



FISCAL YEAR 2019 ANNUAL RESEARCH REPORT

WASHINGTON STATE  UNIVERSITY



Greetings!

With this report, I am excited to highlight the outstanding research, scholarship, and creative activities conducted by Washington State University faculty, staff, and students and their collaborators during fiscal year 2019. We are proud of our researchers' accomplishments as they push back the frontiers of knowledge and seek novel solutions to societal problems in support of the University's land-grant mission and President Kirk Schulz's Drive to 25.

WSU research continues to grow. In FY18, we set a record of \$360.5 million in total research and development (R&D) expenditures, as reported by the National Science Foundation. In FY19, the Office of Research Support and Operations submitted over 2,500 proposals and processed over 1,600 awards, bringing in over \$230 million to support WSU researchers. Additionally, the Office of Research received \$6.7 million in license income, setting a new WSU record.

We also celebrated milestones reached by our researchers, including the election of eight WSU faculty members to the Washington State Academy of Sciences, three of our faculty named fellows of the American Association for the Advancement of Science, and two WSU researchers who received the faculty Early Career Awards from the National Science Foundation.

Some notable research achievements highlighted in this report include:

- The development of a new, genetically distinct variety of wheat that's safer for people with celiac disease.
- The discovery of a critical link in mapping recurrent mutations of melanoma. From this discovery, researchers have developed a next-generation sequencing-based technology that allows them to precisely map the locations of UV-induced DNA damage throughout the whole human genome.
- Research that aided in the first full-length biography tracing the lives of slaves in the Indian Ocean in the 1750s, including a man named Furcy who battled relentlessly for his freedom in the courts for more than two decades.
- The discovery of significant vulnerabilities in high-performance computer chips that could lead to failures in modern electronics.

The work described here includes the effort of WSU faculty, staff, and students—as well as numerous local, regional, national, and international partners and collaborators. On behalf of WSU, thank you all for your hard work, making the exciting achievements described here possible!

To learn more about the research unfolding at WSU, please read on.

Sincerely,



Dr. Christopher J. Keane
Vice President for Research



Research Stories with Impact FY19


Strategic Research Investment Program

Growing WSU research requires investment in our research strengths. In 2016, WSU furthered its mission by strategically investing resources into research, academic, and student success programs with the potential for a wide societal impact. The research component, referred to as the Strategic Research Investment Program, identified specific projects to be funded over the period FY17–FY21. These investments will help establish WSU as a distinguished public research university, focused on improving the quality of life for the people and the communities we serve.

The Strategic Research Investment Program is currently funding four projects:

- Functional Genomics Initiative
- Health Equity Research Collaborative (HERC)
- Nutritional Genomics and Smart Foods for Optimal Nutrition and Health in Diverse Populations
- Maximizing the potential for green stormwater infrastructure to save energy and provide clean water for people and the fish they eat

Here are some of the achievements of each project made during fiscal year 2019.

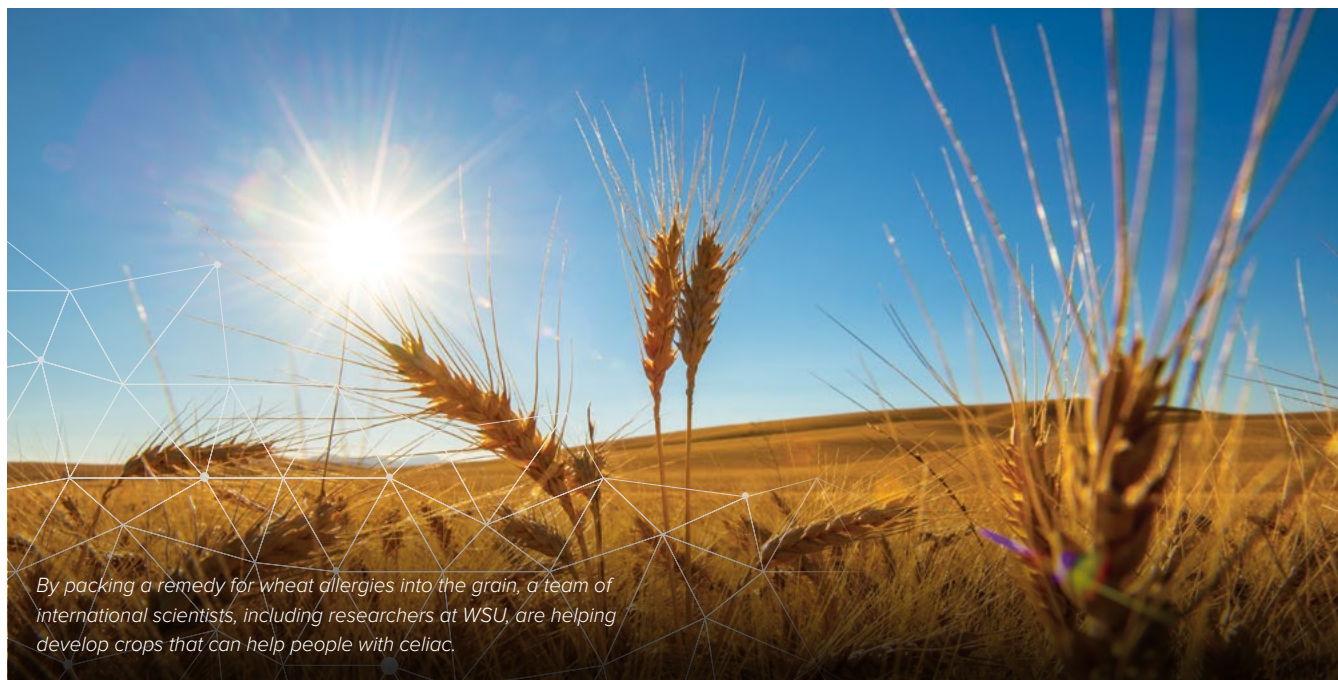


The Functional Genomics Initiative made excellent progress in advancing the core facilities to not only further the functional genomics program but also evolve into well-utilized campus resources. This infrastructure addition has allowed for multiple streams of grant submissions and support to be catalyzed and appears capable of increased utilization by the WSU life science research community. The team received \$3.5 million in research grants and published 18 journal articles. Additionally, Jon Oatley's work on surrogate sires was featured in a March 14, 2019 [Nature editorial](#).

HERC is to be commended for its successes in building interdisciplinary teams and establishing a set of collaborating healthcare sites that serve diverse populations. The Northwest Health Education and Research Outcomes Network (NW HERON) was formed as a practice-based research network with a focus on primary care practices. NW HERON's mission is to improve the quality of clinical care and ameliorate health disparities in communities across Washington and its bordering states.

Nutritional Genomics and Smart Foods for Optimal Nutrition and Health in Diverse Populations has a goal of establishing WSU as a world leader in nutritional genomics. Kevin Murphy was appointed as director of this program and a faculty hire is in progress. The team has submitted several grant applications and has already received \$1.3 million in research awards. An advisory committee has been set up and a graduate certificate in human health and nutrition is being developed to complement the existing graduate certificate in sustainable agriculture.

The **Stormwater** project has made progress in growing its team, expanding its messaging, and continuing student training and graduation from the School of the Environment. A key example of this progress can be seen in their ideation process and team building. Two summits were held with faculty divided into four teams that addressed different research issues. The purpose was to develop new collaborations that will lead to new multidisciplinary research proposals.



By packing a remedy for wheat allergies into the grain, a team of international scientists, including researchers at WSU, are helping develop crops that can help people with celiac.

Healing grain: Scientists develop wheat that fights celiac disease

Researchers have created a new, genetically distinct variety of wheat that's safer for people with celiac disease, opening the door for new treatments and healing potential for the staple grain.

Working together, scientists at WSU, Clemson University, and partner institutions in Chile, China, and France developed a new genotype of wheat with built-in enzymes designed to break down the proteins that cause the body's immune reaction. Their discovery, published in *Functional and Integrative Genomics*, opens the door to new treatments for celiac and for new wheat crops with a built-in defense against the disease.

The scientists introduced new DNA into wheat, developing a variety that contains one gluten-busting enzyme (or glutenase) from barley and another from bacteria *Flavobacterium meningosepticum*.

These enzymes break down gluten proteins in the human digestive system.

Simulating the human body's digestive tract, scientists tested gluten extracts from the experimental grain and found that it had far fewer levels of the disease-provoking proteins. The enzymes reduced the amount of indigestible gluten by as much as two thirds.

These novel wheat genotypes open new horizons for treating celiac disease through enzymes in grains, while increasing agricultural potential for the staple grain.

Led by **Sachin Rustgi**, assistant professor in molecular breeding at Clemson University and adjunct assistant professor with WSU's Department of Crop and Soil Sciences, the research team included **Claudia Osorio**, a WSU-affiliated scientist based at the Center for Nutritional Agro-Aquacultural Genomics

in Chile; WSU affiliate **Jaime Mejias** with Chile's Institute for Agricultural Investigation (INIA); Nuan Wen, WSU Molecular Plant Science researcher; **Bao Liu**, scientist at Northeast Normal University, China; Stephen Reinbothe, scientist at Université Grenoble-Alpes; and the late **Diter von Wettstein**, a distinguished WSU professor in plant genetics and member of the National Academy of Sciences.

The project was launched at WSU, where the initial wheat varieties were developed. Detailed biochemical analysis was then done at Clemson University. Since most wheat products are baked at hot temperatures, Rustgi's team is now developing heat-stable variations of these enzymes.

The new biotech genotype is still at the research stage and has not been approved for sale.

Research Stories with Impact FY19

WSU study links gene to sleep problems in autism

A study published in the open access journal *eLife* and led by a team of neuroscientists at WSU suggests that SHANK3, a gene linked to autism spectrum disorder (ASD), regulates sleep and genes of the body's 24-hour day and night cycle. Sleep problems can affect up to 84 percent of individuals with ASD, making ASD more severe and worsening quality of life, but the reason is unknown.

The study showed that people who were missing the SHANK3 gene and mice that lacked part of the gene had difficulty falling asleep. Their study in mice also strongly supported one possible explanation as to why individuals with autism have trouble falling asleep: It's not that they are not sleepy. They are sleepy, but they simply cannot fall asleep.

Lucia Peixoto, assistant professor in the WSU Elson S. Floyd College of Medicine

and the principal investigator and senior author on the study, and her colleagues analyzed sleep data from patients with Phelan-McDermid syndrome (PMS), a genetic disorder that often goes hand-in-hand with autism and is thought to be related to the SHANK3 gene. They found that PMS patients who are missing the SHANK3 gene have trouble falling asleep and wake up multiple times during the night, starting at age five.

For the next step, **Hannah Schoch** and **Ashley Ingoisi**, postdoctoral research associates and co-first authors, studied sleep in a mouse model of PMS, which used mice that are missing a part of the SHANK3 gene and wild-type control mice.

When allowed to sleep normally, mice with the SHANK3 mutation spent more time awake at the end of the dark period, when nocturnal mice would normally take

a nap. The data also suggested that the quality of their deep sleep was reduced. More importantly, when deprived of sleep the mutant mice took longer to fall asleep, despite being sleepy.

A genome-wide gene expression analysis of these mice showed decreased activity in a group of genes related to the body's circadian clock, which helps to maintain a 24-hour day and night rhythm. Sleep deprivation made this worse—the number of genes that didn't turn on correctly was twice as high in sleep deprived mutant mice. This suggests that sleep deprivation exaggerates the genetic differences between SHANK3 mutants and wild-type mice, which may translate to a worsening of symptoms in people who have conditions associated with SHANK3 mutations.

This work was highlighted with an editorial in *Science Translational Medicine*.

Neuroscientists Hannah Schoch and Ashley Ingoisi investigate the genetic basis of sleep problems in autism in the Peixoto laboratory at WSU Health Sciences Spokane.





David Makin, assistant professor, WSU Department of Criminal Justice and Criminology, is finding that following the legalization of marijuana the police clearance rates for certain crimes have improved.

Photo by Shelly Hanks, WSU Photo Services.

Positive policing changes after cannabis legalization seen by WSU researchers

WSU researchers have found that marijuana legalization in Colorado and Washington has not hurt police effectiveness. In fact, clearance rates for certain crimes have improved.

Clearance rates—the number of cases solved, typically by the arrest of a suspect—were falling for violent and property crimes in the two states before they authorized retail sales of marijuana late in 2012. The rates then improved significantly in Colorado and Washington while remaining essentially unchanged in the rest of the nation, according to the researchers' analysis of monthly FBI data from 2010 through 2015.

David Makin, associate professor in the Department of Criminal Justice and Criminology, led the study that found that legalization did not have a negative impact on clearance rates in Washington

or Colorado. In fact, for specific crimes, it showed a demonstrated, significant improvement on those clearance rates, specifically within the realm of property crime. The legalization created a natural experiment for researchers to study the effects of a sweeping policy change on public health and safety.

Citizens in 12 states have voted on marijuana legalization and proponents in all of them have argued that it would let police reallocate resources to property and violent crimes. The Colorado measure specifically says it is “in the interest of the efficient use of law enforcement resources” while the Washington one says it “allows law enforcement resources to be focused on violent and property crimes.”

The WSU study bears that out. It finds that after legalization:

- Arrest rates for marijuana possession dropped considerably. Following legalization in 2012, they dropped nearly 50 percent in Colorado and more than 50 percent in Washington.
- Violent crime clearance rates shifted upward.
- Burglary and motor vehicle theft clearance rates “increased dramatically.”
- Overall property crime clearance rates jumped sharply and reversed a downward trend in Colorado.

The study was funded by the National Institute of Justice, an arm of the U.S. Department of Justice. The other WSU researchers involved in the study are **Dale W. Willits**, **Guangzhen Wu**, **Kathryn DuBois**, **Ruibin Lu**, **Mary Stohr**, **Wendy Koslicki**, **Duane Stanton**, **Craig Hemmens**, **John Snyder**, and **Nicholas Lovrich**.

Research Stories with Impact FY19

WSU Spokane researchers develop potential drugs to help curb smoking

WSU researchers have created more than a dozen candidate drugs with the potential to curb smokers' desire for nicotine by slowing how it is broken down in the body. The researchers hope the substances can help people reduce their consumption of tobacco, if not quit altogether.

The discovery, published in the *Journal of Medicinal Chemistry*, targets a liver enzyme called CYP2A6, which metabolizes nicotine. Nicotine triggers the release of dopamine and serotonin, two pleasure causing chemicals produced by the body. But as it gets metabolized, users can experience withdrawal symptoms like tingling in the hands and feet, sweating, anxiety, and irritability. Canadian researchers in the

late 1990s and early 2000s found that people who have fewer copies of the CYP2A6 gene tend to smoke less and are less likely to be addicted to smoking.

Travis Denton, assistant professor of pharmaceutical sciences, and **Philip Lazarus**, Boeing Distinguished Professor of pharmaceutical sciences, have collaborated to design dozens of molecules that bind to CYP2A6 and inhibit its ability to metabolize nicotine.

"This desire for nicotine is the feeling that we are targeting," said Denton, a former tobacco chewer who has been working on solutions to nicotine dependence for 15 years.

So far, the researchers have tested their candidate drugs to make sure they don't disrupt other major enzymes that help the body metabolize other substances. This helped narrow the number of potential drugs down to 13.

Once the Food and Drug Administration verifies a drug's safety, clinical trials will begin to see how it works in a human.

Other WSU researchers working with Denton and Lazarus include Zuping Xia, Gang Chen, Christy Watson, Mary Paine, and Senthil Natesan. The work was supported by the Health Sciences and Services Authority of Spokane County.





Ten years of painstaking archival detective work

Ten years of painstaking research led to **Sue Peabody's** seventh book, *Madeleine's Children: Family, Freedom, Secrets, and Lies in France's Indian Ocean Colonies* (Oxford, 2017), the first full-length biography tracing the lives of slaves in the Indian Ocean world. Now available in French as *Les Enfants de Madeleine* (Karthala, 2019), Peabody's research is also the basis of a French museum exhibit, *The Strange Story of Furcy Madeleine*.

Madeleine, a Bengali girl, became the slave of a French woman in the 1750s, who sold her to a planter couple from the Indian Ocean Isle Bourbon (now Réunion). Madeleine had three children, one of whom, Furcy, has become an important symbol of human rights in his homeland. Furcy battled

relentlessly for his freedom in the courts for a quarter century. Finally, the Royal Court of Paris declared him freeborn in 1843, and he collected reparations.

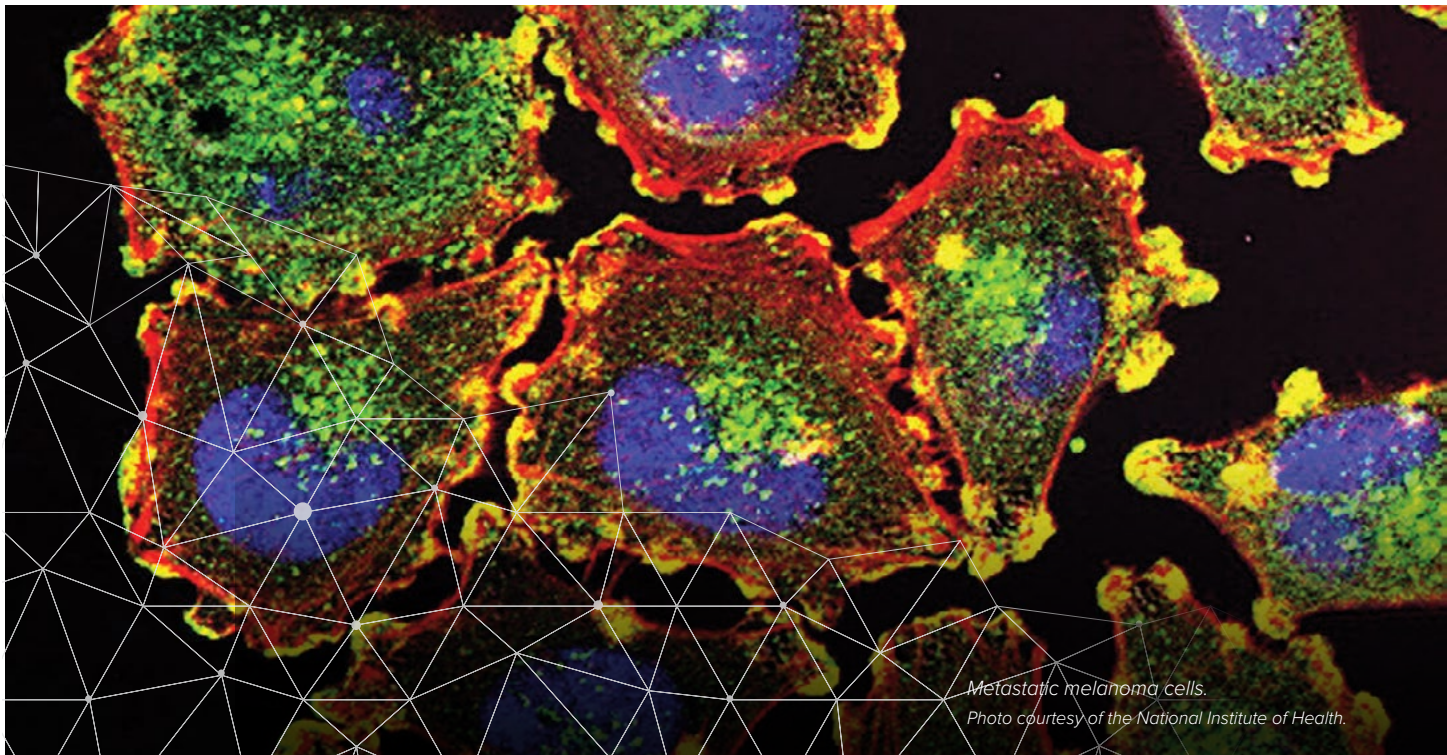
Peabody's book traces the twists and turns of the legal arguments offered on behalf of Furcy's freedom. While Furcy believed that his mother had been swindled out of funds to purchase his freedom, Furcy's lawyers, recognizing that these grounds would not hold sway in court, concocted other legal arguments. The courts ultimately determined that Madeleine's brief residence on France's "free soil" in Europe was sufficient to free her and thus Furcy.

The core document in Peabody's research was a legal pamphlet that publicized

the outcome of Furcy's case in 1844. In addition, her sources—drawn from archives in France, Mauritius, and London—included three grocery bags of documents the archivist in Réunion showed Peabody in 2008, the first historian to look at them. In addition, she pored over census, parish, and notary records; letters; and newspapers.

The story she had expected to find differed in important ways from the story she actually found. Furcy—who struggled for years to win his freedom—soon became a slave owner, a master, himself. Furcy's story vividly depicts slaves' vulnerability to the master class, including the many ways that owners and their descendants sought to keep his story hidden.

Research Stories with Impact FY19



Metastatic melanoma cells.

Photo courtesy of the National Institute of Health.

Researchers map DNA damage linked to onset of skin cancer

A critical link in mapping recurrent mutations of melanoma—the most serious form of skin cancer in humans—has been discovered by researchers at WSU’s School of Molecular Biosciences, in collaboration with researchers at Georgia State University.

In a paper published in *Nature Communications*, researchers established that DNA binding by a specific set of transcription factors, called ETS, is inherently mutagenic in UV-exposed cells. With new genome mapping technology, these findings provide a crucial understanding of mutations that result at ETS binding sites located in specific genes that are known to be drivers in the onset of melanoma in humans.

WSU researchers have developed a next-generation sequencing-based technology that allows them to precisely map the locations of UV-induced DNA damage throughout the whole human genome. Using this advanced technology, they generated a high-resolution UV damage map in human cells. By correlating the UV damage map with melanoma mutations, they discovered significantly elevated UV damage levels at ETS binding sites, which massively increased mutation rates at the same sites in sequenced melanoma genomes.

Steven Roberts, assistant professor in the WSU College of Veterinary Medicine School of Molecular Biosciences, stated that UV-induced DNA damage is the major risk factor for melanoma, and DNA repair is a vital first line of defense

against DNA damage to prevent mutations and cancer. Determining that specific transcription factors may increase the frequency of DNA damage and mutation helps explain why some sites are so commonly mutated in melanoma. The pivotal results establish a fundamental research tool in cancer research and confirms researchers are on the correct course to further discovery by mapping UV damage in human cells.

Researchers contributing to the paper include Roberts, **Peng Mao**, **Alexander J. Brown**, **Michael J. Smerdon**, and **John J. Wyrick**, all from WSU’s School of Molecular Sciences; **Svetlana Lockwood**, WSU Paul G. Allen School for Global Animal Health; and **Shingo Esaki** and **Gregory M. K. Poon**, Georgia State University Center for Diagnostics and Therapeutics.

Computer chip vulnerabilities discovered by WSU researchers

A WSU research team has uncovered significant and previously unknown vulnerabilities in high-performance computer chips that could lead to failures in modern electronics.

The researchers found they could damage the on-chip communications system and shorten the lifetime of the whole computer chip significantly by deliberately adding malicious workload.

Led by **Partha Pande**, Boeing Centennial Chair, and Janardhan Rao Doppa, assistant professor in the School of Electrical Engineering and Computer Science, they reported on the work during the 2018 IEEE/ACM International Symposium on Networks-on-Chip.

Researchers have been working to understand the vulnerabilities of computer chips as a way to prevent malicious attacks on the electronics that make up everyday life. Some consumer electronics

vendors, such as Apple and Samsung, have been accused of exploiting vulnerabilities in their own electronics and sending software updates that intentionally slow down earlier phone models as a way to encourage consumers to purchase new products.

Previous researchers have studied computer chip components, such as the processors, computer memory, and circuits for security vulnerabilities, but the WSU research team found significant vulnerabilities in the sophisticated communications backbone of high-performance computer chips.

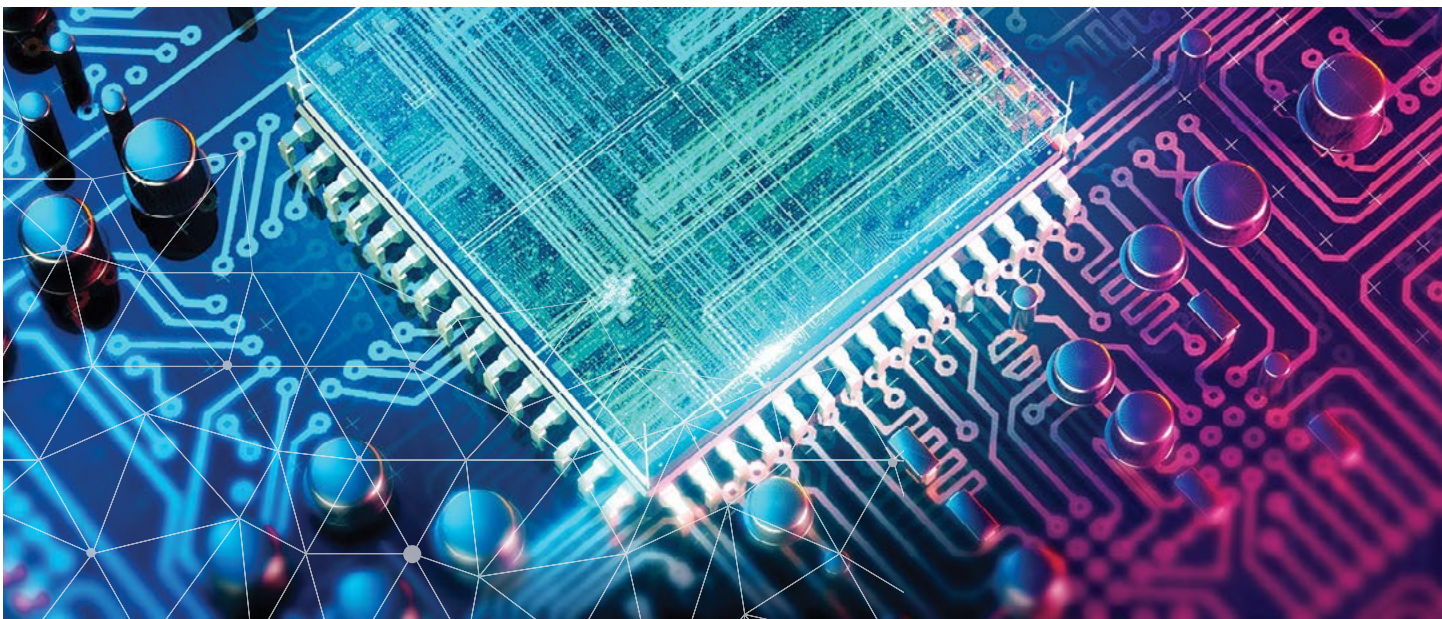
High-performance computers use a large number of processors and do parallel processing for big data applications and cloud computing, and the communications system coordinates the processors and memory. Researchers are working to increase the number of processors and incorporate

high-performance capabilities into hand-held devices.

The researchers devised three “craftily constructed deleterious” attacks to test the communications system. This additional workload enhanced electromigration-induced stress and crosstalk noise. The researchers found that a limited number of crucial vertical links of the communication system were particularly vulnerable to fail. Those links connect the processors in a stack and allows them to talk with each other.

The researchers will now be working to develop ways to mitigate the problem, such as automated techniques and algorithms to detect and thwart attacks.

The work was part of the National Science Foundation and the U.S. Army Research Office funded projects. The WSU team collaborated with researchers from New York University and Duke University.



Research Stories with Impact FY19



From left to right: Associate Professor Michele Shaw, Assistant Professor Marian Wilson, and Research Associate Mary Lee Roberts, all of the WSU College of Nursing

Researching the transition from opioid addiction to treatment

Three researchers at the WSU College of Nursing studied how people with chronic pain transition from using opioids for pain relief to developing problematic patterns of opioid use beyond pain mitigation, namely to reduce stress, get high, and cope with difficult life situations. Their findings were published in the journal *Nursing Research*, under the title "Opioid Initiation to Substance Use Treatment: 'They Just Want to Feel Normal.'" The research team was led by assistant professor **Marian Wilson**, former associate professor **Michele R. Shaw**, and research associate **Mary Lee A. Roberts**, all registered nurses.

The researchers interviewed 10 adults in the Spokane area diagnosed with chronic pain who were receiving outpatient medication-assisted treatment for opioid use disorder.

In most cases, the study participants began using opioids via a legitimate prescription

for pain caused by injury in an accident, or for a medical condition such as infection, childbirth, or a birth defect. Two participants reported that they began taking illegal opioids to self-medicate their pain.

The participants unanimously agreed that they did not receive much information regarding nonopioid therapies to help ease their pain. Some reported being surprised by the high dose of opioids they received for relatively minor pain conditions.

In all cases, psychological and physical cravings for opioids set in, then a gradual shift whereby participants began to realize they were now addicted to opioids. This transition into dependency often involved stealing or lying to get more opioids, and often resulted in devastating consequences regularly described by participants as losing everything that was important to them.

Eventually, the subjects reached a point where they decided they couldn't

sustain that lifestyle and wanted to return to a more normal life. Often the subjects made several failed attempts at stopping opioids before entering medication-assisted treatment at an outpatient clinic where daily opioids, such as methadone, were prescribed to curb their drug cravings.

The participants relayed that in many cases, their health care providers had opportunities to help them identify their opioid use disorder and successfully transition into treatment. However, most participants said they felt judged by health care providers, who didn't believe their medical complaints or didn't take their pain complaints seriously. The study findings indicate that nurses and other healthcare workers can play an important role in addressing the nation's opioid crisis by providing compassionate, nonjudgmental care and offering nonopioid pain management options early on.

Relationship between college, health in later life explored by researcher

There's a familiar correlation in social science: more education is associated with increased health in society. Now a WSU researcher is using a new grant from the Evidence for Action Program of the Robert Wood Johnson Foundation to examine whether more education can actually contribute to better health later in life.

Ben Cowan, an associate professor in the School of Economic Sciences, leads the study with colleague Nathan Tefft at Bates College in Maine. The dramatic increase in two-year colleges from 1960 to 1990 is an ideal experiment to study the correlation.

The researchers also want to study two-year colleges because those tend to increase access to education to underserved groups, like low-income people or racial or ethnic minorities. The grant from the foundation is just under \$200,000 for two years and allows Cowan to look at two different data sets to compile his research.

They hope to find out if making college education more accessible, like adding more community colleges or reducing tuition costs, leads to better health outcomes later in life.

There's a debate over whether we should be investing in higher education

as opposed to other societal goals. Researchers want to truly understand any benefits of that investment, especially if two-year institutions help lead to better outcomes later in life. That would show a return on investment that is higher than previously thought.

In addition to eventually publishing their results in academic journals, Cowan hopes to also make any findings available to policy makers and higher education administrators. Cowan wants to make sure decision makers have all the information on the costs and benefits of funding higher education. Even if results show there isn't a benefit, that's important for decision makers to know.



Research Stories with Impact FY19



Alcohol advertisements influence bystanders' intention to intervene in a sexual assault situation

College students who viewed alcohol advertisements that included objectified images of women were less likely than others to report intentions to intervene in alcohol-facilitated sexual assault situations, according to a study published in the *Journal of Health Communications*.

Professors at the Edward R. Murrow College of Communication and the College of Agricultural, Human, and Natural Resource Sciences at WSU analyzed the influence of alcohol advertisements on college students' intentions to intervene in sexual assault situations. The authors conclude that individuals' perceptions of alcohol advertisements moderate the relationship between exposure to objectifying alcohol advertisements and intentions to intervene in sexual assault situations.

The study led by **Stacey Hust**, associate professor in the Murrow College, estimates some of the ways alcohol advertising and the objectification of women in alcohol ads could affect college students' intentions to intervene in sexual assaults linked to alcohol. Understanding the real-life consequences of exposure and perceptions of this type of advertising can help mitigate risk of sexual assault among college students, female college students in particular.

The authors found that while most of the 1,208 college students at a northwestern university that participated in the study reported that they intended to intervene in an alcohol-facilitated sexual assault, women reported significantly greater intentions to intervene than men. Further, exposure to alcohol ads and perceptions of the women in the ads made a difference

as to whether individuals expressed intentions to intervene in a sexual assault situation.

The results from the study suggest that exposure to alcohol advertising coupled with use of alcohol in settings where bystanders are present has an effect on whether those bystanders intend to take steps to prevent or interrupt a sexual assault situation when it occurs.

The study largely supports objectification theory, which suggests that perceptions of women as powerless objects result in individuals' negative treatment of women. **Kathleen Boyce Rodgers**, associate professor in WSU's Department of Human Development and the second author of the study, suggests that society needs to help emerging adults make sense of media portrayals of women.

WSU's new WADDL facility to support animal human health

WSU's College of Veterinary Medicine broke ground on a new facility for the **Washington Animal Disease Diagnostic Laboratory (WADDL)**, creating a new wing of the **Paul G. Allen Center for Global Animal Health**. It marks a new era in diagnostic testing and disease surveillance, supporting public health and food security, animal health, and the success of thriving livestock industries.

The new facility will allow WADDL to continue to serve as a critical resource for the state, region, and nation, ensuring that WSU remains an industry leader in disease surveillance, diagnostics, innovative research, and education on a global scale. When complete in 2021, the WADDL facility will provide the enhanced sample security and workflow, biosafety, and biosecurity required for increased testing capacity, discovery, and regulatory compliance.

WADDL conducts more than 210,000 tests annually and that number is growing. Since 1974, WADDL's testing demand has increased more than 250 percent, with 2.5 million tests conducted in the last 10 years. WADDL is the only animal health diagnostic laboratory in Washington state officially sanctioned and funded to provide comprehensive animal, food, and environmental surveillance for diseases such as influenza, tuberculosis, West Nile encephalitis, Bovine spongiform encephalopathy (BSE), and foot-and-mouth disease. As such, WADDL is a critical resource for other state and federal agencies, including the Washington State Departments of Agriculture and Health.

WADDL serves as the first alert system by maintaining one of just 15 USDA National Animal Health Laboratory Network (NAHLN)

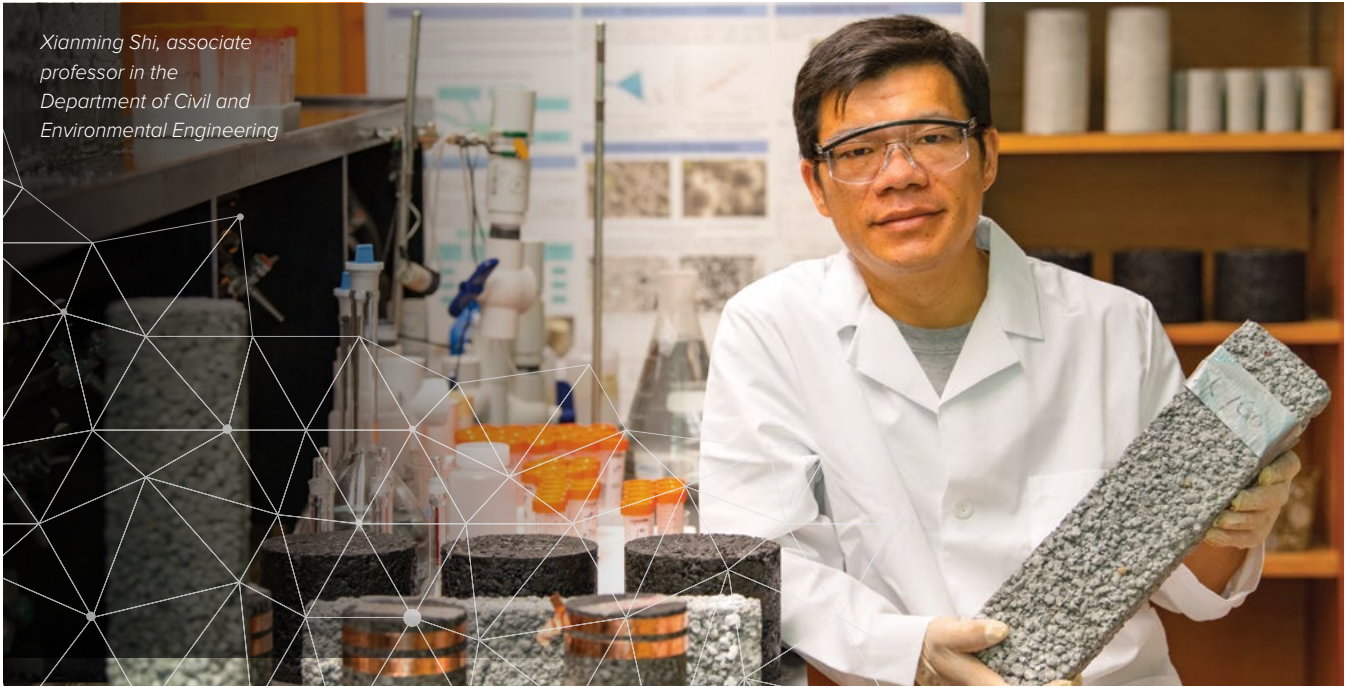
Level 1 laboratories, the FDA Veterinary Laboratory Investigation and Response Network, and the CDC Laboratory Response Network for Bioterrorism. WADDL testing is vital for early disease detection, protecting public health and food security, and protecting Washington's \$1.5 billion animal agriculture industry. In 2014–15, WADDL detected the initial case of bird flu in the United States and helped prevent devastating economic losses to Washington's poultry industry.

The new facility will optimize Paul G. Allen School for Global Animal Health research to develop twenty-first century animal and human diagnostics tests, implement innovative infectious disease surveillance tools, and train the next generation of scientists and diagnosticians to advance global health security.



Research Stories with Impact FY19

Xianming Shi, associate professor in the Department of Civil and Environmental Engineering



WSU to lead national center to address failing transportation infrastructure

WSU is leading a \$7.5 million grant from the U.S. Department of Transportation for a national university transportation center focused on improving the durability and extending the lifespan of the nation's transportation infrastructure.

The new center is one of just seven in the country and the only one focused on the state of repair of infrastructure. **Xianming Shi**, associate professor in the Department of Civil and Environmental Engineering will lead the center.

Much of the nation's critical infrastructure, such as the U.S. highway system, was built from the 1950s to the 1970s and is now reaching the end of the lifetime for which it was designed. Every four years since the late 1990s, the American Society of Civil Engineers has provided a report card of U.S. infrastructure that shows consistently

failing grades of between D to D+. More than nine percent of approximately 600,000 bridges in the United States are considered structurally deficient, and one out of every five miles of highway pavement is in poor condition. The problem is exacerbated by population and traffic growth and an increasing number of disruptive and extreme weather events.

The center will provide support for research, education, workforce development, technology transfer, and industry and public partnerships as a way to catalyze interactions and innovations. Key research areas include new materials, like ultra-high performance concrete and fiber-reinforced polymeric composites, as well as nondestructive ways of evaluating the condition of infrastructure. Researchers will also study asset and performance management and resilience,

so that engineers and managers can make better and more cost-effective decisions around maintenance. A newly established Springer-Nature journal, *Journal of Infrastructure Preservation & Resilience*, for which Shi is the editor-in-chief, will be leveraged for outreach and information dissemination.

As the leader of the consortium, WSU will provide coordination, integration, program management, outreach, and fiscal management for the center. The consortium includes researchers from Missouri University of Science and Technology, Texas A&M University, Case Western Reserve University, University of Utah, University of Colorado Denver, South Dakota State University, Florida Atlantic University, University of Mississippi, Alabama A&M University, and Tennessee State University.

University Achievements FY19

Carson College of Business named a top contributor to entrepreneurship research worldwide

WSU's Carson College of Business was named one of the top contributors to entrepreneurship research in 2019 rankings released by the TCU Neely Institute for Entrepreneurship and Innovation.

WSU is ranked 18 in the world out of 497 schools, based on research articles published in the *Strategic Entrepreneurship Journal*, *Journal of Business Venturing and Entrepreneurship*, and *Theory and Practice*. These are the top three journals in entrepreneurship research and appear in the top 50 journals the *Financial Times* uses to rank business school research.

The 2019 TCU world rankings track research publications in premier entrepreneurship journals for the past five years. Inclusion in the rankings reflects the commitment of Carson College entrepreneurship research faculty to contribute rigorous and influential research to their disciplines, as well as supports WSU's Drive to 25 initiative to increase the quality and quantity of research publications.



Professor Arvin Sahaym teaches a graduate-level entrepreneurship workshop during the WESKA consortium.

WSU's Foley Institute joins National Civility Network

WSU's Thomas S. Foley Institute for Public Policy and Public Service has joined the National Civility Network, a program of the National Institute for Civil Discourse (NICD).

The National Civility Network is composed of centers and institutes on college campuses around the country dedicated to creating a more robust democracy through collaborative projects focused on civility and civic engagement.

Foley Institute's engagement with the National Civility Network is spearheaded by **Steven Stehr**, the Sam Reed Distinguished Professor in Civic Education and Public Civility at WSU. Stehr, who also serves as director of the WSU's School of Politics, Philosophy, and Public Affairs, plans to use the professorship—housed in the Foley Institute—to work with the NICD and other organizations to build programs to educate elected officials and the public more widely about the importance of civility in politics.

The Thomas S. Foley Institute for Public Policy and Public Service is a nonpartisan public policy institute, located at WSU Pullman focused on bringing world-class speakers for public events, and supporting student internships in public service and scholarly research on public policy and political institutions.



Steven Stehr



In northeastern Washington, WSU Extension is partnering with communities to help solve hunger challenges through farm to food bank initiatives, such as extension-designed micro-delivery systems using refrigerated trailers.

Feeding hungry families earns extension programs a national award

A team of WSU Extension professionals working to combat hunger were honored by the National Association of Community Development Extension Professionals (NACDEP) for this life-changing work.

Hunger is increasing in Washington. Statewide, the latest statistics show that the number of hungry families is growing, with more than 15 percent of households struggling to find enough nutritious, healthy food.

In many of Washington's highest areas of need, WSU Extension helps families and communities overcome hunger through education and local partnerships. Working as part of the Northeast Washington Hunger Coalition in Ferry, Stevens, and Pend Oreille Counties, and with the Peninsula Food Coalition in western Washington, extension programs help build healthy, equitable, and resilient community food systems.

Earning NACDEP's Cross-Program Team Award, **Debra Hansen**, Stevens County Extension director; **Clea Rome**, Clallam County Extension director; **Rebecca Sero**, evaluation specialist for WSU Extension; **Laura Ryser**, assistant professor in food systems and community development at WSU Kitsap Extension; **Laura Lewis**, WSU Food Systems Program director; **Nils Johnson**, agriculture and food systems coordinator in Stevens County;

Shannon Rowley, extension coordinator for SNAP-ED and 4-H; and **Karlena Brailey**, community health and food access coordinator, were recognized for their Extension work integrating community resources with economic development.

On the east side of the state, WSU Extension worked as part of the Northeast Washington Hunger Coalition, designing resources and tools to help communities feed themselves. Hansen chaired the coalition, marshalling food banks, community food system partners, and farmers to develop and support Johnson's Farm to Food Pantry and Schools Program, a pilot effort serving Stevens, Ferry, and north Pend Oreille Counties.

In Northwest Washington, Extension has taken a similar approach, collaborating on a regional food systems program across Clallam, Jefferson, and Kitsap counties. Brailey chairs the Peninsula Food Coalition, a network of food banks, tribes, nonprofits, and economic development agencies that works to increase access and nutrition education across the counties.

NACDEP helps extension professionals across the country to network, exchange ideas, and advance community development knowledge, skills, and projects. Each year, the association recognizes outstanding work being done in this area at regional and national levels.

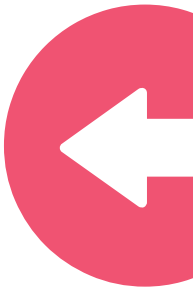
Faculty Recognition FY19

Eight WSU faculty elected to Washington State Academy of Sciences

Eight faculty from Washington State University have been elected to membership in the Washington State Academy of Sciences, an organization that advances science in the state and informs public policy. The new members come from WSU campuses across the state and represent a range of scientific specialties.

In addition, two WSU faculty have been elected to the academy's board of directors. The Washington State Academy of Sciences advances science in the state and informs public policy.

The WSU faculty were among about 40 new members elected to the Washington State Academy of Sciences in 2019. The academy hosts events to raise awareness of key issues affecting the future of Washington's people, prosperity, and places, and working groups provide unbiased assessments to guide public policy-making in the state. With the new additions, the academy has more than 300 members statewide.



The WSU scientists who were elected by their peers are:



Barbosa-Leiker



Kawula



Keane



Kmec



Schmitter-Edgecombe



Skinner



Stark



Tang

Celestina Barbosa-Leiker, vice chancellor for research, Washington State University Health Sciences Spokane, associate professor in the College of Nursing

Tom Kawula, director of the Paul G. Allen School for Global Animal Health in the College of Veterinary Medicine, infectious disease microbiologist

Christopher J. Keane, vice president for research, professor of physics

Julie Kmec, professor in the Department of Sociology in the College of Arts and Sciences

Maureen Schmitter-Edgecombe, H. L. Eastlick Professor of Psychology in the College of Arts and Sciences

Michael Skinner, Eastlick Distinguished Professor in Health Sciences in the School of Biological Sciences in the College of Arts and Sciences

John Stark, professor in the Department of Entomology at the WSU. Puyallup Research & Extension Center, Center for Reproductive Biology in the College of Veterinary Medicine

Juming Tang, Regents Professor, department chair, and Distinguished Chair of Food Engineering in the College of Agricultural, Human, and Natural Resource Sciences

The faculty members elected to the Washington State Academy of Sciences Board of Directors are:



Mittelhammer



Ritter

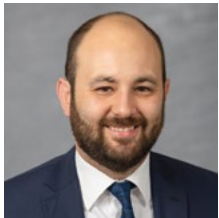
Ron Mittelhammer, Regents Professor in the School of Economic Sciences in the College of Agricultural, Human, and Natural Resource Sciences

Sue Ritter, Regents Professor in the Department of Integrative Physiology and Neuroscience in the College of Veterinary Medicine

Faculty Recognition FY19

Faculty Recognition

Researchers receive NSF Career Awards



Gozen



Doppa

Two WSU researchers have received faculty Early Career awards from the National Science Foundation.

Arda Gozen, Berry Family Professor in the School of Mechanical and Materials Engineering, and **Jana Doppa**, Berry Family Professor in the School of Electrical Engineering and Computer Science, each received the five-year awards. The grants are intended to provide significant research support to young faculty beginning their careers who have the potential to serve as academic role models in research and education.

Gozen will work to improve manufacturing methods of polymer nanocomposites. He has been working to develop a more reliable manufacturing process for nanomaterials using additive manufacturing, also known as 3D printing. In particular, he will use direct-ink-writing, in which a nozzle controllably dispenses polymer nanocomposite “inks” at tiny scales layer-by-layer, allowing high precision and accuracy in materials design.

As part of the \$500,000 grant, Gozen will incorporate additive manufacturing techniques into the mechanical engineering curriculum to train the next generation of engineers with skills in-line with recent trends in the manufacturing industry. Gozen will work with WSU’s 3D Printing Club to test, implement, and demonstrate novel manufacturing methods and materials to the community.

Doppa received a \$550,000 grant to develop algorithms to support scientists and engineers in their decision-making and experimental design process.

In many science and engineering fields, from computer chip design to discovering materials and studying microbiomes, problem solving is complex and multifaceted. Understanding complex systems with many variables combined with experimental data often include too many factors for humans to consider.

The CAREER award will support Doppa’s work to develop general-purpose learning and reasoning algorithms to support engineers and scientists, and to streamline experimental processes. He will collaborate with scientists to apply the algorithms, in particular, in the fields of computer hardware, materials, and synthetic microbiomes, helping the researchers decide on the optimal way to conduct their experiments.

The work will build on his success in developing algorithms for electronic design automation and computer architecture domains. He received the Voiland College’s Reid Miller Teaching Excellence award in 2018 and has worked to democratize computer science and machine learning skills for interdisciplinary research. Doppa will develop a short course on data-driven design optimization and will work with researchers to develop efficient algorithms with an easy interface. While he is teaching them, he will also learn and work to improve the easy-to-use algorithms.

Guy Palmer receives Excellence in Research Award



The founding director of WSU's Paul G. Allen School for Global Animal Health, **Guy Palmer**, has received the 2019 Excellence in Research Award from the Association of American Veterinary Medical Colleges.

Selected by a committee of peers, the honor designates Palmer as the outstanding veterinary medical researcher of the year. The association's Board of Directors established the annual research award in 2010 to recognize outstanding research and scholarly achievements in the field of veterinary medicine. It recognizes an individual who, over the course of his or her career, has demonstrated excellence in original research, leadership in the scientific community, and mentoring of trainees and colleagues in any discipline of veterinary medicine.

Palmer

Palmer is WSU's Regents Professor of Pathology and Infectious Diseases and the Jan and Jack Creighton Endowed Chair in Global Health. His research has led to discoveries related to pathogen emergence and spread, including insight into how pathogens evade the immune system. His work aims to reduce the impact of zoonotic diseases on human health, economic development, and food security using a One Health approach. He leads global health programs in Africa and Central America.

Jacob Leachman receives national cryogenics award



Jacob Leachman, associate professor in the School of Mechanical and Materials Engineering, has received the Cryogenic Society of America's Roger W. Boom award.

Leachman was recognized for his research on the cryogenic properties of hydrogen, as well as for his work in student mentoring and education.

The Roger W. Boom award, named for the late University of Wisconsin professor in cryogenic engineering, is awarded every other year to young professionals under the age of 40 who show promise in making significant contributions in cryogenic engineering and applied superconductivity, according to the Cryogenic Society of America (CSA) website.

Leachman

Leachman, who has been at WSU since 2010, established the Hydrogen Properties for Energy Research laboratory at WSU. The lab is focused on the study of cryogenic hydrogen for energy and aerospace related applications. His research includes hydrogen, deuterium, tritium, and mixtures; small, modular hydrogen liquefier design, thermophysical property modeling and measurement, rocket and space stage vehicle design ; and liquid hydrogen fueling of unmanned aerial systems. Leachman has also served as a faculty mentor on several student projects, including an effort to build the first university-based liquid hydrogen fuel unmanned aerial system.

Faculty Recognition FY19

Faculty Recognition

McKeirnan receives national honors for work in pharmacy practice



McKeirnan

The American Pharmacists Association (APhA) honored **Kimberly McKeirnan** for her work and research in clinical pharmacy.

McKeirnan, a clinical associate professor at the WSU College of Pharmacy and Pharmaceutical Sciences (CPPS), was selected for the APhA's Academy of Pharmacy Practice and Management 2019 Distinguished Achievement Award in Pharmacy Practice.

McKeirnan was selected for the award for her work to increase access to vaccinations, an issue very current in the state of Washington. Part of her work at WSU includes running a vaccine administration training program for pharmacy technicians, along with conducting research that supports expanding clinical services that can be provided in a community pharmacy.

The APhA also announced the recipients of their 2019 Immunization Champion Awards. McKeirnan was named its national winner for individual practitioner. The Immunization Champion Awards recognize individuals and organizations who have made extraordinary contributions toward improved vaccination rates within their communities.

Hospitality, tourism professor Dogan Gursoy recognized for research leadership



Gursoy

Dogan Gursoy, Taco Bell Distinguished Professor in the School of Hospitality Business Management, has received the Michael D. Olsen Research Achievement Award. The annual award honors Michael Olsen, the late professor at Virginia Tech, known for numerous contributions to the field of hospitality education and for his mentoring of graduate students.

The award recognizes someone who has made a significant contribution through research to the body of knowledge in the hospitality and tourism industries. It considers the overall contribution to the academy, including serving on editorial review boards, international symposia and conferences, graduate education, and mentoring of graduate students. This award is considered the highest honor for hospitality and tourism scholars.

Gursoy's research focuses on a wide range of topics including sustainability, services management, hospitality and tourism marketing, tourist behavior, traveler's information search behavior, community support for tourism development, cross-cultural studies, consumer behavior, generational leadership, and artificially intelligent device use in service delivery. He is widely published and presented his research at numerous hospitality and tourism conferences.

Gursoy is editor-in-chief of the *Journal of Hospitality Marketing and Management*. He has been recognized during the past decade as one of the top 10 authors in the world in terms of publications in the top six hospitality and tourism journals.

Nursing professor honored by the American Association of Nurse Practitioners



Rasmor

The American Association of Nurse Practitioners (AANP) honored **Melody Rasmor**, clinical assistant professor in the College of Nursing at WSU Vancouver and occupational nurse practitioner at Portland Adventist Medical Center, as a leader in the profession in Washington. The AANP recognizes outstanding achievements by nurse practitioners and nurse practitioners advocates in each state who demonstrate excellence in clinical practice.

Rasmor started her career as a school nurse. Since 1982, she has been a family nurse practitioner. She has extensive experience in occupational health, having consulted with national companies such as Levi Strauss & Co., the Hewlett-Packard Company, and Intel on reducing workplace injuries.

She began teaching at the WSU College of Nursing in 1998. Rasmor has also devoted many hours to community service in Clark County. She founded sports physical clinics for Vancouver-area students a decade ago, an activity that earned her an award as a “real hero” of the education system there.

WSU scientist earns prestigious position with national society



Jacoby

Pete Jacoby, plant ecologist in the Department of Crop and Soil Sciences, was named vice leader in 2019 and leader in 2020 of the American Society of Agronomy (ASA) Sensor-based Water Management Community, which explores and shares research on water sensors, sensor-based irrigation, and how plants and the soil are affected by water and drought. As the leader of the community, Jacoby will preside over the community meeting at the ASA annual meeting in 2020.

The ASA advances the profession of agronomy, promoting soil and plant sciences and the wise use of natural resources and conservation to produce food, feed, fuel, fiber, and pharmaceutical crops for our world’s growing population. Members of the Sensor-based Water Management Community are helping develop new tools that tell growers exactly what is happening in the air, soil, and plants.

A longtime ASA member, and a former WSU College of Agricultural, Human, and Natural Resource Sciences associate dean who has worked at WSU for 23 years, Jacoby applied for the role, seeing an opportunity to meet and work with like-minded scientists. As vice leader, Jacoby will help the community of scientists review and share information to build a better picture of plant responses, automation, and how technologies can sense water in the soil and control irrigation.

Faculty Recognition FY19

Faculty Recognition

Three WSU faculty named AAAS 2018 fellows

Three WSU faculty have been named fellows of the American Association for the Advancement of Science (AAAS), an honor bestowed upon AAAS members by their peers. The new WSU fellows are among 416 members awarded for their scientifically or socially distinguished efforts to advance science or its applications.



Meier



Johnson



Prestwich

Kathryn Meier, professor of pharmaceutical sciences and College of Pharmacy and Pharmaceutical Sciences associate dean for faculty and student development

Elected for distinguished contributions to the field of signal transduction, in particular on G protein-coupled receptors, protein phosphorylation, and phospholipid metabolism.

Monica Kirkpatrick Johnson, professor of sociology and department chair

Elected for distinguished contributions to research on life course development focusing on how adolescents transitioning into adulthood are impacted by different social relationships and economic resources.

Glenn Prestwich, President's Distinguished Professor at WSU Health Sciences Spokane

Elected for entrepreneurial uses of chemistry to solve biological problems, including insect pest control, lipids in cell signaling, and hyaluronan materials for regenerative medicine and inflammation. He is an emeritus professor of medicinal chemistry with University of Utah, where much of the work cited in his election as an AAAS fellow occurred, and joined the WSU Spokane faculty in 2017 after serving as a visiting professor in 2015.

Lloyd Smith named ASME fellow



Smith

Lloyd Smith, a professor in the School of Mechanical and Materials Engineering, has been named a fellow of the American Society of Mechanical Engineers (ASME).

The ASME fellow grade recognizes exceptional engineering achievements and contributions to the engineering profession. The title of fellow has been awarded to only about two percent of over 130,000 ASME members.

Smith, a nationally renowned expert on baseball bat and ball performance, runs the Sports Science Lab at WSU, which is the official certification center for 10 amateur baseball and softball federations, including the National Collegiate Athletic Association (NCAA), the American Softball Association, and USA Baseball. The lab quantifies and certifies balls and bats, helping keep the game consistent by controlling equipment efficiency.

Smith, who has been with WSU since 1996, revolutionized how baseball bats' performance was measured by creating new techniques in the early 2000s, eventually developing an innovative measurement machine. Smith's invention has now been adopted by most major bat manufacturers and sports federations in the design and regulation of bat performance. Smith also developed a portable tester, now widely used, to check if a bat was altered to exceed its approved performance limit. This tester was more reliable and simpler to use than existing solutions.

WSU pharmacist recognized with profession-wide award



Akers

Julie Akers, a clinical associate professor at the WSU College of Pharmacy and Pharmaceutical Sciences (CPPS), was selected for the American Pharmacists Association's (APhA) 2019 Good Government Pharmacist-of-the-Year Award. She was nominated by WSU faculty colleague Jennifer Robinson for her contributions to the pharmacy community through her involvement in the political process.

Akers works with the Washington State Pharmacy Associate (WSPA) student leadership to educate student pharmacists on state level health care legislation. As part of this effort, she helps organize an annual Legislative Day. During the event each spring, over 100 student pharmacists travel to Olympia to meet with members of the state legislature to discuss current bills and advocate for the practice of pharmacy.

Akers has also served on the WSPA Board of Directors for over ten years and served as president of the association in 2012. She serves on the APhA government affairs committee and has represented the state of Washington as an APhA delegate for several years. For the past three years, Akers has represented the college at the state Pharmacy Quality Assurance Commission meetings where she works to advance the role of pharmacists in Washington through both the legislative and rule-making process.

Faculty Recognition FY19

Faculty Recognition

WSU scientists recognized as AI pioneer by *Connected World*



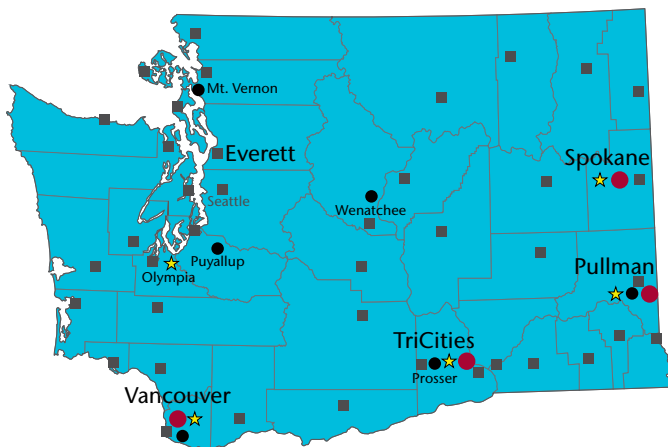
Karkee

Discovering new ways for machines to boost productivity and conserve resources on Northwest farms and orchards has earned **Manoj Karkee**, a WSU scientist, recognition as a 2019 Pioneer in artificial intelligence and the "Internet of Things" by *Connected World* magazine. Karkee was one of 11 scientists in the United States and Canada to receive the recognition from *Connected World*.

Recognition of Karkee as a 2019 Pioneer underscores the significance of discoveries at WSU's Department of Biological Systems Engineering and the WSU Center for Precision Automated Agricultural Systems to save labor, conserve natural resources, and improve farm productivity and efficiency.

Among his projects, Karkee is building apple-picking robots, smart irrigation systems for grapes and fruit trees, flying drones to deter birds from fruit crops, and machines to bundle red raspberries. Just as important as building machines, he develops artificial intelligence for field agriculture, creating the software that tells agricultural robots how to do their work.

Advancing research statewide



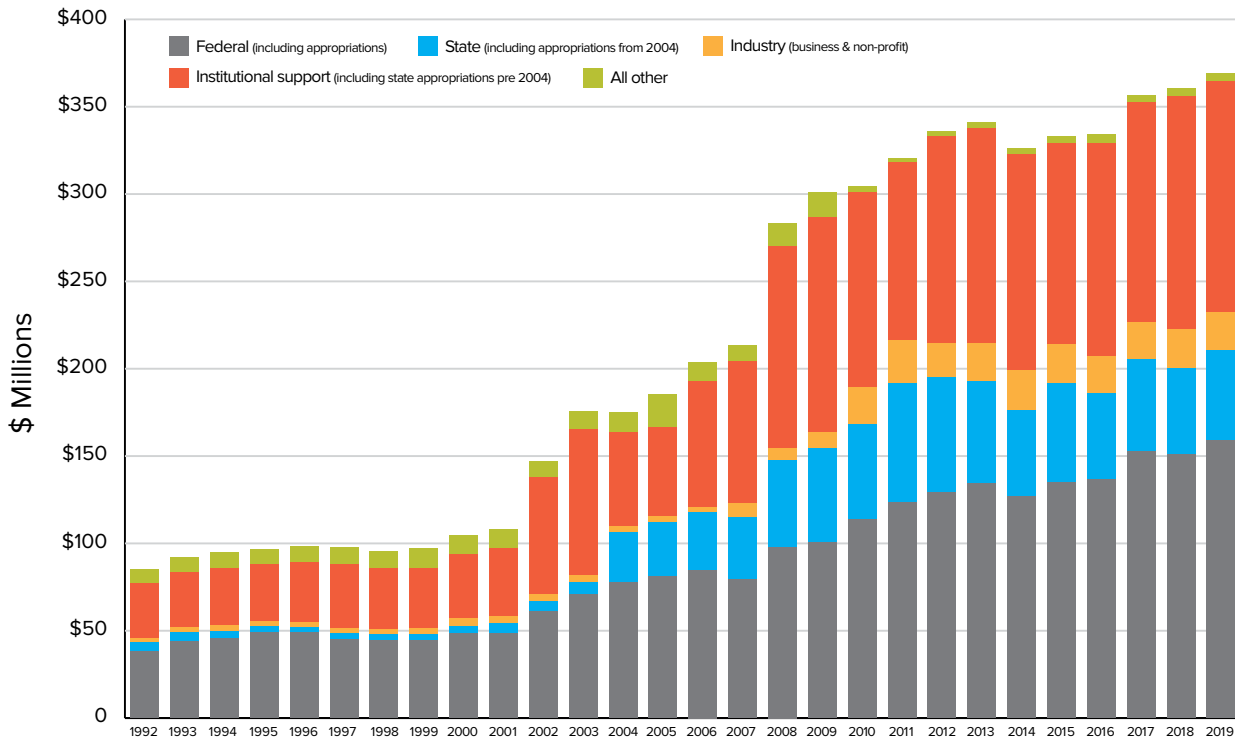
Washington State University faculty conduct research at campuses across the state. Extension offices in each of Washington's 39 counties turn research into action for local industry and communities.

- **Research centers, institutes, and core facilities** - More than 30 research centers and institutes bridge disciplines to answer difficult questions. Core facilities support investigations with instrumentation and services.
- **Research and extension centers** - Agricultural and natural resource research at four strategically located centers is supported largely by state and federal research grants and contracts. Public investment in these centers yields enormous returns in land productivity, disease-resistant crops, and the conservation and safer use of natural resources.
- ★ **Libraries** - WSU serves the state with eight libraries at five locations: Pullman, Spokane, Tri-Cities, Vancouver, and Olympia.
- **Extension offices** - WSU Extension leverages research to find solutions to local issues.

Facts & figures

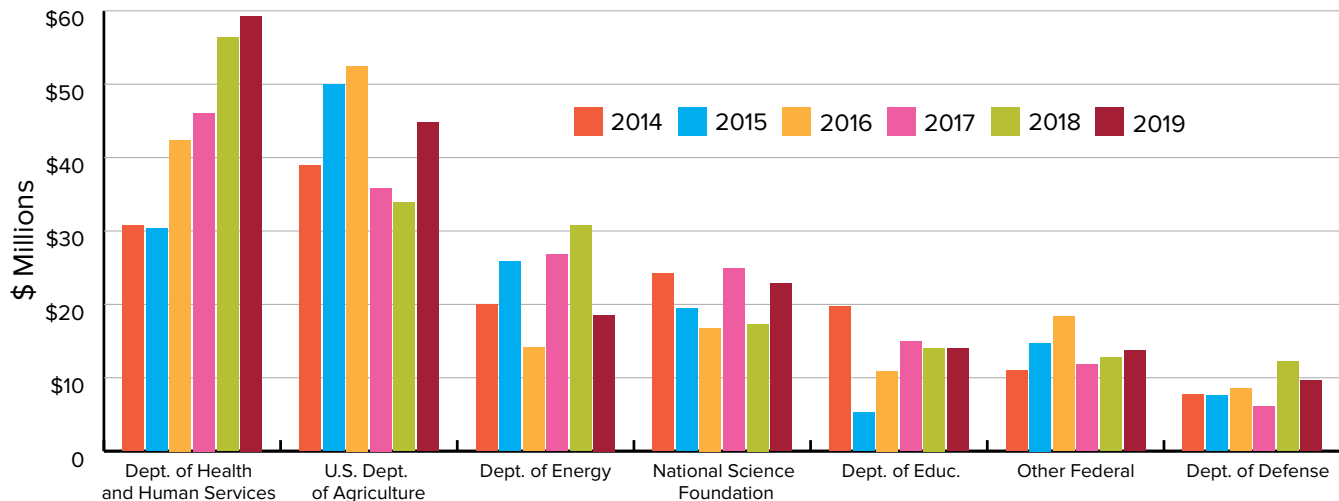
WSU Research Expenditures

\$369.3 million total FY19



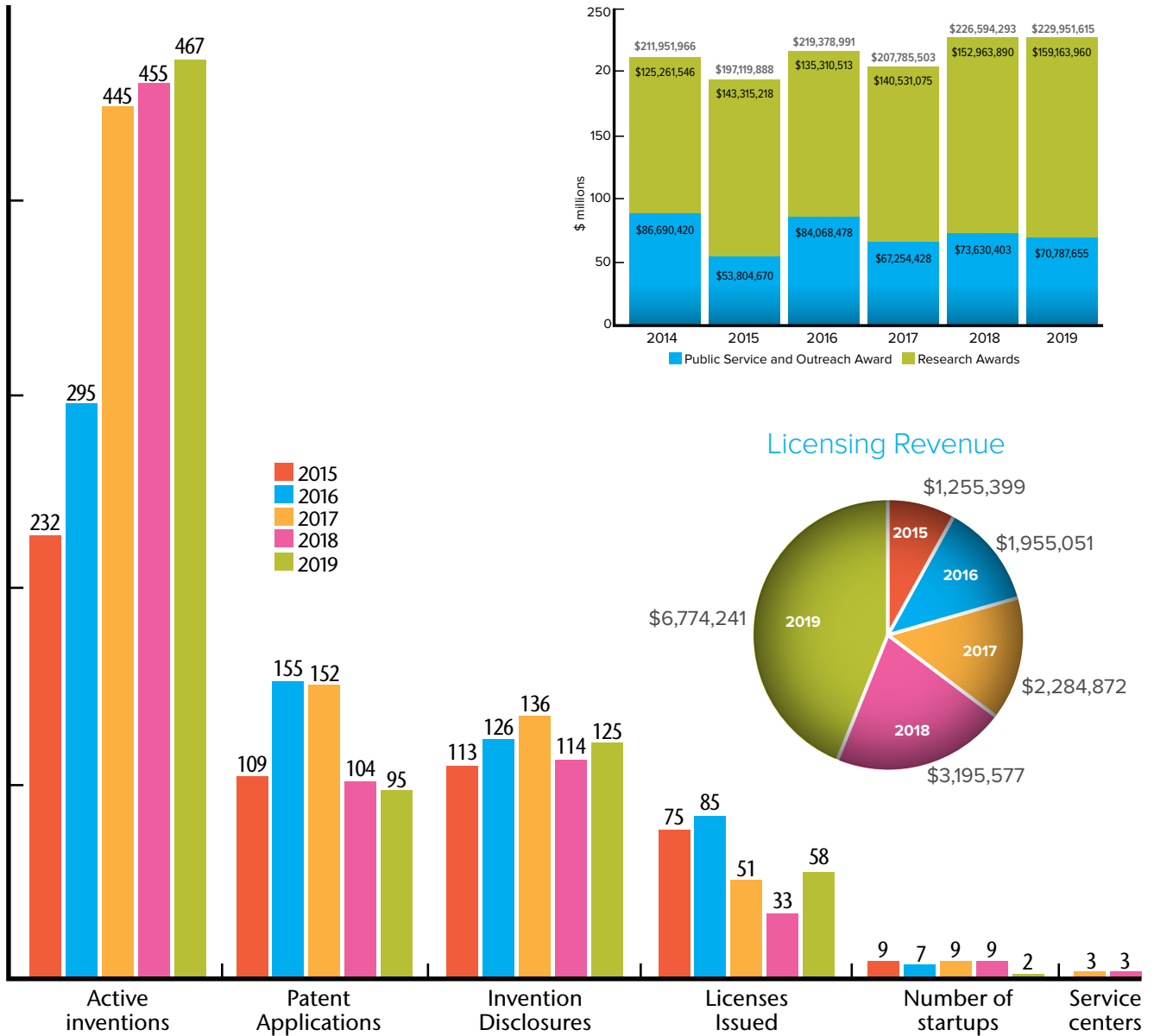
Trends in Federal Awards

HHS (includes NIH) largest federal agency at WSU

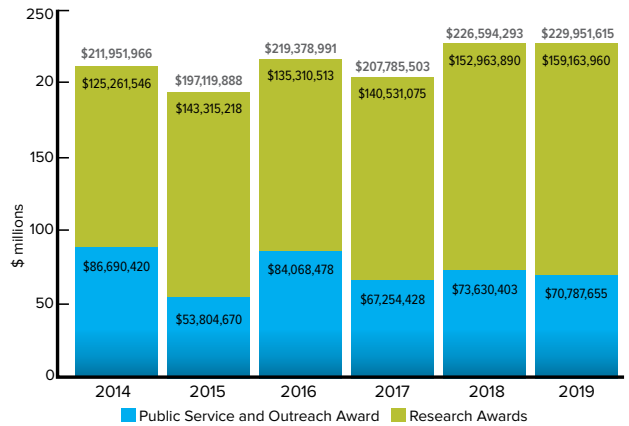


Facts & figures

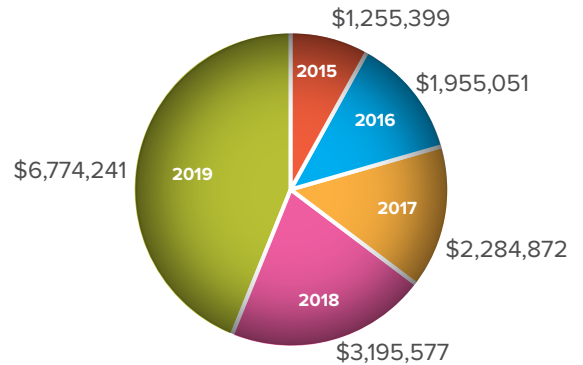
Commercialization on the Rise FY15–FY19



Totals Awards—Research and Outreach/Public Service

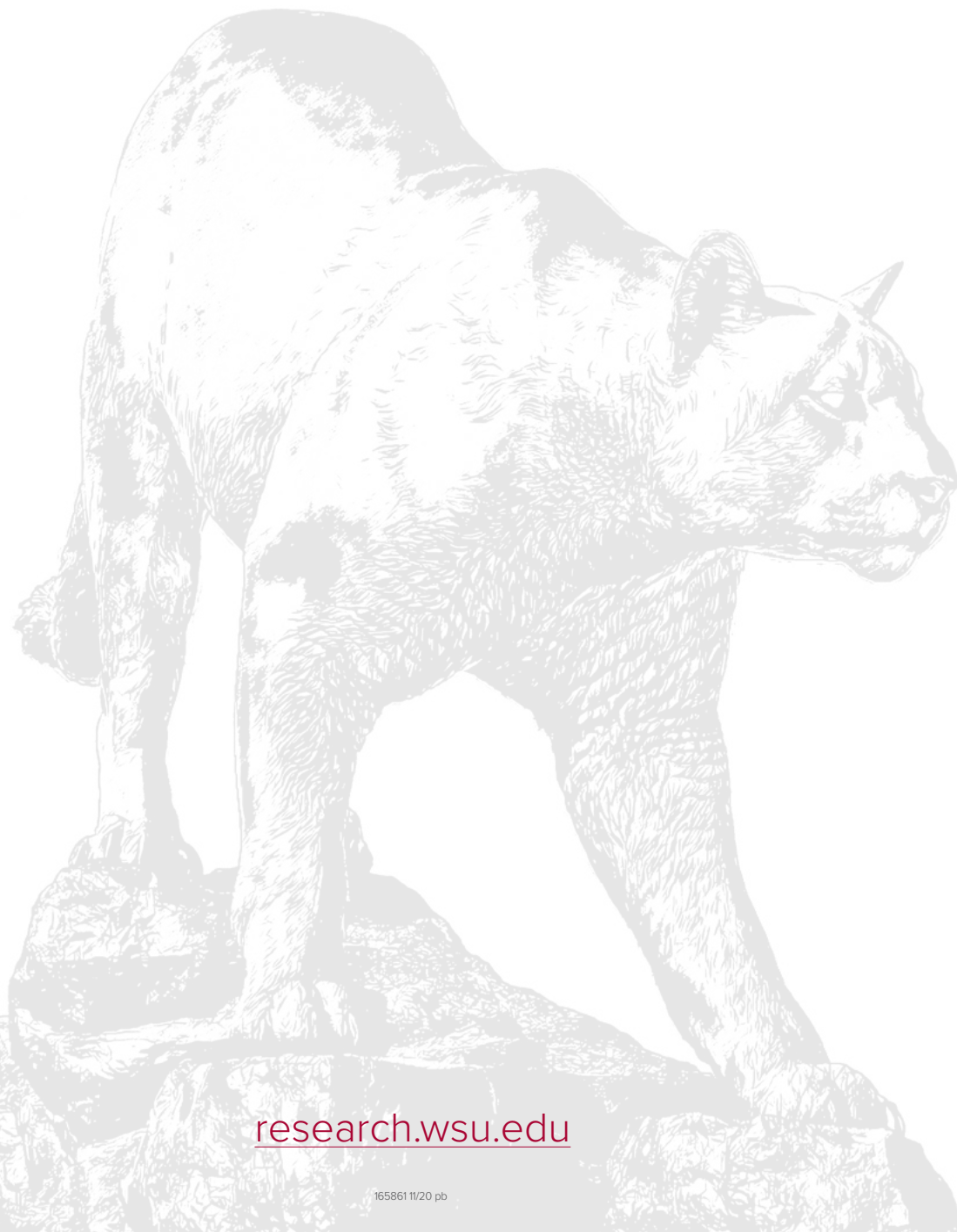


Licensing Revenue



WASHINGTON STATE  UNIVERSITY

Everett | Extension | Global | Pullman | Spokane | Tri-Cities | Vancouver



research.wsu.edu