RESEARCH ENTERPRISE ANNUAL REPORT 2016

Discovery in Every Direction

NORTHERN ARIZONA UNIVERSITY

MESSAGE FROM THE PRESIDENT

At Northern Arizona University, we pursue discovery in every direction from our vantage point here on the Colorado Plateau. Throughout our history, our desire and drive to understand the world have resulted in cutting-edge research that addresses some of the world's most pressing challenges.

Last year was an exciting year for our research enterprise. We have long been strong contributors to discovery in disciplines like land management and climate sciences, microbiology, astronomy and planetary science, and health sciences. In 2016, we capitalized on those strengths while also increasing investments in emerging technologies aligned with bioengineering, informatics and cyber systems, and the human microbiome. Building these areas of capability will foster interdisciplinary collaboration across the university, as well as grow partnerships with business and industry.

Research holds tremendous possibilities for NAU, and we are committed to accelerating this growth in the years ahead. By strategically increasing the university's research capacity, we will enable faculty to continue to expand the boundaries of knowledge—spurring innovation and technology transfer that contributes to the intellectual and economic development of the state and beyond.

Rita Hartung Cheng, President

MESSAGE FROM THE VICE PRESIDENT FOR RESEARCH

In 2014, President Rita Cheng came to NAU with a bold vision: to make NAU a top-200 research university. In fact, we are now well on the way to achieving this goal. In 2015, the National Science Foundation* ranked NAU 219th among the approximately 900 U.S. universities that report research activities to the NSF. NAU has moved up 10 places in the rankings since President Cheng came to NAU, and we expect to be ranked among the top 200 research universities within two to three years. Under President Cheng, NAU has created new research centers, developed new partnerships, made strategic hires, established new PhD programs, and generated a new pride in our status as a Carnegie-designated "higher research" university and the achievements that such a designation represents. Under the leadership and direction of Dr. Cheng, the university is now well-positioned for continued and accelerated research growth.

William Grabe, Vice President for Research

* Source: National Science Foundation's Higher Education Research & Development (HERD) survey, 2015

Discovery
in Every Direction

"Discovery in Every Direction" is the theme of our 2016 annual report. It underlies Northern Arizona University's overall commitment to growing our research capacity by investing in new programs, recruiting world-class faculty, and building infrastructure that will bring NAU's research enterprise national and international recognition.

This report highlights some of our achievements over the past year—achievements resulting from strategic investments and the hard work of our dedicated faculty, staff, and student researchers.

Review our 2016 Annual Report to see where our discoveries are taking us.

Strategic Recruiting Initiative Attracts World-Class Researchers to NAU

With the arrival of President Rita Cheng in 2014, Northern Arizona University began shaping a vision for accelerated growth of the research enterprise, and a new recruiting strategy emerged. This strategy expanded the university's existing areas of research strength–specifically, ecology and environmental science, microbiome and pathogen research, healthcare involving underserved communities, astronomy, informatics and computing, bioengineering, and geology. This strategy entailed identifying highly productive researchers at other universities across the country who have existing connections to NAU faculty and recruiting them to NAU.

By focusing our hiring strategy on these nationally known faculty with expertise that crosses narrow disciplinary boundaries, the university began creating opportunities for larger interdisciplinary projects to succeed. Ultimately, NAU envisions a future in which its researchers easily collaborate across disciplines to produce applications in areas such as pathogen research and environmental solutions that will have far-reaching implications for, and impact on, our world.

In 2016, we began to see the results of our strategic recruiting initiative and investment. For the last two years, NAU has attracted a number of world-class experts who are generating increased external grant funding, producing high-impact scholarship, and recruiting high-quality graduate students to their laboratories and programs.

Loren Buck

Loren Buck, an environmental physiologist, joined NAU as the associate director of the Center for Bioengineering Innovation. He came to NAU from the University of Alaska Anchorage. Dr. Buck has published extensively in peer-reviewed journals such as *General and Comparative Endocrinology, Journal of Toxicology and Environmental Health, Physiology,* and *Nature*. The Buck laboratory has been awarded more than $20 million in external funding over the past 17 years. Dr. Buck has several ongoing research projects in the United States, Brazil, and Argentina; the National Science Foundation and the National Institutes of Health currently fund his work in the areas of organism/environment interactions, biological timing, and endocrine disruption. These projects span from the basic to the applied sciences with relevance to both climate change biology and human health.


LOREN BUCK

Christopher Edwards

A planetary scientist, Assistant Professor **Christopher Edwards** came to NAU's Department of Physics and Astronomy from the U.S. Geological Survey's Astrogeology Science Center. Dr. Edwards studies the surfaces of extraterrestrial planets using high-resolution imagery, thermal infrared radiometry, and spectroscopy. He works with multiple NASA Mars missions, conducts planetary analog fieldwork, and develops new remote sensing instruments for use in the laboratory, field, and space-based applications. Dr. Edwards' findings recently sparked debate and attracted attention from national media outlets, including the *Washington Post*, because his findings contradict beliefs that liquid water may exist on the surface of present-day Mars.


CHRISTOPHER EDWARDS

Scott Goetz

Professor **Scott Goetz** came to NAU in 2016 from the Woods Hole Research Center, where he was a senior scientist and deputy director. Using information derived from satellite imagery, Dr. Goetz conducts research on ecosystem responses to environmental change. He has more than 160 publications, including refereed journal articles, book chapters, professional commentaries, and perspectives; his work has been cited more than 15,000 times. Dr. Goetz' work as principal investigator and co-principal investigator for many projects has earned more than $15 million in research grants from agencies such as NASA, the National Science Foundation, and the National Oceanic and Atmospheric Administration.


SCOTT GOETZ

Michelle Mack

An ecologist, Professor **Michelle Mack** came to NAU's Center for Ecosystem Science and Society from the University of Florida, where she was a professor of biology. Dr. Mack has published 125 peer-reviewed articles, which have been cited more than 7,400 times. She is the lead investigator on a $1.6 million collaborative grant from the National Science Foundation to study the role of deep roots and mycorrhizae in the response of arctic plants to climate warming. NASA recently awarded Dr. Mack an $897,000 grant to study the increasing fire severity and the loss of legacy carbon from forest and tundra ecosystems of northwestern North America. In 2016, Dr. Mack was elected a Fellow of the Ecological Society of America in recognition of her seminal research contributions in climate change and fire ecology, training future ecologists, and outstanding science communication and outreach to the public.


MICHELLE MACK

Benjamin Ruddell

Associate Professor **Benjamin Ruddell**, a civil engineer, came to NAU's School of Informatics, Computing, and Cyber Systems from Arizona State University, where he was an associate professor of engineering. His research focuses on the quantification and management of complex coupled natural-human systems, including regional water and climate systems strongly influenced by the economy and society. Shortly after joining NAU, he received a $3 million grant from the National Science Foundation for an interdisciplinary research project to create the first comprehensive data map showing how the country's food production systems, energy production systems, and water supply align and interact. The map will be used to advance understanding, inform future policies, and spur new technologies.


BENJAMIN RUDDELL

Ted Schuur

Professor **Ted Schuur** is an ecosystem ecologist. He came to NAU's Center for Ecosystem Science and Society from the University of Florida. Dr. Schuur has published more than 130 articles in peer-reviewed scholarly journals, including *Nature, Science, Proceedings of the National Academy of Science,* and *Nature Climate Change*, with more than 11,000 citations. As the lead investigator for the international Permafrost Carbon Network, Dr. Schuur's research focuses on the response of Arctic ecosystems in a warmer world. He is currently lead investigator on a project awarded a $1.4 million grant by the U.S. Department of Energy to study the regional vulnerability of permafrost carbon to climate change. Working to bring public awareness to the issues revealed by his research findings, Dr. Schuur also published an article on thawing permafrost in the December 2016 issue of *Scientific American*.


TED SCHUUR

Frank von Hippel

Ecotoxicologist **Frank von Hippel** joined NAU in 2016 as a professor of biological sciences. Dr. von Hippel, who came to NAU from the University of Alaska Anchorage, studies a spectrum of problems in environmental toxicology in both lab and field settings. Many of Dr. von Hippel's projects incorporate community-based participatory research with indigenous peoples, including the Yupik communities of St. Lawrence Island and the Qawalangin community of Unalaska Island, Alaska; the Mayan communities at Lake Atitlán, Guatemala; and the Anindilyakwa communities on Groote Island, Australia. He studies the health and development effects of a variety of contaminants, including perchlorate, PCBs, neurotoxic metals, pesticides, and flame-retardant and industrial chemicals.


FRANK VON HIPPEL

Integrating Computational and Data Sciences across Academic Disciplines

"NAU's commitment to technological research directly impacts our changing society and the individuals within it," said NAU President Rita Hartung Cheng. "This new school will put NAU at the forefront of information sciences needed for our increasingly technological world. It will enhance research possibilities and strengthen the quality and content of our degrees."

PAUL JAGODZINSKI

NAU's New School of Informatics, Computing, and Cyber Systems

Northern Arizona University's new School of Informatics, Computing, and Cyber Systems (SICCS) was formed in July 2016 to meet the need for advanced interdisciplinary computational and data sciences, and to enable NAU to compete with major research universities in informatics, cyber systems development, and cybersecurity. This research-intensive academic unit, which is growing at a brisk pace, brings together expertise in computer science, electrical engineering, eco/environmental informatics, and bio/health informatics. The school's core mission is to integrate rapidly developing scientific knowledge around computation, data interpretation, and systems design with traditional science and engineering disciplines to drive breakthroughs that address key challenges of the twenty-first century.

"We're very excited that President Cheng is investing in, and helping to grow, our programs in SICCS. We're working hard to ensure the president's vision is a success."

– PAUL JAGODZINSKI, DEAN, COLLEGE OF ENGINEERING, FORESTRY, AND NATURAL SCIENCES

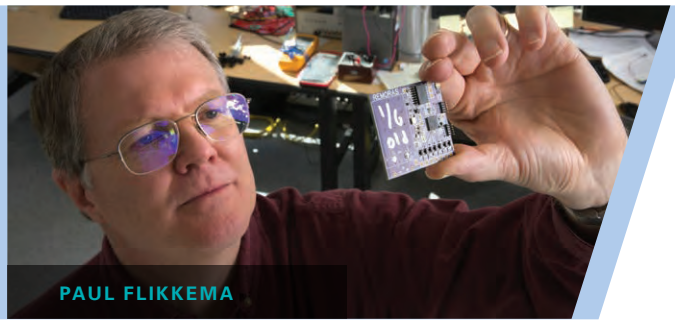
Building Strong Collaborations and Partnerships

By combining the expertise of the university's electrical engineering and computer science department and the Informatics and computing program into one academic unit, with interdisciplinary research as a primary mission, SICCS bridges disciplinary divides and leverages the shared expertise of many faculty to strengthen both research and academic programs.

Through collaborative research projects and academic program development, SICCS faculty work closely with other university researchers to incorporate informatics and computing as an essential element of research and learning. SICCS faculty members collaborate with researchers at institutes such as the Pathogen and Microbiome Institute, the Center for Bioengineering Innovation, the Merriam-Powell Center for Environmental Research, the Center for Ecosystem Science and Society—as well as the Departments of Physics and Astronomy, Biology, Chemistry, Geology, and Health Sciences.

"Our school's researchers are addressing a broad range of emerging challenges in science, engineering, and other disciplines that involve extremely large datasets and high-performance networked computation."

– PAUL FLIKKEMA, DIRECTOR, SCHOOL OF INFORMATICS, COMPUTING, AND CYBER SYSTEMS



PAUL FLIKKEMA

Recruiting Talented Faculty to Enhance Research Capacity

The university is making a significant investment in SICCS, both in physical infrastructure and through the strategic hiring of highly talented new faculty. The recruiting plan for SICCS is ambitious, integrating cyber-physical systems (Internet of Things), data sciences, reconfigurable computing, and cybersecurity with NAU's strong programs in ecosystems, microbiology and pathogens, social sciences, health sciences, the arts, and business.

In 2015-2016, NAU recruited several new researchers to the SICCS faculty, including Scott Goetz and Benjamin Ruddell*:

- Assistant Professor **Chris Doughty** came to NAU from Oxford University, where he held a research lectureship in the School of Geography and the Environment. His main area of interest is understanding how climate change will impact tropical forests, and he conducts research projects to determine how large animal extinctions could impact ecosystem function.
- Associate Professor **Marco Gerosa** came to NAU from the University of São Paulo, Brazil, where he was associate professor of computer science. He conducts research focusing on the fields of empirical software engineering, open-source software, mining software repositories, software evolution, and social dimensions of software development.
- Associate Professor **Alex Groce** came to NAU from Oregon State University, where he was an associate professor of electrical engineering and computer science. He is exploring methods for bringing advanced automated testing techniques into development practice, especially for Python and other languages used widely in bioinformatics and other scientific applications.
- Professor **Frédéric Loulergue** came to NAU from the University of Orléans, France, where he was a professor of computer science. He conducts research in the areas of high-level parallel programming, semantics and implementation of parallel languages, formal verification of parallel programs and compilers, parallel (scientific) applications, and formal methods applied to software security.
- Associate Professor **Kiona Ogle** came to NAU from Arizona State University, where she was a faculty member in the School of Life Sciences. Dr. Ogle's research employs an integrative approach that merges mathematics, statistics, computing, and ecology, with the aim of understanding and predicting how plants and ecosystems are affected by environmental perturbations such as those associated with climate change. Since joining NAU, Dr. Ogle has co-authored many scholarly articles, including those published in *Science, Ecology Letters, Global Change Biology*, and *Ecological Monographs*. She was awarded a $190,000 grant from the National Science Foundation to study whether trees that suffered from regional droughts show impaired recuperative responses to the increased precipitation of the 2016 El Niño.


CHRIS DOUGHTY


FRÉDÉRIC LOULERGUE


KIONA OGLE

* Scott Goetz and Benjamin Ruddell featured on pages 4-5.

Offering a Broad Range of Degree Programs

The School of Informatics, Computing, and Cyber Systems integrates computational and data sciences research with innovative academic programs. New degree programs transform traditional curricula in computer sciences and electrical engineering and also combine SICCS expertise with environmental and ecological informatics, health and bioinformatics, computer science, and electrical engineering. SICCS provides a wealth of opportunities for students to enhance their education by working on meaningful research projects with faculty mentors who are leaders in their field.

Among the new SICCS degrees are an interdisciplinary PhD in Informatics and Computing, MS and MSE degrees in computer science and electrical engineering, and a certificate program in informatics and computing. SICCS also is redesigning its undergraduate degrees in computer science (ABET-accredited), applied computer science, and electrical or computer engineering (ABET-accredited).

The school will soon launch the new Bachelor of Science in Informatics degree program, a research-intensive program for high-achieving students who are inherently interested in interdisciplinary applications of computing. Students can specialize in bioinformatics, ecoinformatics, or astroinformatics.

JOHN GEORGAS

"The launch of the new School enables the university to dramatically expand its capabilities in informatics research as well as education. The development of the informatics and computing doctoral program is a key element of the initiative, enabling us to leverage the tremendously valuable contributions of doctoral students in our research programs and be much more successful in recruiting high-caliber faculty. It's also important to note that NAU's investment in SICCS is paying dividends in the quality of the undergraduate education we're able to offer."

– JOHN GEORGAS, ASSOCIATE DIRECTOR OF RESEARCH AND GRADUATE PROGRAMS, SCHOOL OF INFORMATICS, COMPUTING, AND CYBER SYSTEMS

Preventing Cyberattack with Innovative Solutions: Bertrand Cambou

According to the U.S. Department of Homeland Security, the country's economic vitality and national security depend on a stable, safe, and resilient cyberspace. As information technology becomes increasingly integrated with physical infrastructure operations (think Internet of Things), there is increased risk for wide-scale or high-consequence events that could cause harm or disrupt services that are vital for our economy and the daily lives of millions of Americans.

To address this challenge, NAU is investing in research faculty and academic programs in the very specialized discipline of cybersecurity. This is a high priority for the new School of Informatics, Computing, and Cyber Systems, which aims to quickly grow its cybersecurity research capabilities and develop innovative solutions for both commercial and national security applications.

SICCS' cybersecurity program is led by **Bertrand Cambou**, who joined the faculty of NAU in 2015 as Professor of Practice. Dr. Cambou brings a wealth of experience to NAU from the private sector, where he served in executive leadership roles for companies including Motorola, AMD, and Gemplus (now Gemalto). He earned a doctorate in electronics from Paris-South (XI) University, an engineering degree in electronics from Supelec Paris, and a maîtrise degree in physics from Toulouse III University.

BERTRAND CAMBOU

Dr. Cambou's primary research interests are in cybersecurity and applying microelectronics to strengthen hardware security, including the design of novel public key encryption methods, password generation systems, physically unclonable functions (PUF), and true random number generators (TRNG) based on nanotechnologies such as ReRAM. He currently teaches graduate classes in the informatics program in cryptography, and in the use of nanotechnologies for cybersecurity. Dr. Cambou believes that NAU has the potential to become a global leader in the field.

As the principal investigator of "Exploiting Nanomaterials for End-to-End Cybersecurity Solutions," Dr. Cambou leads a team of researchers from Northern Arizona University, Arizona State University, and the University of Arizona. The team is working to develop solutions exploiting the inherently complex physical properties of nanomaterials to advance the field and provide unprecedented levels of cyber defense for mainstream and emerging systems such as critical national infrastructures, cyber-physical systems (CPS), Internet of Things (IoT), transportation networks, healthcare, and e-commerce. The project is funded through a $500,000 grant co-sponsored by the Arizona Board of Regents and NAU.

"This proof [of concept] will ignite government agencies and public/private enterprises to support further research and commercialization of the intellectual property developed under this program. The use of nanotechnologies for cybersecurity also represents an opportunity to educate students in a growing strategic area," Dr. Cambou explained.

NAU's Pathogen and Microbiome Institute Fights Potentially Deadly Diseases

In an era of superbugs, bioterrorism, and pandemics, the need for new technologies to fight a host of rapidly evolving and potentially deadly diseases has never been greater. In response to this need, Northern Arizona University is increasing its investment in the highly specialized fields of pathogen genomics, infectious disease ecology, and microbiome research.

Building on the recognized expertise of its faculty and their world-renowned contributions in the areas of anthrax and infectious diseases, the university launched the Pathogen and Microbiome Institute (PMI) in 2016. Representing a key investment in the technologies of the future, the new institute will greatly expand NAU's capabilities to conduct both basic and translational research in the following areas:

- Pathogen microbiology
- The role of the microbiome in chronic healthcare challenges
- Hospital-acquired infections
- Biological Select Agents or Toxins (BSAT)

> *"I cannot think of a greater goal for NAU Research than ensuring we have the capabilities in place to move quickly to combat the threats posed by an ever-growing list of infectious diseases, as well as the potential threat of biological warfare."*
>
> **– NAU PRESIDENT RITA HARTUNG CHENG**

Developing Partnerships to Spur Innovation

The Pathogen and Microbiome Institute is leading interdisciplinary collaborations with NAU experts across campus in a wide range of areas—including health sciences, bioinformatics, and human microbial ecology—to expand the frontiers of knowledge while developing new technologies for detecting, preventing, and treating infectious diseases.

For example, PMI faculty collaborated with NAU bioinformaticians in 2016 to perform whole genome sequencing and advanced statistical analysis to track the origins and dispersal of the fungus that causes Valley Fever. Researchers from PMI and NAU's School of Informatics, Computing, and Cyber Systems (SICCS) collaborated on a project using advanced genomic technology to study the anthrax used in the Soviet Union's biological weapons program, which killed at least 66 people in an accidental release of the spores in Sverdlovsk, Russia, in 1979. Faculty from PMI, SICCS, NAU's Department of Dental Hygiene, and the Center for Health Equity Research (CHER) began working together in early 2017 on a project to identify the biological factors involved in the high rate of caries, or tooth decay, among Arizona's preschool population.

PMI continues to strengthen research and healthcare relationships with its key funding agencies, including the U.S. Department of Homeland Security, the Centers for Disease Control, and the National Institutes of Health. Such investment and commitment is building a strong foundation for future economic growth in the region and around the state. Over the next few years, PMI will continue to play a vital role in expanding partnerships that spur innovation and opportunity.

PMI Faculty Researchers

The following faculty are founding members of the Pathogen and Microbiome Institute. Additional faculty will be recruited to expand research capacity in the organization's key focus areas.

- Regents' Professor and Cowden Endowed Chair of Microbiology **Paul Keim** is the executive director of PMI. A world-renowned expert in anthrax and other infectious diseases, Dr. Keim directs investigations into how to bolster the nation's biodefense and prevent outbreaks of such contagions as flu, cholera, E. coli, salmonella, and the plague. Dr. Keim has published extensively, with more than 300 scholarly articles and policy papers. His work is frequently cited and receives significant media coverage worldwide. A former member and chair of the federal government's National Science Advisory Board for Biosecurity, Dr. Keim helped draft national research policy guidelines for blunting bioterrorism while elevating ethical standards and improving the quality of scientific research.
- Assistant Professor **Bridget Barker**, a geneticist, conducts research in microbiology, molecular biology, medical mycology, and fungal infections. Her interests include fungal pathogenesis, *coccidioidomycosis*, and the ecology of the fungus *Coccidioides*. Dr. Barker comes to NAU from The Translational Genomics Institute (TGen).
- Assistant Professor **Greg Caporaso** is a bioinformatician and microbial ecologist. His research is focused on microbial ecology, the human microbiome and disease, and the development of software and methods for studying microbial ecology. Dr. Caporaso is the lead author and/or developer of several open-source software projects, notably Qime, a widely used software tool for genomic analytics; and he has been the recipient of numerous grants from funding agencies, including the National Science Foundation, the Alfred P. Sloan Foundation, and the National Institutes of Health.
- Assistant Professor **Emily Cope**, a microbiologist, conducts research focused primarily on the role of the upper airway microbiome in chronic rhinosinusitis, cystic fibrosis, and asthma. Dr. Cope is the co-author of a number of scholarly papers investigating these topics.
- Research Assistant Professor **Talima Pearson** is a geneticist focusing on fine-scale and global epidemiological and evolutionary tracking of pathogenic bacteria, particularly the causative agents of anthrax, leptospirosis, melioidosis, and Q fever. Dr. Pearson is also working on understanding how the human microbiome is affected by cancer and therapeutic treatment.
- Assistant Professor **Jason Sahl**, a bioinformatician, focuses on comparative genomics, algorithm development, and functional genomics. Dr. Sahl has co-authored numerous scientific papers on a variety of pathogens and diseases, including E. coli, the plague, and anthrax.
- **Dave Wagner**, professor of biological sciences and director of the Biodefense and Disease Ecology Center of PMI, is a disease ecologist whose primary research interests are the ecology and evolution of infectious diseases. Dr. Wagner uses genetic and genomic variation within pathogen, vector, and host species to better understand the distribution, ecology, evolutionary history, and transmission patterns of infectious diseases. Dr. Wagner is one of the world's leading experts on several pathogens and infectious diseases, including plague and tularemia.


PAUL KEIM


BRIDGET BARKER


GREG CAPORASO


EMILY COPE


TALIMA PEARSON


JASON SAHL


DAVE WAGNER

New Research Center Focuses on Health Disparities

Health disparities in Arizona are significant and are related to the state's rural nature, widespread poverty, and social environmental factors among diverse populations, for example:

- More than one-fifth of Arizonans live in poverty.
- 13 of 15 Arizona counties are rural.
- The state's rate of uninsured is one of the three highest in the nation.
- Arizona ranked in the bottom third of states in overall child health and economic wellbeing in 2015.

To address these issues, NAU established the Center for Health Equity Research (CHER) in 2016, initiating a new, robust program of original research in health equity. CHER faculty work with minority, rural, and other underserved communities to

- Identify and understand health disparities and health priority areas.
- Build and maintain partnerships between these communities and researchers.
- Develop strategies to alleviate health disparities.

CHER is also working to build a stronger, more diverse healthcare workforce through professional development efforts. Increasing the racial and ethnic diversity of the healthcare workforce is essential for providing culturally competent care to underserved populations, fostering research in neglected areas of societal need, and enriching the pool of managers and policymakers to better meet the needs of a more diverse society.

Building Capacity in Health Research throughout Arizona

Beginning in 2016, the Arizona Biomedical Research Commission sponsored the Translational Health Research InitiatiVEs (THRIVE) five-year series of workshops to build capacity in health research throughout northern Arizona and NAU's statewide campuses. THRIVE is a partnership between Northern Arizona University and Northern Arizona Healthcare to facilitate collaborative research that builds on strong biomedical, behavioral, and cultural health research.

CHER recently partnered with NAU's Phoenix Biomedical Campus on the "Innovations in Stroke Rehabilitation" conference, and co-hosted, with NAU Yuma, a workshop on research to build capacity in the southwest region of the state.

Conducting a Comprehensive Regional Needs Assessment

The NARBHA Institute and the Northern Arizona Healthcare (NAH) Foundation awarded CHER a $773,000 grant to conduct a comprehensive regional needs assessment of health in northern Arizona. CHER is compiling and analyzing existing data and meeting with community members, leaders, and healthcare providers to understand what their priorities are and what resources they believe would have the most impact on improving health across the region. The project will also document existing community strategies that are successfully tackling some of these issues and assemble a "best practices" guide. This initial assessment is expected to help build a strong relationship between CHER and the organizations funding the work.

CHER Faculty

The Center for Health Equity Research is building capacity by recruiting nationally recognized faculty:

- CHER director **Julie Baldwin** is a professor of health sciences. With expertise in public health, behavioral and community sciences, and health education, Dr. Baldwin's research is focused on the prevention of HIV/AIDS, substance abuse, and chronic disease among diverse and rural populations. An NAU faculty member from 1994 to 2004, Dr. Baldwin returned to NAU in 2015 from the University of South Florida.
- Professor **Nicolette Teufel-Shone** will join CHER in 2017 as associate director, coming to NAU from the University of Arizona, where she has been professor and program director of the Family and Child Health section of the Mel and Enid Zuckerman College of Public Health. She has worked with Native American communities in the Southwest since the mid-1980s to build community capacity to address health promotion. More recently, Dr. Teufel-Shone's work has focused on community resilience and the impact of social stress on health outcomes.

JULIE BALDWIN


NICOLETTE TEUFEL-SHONE

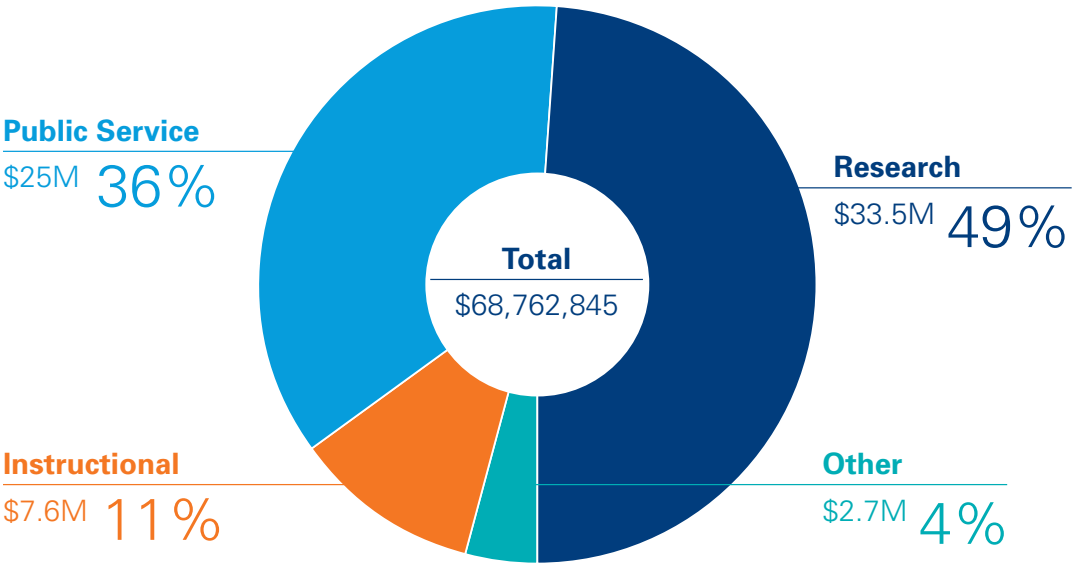
> *"Finding solutions to these problems will involve engaging researchers, healthcare providers, and communities in conducting research through new ways that are culturally relevant and respectful, and that provide solid information on which to base conclusions and actions."*
>
> **– JULIE BALDWIN, DIRECTOR, CENTER FOR HEALTH EQUITY RESEARCH**

Sponsored Projects, Proposals, and Awards

SPONSORED PROJECTS METRIC	FY2012	FY2013	FY2014	FY2015	FY2016
Number of Proposals	282	416	412	514	566
Dollars Requested	$36,752,874	$56,837,417	$64,413,290	$80,026,561	$104,495,447
Number of Awards	495	364	466	485	640
Dollars Received	$47,514,496	$42,462,109	$62,715,946	$49,677,695	$68,762,845

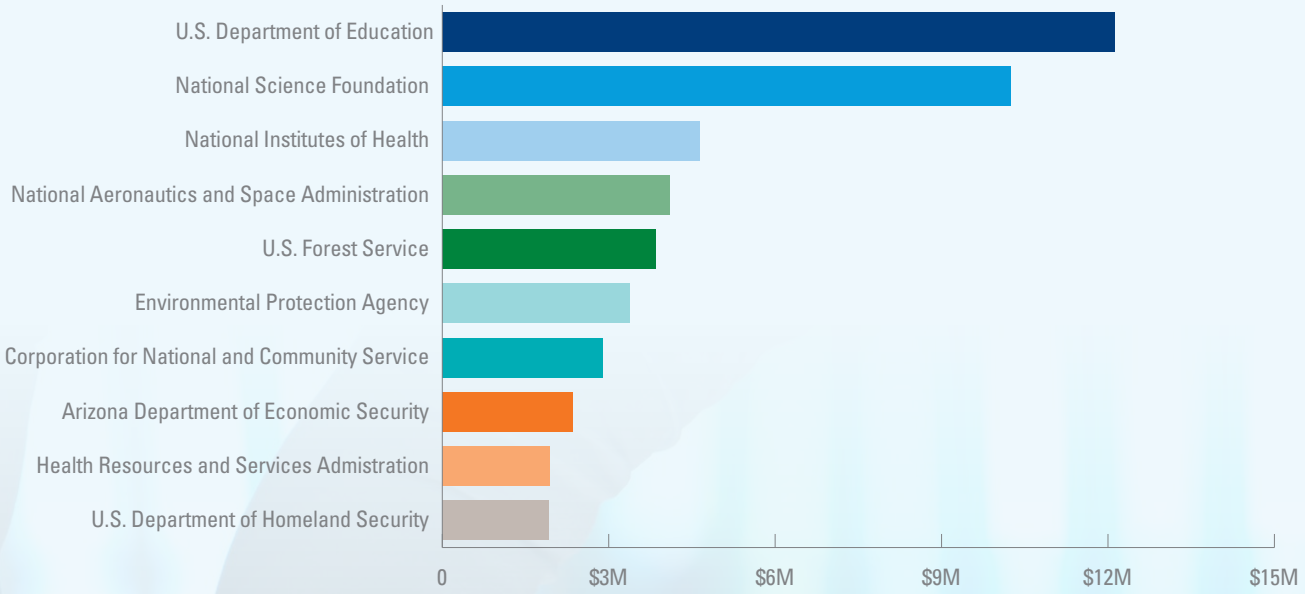
SPONSORED PROJECTS AWARDS BY ACTIVITY IN FY2016

Research	$33,456,939	49%
Public Service	$24,966,252	36%
Instructional	$7,634,921	11%
Other	$2,704,733	4%
Total	$68,762,845	100%



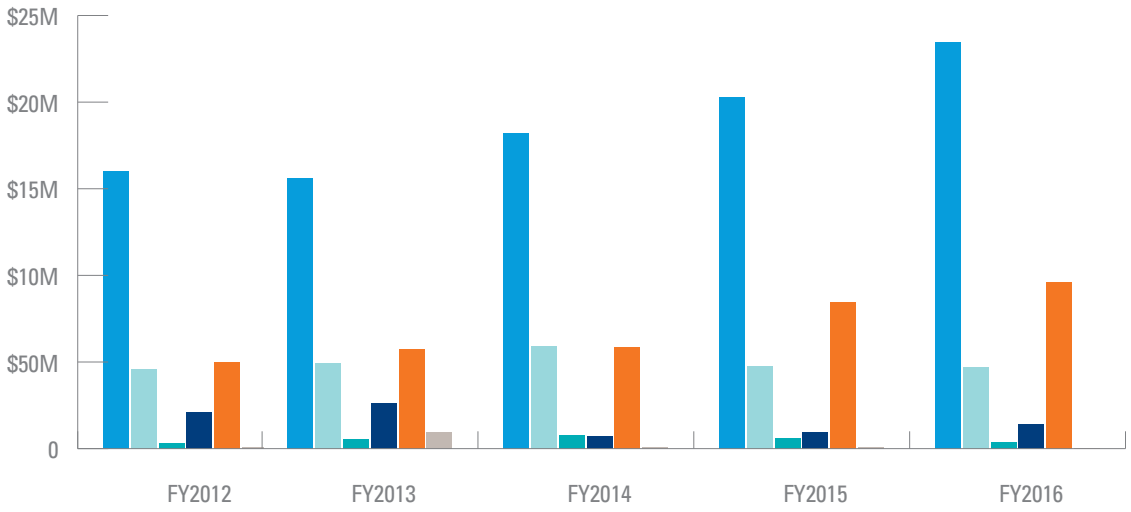
SPONSORED PROJECTS TOP FUNDING SOURCES IN FY2016

U.S. Department of Education	$12,130,235
National Science Foundation	$10,254,036
National Institutes of Health	$4,648,787
National Aeronautics and Space Administration	$4,100,875
U.S. Forest Service	$3,854,060
Environmental Protection Agency	$3,374,700
Corporation for National and Community Service	$2,899,460
Arizona Department of Economic Security	$2,360,977
Health Resources and Services Administration	$1,936,279
U.S. Department of Homeland Security	$1,913,763



Research Expenditures by Source

SOURCE OF FUNDS	FY2012	FY2013	FY2014	FY2015	FY2016
U.S. Federal Government	$16,015,000	$15,638,000	$18,209,000	$20,285,000	$23,442,000
State and Local Government	$4,568,000	$4,945,000	$5,909,000	$4,787,000	$4,693,000
Industry	$327,000	$552,000	$762,000	$623,000	$369,000
Non-Profit Organizations	$2,126,000	$2,648,000	$741,000	$981,000	$1,402,000
Institutional Funds	$5,005,000	$5,762,000	$5,858,000	$8,438,000	$9,628,000
Other Sources	$59,000	$971,000	$111,000	$92,000	$46,000
Total Expenditures	**$28,100,000**	**$30,516,000**	**$31,590,000**	**$35,206,000**	**$39,580,000**



Douglas Biber: Developing a Linguistic Taxonomy of Web Registers

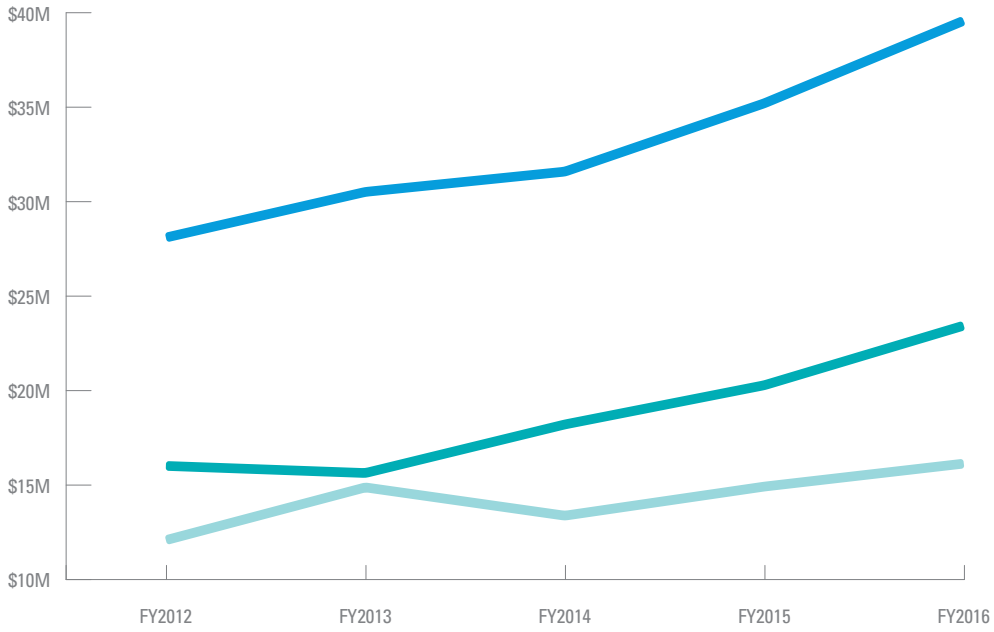

DOUGLAS BIBER

Regents' Professor of Applied Linguistics **Douglas Biber** is the principal investigator of a $332,000 research project funded by the National Science Foundation focused on developing a comprehensive linguistic taxonomy of web registers that will be shared with the linguistics community as a free online research resource.

"For both general users and linguists, the Internet provides a massive amount of information and linguistic data, readily accessible to anyone who has value for research in linguistics, computational linguistics, and the social sciences. However, the nature of the different types of language used on the web remains unclear," explained Dr. Biber. "To better understand the language of the Internet, we're developing a comprehensive linguistic taxonomy of web registers, applying it to a large, representative corpus of Internet texts. The linguistic descriptions resulting from this project, and the searchable online corpus, will provide the basis for more principled uses of the web as a data source."

Dr. Biber is considered one of the foremost corpus linguistics scholars in the world because of his groundbreaking work on corpus-based approaches to the study of language. The most prolific of all NAU researchers, Biber has authored and edited 23 books and published 225 scholarly articles; his work has been cited more than 32,000 times.

SPONSOR GROUP	FY2012	FY2013	FY2014	FY2015	FY2016
Research Total	$28,100,000	$30,516,000	$31,590,000	$35,206,000	$39,580,000
Federal	$16,015,000	$15,638,000	$18,209,000	$20,285,000	$23,442,000
Non-Federal	$12,085,000	$14,878,000	$13,381,000	$14,921,000	$16,138,000



Natalie Cawood: Preventing Suicide in Tribal Youth and Child Abuse

A licensed clinical social worker, Associate Professor **Natalie Cawood** brings 14 years of professional social work practice experience to her research, focusing on evidence-based practice with vulnerable children and youth. She has published research on evidence-based programs to address interpersonal violence in the school context and an examination of the experience of youth participating in a community-based group mentoring program while on probation. She is currently serving as the director of the NAU Social Work Program and is the associate chair for sociology and social work.

Dr. Cawood is co-principal investigator for a tribal youth suicide prevention program evaluation project. The goal of the project is to work collaboratively with Native Americans for Community Action's (NACA) Tribal Youth Suicide Prevention Program project staff in Northern Arizona on data collection and analysis.

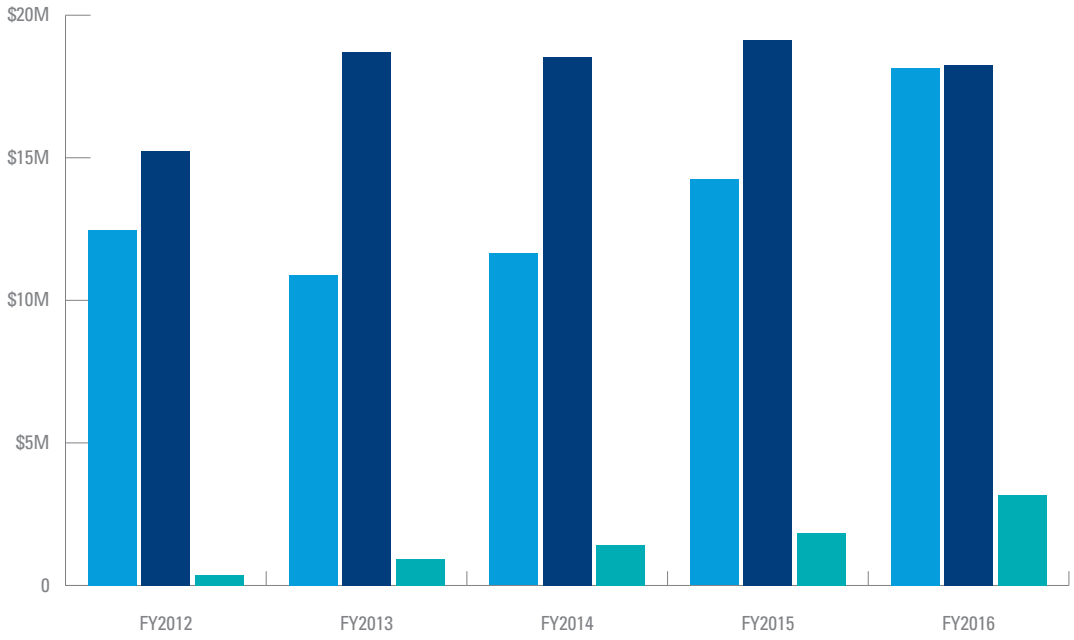
"The evaluation plan is developed in collaboration with NACA and carried out for a number of project objectives," explained Dr. Cawood, "specifically those designed to increase capacity to intervene with youth who may be at risk for suicide."

Dr. Cawood is also the principal investigator for a five-year, $5 million, Child Welfare Training Project grant. This grant, a collaborative effort between the NAU Social Work Program and the Arizona Department of Child Safety (DCS), provides scholarships to social work students who are trained to work in the field of child welfare. Through this grant, Dr. Cawood is also collaborating with DCS to evaluate a child abuse prevention program for families living in Maricopa County.

"Prevention programming is vital to helping at-risk families safely care for their children," said Dr. Cawood, "and this research may provide evidence to support the funding of statewide programs aimed at assisting families and preventing situations that can result in abuse."

Research Expenditures by Activity

RESEARCH EXPENDITURES	FY2012	FY2013	FY2014	FY2015	FY2016
Basic Research	$12,481,000	$10,897,000	$11,643,000	$14,238,000	$18,136,000
Applied Research	$15,251,000	$18,701,000	$18,542,000	$19,115,000	$18,255,000
Development	$368,000	$918,000	$1,405,000	$1,853,000	$3,189,000
Total Research	**$28,100,000**	**$30,516,000**	**$31,590,000**	**$35,206,000**	**$39,580,000**



Michael Shafer: Developing New Technology for Tracking Animals in the Wild


MICHAEL SHAFER

Assistant Professor of Mechanical Engineering **Michael Shafer** is the principal investigator of a $602,000 multidisciplinary research project funded by the National Science Foundation. Along with Paul Flikkema, professor of electrical engineering, and Carol Chambers, professor of wildlife ecology, Dr. Shafer is developing low-cost radio telemetry systems mounted on unmanned aerial vehicles (UAVs) that can receive radio signals from tagged wildlife. By making the pre-engineered systems available to wildlife researchers via open source publishing, he hopes to significantly reduce barriers to tracking animals in the wild.

"This technology has the potential to vastly improve our ability to track small wildlife for conservation purposes," said Dr. Shafer.

The lightweight modules leverage the flight capabilities of UAVs to better detect signals from wildlife transmitters. This involves developing signal-processing algorithms to assist in detecting and localizing very high frequency radio tags, assembling a radio system capable of providing the required sensitivity, and designing a system compact enough to fit on a UAV.

In addition to the technical development effort, Dr. Shafer and his team are working with the Upward Bound program at Northern Arizona University to guide first-generation, low-income high school students from the Four Corners region—Arizona, Utah, Colorado, and New Mexico—toward successful college careers.

Center for Ecosystem Science and Society (Ecoss)

At NAU's Center for Ecosystem Science and Society, we study ecosystems—soils to streams, food to forests, tall trees to tundra, and hot springs to humans. We seek to understand ecosystems, how and why they change, and their implications for society, now and in the future.

Learn more at nau.edu/Ecoss

NORTHERN ARIZONA UNIVERSITY

Bruce Hungate: Scaling the Microbial Ecology of Soil Carbon


BRUCE HUNGATE

Regents' Professor of Ecosystem Ecology **Bruce Hungate** is the principal investigator of a $2.5 million research project funded by the U.S. Department of Energy. Along with a team of collaborators from NAU, West Virginia University, Lawrence Livermore National Laboratory, and the Pacific Northwest National Laboratory, Dr. Hungate is developing a new technique to enable researchers to measure the growth rates of individual species of bacteria in soil. This technique is important because soils house more bacterial species than any other ecosystem on Earth and, so far, no one has been able to quantify activities even as basic as each species' rate of growth in its natural environment. The team will also determine how these organisms contribute to carbon cycling, based on how the organisms respond to warming soils as the global climate changes.

"This work is exciting, both because we're digging into uncharted territory to connect bacterial diversity to global element cycles, and because the work will help us understand how these tiny organisms' responses to climate change will shape Earth's future climate," said Dr. Hungate.

Dr. Hungate has co-authored more than 170 publications; his research results have been published in leading scientific journals, including *Science, Nature, Bioscience, Frontiers in Ecology and the Environment,* and *Nature Climate Change*. He co-authored a report published in *Science* in 2016 showing that plants can grow faster as atmospheric carbon dioxide concentrations increase, but only if they have enough nitrogen or partner with fungi that help them get it. In addition to directing NAU's Center for Ecosystem Science and Society (Ecoss), Dr. Hungate directs the Colorado Plateau Analytical and Stable Isotope Laboratories. Dr. Hungate was elected a Fellow of the American Academy of Microbiology in 2016 based on his record of scientific achievement and on his original contributions that have advanced microbiology.

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