the advisor for four Civil and Environmental Engineering graduate students, two Ph.D. and two master's. She also serves on the graduate committee for four Civil and Environmental Engineering and one biology students. Datta also advises 24 undergraduate students every semester and currently mentors four undergraduate students on their interests in the field of environmental engineering through research projects. Datta is also a member of the Tennessee Tech Research and Graduate Affairs Committee, Facilities Committee, the Sigma Xi Tennessee Tech Chapter Membership Committee, the Rural Development Institute, and serves as the Laboratory Safety and Facilities Coordinator for the Water Center Lab, is faculty advisor for the Tennessee Tech Chapter of Engineers Without Borders, and the faculty co-advisor for Water Professionals, a Water Environment Federation and America Water Works Association Student Chapter at Tennessee Tech.

Justin Murdock, biologist, served as the advisory to master's student Lucas Hix, who graduated Fall 2015.

• **Professional Services**

Environmental engineer Tania Datta serves as the ad-hoc vice chair of the Water Environment Federation's (WEF's) Residuals and Biosolids Committee and as the Task Force Chair for that organization's Water Reuse Task Force, Municipal Water Resource Recovery Design Committee (2016-2018). She is also an active member of the WEF Literature Review, Program, and Residuals and Biosolids committees.

• **Scholarly Services**

Environmental engineer Tania Datta reviewed papers for the *ASCE Journal of Environmental Engineering, Water Science and Technology*, and *Journal of Applied Microbiology*.

• **Outreach**

Tania Datta, environmental engineer, received a grant from the USAID-STRIDE Visiting Professor Program through the Technical University of the Philippines in Summer 2015. This grant allowed her to travel to the Philippines for three weeks and initiate research collaborations in the field of water and wastewater with universities and industries there. As a result, they were able to initiate some collaborative research ideas for which they are now jointly pursuing research funding opportunities. Datta also led an activity for the 2015 Engineering a Future event, designed to inspire middle school girls to pursue STEM-related career paths. For the event, Datta organized an introductory presentation, highlighting the importance of water conservation and treatment and the power of water. This was followed by a hands-on activity where students were able to learn about water quality. Datta also served as a judge for the 61st Annual Cumberland Plateau Regional Science and Engineering Fair, hosted by the Tennessee Tech STEM Center. She served as a judge for Tennessee Tech's Student Research and Creative Activities Day and led a Fab Friday event related to water quality and water/wastewater treatment at the STEM Center.

c. **Professional Activity Summary**

1. **Journal Articles Published**

• **Alfred Kalyanapu: 1**

Ahmadisharaf, E., A. Kalyanapu, and E.-S. Chung. Spatial probabilistic multi-criteria decision making for assessment of flood management alternatives. *Journal of Hydrology*, 533, 365-378, doi: 10.1016/j.jydrol.2015.12.013.

• **Hayden Mattingly: 3**

Black, T.R., H.T. Mattingly, and D.D. Smith. 2015. Utilization of PIT telemetry to assess microhabitat affinities of stream-dwelling female crayfish during reproductive seclusion. *Freshwater Crayfish*, 21(1): 71-82.

Herleth-King, S.S., H.T. Mattingly, and R.J. DiStefano. 2015. Habitat use of *Orconectes meeki* and *Orconectes williamsi* in an intermittent Ozark stream. *Freshwater Crayfish*, 21(1): 103-114.

Johansen, J.W., H.T. Mattingly, and M.D. Padgett. 2016. Population densities of two rare crayfishes, *Cambarus obeyensis* and *Cambarus pristinus*, on the Cumberland Plateau of Tennessee. *Southeastern Naturalist* (In press).

• **Justin Murdock: 1**

Murdock, J.N. 2016. Detecting carbon uptake in individual algae within multi-species assemblages. *Limnology and Oceanography: Methods*, 14(2):124-137.

• **Joshuah Perkin: 1**

Perkin, J., N. Knorp, T. Boersig, A. Gebhard, L. Hix, and T. Johnson. 2016. Life history theory predicts long-term fish assemblage response to stream impoundment. *Canadian Journal of Fisheries and Aquatic Sciences*.

2. **Conference Articles Published: 0**

3. Book Chapters: 0

4. Presentations

• **Phil Bettoli: 4**

Harty, C., and P.W. Bettoli. 2016. Population dynamics of catfishes in three Tennessee River reservoirs and developing standardized sampling protocols. Annual Meeting of the Southern Division of the American Fisheries Society, Wheeling, WV.

Harty, C., and P.W. Bettoli. 2016. Evaluation of catfish populations and development of standardized sampling protocols in Tennessee reservoirs. Annual meeting of the Tennessee Chapter of the American Fisheries Society, Burns, TN.

Ridgway, J., and P.W. Bettoli. 2016. Gear efficacy and population characteristics of Bigheaded Carp on the southeastern leading edge of their North American invasion. Annual Meeting of the Southern Division of the American Fisheries Society, Wheeling, WV.

Ridgway, J., and P.W. Bettoli. 2016. Bigheaded Carp in the lower reaches of the Tennessee River and Cumberland River. Annual Meeting of the Tennessee Chapter of the American Fisheries Society, Burns, TN.

• **Tania Datta: 1**

Garcia, T.P., T. Datta, and A.S. Pili. 2015. An evaluation of current waste disposal practices and possible pathways to pollution prevention in the Philippines printing industry. The 2015 Asian Symposium on Printing Technology in Tokyo, Japan.

• **Alfred Kalyanapu: 8**

Kalyanapu, A.J. Challenges and advances of modeling flood

hazards in the 21st Century: Use of gaming technology, Monte Carlo methods and geo-spatial analysis for realistic predictions. Fortieth Natural Hazards Research and Applications Workshop, Broomfield, CO, July 19-22, 2015.

Dullo, T.T., A.J. Kalyanapu, S.K. Ghafoor, V. Ananthraj, R.J. Marshall, J. Tatarczuk, and K. Shih-Chieh. Computational performance of a two-dimensional flood model in single and multiple GPU frameworks. Geophysical Research Abstracts, 17, EGU2015-14739, 2015, EGU General Assembly.

Ahmadisharaf, E., and A.J. Kalyanapu. A risk and reliability analysis approach to investigate the impact of reservoir inflow change on dam overtopping. Twenty-fourth Tennessee Water Resources Symposium, 2B4-7, Burns, TN, April 2015.

Ahmadisharaf, E., and A.J. Kalyanapu. Investigation of the impact of streamflow temporal variation on dam overtopping risk: Case study of a high-hazard dam. In Karvazy, K., Webster, V.L. (Eds.). Proceedings of the World Environmental and Water Resources Congress, 1050-1057, Austin, TX.

Alamdari, N., J.C. Thornton, Y. Clark, D. George, T. Datta, and A. Kalyanapu. Modeling impacts of land use/land cover change of Obed River Watershed using Watershed Quality Index (WQI) model. In Karvazy, K., Webster, V.L. (Eds.) Proceedings of the World Environmental and Water Resources Congress, Austin, TX.

Bhuyian, N.M., J.C. Thornton, and A.J. Kalyanapu. Developing "Flood Loss Curve" for City of Sacramento, Mitigation on the Mind, 2015 ASFPM National Conference, Atlanta, GA, June 2015.

Dullo, T.T., A.J. Kalyanapu, S.K. Ghafoor, R.J. Marshall,

K.J. Tindall, V. Anantharaj, K. Shih-Chieh, and S. Gangrade. Computational performance of a MPI-enabled and GPU-accelerated two-dimensional flood model. 2015 AGU Fall Meeting, San Francisco, CA, December 14-18, 2015.

Dullo, T.T., A.J. Kalyanapu, J.C. Thornton, L.A. Auld, and S.A. Hawkins. Investigating the performance of one- and two-dimensional flood models in a channelized river network: A case study of the Obion River system. 2015 AGU Fall Meeting, San Francisco, CA, December 14-18, 2015.

• **Robert Kissell: 1**

Johnston, S., and R.E. Kissell, Jr. Status and distribution of long-tailed weasels in Arkansas. The Wildlife Society's Annual Conference, October 18-21, 2015, Winnipeg, Canada.

• **Hayden Mattingly: 1**

Boersig, T., III, H.T. Mattingly, and J.W. Johansen. Life history of the obey crayfish, *Cambarus obeyensis*, an endemic crayfish of the Cumberland Plateau. American Fisheries Society Southern Division Annual Meeting, Wheeling, WV, February 2016.

• **Justin Murdock: 8**

Knorp, N.E., and J.N. Murdock. Investigating herbivore-biofilm interactions using macroinvertebrate exclusion cages: A design comparison. Ecological Society America National Meeting, Baltimore, MD, August 9-14, 2015.

Hix, L., J.N. Murdock, and N.E. Knorp. *Didymosphenia geminata* distribution and food web impacts in the upper Tennessee River watershed. Tennessee Academy of Sciences Annual Meeting, Morristown, TN, November, 2015.

Knorp, N.E., and J.N. Murdock. Investigating herbivore-biofilm

interactions using invertebrate exclusions: A design comparison. Society for Freshwater Science National Meeting, Sacramento, CA, May 2016.

Engle, A., J.N. Murdock, and G. Moyer. Monitoring for *Didymosphenia geminata* in Tennessee: An environmental DNA approach. Society for Freshwater Science National Meeting, Sacramento, CA, May 2016.

Murdock, J.N., N.E., Knorp, L. Hix, and A. Engle. The impact of *Didymosphenia geminata* mats varies across trophic levels in southern Appalachian streams. Society for Freshwater Science National Meeting, Sacramento, CA, May 2016.

TTU TECHnovations Podcast series. November 16, 2015. Episode 18. Murdock discussed his research involving algae and healthy waterways. He spoke about *Didymosphenia geminata*, an algae that is forming cottony mats in some Tennessee waterways.

Murdock, J.N. Determining *Didymo* distribution and stream susceptibility to invasion in the upper Tennessee River watershed. Trout Unlimited, Little River Chapter, TN, Dec. 3, 2015.

Murdock, J.N. Current distribution and potential spread of *Didymo* in Tennessee. Trout Unlimited Tennessee State Coldwater Fisheries Meeting, Feb. 13, 2016.

5. **Research Proposal Reviewer: 0**

6. **Journal Reviews: 0**

Student Spotlight: Grace McClellan

Grace McClellan, Water Center student from Lebanon, Tennessee, was recently awarded a fellowship through the National Science Foundation Graduate Research Fellow Program, based on her "demonstrated potential to contribute to strengthening the vitality of the U.S. science and engineering enterprise."

McClellan's dissertation is titled "Linking Diversity of Polyphosphate Accumulating Organisms to Improved Functional Stability of the Enhanced Biological Phosphorus Removal Process." Her work is done on this project as a graduate student under Tania Datta, assistant environmental engineering professor, and its goal is to improve an existing process that uses microorganisms to remove nutrients from wastewater. McClellan earned her bachelor's in biology, with a concentration in genetics and biotechnology, from Middle Tennessee State University in 2004.

The biological nutrient removal process has already been implemented in many wastewater treatment facilities; however, it is not entirely reliable. The unpredictable failures of this process are mostly due to a lack of understanding of the microorganisms involved. McClellan's research will help to increase that understanding.

Through the NSF award, McClellan will receive a stipend over the course of three years, or until she graduates. TTU will also receive a cost of education allowance in lieu of all required tuition and fees for the years she receives the Fellowship funding.

Prior to earning this award, McClellan received TTU's Diversity Fellowship, a "Grant in Aid of Research," from Sigma Xi and the Albert A. Cannella Engineering Memorial Scholarship.

"The NSF GRFP award has definitely been the most prestigious, but all of the awards I've received have been meaningful in that they've allowed for me to attend graduate school and make the achievements that led to the NSF fellowship," McClellan said.



Grace McClellan



Tania Datta

Research Spotlights: Fisheries

Phillip Bettoli, biology professor and assistant unit leader of the Tennessee Cooperative Fishery Research Unit (TCFRU), and his research team including Mark Rogers, unit leader of the TCFRU, are involved in several projects related to the protection of endangered and threatened fish species. The following are summaries of some of those projects.

Sampling and Population Characteristics of Bighead Carp and Silver Carp in the Tennessee River and Cumberland River Systems (PI: P.W. Bettoli, Co-investigator: J. Ridgway, master's student | Funding Agency: Tennessee Wildlife Resources Agency, \$35,850)

The invasive Bighead Carp *Hypophthalmichthys nobilis* Richardson and Silver Carp *H. molitrix* Valenciennes (collectively referred to as bigheaded carps) were introduced to the U.S. in the 1970s to control noxious algae blooms in polyculture ponds. In the lower reaches of the Tennessee River and Cumberland River systems, bigheaded carps were systematically sampled in 2015 and 2016 using multiple gears. Silver Carp in Kentucky Lake and Lake Barkley were similarly robust, and more robust than Silver Carp below Barkley Dam, suggesting food resources and habitat are ideal in the reservoirs. Future efforts to control bigheaded carps in Tennessee waters should include studying the efficacy of barriers at navigation locks, determining where natural reproduction is occurring, and increasing the commercial harvest of both species. (This project is complete.)



Assessment of Blue Catfish and Channel Catfish Populations in Tennessee Reservoirs (PI: P.W. Bettoli, Co-investigator: C. Harty, master's student and research technician | Funding Agency: Tennessee Wildlife Resources Agency \$210,000 over three years)

Channel Catfish and Blue Catfish are popular commercial and recreational species throughout the United States, especially in Tennessee. Catfish are the second most pursued recreational species in Tennessee behind black bass and commercial catfish harvest can exceed 700,000 kg annually. Thus, Tennessee reservoirs provide an ideal stage to study these popular fish. In this study, we examined the catfish populations in Tennessee's largest commercial and recreational catfish fishery (Kentucky Lake), its second largest fishery (Chickamauga Lake), and in a reservoir with a fish consumption advisory that is closed to commercial fishing (Fort Loudoun Lake). (The final report for this project is due December 2016.)



Research Spotlights: Fisheries (cont.)

Movements and Lock and Dam Passage of Asian Carp in the Tennessee River
(PI: M. Rogers, Co-investigators: Students and Staff | Funding Agency: Tennessee Wildlife Resources Agency, \$77,500)

Silver Carp *Hypophthalmichthys molitrix* are spreading in the Ohio River Basin and many of its tributaries. Increasing occurrences in one of the major tributaries, the Tennessee River, has created concerns for the five states that manage fisheries within the Tennessee River's watershed. Multiple agencies have begun an effort to understand the movement of Asian carp in the Tennessee River basin via acoustic telemetry. This project would fill in the gaps and complete the array of receivers on the Tennessee River system. This project joins multiple, independent projects on the system working towards a common goal. Movement data from these projects will lead to better understanding of Asian carp dispersal and invasion dynamics, evaluation of movement through lock and dam systems, and identification of seasonal congregations in the Tennessee River. (The project will commence January 2017.)



Relative Population Densities of Asian Carp in the Tennessee River and Cumberland River Drainages (PI: Mark Rogers, Co-investigators: Students and Staff | Funding Agency: Tennessee Wildlife Resources Agency, \$111,433)

Asian carp (AC) are increasingly expanding within multiple Tennessee river systems, but knowledge of current distributions and abundance is lacking. Bighead carp have been observed in the Tennessee waters of the Cumberland River and Tennessee River for at least 10 years. Silver carp were first observed in Tennessee waters in ~2008, but they were not observed in the headwaters of the lowermost reservoirs in each river system until ~ 2012. The objectives of this project are to (1) assess spatial variation in relative abundance of AC in the main basins of two Tennessee River impoundments (Kentucky and Pickwick lakes) and two Cumberland River impoundments (Barkley and Cheatham lakes); (2) develop indices of AC abundance in the headwaters (i.e., dam tailwaters) of those four impoundments, which are proximal sources for further upstream invasion; (3) evaluate tailwater sampling efficiency and relate tailwater AC indices to AC catches in the main basins; and (4) sample additional tailwaters within the Tennessee and Cumberland river systems where the status of AC is unknown to further delineate the leading edge of AC in the waters of Tennessee, Mississippi, and Alabama. (The project will commence January 2017.)



Research Spotlights: Fisheries (cont.)

Effect of Asian Carp Invasion on the Food Web of a Mussel Biodiversity Hotspot in Tennessee
(PIs: M. Rogers and J. Murdock | Funding Agency: U.S. Fish and Wildlife Service, \$24,610)

Asian carps (*Hypophthalmichthys* spp.) continue to spread throughout the Mississippi River basin and have recently become established in the lower Tennessee River watershed. Silver Carp (*H. molitrix*) have now entered the Duck River, a tributary to the Tennessee River, which is a hotspot for fish, crayfish, and mussel biodiversity. Given that both Asian Carp and mussels are filter-feeders, the invasion of Asian Carp in the Duck has created concerns about potential food web disruption and potential for deleterious effects on the river's native freshwater mussel community. The potential effects of Asian Carp on native mussels has not been evaluated despite knowledge that they are both filter-feeders and consume some of the same food resources. The primary objective of this project is to evaluate diet niche overlap between native mussels and Silver Carp across three seasons in the Duck River. We will also evaluate indirect pathways in which Silver Carp could affect native mussels by quantifying diet niche overlap between the carp and representative host fish for mussel glochidia. (This project will commence January 2017.)



Other Highlights

Environmental Quality Lab: The Center's lab has been remodeling and undergoing change, including the purchase of several new pieces of equipment, making it a more viable resource for faculty and funding agencies, especially the Tennessee Department of Environment and Conservation who is in the process of making the TTU lab its one-stop facility for water analysis. The lab also revised its brochure to make it more marketable and appealing to a larger audience of prospective customers.

Environmental App: Through a partnership with the TTU iCube, a field engineer app that will help predict water flows was developed for the Tennessee Department of Environment and Conservation.

Water-Energy-Food Nexus: Laura Arias-Chavez, chemical engineering assistant professor, and her research team including Ehsan Languri, mechanical engineering assistant professor, and Milad Esfahani, chemical engineering post-doc, are working on projects related to membranes for sustainability at the water-energy-food nexus. The work focuses on new membrane applications for better resource production and recovery and nano-scale design and fabrication of membranes to support these applications. An NSF proposal related to the water-energy-food nexus has been submitted but was unfunded. The Center still plans to continue to support those efforts through seed funds.



Laura Arias-Chavez



Ehsan Languri



Milad Esfahani

Environmental Ecology: Robert Kissell, chair of the Biology Department, and his graduate assistant, Suzanne Johnston, are working on a project funded by the U.S. Department of the Interior, through the Arkansas Game and Fish Commission, to determine the habitat requirements and distribution of the long-tailed weasel, an animal whose populations seem to be declining. Johnston uses a cubby to collect information about the weasel's habitat.



Suzanne Johnston



Justin Murdock

Integrated Computational Approach: The Center is collaborating with the TTU Information Technology Services to build a high-performance computing system that will provide 42 teraflop processing capabilities by December 2016. Graduate student Justin Medley is also using the latest information technology tools and virtual reality in a project he is involved in for the Center.

Stream Structure and Function: Justin Murdock, biology assistant professor, and his team are working on projects to understand the impacts of stream physical, chemical, and biological changes on ecosystem structure, biogeochemical cycling, and energy flow.

Other Highlights (cont.)

Molecular Approaches to the Assessment and Conservation of Biological Diversity: Assistant Professor of biology Carla Hurt and her students are involved in projects that apply sophisticated molecular tools to improve the management strategies for conserving imperiled and endangered aquatic biodiversity. Her research interests are in assessing levels of biodiversity at the species level; examining the patterns of divergence in incipient species; identifying units of conservation and management priorities; and developing environmental DNA sampling techniques for defining the distribution of endangered and imperiled aquatic species.



Carla Hurt

Fish and Aquatic Landscape Ecology: Assistant Professor of biology Joshua Perkin and his students focus on freshwater fish biodiversity, understanding reasons for its decline, and developing approaches for mitigating threats. His research interests are in connectivity of aquatic landscapes ("riverscapes"); natural and anthropogenic structuring mechanisms for fish communities; movement of the ecology of stream fishes; and the life history variation in freshwater fishes.



Joshua Perkin



Brian Leckie

Other Highlights (cont.)

Molecular Ecology and Evolution of Microorganisms: Assistant Professor of biology Donald Walker and his students' research expertise lies in the areas of molecular evolution and molecular ecology of microorganisms with an emphasis on fungi. Past research projects have focused on the evolution of plant-fungal pathogen relationships and utilized systematics, phylogenetics, and molecular marker development to integrate evolutionary biology, host/fungus associations, and ecological vicariance events, to describe species diversity in non-model groups of organisms. More recently the Walker lab group has concentrated on using metabarcoding and high-throughput sequencing techniques to study host-microbe associations of the reptile, amphibian, fish, and bat microbiome. Emerging infectious fungal pathogens are threatening wildlife species world-wide, therefore, the group is interested in answering broad questions centered on the importance of the host microbiome for biodiversity conservation. The southeastern United States is a global 'hotspot' for biological biodiversity and serves as a foundation for their field studies.



The Center for the Management, Utilization and Protection of Water Resources requests a three percent budget increase for the 2017-2018 fiscal year to accommodate potential increases in salaries and other supplies and equipment expenses.

Editor, Designer and Writer: Amy Hill

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**Tennessee
TECH**

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August 2016

Tennessee Technological University is a constituent university of the Tennessee Board of Regents. The TBR, the sixth largest system of higher education in the nation, governs 45 institutions: six universities, 13 community colleges and 26 area technology centers, providing programs to more than 190,000 students in 90 of Tennessee's 95 counties.

TTU does not discriminate on the basis of race, color, national origin, sex (gender), disability (ability), or age in its programs and activities. The following person has been designated to handle inquiries regarding the non-discrimination policies: Director of Diversity and Legal Affairs, PO Box 5164, Cookeville, TN 38505, 931-372-3016; affirmact@tntech.edu.