

COLORADO STATE UNIVERSITY

RESEARCH

WINTER 2022

EXTENDING
OUR REACH

COLORADO



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ON THE COVER

CSU research – fueled by a diverse faculty and staff – extends well beyond state lines, impacting individuals and communities across the globe.

*Illustration by Bonnie Palmatory,
CSU Marketing and Brand Management*

NOTEWORTHY

At the time of print, the Marshall Fire had ravaged through Boulder County, and the Omicron COVID-19 variant once again capped ICU beds. Read more about CSU's efforts related to pandemics and wildfires on pages 3, 11, 20, 24, 32, and 37.

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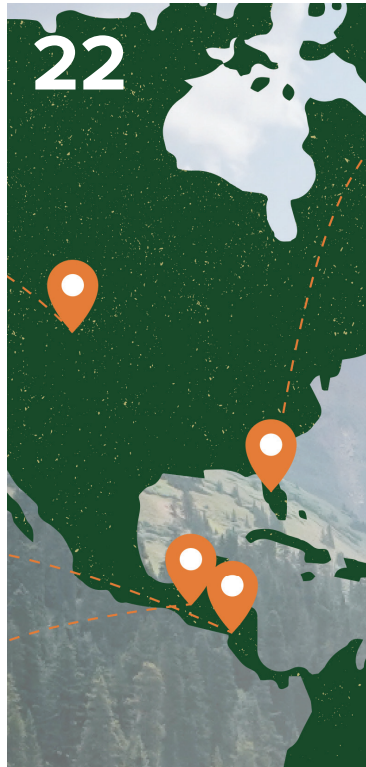


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Send comments, news, or story tips to:

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Guest Publisher Letter BLAKE NAUGHTON



community to the table at the start, working together in research that is relevant locally. We also serve as the bridge to the engaged research and scholarship conducted at the Fort Collins campus, providing access to all of CSU's resources and expertise to communities across Colorado. With each conversation, new opportunities are identified to continue to grow community connections.

Our faculty lead the way in community-based research. In 2019, the Provost's Council for Engagement introduced a "Continuum of Engaged Scholarship" framework to identify the breadth of engaged research, teaching, and service activities that move us from outreach to engagement. This model of co-creation with the community enables us to realize even greater levels of innovation.

To take a line from our Courageous Strategic Transformation framework, we have a tremendous opportunity to build on our greatness – the accomplishments and outcomes that our research has brought to communities – and to rise to new challenges. This is the heart of our land-grant mission.

A handwritten signature in black ink, appearing to read "Blake Naughton".

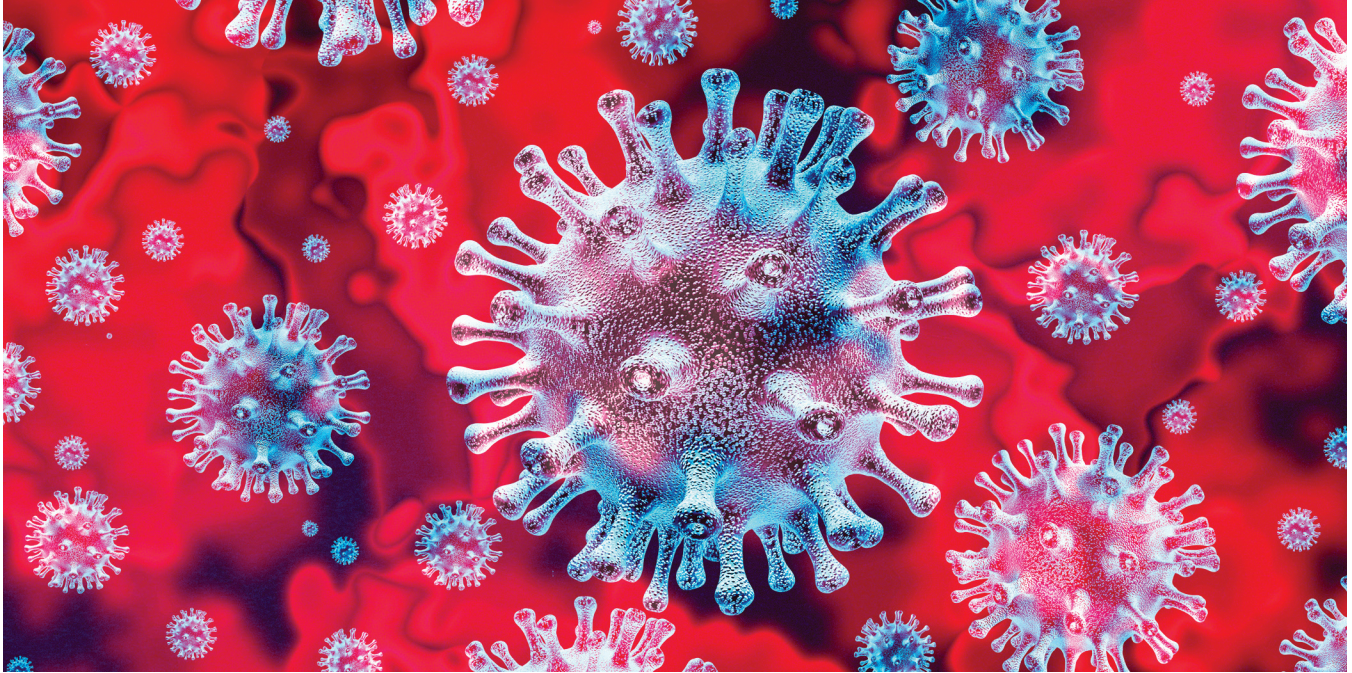
Blake Naughton

*Vice President for Engagement
and Extension*

Extending Our Reach. That's our commitment as a land-grant university to offer access, inclusion, and opportunity to the University's educational programs, resources, and services. As the Office of Engagement and Extension, we support and enable this mission for all Coloradans and audiences beyond our state to empower individuals and communities to thrive from learning.

This year, we completed a statewide community needs assessment designed to understand changing needs across Colorado and our potential for an even more significant impact in the future. These new insights and enhanced understanding will support conversations and co-creation with our Colorado State University and external partners on future scholarship priorities and plans.

With this awareness of the issues our communities face at our CSU campuses, centers, and Extension offices across the state, we bring the



DIVERSE FACULTY ADVANCING COVID RESEARCH

MARCELA HENAO-TAMAYO

Health care workers often experience frustration when, despite their efforts, resources are insufficient to properly treat their patients. That was my experience while attending medical school in a developing country: I wanted to do more! The best route I found was through disease prevention, a perspective that could potentially have a major impact on human health. CSU's researchers, community, and facilities offered a unique opportunity for the type of work I wanted to do.

For the past 20 years, I have studied tuberculosis, a pandemic that kills 1.4 million people annually, especially in developing countries. Most of my research has focused on tuberculosis pathogenesis and refining tuberculosis vaccines by elucidating immune mechanisms conveying protection.

Even though the currently available tuberculosis vaccine prevents disseminated disease in children, its protective capacity diminishes over time, leading to this tragic death toll.

With time, I realized we needed better tools to evaluate the immune response to infectious diseases and the protective capacity of new vaccines at CSU. Thanks to support from the MIP department, CVMBS, and the OVPR, we launched the Flow Cytometry and Cell Sorting Facility to address this need. The equipment and expertise of this facility allow us to evaluate how our immune cells respond to vaccines and infection; they can detect infected cells or even assess infectious organisms. We can analyze millions of cells in seconds and examine many aspects of each cell. If required, we can separate a specific type of cell or infected cells at a single-

cell level and perform more studies such as sequencing and culturing.

CSU rapidly responded to the COVID-19 pandemic. Our strength lies in the diverse and vast expertise with infectious diseases and the community's willingness to work together in a concerted effort, while addressing the pandemic from multiple angles. We have researchers working on candidate vaccines, vaccines that could be easily administered in remote locations or in underprivileged regions, and novel therapeutic drugs or immunomodulators. Some groups are working in epidemiology to prevent dissemination by rapidly detecting the virus in the community; others evaluate different kinds of disease severity and long-term consequences. Many assess how our body responds to this infection and possible explanations underlying

COVID RESEARCH continued

differences in disease presentation and severity. Others are investigating the source of the virus and the evolution of similar viruses, including those that could become a health problem in the future. Transmission patterns, the aerobiology of this infection, and its association with climate change are all being investigated here at CSU. We have been fortunate to collaborate with several of these groups. Many research fields have advanced vertiginously: Investigators who had never worked together are collaborating, science that we could not do before is happening, and that is how we know this problem is far from being solved.

We, as the world, have gone through a steep, often sad, learning curve. The world is interconnected: This pandemic has demonstrated how much we all depend on each other. Several first-world countries and regions in the U.S. now have the privilege of having vaccinated a significant percentage of their population. Unfortunately, the pandemic is not contained until the entire world gets some protection. The world can achieve herd immunity only by vaccination or infection of a high percentage of the population. We hear that message quite often these days. Thus, better efforts to vaccinate disadvantaged communities are needed. We must reach those who don't have the advantage of understanding the risk they are taking if they don't get vaccinated; in this pandemic, those are also underprivileged people regardless of where they live. While the virus lives and replicates in any human being, it will keep mutating; it will keep infecting and causing pain and sorrow. There is no way to hide from an infectious disease; we can manage it, sometimes we can shorten it with drugs, but the best way is to prevent it ... easier said than done.

Nowadays, teamwork is key to any effort conducive to successful accomplishments. A team of doctors provides treatment for patients in order to get the best care. Researchers from different fields collaborate to investigate novel and better ways of addressing diseases. Governments should listen and consult with those who have experience and think about managing and solving our communities' problems.

has limitations. Every day we find different, often unexpected, answers to a problem. There are fears in those who "hide" from the advancements in science. Skepticism is often a defense mechanism when we suffer, do not understand the problem, and cannot find clear, reliable help. Could we probably address those feelings and the misinformation through reliable methods of communication? I ask myself



Vice President for Student Affairs Blanche Hughes gets her first of two COVID-19 vaccination shots.
Photo: Joe A. Mendoza

We learned health care professionals and researches should connect and share their knowledge to find the best approach to contain the pandemic. There is no unique voice with a solution, and those who think they have it might be dangerous to the community. A concerted effort to work together with clear goals can prevent more suffering and save many lives.

We need to engage our communities. Science communication is vital; society needs to understand our efforts, our science, and proposed approaches. We should acknowledge and explain to our communities that every field

constantly how I can motivate people to open their minds to other, probably better, alternatives.

At CSU, many researchers like me, with a passion for life and wellness, work together to address many of the problems our community experiences. We try to push our limits. We educate with love and compassion. Our undergraduates are inspirational, and our graduate students and staff are the best teams we could hope for. I am honored and lucky to be part of this organization. ■

3-MINUTE CHALLENGE WINNERS BECOME 2021-2022 RESEARCH FELLOWS

LAUREN WELLER

Twelve participants in the Vice President for Research's 3-Minute Challenge were selected to become the next cohort in the VPR Graduate Fellows Program at Colorado State University. In addition to receiving \$4,000 for travel and research expenses, the new fellows are also engaging in professional development workshops along with leadership and mentorship opportunities during the 2021-2022 academic year.

Fellows were selected based on their presentations for the 3-Minute Challenge. Although the live virtual event planned for 2021 was canceled due to a University weather closure, participants were able to record and relay the relevance and potential applications of their research and scholarship to a panel of six judges.

Judges selected the 12 winners from 35 graduate students from seven of CSU's eight colleges who presented, based on effective communication and content of presentations. ■



Scan here to watch the winning presentations.

2021-2022 VPR FELLOWS



Jewels (Michelle) Fallon
Chemistry
Methods Matter: A New Technique To Make Solid Materials



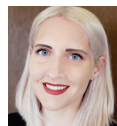
Anna Clare Monlezun
Ecosystem Science and Sustainability
Cattle As Partners In Conservation: Collaborative Management Of Government-Owned Lands



Arielle Hay
Microbiology, Immunology, and Pathology
In Your Head, In Your Head, Zombie Proteins, Zombie Proteins



Sarah Myers
Psychology
Should Students Create Their Own Practice Tests?



Kayna Hobbs
Environmental and Radiological Health Sciences
Face Masks: Does One Size Fit All?



Mariel Price
Chemistry
Designing Plastics With A Circular Lifecycle



Shivani Kaushik
School of Social Work
Dying For A Change: End-Of-Life Care In U.S. Corrections



Katie Rocci, Ecology and Soil and Crop Sciences
Not All Soil Carbon Is Made Equal: Unique Responses Of Soil Carbon Components To Human-Induced Environmental Change



Allison Kohler
Graduate Degree Program in Ecology
Bright Pink And Green, Glow-In-The-Dark Flying Squirrels And Platypuses



Marina Rodriguez
Biology
The Long And The Short Of It: Using Telomere Length As An Indicator Of Climate Change Effects On Yellow Warblers



Marija Kronic
Systems Engineering
Keeping Public Restrooms COVID-19 Free: Cell Phone Sanitizer And Charger



Ariel Timkovich
Microbiology, Immunology, and Pathology
A Receptor Gone Bad: The Tale Of Uncontrolled Inflammation And Joint Degeneration



STEVEN MILLER NAMED NEW DIRECTOR OF CIRA

MATTHEW ROGERS

Research scientist and Colorado State University alumnus Steven Miller has been named director of CIRA, the Cooperative Institute for Research in the Atmosphere. Miller will hold a joint appointment as professor in the CSU Department of Atmospheric Science.

As one of 15 cooperative institutes partnering with NOAA, CIRA works with the department to conduct cutting-edge atmospheric science research that benefits the nation. CIRA's research encompasses satellite meteorology, numerical forecasting, tropical storm prediction, air quality monitoring, and data dissemination.

Miller has led important research initiatives, developed new programs, and pursued new avenues for funding as CIRA's deputy director since 2007.

In August, he replaced the current director, Christian Kummerow, who stepped down after 11 years to focus on his research as a CIRA Fellow and professor in atmospheric science.

MORE THAN 40 YEARS OF CIRA RESEARCH

Founded in 1980 under the direction of University Distinguished Professor Emeritus Tom Vonder Haar, CIRA's research into satellite meteorology quickly spread into other topics, including hurricane forecasting and weather forecast models. CIRA works with NOAA, NASA, and the U.S. departments of Defense, Energy, and Interior to advance our understanding of weather, water, and air quality. Intended as a clearinghouse to leverage the research capabilities of

academic institutions to benefit from real-time forecast operations, the cooperative institute model created by NOAA helps guide academic research on topics of immediate and critical importance to the nation.

CIRA products help visualize tropical storms, air quality, and fire or dust events. If you've seen stunning color imagery of weather over the United States posted by NOAA, odds are you're looking at a product developed at CIRA.

CIRA has branch offices across the country – in Maryland, at the Aviation Weather Center in Kansas City, at the National Hurricane Center in Miami, and at the Earth System Research Laboratory in Boulder – where nearly 200 scientists, engineers, and researchers work on myriad topics. Miller is responsible for managing the strategic planning and oversight of these scientists. He brings to the position a deep understanding of what makes for relevant science, as well as significant management and interpersonal skills, and a strategic vision to keep the vibrant research institute thriving.

GUIDING CIRA FOR MORE THAN A DECADE

Kummerow served as director starting in 2010, following University Distinguished

Professor Emeritus Graeme Stephens, who succeeded Vonder Haar in 2008.

Under Kummerow's tenure, CIRA significantly grew its research volume – to \$26 million annually from \$17 million in 2010 – and added a new wing to the CIRA building on the Foothills Campus at CSU. Partnerships with the Aviation Weather Center, the National Hurricane Center, and NOAA offices have flourished, along with programs in education and social science.

Kummerow said managing CIRA during a pandemic was one of his greatest challenges.

"While the workload increased to keep everything running, it was also an incredible realization of just how good and how dedicated the CIRA team was," Kummerow said. "We've seen tremendous growth in CIRA over the past 11 years, and I would fully expect that growth to continue under Steve's leadership. I plan to work very closely with him."

STEPPING UP

Miller also returned as professor to his alma mater (M.S., '97; Ph.D., '00). After completing his doctorate, Miller worked at the Naval Research Laboratory in Monterey, Calif., supporting the U.S. Navy and coalition forces in the wake of 9/11, before coming back to CSU in 2007 as CIRA deputy director. His role

at CIRA is complemented by his new role as professor in the Department of Atmospheric Science.

"CIRA and the Department of Atmospheric Science have developed a great synergy over the years, effectively combining the basic and applied science expertise of our faculty, students, and scientists," said Jeff Collett, professor and head of the Department of Atmospheric Science. "CIRA also represents a tremendous draw in recruiting new ATS students and a highly desirable option for ATS graduates who fall in love with Fort Collins during their graduate studies."

Miller helped develop gorgeous full-color satellite images and identify new forms of light in the nighttime skies. He is also leading large research projects focused on dust observations. Most recently, his research team has explored ways to see the impacts of the COVID-19 pandemic using satellite imagery.

"Sometimes I feel that CIRA and its core mission are just part of my DNA," Miller said. "CIRA's ability to connect CSU's powerful academic research program to applied research topics benefiting society gives us all an exciting 'so what?' story to tell the public about the importance and immediate relevancy of science to our everyday lives." ■



A hurricane heading toward the Gulf of Mexico. Photo: Shutterstock



Researcher Rebecca Moritz at the CSU BSL3 training center, located at the Research and Innovation Center. *Photo: John Eisele, CSU Photography*

THE NEW AGE OF BIOSECURITY

REBECCA MORITZ

For all of us, the last two years have been challenging on multiple levels, both professionally and personally. As a person who has dedicated their career to conducting and supporting biological research, often focused on pathogens, preparedness, and response, the COVID-19 pandemic has been surreal. The current pandemic is vastly different from the last caused by the 2009

influenza virus. At that time, I was still conducting influenza research in laboratories specially designed for working with exotic influenza strains, in addition to safety and security duties such as training fellow researchers, writing protocols, obtaining shipping permits, and interacting with regulators. The main difference between then and now is the virus itself. There were years of influenza research at our

disposal and a vaccine already existed. The response time was based on how quickly the new vaccine could be made and distributed using existing systems.

Scientists have never seen a virus quite like SARS-CoV-2 before. There are many unique attributes to this virus and the scientific, medical, and public health communities are learning more about it and the disease it causes, COVID-19, every day. It is astonishing

how quickly the scientific community changed research directions to utilize their expertise and attack the problems posed by SARS-CoV-2 and COVID-19 from multiple angles. CSU has been, and remains to be, uniquely positioned to support the Colorado community as well as the world because of key research infrastructure investments that have been made over the years.

CSU has numerous laboratories specially designed to study pathogens such as SARS-CoV-2. These laboratories look the same as any ordinary laboratory from the inside. However, they are very different and highly regulated, both internally and externally, by CSU. Nothing that goes into these laboratories can come out without being decontaminated in some way. That includes the air, water, waste, and people working inside; the support systems that serve these laboratories ensure this. Then, with the procedures followed, safety equipment used, and personnel protective equipment utilized, the researchers doing the work are protected. Upon leaving these laboratories, the researchers must remove their PPE in a specific order and location on their way out. In addition, there are specialized rooms that were used for PPE for medical providers when there was a PPE shortage early in the pandemic.

CSU also has a manufacturing facility capable of making vaccines and requires a higher safety level; this lab is working on several vaccine projects related to the pandemic. Then, let us not forget about the Veterinary Diagnostic Laboratories and other CSU research laboratories that continue to

support Larimer County's and CSU's COVID-19 testing needs.

Yet those are just the highly visible contributions that CSU has made to the pandemic. Behind those contributions is an entire safety and security infrastructure that is mostly invisible to the public. Its contributions are focused on the safety and security

Program had to determine how to ensure researchers were protected from their work, as well as protected from each other while at work. We had to make sure the researchers all had the appropriate experience, training, and access to PPE. This often meant that we were on site, ensuring the research was being done in the right type of laboratory, providing hands-



Researchers at the CSU BSL3 training center, located at the Research and Innovation Center.
Photo: John Eisele, CSU Photography

of working with pathogens such as SARS-CoV-2 and all the activities described above. Researchers were not the only ones adapting; so were the safety and security, occupational health, and regulatory compliance professionals. In a brief time, we were inundated with research requests associated with a virus no one knew much about. We at CSU's Biosafety Office and Occupational Health

on-training for all aspects of working in the laboratory, and responding to incidents and emergencies, walking through procedures, and making sure all aspects were in proper order. Lastly, the Biosafety Office had to work with the various CSU compliance committees and their coordinators to ensure the required regulatory approvals for doing their specific research were in place. All of this had to be done to ensure

BIOSECURITY continued



Researcher working at the CSU BSL3 training center, located at the Research and Innovation Center.
Photo: John Eisele, CSU Photography

the researchers, community, and environment were protected.

At the same time, the security of this research infrastructure and the intellectual property of CSU's researchers requires equal thought and protections. Usually, this concept invokes the idea of "guards, gates, and guns." While physical security is incredibly important and critical to the research enterprise, so is the protection of novel technology and research data, i.e., bio-cybersecurity. Countries and companies around the world were clamoring to be the first to successfully create effective vaccines and treatments to prevent and treat COVID-19 to protect their citizens and political interests.

There were multiple cyberattacks attempting to obtain technology and research data from companies and research institutions involved in developing vaccines and treatments. There were also cyberattacks aimed at disrupting vaccine production and distribution pipelines. Even before the pandemic, CSU recognized the importance of teaching students about bio-cybersecurity and gave them hands-on experience through weekend-long hackathon challenges, one of

which is scheduled for this spring. Our unique assets in the biosecurity arena position us to train the next-generation workforce needed to thwart these attacks. We will continue to seek ways to integrate biosecurity into our cyber and data sciences curriculum.

This pandemic is a sobering reminder of how important it is to have a nimble research infrastructure protected from physical and virtual threats. Unfortunately, SARS-CoV-2 is not the last emerging pathogen. There are many more on the horizon; some already threatening humans, animals, agriculture, and food supplies. CSU's research enterprise will always be a wealth of valuable technology and research data. CSU will continue to be a leader in pandemic preparedness and response by working to minimize the effects these pathogens have locally and worldwide. While doing so, the CSU research enterprise will continue to invest in and support the infrastructure needed to ensure this research is conducted in the safest and most secure manner possible, while also protecting its research enterprise and intellectual property and creating a strong bio-cybersecurity workforce. ■





Larimer County Sheriff's Office firefighter Quinn de la Haye uses a drip torch to ignite unburned fuel to protect structures from the East Troublesome Fire.
 Photo: William A. Cotton, CSU Photography

CSU EXTENSION: EXPANDING OUR REACH EVERY DAY IN EVERY COUNTY

RAGAN ADAMS

In 1912, D.C. Bascom of Logan County became the first CSU Extension agent. In that year, he logged 14,000 miles, sharing farming techniques appropriate for the dry soils and high altitude of Colorado to homesteaders. Bascom also offered “kids clubs,” where he taught children to raise livestock and grow corn and wheat. These clubs were the predecessor of 4-H, now America’s largest youth development organization.

For the next 100 years, local Extension agents continued to link University-based research with the experiential-based practices of the community to improve responses to challenges such as family, business, natural resources, agriculture, world wars, and economic depressions. Presently, natural disasters and infectious disease outbreaks in animals and people are more frequent and need Extension’s attention. One in

three Americans lived in a county hit by a weather disaster in the summer of 2021, according to a *Washington Post* analysis. The threat struck home in Colorado last month when the Marshall Fire roared through Boulder County, incinerating nearly 1,000 structures, and in 2020 when the Cameron Peak Fire scorched more than 200,000 acres – the biggest blaze in state history.

EXTENSION continued



CSU researchers prepare for the arrival of African swine fever virus. Photo: Lightpoet via Shutterstock

Following Colorado's wildfires in 2020, Vice President for Engagement and Extension Blake Naughton formalized his support for Extension's role helping with local disasters by requiring all CSU Extension agents to take basic FEMA courses and meet with county emergency managers to prepare for disasters.

Extension is an important part of FEMA's 2011 Whole Community approach to disaster response. This strategy emphasizes the need for the full capacity of a community to collaborate on the three phases of emergency management: preparedness, response, and recovery. Thus, the responsibility no longer lies only with first responders, but necessitates the year-round involvement of the private and nonprofit sectors with the general public and all levels of governmental partners.

CSU has also strengthened its involvement with the national Extension Disaster Educational Network. This USDA National Institute of Food and Agriculture-funded network, composed of representatives from Extension organizations in 50 states and two territories, shares educational material

and experiences about disaster preparedness, response, and recovery. Relationships formed across this network facilitate regional cooperation during multistate disasters.

CSU EXTENSION AND NATURAL DISASTERS

Here are a few examples of emergency management efforts in Colorado supported by Extension:

Retta Bruegger, Western Region Extension rangeland specialist, has gathered ranchers, professional colleagues, and community residents to discuss drought planning since 2018. These groups create long-range and innovative responses to unprecedented drought conditions.

Karen Crumbaker, Larimer County natural resource agent, has partnered with other agents along the Front Range to help residents living at the wildland-urban interface to protect their properties from fire. Last year's four-week series, Wildfire Wednesdays, attracted 751 registrants.

Dan Schroder is a one-man show in the Summit County Extension office. He offers wildfire prevention programs but

also is a voice in multiple organizations for healthy forests and proactive county wildfire preparedness.

MyPI, a national youth preparedness initiative, has been offered to Colorado 4-H youth since 2018. Teenagers complete the U.S. Department of Homeland Security/FEMA-certified CERT training and build personal preparedness plans with families to increase the overall resiliency of their community.

In the south-central part of the state, Michael Fisher, Pueblo County director, is partnering with other counties in his region and Homeland Security specialist Christe Coleman to develop a strike force team of agents who can be shared across counties.

During disaster, county Extension agents assist with logistics and operations. Their relationships with community members and knowledge of available resources are valuable to the incident command team. Extension often leads the team that supports agriculture and natural resources. The most common job is assistance with evacuation and sheltering of animals, both pets and livestock. Last summer, under local Extension leadership, counties prepared for animal needs in their own counties and neighboring counties facing large wildfires.

After the first responders leave, the community assumes the complicated process of recovery. County Extension agents shine in this stage of emergency management because of their local knowledge and relationships and their connections with state and federal agencies, as well as their talents with volunteers and partnership development. CSU and Boulder County extension teams have been involved in immediate and ongoing support after the Marshall Fire. The Boulder County team is the boots on the ground response with the CSU and state teams, providing backup and additional support where needed. They created a

bilingual “After the Disaster Guidebook” to help officials and local residents with restoration and recovery.

Blake Osborn, an Extension regional water specialist, developed a program in 2018 to assist private landowners with their post-wildfire damage. The value of the Watershed Assessment Vulnerability Evaluation has been recognized by Colorado Department of Agriculture and will receive financial support to expand capacity from the 2021 state drought recovery bill.

After the 2020 Colorado fires, the state recovery team formed a task force specifically focused on agricultural needs, co-led by CDA and CSU Extension. This group initially focused on disseminating information about repairing the burned landscape to private agriculturists. Last summer, in cooperation with CDOT and agricultural producers, the task force focused on supporting the challenges of transporting perishable products such as fruit, vegetables, and livestock, due to disruptions along I-70, the major corridor to urban markets.

NOT JUST ABOUT NATURAL DISASTERS

Extension agents play a large role in preventing and responding to human and animal health crises as well. Community economic development initiatives facilitated by Extension will help strategize local recovery plans. The CSU Board of Governors has designated \$8.5 million to improve the health and economies of rural counties.

Animal health and welfare has always been part of Extension programming, especially in areas where veterinarians are in short supply. On the prevention side, Extension agents educate 4-H participants and animal producers about husbandry practices and biosecurity protocols that decrease the likelihood that animals develop infectious disease. This year, CSU Extension partnered with Washington State University and

University of California Davis Extension programs for funding from the USDA National Animal Disease Preparedness and Response Program to focus delivery of biosecurity education to previously underserved livestock producers.

Extension personnel are also involved in preparation for the potential arrival of African swine fever in the United States. For example, the virus can remain viable in food waste if it is not sufficiently cooked before feeding to animals, though some producers feed raw food waste from local schools and restaurants to their animals, thus decreasing waste sent to landfills.

Presently, the U.S. pork industry and the USDA APHIS are ramping up biosecurity against African swine fever. This very infectious disease of pigs that has never been identified in the United States was found within the Dominican Republic last July.

Also, to prevent foot-and-mouth disease, Frank Garry, CSU professor and veterinary Extension specialist, has assembled a team consisting of personnel from Dr. Colleen Webb’s laboratory on systems disease modeling, CSU Ag Next, and USDA APHIS to assist Maggie Baldwin, the Colorado state veterinarian, to develop Colorado plans. The effort could eventually lead to multistate cooperative efforts.

CSU Extension local personnel are deeply committed to building resilience within their communities. Their efforts span multiple topics, from youth development to small-acreage management, family and business financial stability, community and individual health, promoting sustainable agriculture, and protecting natural resources such as rangelands and watersheds. This consistent presence in good times and bad enhances their reputation as trusted partners in the community and fortifies the land-grant mission. ■

IDENTIFYING A PROMISING MODEL FOR HEALTHY AGING

HANNAH HALUSKER

There are many components to aging, both mental and physical. When it comes to the infrastructure of the human body – the musculoskeletal system that includes muscles, bones, tendons, and cartilage – age-associated decline is inevitable, and the rate of that decline increases the older we get. The loss of muscle function – and often muscle mass – is scientifically known as sarcopenia or dynapenia.

For adults in their 40s, sarcopenia is hardly noticeable – about 3% muscle mass is lost each decade. For those aged 65 years and older, however, muscle decline can become much more rapid, with an average loss of 1% muscle mass each year. More importantly, sarcopenia is also marked by a decrease in strength, impaired gait, reduced physical activity, or difficulty completing everyday tasks.

The proportion of older adults aged 65-plus is projected to more than double by the year 2060, driving research into the process of musculoskeletal decline. Researchers at Colorado State University's Columbine Health Systems Center for Healthy Aging believe they have found an animal model that will help them better understand it and find ways to curtail the symptoms.

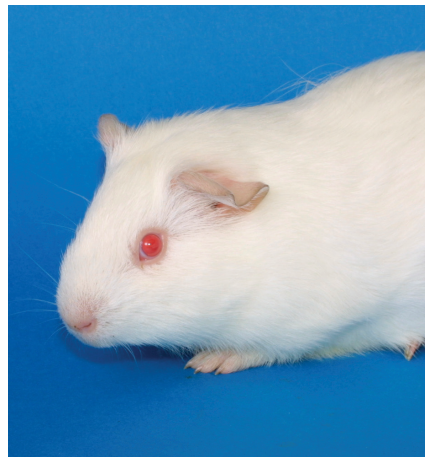
The study, published by *Frontiers in Striated Muscle Physiology* in October 2020, is an example of using comparative medicine to understand human diseases and conditions.

ANIMAL MODELS

Scientists often rely on animal models to mimic disease progression and study the prevention, diagnosis, and

treatment of conditions. However, until now, no animal model has been able to fully capture all aspects of human musculoskeletal aging.

“Existing preclinical models either rely on unloading the muscle, meaning mimicking bedrest in an animal, or they must wait until the animals get really, really old, and even then, they don’t really get the same muscle aging phenotype as people do,” said Karyn Hamilton, a professor in the CSU Department of Health and Exercise Science, an associate director at the Center for Healthy Aging, and a researcher on the study.



Dunkin Hartley guinea pig. Photo: Hilltop Lab Animals, Inc.

In their work, Hamilton’s team found that the Dunkin Hartley guinea pig was a good candidate for a muscle aging model, due to the animal’s tendency to develop osteoarthritis at a young age.

The two conditions – OA and sarcopenia – seem to be linked in humans; with advancing age, skeletal muscle dysfunction increases the risk

for OA, and OA increases the risk for further muscle decline.

Hamilton teamed up with Dr. Kelly Santangelo – an associate professor in the Department of Microbiology, Immunology, and Pathology at CSU, who has been studying primary OA in Hartley guinea pigs for many years – and Associate Professor Raoul Reiser, also in the Department of Health and Exercise Science, to understand how skeletal muscle changes as OA progresses in guinea pigs.

The team hypothesized that those muscle changes might mimic human musculoskeletal aging.

CLASSIC SIGNS

Muscle composition also changes with age as fast-twitch fibers, which are larger and capable of exerting stronger forces, decrease in number, and slow-twitch fibers, which are smaller and less metabolically efficient, tend to increase. Generally, when people “lose muscle mass,” it’s the large, fast-twitch fibers that are affected. With decreasing muscle mass, there also tends to be an increase in fat mass, or adipose tissue, in the body.

As humans age, it may be that maintaining muscle function is more important than preventing loss of mass.

“What we’ve learned over the decades is that age-related loss of muscle mass and age-related loss of muscle function don’t always go hand in hand,” Hamilton said. “You can do things to improve muscle mass, and you might not get an improvement in muscle function; you can do things to improve muscle function and may not get an increase in muscle mass.”

The researchers compared muscle changes observed in Hartley guinea pigs with those in Strain 13 guinea pigs, which tend to develop OA later in their lifespan and, therefore, might not exhibit the same classic signs of muscle aging.

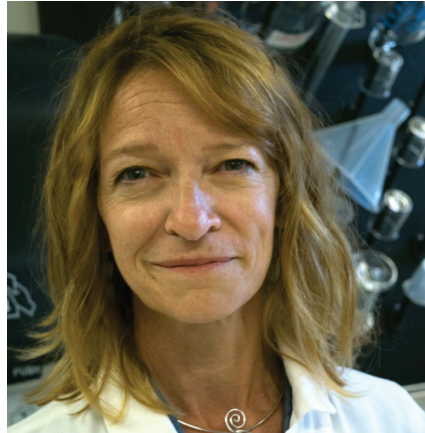
They found some striking similarities to human muscle aging, such as a decrease in muscle density, likely due to an increase in fat mass. While a decrease in muscle mass was not noted, researchers did find a shift toward smaller, slow-twitch muscle fibers, as is expected in human muscle with advancing age.

“If you look at the overall picture, we think that some of the key things that always happen with human muscle aging – that shift toward a less powerful, slower-twitch muscle phenotype – are quite clearly modeled in the Hartley guinea pigs,” Hamilton said. “And we believe that if we started looking at even older guinea pigs, we might see more of the things that people think of as classic sarcopenia.”

FUTURE DIRECTIONS

This study provides a baseline that allows the team to take multiple directions in future research. One direction will be to employ functional tests to study how muscle strength and gait or mobility change with age in the Hartley guinea pigs, and how these changes mimic the deterioration of muscle function in aging humans.

A priority will be to identify if Hartley guinea pigs can be a valuable translational model for identifying interventions that show promise for preventing or slowing the decline



Karyn Hamilton, professor, Department of Health and Exercise Science, and associate director at the Center for Healthy Aging.

in overall musculoskeletal function with aging in humans.

In fact, Hamilton and Santangelo have already begun treating the guinea pigs with plant-based phytochemicals that target a protective suite of genes. The treatment seems to reverse some signs of musculoskeletal aging at the molecular level by improving mitochondrial function, as well as preventing joint deterioration and preserving aspects of gait that normally deteriorate with advancing age.

Overall, Hamilton says she hopes this work can provide researchers with another animal model for studying human aging, one that can “successfully translate preclinical findings and basic science discoveries to encouraging interventions to increase human health span or improve healthy aging.” ■

The Department of Health and Exercise Science is part of CSU's College of Health and Human Sciences.



Aerial view of the new Temple Grandin Equine Center, located at 725 S. Overland Trail in Fort Collins.
Photo: Joe A. Mendoza, CSU Photography



Main entrance of the new Temple Grandin Equine Center.
Photo: Joe A. Mendoza, CSU Photography



Celebrating the role of the horse in society as a place of healing, treatment, education, and research for diverse clients.

NEW TEMPLE GRANDIN EQUINE CENTER OPENS

ANNA GERBER

Just west of Colorado State University's Main Campus in Fort Collins, the new state-of-the-art Temple Grandin Equine Center opened its doors recently as the new home of one of the leading equine-assisted services facilities in the world.

Named for CSU Department of Animal Sciences professor and autism advocate Temple Grandin and constructed with generous support from donors, the building is home to a 14,000-square-foot

climate-controlled arena, a 100-person viewing area with smart technology, and a 500-square-foot traditional clinical therapy room; all support student learning, client success, and research advancement for the EAS industry. The modern facility will enhance CSU's ability to serve individuals with physical, emotional, and developmental challenges, while elevating the role of the horse in society in a world-class teaching and learning environment.

CELEBRATING A MILESTONE

Last year, a small group gathered at the Temple Grandin Equine Center for a ribbon-cutting and celebration. The facility buzzed with energy from concurrent therapy sessions, and client families watched from the arena viewing area. Ribbon-cutters included CSU President Joyce McConnell, College of Agricultural Sciences Dean James Pritchett, head of the Department of Animal Sciences Keith Belk, Temple

EQUINE CENTER continued

Grandin Equine Center Director of Administration and Outreach Adam Daurio, and the building's namesake, Professor Grandin.

Grandin's story is widely known. When she was a teenager with autism struggling to find her place in the world, a summer on her aunt's ranch in Arizona sparked an interest in horses that she took home with her to New Hampshire.

"Horses saved my life," says Grandin. "They were very important for me for getting friends."

At boarding school, Grandin and her roommate connected over their shared passion, working together at the school's horse barn. Horses, she said, gave her a purpose.

"I was responsible for the school's horse barn, every day," Grandin says. "Nine stalls. I put them in and out. Fed them. Made sure I never left the grain box open. That's responsibility. The other thing I learned from horses; I learned how to work."

Today, Grandin is a leading voice for animal welfare, a college professor, and an outspoken advocate for people with autism. She recognizes the transformative affect that horses can have on others with physical, emotional, and developmental challenges, as they did on her.

The new facility is as unique as Grandin herself, combining all of the facets of an equine facility with those of a physical and occupational therapy clinic.

A UNIQUE FACILITY

The Temple Grandin Equine Center totals 30,000 square feet and includes equine, clinical, administrative, and classroom spaces. In addition to the arena, the center's nine therapy horses reside in a 10-stall barn, with nearby outdoor runs, tack area, and space for boots and helmets. A mounting area makes it easier for riders of all physical abilities to mount their therapy horses.

Family members and other viewers can watch sessions in the arena's 1,100-square-foot viewing area.

Separate from the equine areas, clinical space includes a therapy room featuring a climbing wall, swings, games, and an "equicizer," a mechanical horse that helps riders build strength, balance, and confidence outside the arena. Down the hall is an accessible restroom with an adult changing table and a roll-in shower. The facility also includes conference and office space, as well as a classroom and event space.

"This project is the culmination of many years of hard work and great partnerships with our generous donors, dedicated practitioners, inquisitive researchers, and hardworking students and volunteers," says Daurio. "Through this innovative facility, we are proud to offer a broad array of equine-assisted programming and education to uphold the CSU mission of teaching, research, and engagement."

From 8 a.m. to 7 p.m. on weekdays, the Temple Grandin Equine Center offers a variety of therapy and therapeutic services to clients of all abilities and backgrounds, ranging in age from 18 months to 99 years. The center partners with licensed practitioners and certified instructors from Front Range Exceptional Equestrians, My Heroes Therapy, and Hearts & Horses.

With COVID-19 protocols in place, about 100 clients come to the center each week for research, evaluation, and therapy. This is an increase of 65 patients a week compared to the capacity in neighboring Adams Atkinson Arena, where the program has been housed since its creation in 2015. Once the pandemic subsides, physical and occupational therapy and adaptive horsemanship sessions will expand to include more group programming.

The first official research project in the new facility, led by Dr. Caiti Peters, began in February 2021. In addition



Temple Grandin leads a horse at the equine center's grand opening. *Photo: Tanya Fabian*



Grandin supports an equine-assisted therapy session. Photo: Tanya Fabian

to therapy sessions, around 50 clients participate in research at the Temple Grandin Equine Center each year.

With 2,500 square feet of classroom space, about 65 undergraduate students participate in courses at the Temple Grandin Equine Center each semester. Course offerings include an introduction to EAS; principles of teaching therapeutic riding; facility management; and equine behavior, assessment and evaluation, and care and training. Approximately 150 CSU undergraduate students also engage in extracurricular activities and volunteer work at the TGEC each semester.

EXPANDING THE IMPACT

In 2017, the Temple Grandin Equine Center opened a second facility in Denver's Elyria-Swansea neighborhood, broadening its reach to serve clients in the metro area. That facility also received a major upgrade as it moved to the new CSU Spur campus at the National Western Complex. The equine center, housed in the new Vida building, is home to 15 horses and includes space to facilitate 250 therapy sessions a week. New dormitory space will allow students to live and work on site, and additional clinical spaces will help increase the facility's impact, especially related to mental health services.

While the new Fort Collins facility serves as the hub for equine-assisted education and research, the opportunity to have a robust program with data collection at the Spur building will broaden the community impact.

"As we look ahead to 2022, we are excited to continue building the momentum of this incredible project," Daurio says. "We are looking forward to the opportunity to expand the reach of the Temple Grandin Equine Center in both the Fort Collins and Denver communities and to share the incredible impact of equine-assisted services." ■



FOOTHILLS CAMPUS: A NEW VISION, A NEW DESTINATION

V. CHANDRASEKAR, DAVID PATERSON, AND ALAN RUDOLPH

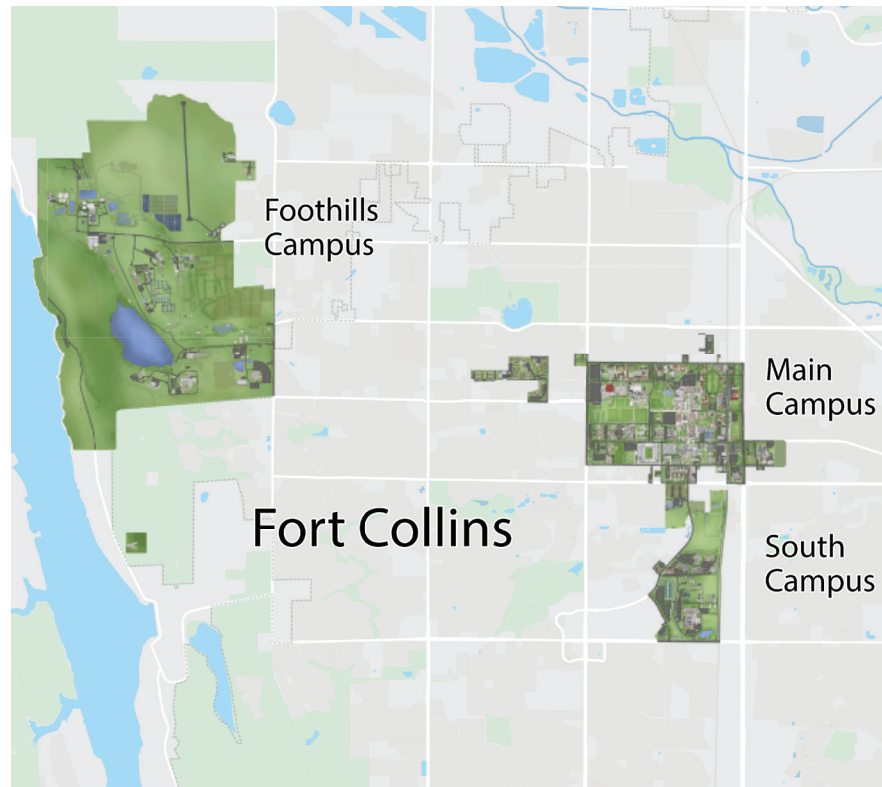
The Foothills Campus, located on the west side of Fort Collins, is widely known by many as a site for a Saturday afternoon Rams football game in the old Hughes Stadium. But the Foothills Campus is much more than that. It is the location of the most impactful research and innovation assets for Colorado State University in prominent and relevant areas in today's headline news.

To the north, bordered by Laporte Avenue, the campus houses the Cooperative Institute for Research

in the Atmosphere, a national center known for hurricane prediction. The Hydrology Engineering Labs at the Engineering Research Center study floods at scale, with access to water from Horsetooth Reservoir.

To the south, bordered by Rampart Road, is our focus on animal and human health, with the Temple Grandin Equine Center, the Animal Reproduction and Biotechnology Laboratory, the Center for Vector-Borne Infectious Diseases, and the Infectious Disease Research Center. Our facilities also house

corporate partners from small and large industries who help scale our discoveries into innovations at scale. One example of this growth at the Foothills Campus is the recent presence of Zoetis, one of the largest global animal health companies. Since 2019, Zoetis has grown the Zoetis Incubator, bringing to Fort Collins 50 discovery scientists focused on livestock and companion animal health, sponsoring faculty research, and engaging graduate research associates.



CSU research expands its reach to the growing Foothills Campus. *Graphic: Concept3D Maps*

Federal labs and partners are currently housed on the campus. These include the U.S. Department of Agriculture National Wildlife Research Center, which focuses on wildlife issues, and the Rocky Mountain Prevention Research Center – the second-largest CDC lab outside of Atlanta, which targets public health and emerging infectious diseases. This unique academia, public, and private innovation landscape was the backdrop for a task force initiated in 2020 to explore a bold new vision and destination: the Foothills Campus.

Sponsored by the offices of the Vice President for Research and the Vice President for Engagement and Extension, 49 faculty convened to discuss and distill potential new opportunities to create a new Foothills Campus.

Central to this task force's mission was to envision a holistic future mission and identity for the campus that will embody new curricular engagement for

undergraduate and graduate students and community-engaged research. The vision incorporates a new engagement center, with conference facilities that invite the community to engage in areas of discovery in climate, health, and natural resource-related issues; a space for museum collections; and access to the broader educational resources of the Main Campus and teaching spaces that engage lifelong students in areas related to their career development and growth. Establishing the Foothills Campus as a new destination will take some help. New federal infrastructure activities in Washington, D.C., have positioned an investment in a new transportation center located at the Foothills Campus that will begin the needed process of new roads, bike paths, and retail infrastructure for an integrated campus vision. This exciting process will now move into the strategic planning efforts across campus as we consider space for places of discovery and innovation. ■



CSU'S GLOBAL REACH

STORIES OF IMPACT FROM
AROUND THE WORLD

ALASKA

A PERFECT ARCTIC STORM

Dr. Colleen Duncan, a veterinary pathologist at CSU, studies infectious disease and population dynamics in wildlife, most notably polar bears.



COLORADO

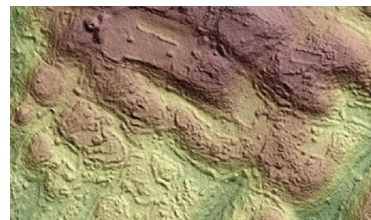
A FIRE SPARKS A NEW MOUNTAIN CAMPUS INITIATIVE

SEE PAGE 24

HONDURAS

ANCIENT CITIES UNDER THE LIDAR

Archaeologist and CSU Professor Chris Fisher is using LIDAR to archive endangered landscapes, cultures, and climate change around the world.



GUATEMALA

A ONE HEALTH APPROACH TO WEST NILE VIRUS

SEE PAGE 28

FLORIDA

REDUCING FELINE INFECTIONS

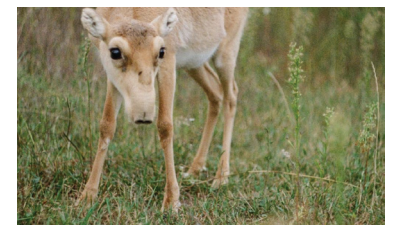
CSU veterinarian and virologist Dr. Sue VandeWoude studies pathogens in domestic and wild felids (e.g., mountain lions) and the ecology and evolution of these feline diseases.



CHILE

NAMING SPECIES CAN PREVENT EXTINCTION

Dr. Joel Berger, wildlife conservation biologist, advocates for studying lesser-known species, because they are less likely to receive the funding needed to keep them from extinction.





MONGOLIA

THE MONGOLIAN MIRACLE

Dr. Maria Fernández-Giménez leads the Mongolian Rangelands and Resilience Project. The team assesses Mongolian systems' resilience to climate change.



SRI LANKA

FOLLOWING THE MONEY

CSU professor John McDonald's work is centered in Sri Lanka, where he studies pangolins, one of the most heavily trafficked animals in the world.



RWANDA

HARNESSING CLEAN ENERGY

Dr. Bryan Willson, along with other researchers at Colorado State University, are helping the nation reach its electrification goals through a large-scale project to design, build, and install microgrids in rural areas.



GUAM

SCALING NEW HEIGHTS

CSU researchers, seeking to protect native birds on Guam, discovered a new form of snake locomotion, which helps explain how brown tree snakes climb up and decimate wildlife.





Firefighter burnout measures and the Cameron Peak Fire met on the ridge west of Colorado State University's Mountain Campus.
Photo: William A. Cotton, CSU Photography

A FIRE AND AN ALUMNUS SPARK NEW MOUNTAIN CAMPUS RESEARCH INITIATIVE

KARINA PUIKKONEN

Sometimes the best ideas happen at the kitchen table. The Cameron Peak Fire filled Fort Collins skies with smoke when Warner College of Natural Resources student Travis Croft and friends sat around their kitchen table. They were discussing what they could do for the forests burning around the Colorado State University Mountain

Campus, a place that had become their classroom and playground. “I was taking a wildfire behavior course, and it made me think more critically about the fire in our backyard,” Croft said. “It hit me that I could tap into this communal sense of the Warner community with its collective knowledge and resources to start a tree regeneration effort.”

The senior was just weeks away from graduation, having taken advantage of every opportunity he could find at CSU. Granted, this required extra time to complete a double major in natural resources management and ecosystem science and sustainability, but an additional year gave Croft the chance to be part of post-fire restoration efforts, something that would be beneficial to his Warner family for years to come.



Croft knew the CSU Mountain Campus area, having spent a month there as a student in the NR 220 course learning the ins and outs of natural resource management methods. He had also taken a natural resource sampling class from Wade Tinkham, an assistant professor in the Department of Forest and Rangeland Stewardship. His initial thoughts involved personally planting trees for forest regeneration at the site. Croft crafted a CSU Sustainability Fund project proposal together with Tinkham and CSU Mountain Campus Director Seth Webb.

It's been a whirlwind for Croft since December 2020, when he received the sustainability grant and his bachelor's degree, he said. He has combined his efforts with those that faculty members in the FRS department

have been envisioning for CSU's high-elevation campus.

"The project has evolved into something bigger that connects to broader opportunities for long-term research and monitoring across Warner College," Croft said.

A SERENDIPITOUS SPARK

More than two years ago, faculty members in the forest and rangeland stewardship department began leading Warner College discussions about possible research opportunities at CSU's Mountain Campus. Once COVID-19 hit, the pandemic put those discussions on hold, but Croft's project, in tandem with the Cameron Peak Fire, helped jump-start them. Virtual discussions continued around kitchen tables. Tinkham and fire ecologist



CSU alumnus Travis Croft, who studied natural resource management, ecosystem science, and sustainability.

MOUNTAIN CAMPUS continued

Camille Stevens-Rumann in the FRS department saw Croft's proposal about post-fire regeneration as part of their greater ecological research and teaching endeavor.

"The overall hope is to establish a research and management demonstration of how to study high-elevation forest systems susceptible to climate change," Tinkham said.

High-elevation forests have been understudied because they aren't heavily managed, residing in wilderness areas that are often difficult to access. The 2020 Colorado wildfire season was unprecedented because it burned in forest types that have been minimally impacted by people or wildfires overall in recent decades.

CSU Mountain Campus offers a unique environment for research and monitoring, because interactions

"We've all
felt a special
attachment to
that place, and
to see and hear
it burn was
heartbreaking."

— TRAVIS CROFT,
CSU ALUMNUS

between multiple disturbances can be openly studied. The 1994 Hourglass Fire burned around 1,700 acres in the surrounding forests, and now the Cameron Peak Fire reburned similar areas, providing new research opportunities and challenges. These same forests have also been hit with mountain pine and spruce beetle epidemics that swept through during the 26-year gap between the two fires.

"All these disturbances offer an opportunity to see how these places have adapted," Stevens-Rumann said. "We want to see if the same kind of recovery we've seen since the Hourglass Fire will happen after the Cameron Peak Fire."

A LONG-TERM NATURAL EXPERIMENT

Croft will become a senior technician on a field crew advised by multiple FRS



The meadow on the southwest side of Colorado State University's Mountain Campus burned during the Cameron Peak Fire.

Photo: William A. Cotton, CSU Photography



Larimer County Sheriff's Office firefighters work on the East Troublesome Fire as it burns in Moraine Park.
Photo: William A. Cotton, CSU Photography

department faculty members. The team will spend several weeks camping at CSU Mountain Campus, establishing experimental vegetation plots, and collecting information about trees and understory plants. These areas will be used in long-term teaching and research ventures at the campus.

FRS faculty identified forest areas that burned once or twice in both high- and low-fire severities, where the field crew will establish nearly 100 plots. Each plot will consist of four subplots with one control plot, and three others respectively planted with lodgepole pine saplings, ponderosa pine saplings, and an herbaceous seed mixture of forbs and native grasses. The field crew will collect the initial baseline data this first growing season post-fire.

Conducting the work in dry seasons is critical to begin understanding post-fire vegetation responses. Future data collection efforts will be done by students in summer once NR 220 and F 230 courses resume at the high-elevation campus after the pandemic. Students in capstone courses from various undergraduate programs across Warner College will also contribute

to and use the data to explore the important role of disturbance in these forests. As an NR 220 and F 230 course instructor, Tinkham sees this long-term project as an important addition to the curriculum and student experiences.

"This initiative provides another hands-on learning experience for students who will eventually get to compare their annual observations and data with those taken by students from years ago," said Tinkham. "They'll appreciate that a fellow student-alumnus was involved in getting the project off the ground."

A LARGER BENEFIT FOR ALL

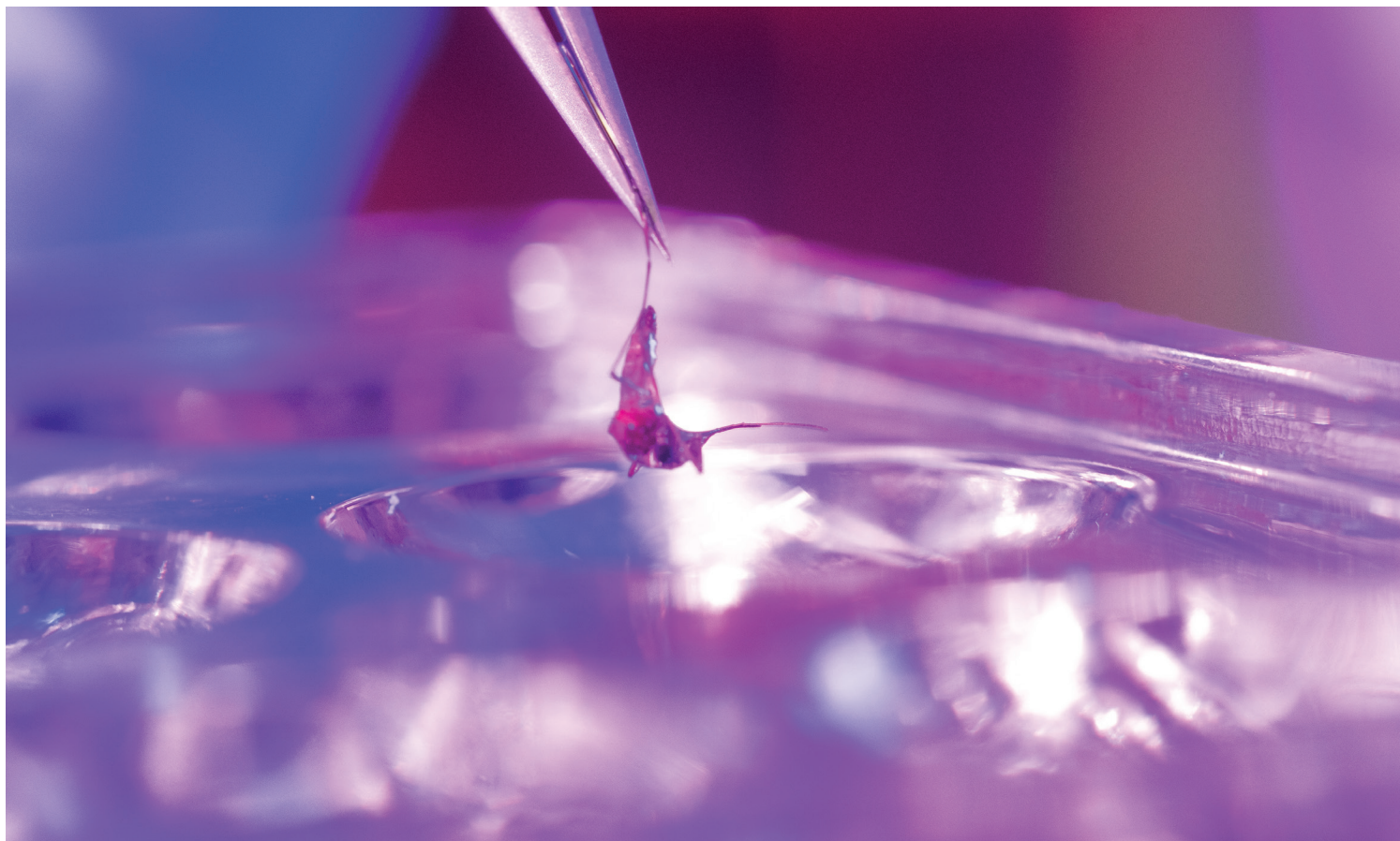
The long-term research and teaching initiative will be important for understanding how vegetation grows and changes over time, as well as how managers can use this data to decide when management efforts are needed. These methods and the corresponding information can also be extended to establish monitoring across all vegetation types and disturbance conditions.

This greater initiative opens up the possibility for new interdisciplinary

collaborations across CSU and the state. Academic departments across scientific disciplines can find common ground. Partnerships and collaborations with other Warner College units such as the Colorado State Forest Service and Colorado Forest Restoration Institute will be strengthened. Opportunities to work with managers from the Arapaho & Roosevelt National Forest and the ability to connect with the national Adaptive Silviculture for Climate Change program led by FRS Department Head Linda Nagel are also on the table.

Croft said he is amazed that his own idea complemented these greater efforts in Warner College. His CSU Mountain Campus experience a few years ago initially taught him about conducting fieldwork in these ecosystems and gave him lifelong friends – the same ones who sat around the kitchen table with him last fall.

"It came full circle to have all this support," Croft said. "We've all felt a special attachment to that place, and to see and hear it burn was heartbreaking. This project helps me give back and set up something that lives beyond me." ■



Rebekah Kading's research staff studies mosquito-transmitted diseases in her lab at Colorado State University's Center for Vector-Borne Infectious Diseases.
Photo: John Eisele, CSU Photography

EXTENDING REACH USING A ONE HEALTH APPROACH

SUE VANDEWOUDE AND CLAIRE TUCKER


The CSU One Health Institute works to solve complex problems at the intersection of human, animal, and environmental health through research, training, outreach, and advocacy. By taking a transdisciplinary approach that aligns expertise across departments and colleges, the institute supports initiatives to achieve outcomes that extend individual programs' work. Community-engaged projects

highlighted here provide impact guided by local, regional, and global needs.

LOCAL IMPACT: CSU-FORT COLLINS INTEGRATED WEST NILE VIRUS MANAGEMENT

West Nile Virus is a mosquito-borne pathogen that causes disease in humans, birds, horses, and other species. First recognized in Africa, the virus was first detected in the United States in 1999. This disease emerged

in Fort Collins in 2003, resulting in the death of birds of the corvid family, raptors, horses, and people. Since that time, the region has anticipated annual outbreaks. Mosquitoes are monitored for the presence of the virus, and at a particular detection threshold, the city implements insecticide spraying protocols. The city has proactively amended its control protocol over the years to minimize adverse impacts of control measures while protecting the public from this potentially fatal



disease. It seeks to continuously improve its management program by relying on input from the public and scientific expertise from CSU, the Centers for Disease Control Vector-Borne Diseases Laboratory, and vector control companies.

In order to identify new detection and mitigation strategies for WNV, and to develop sophisticated approaches for the prediction and control of emergence, the institute organized more than half a dozen CSU laboratories last summer and conducted projects investigating aspects of the diseases' ecology and transmission dynamics. With program support from the Office of the Vice President for Research and the Department of Environmental and Radiological Health Sciences, researchers focused on various aspects of WNV impacts in Fort Collins. Projects ranged from assessing genetic variants of WNV to surveillance of mosquito movements using DNA-barcoded microcrystals to evaluate the historical impact of WNV and control measures on local bird and butterfly communities. A symposium was held last September to review preliminary research results and plan a coordinated approach to expand research beyond these pilot studies. Attendees from the city, county, state public health, and U.S. Centers for Disease Control and Prevention are anticipated, as well as faculty from CSU and other institutions.

The city of Fort Collins and the CDC Vector-Borne Diseases Laboratory will rely on research generated to develop applied practical outcomes to inform policy management and WNV mitigation. This will lead to a plan to detect and stop WNV outbreaks and

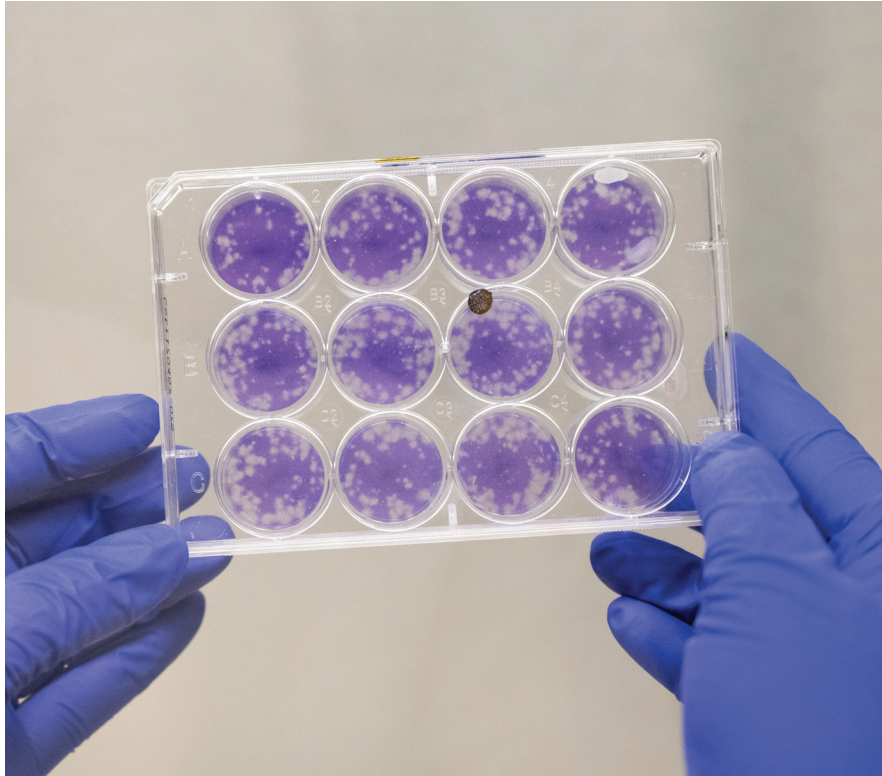
support the community's disease control goals. The connections fostered by this project have established partnerships that will spawn novel approaches and innovations to tackle other infectious disease outbreaks. This team will be poised to take on the grand challenge of predicting and preventing the next pandemic in the shadow of the COVID-19 pandemic.

REGIONAL IMPACT: ONE HEALTH IN 4-H IN COLORADO

One Health can be a difficult concept to convey, but it is a topic that is readily understood by youth, particularly those living in rural and agricultural areas. Recently, CSU veterinary student Bri Rosales worked with Routt County Extension Agent Libby Christenson to translate the transdisciplinary concept of One Health into an accessible and engaging curriculum for 4-H youth. The student intern rooted her work in the community, hoping to discover the unique goals and interests of 4-H youth. With the support of the CSU One Health Institute, CSU faculty from across campus involved with the institute, the CSU 4-H state office, and a field-based Extension agent advisory committee, Rosales attended county fairs, met with stakeholders, and helped 4-H students with science projects.

The resulting One Health curriculum for 4-H youth 11 to 18 years old is ready to be deployed to counties across Colorado, with hopes for expansion across the U.S. The lessons focus on zoonotic disease, vaccinations, food safety, and climate change, using various activities to improve learning. Christenson received funding from the CDC and Extension Foundation to continue this work to develop 4-H

ONE HEALTH continued



A lab worker studies samples at the Colorado State University Center for Vector-Borne Infectious Diseases. Photo: John Eisele, CSU Photography

This program
hopes to
shape the next
generation of
researchers
rooted in a
One Health
approach.

educational content that illustrates the impact and necessity of animal vaccinations to improve animal health, animal production, and public health. The goal of this work is to promote vaccine acceptance via a One Health approach. This program hopes to make the next generation of researchers, practitioners, and thinkers comfortable solving complex problems rooted in a One Health approach.

**GLOBAL IMPACT:
EXPANDING A ONE HEALTH
SURVEILLANCE SYSTEM IN
SOUTHERN GUATEMALA'S
TRIFINIO REGION**

A pilot study supported by CSU OVPR in the resource-limited Trifinio region of southern Guatemala has demonstrated the feasibility of a One Health approach in disease surveillance. Greg Ebel, professor in the Department of Microbiology, Immunology, and Pathology, leads this

study, which includes collaborators Dr. Valeria Scorza, a veterinarian and faculty member in the Department of Clinical Sciences, and Dr. Dan Olson, a pediatrician and investigator in the Center for Global Health at University of Colorado Anschutz Medical Campus. Mosquitoes, ticks, and fleas in the area harbor zoonotic pathogens, such as arboviruses, including Zika and dengue viruses, as well as bacterial infections, including *Bartonella* spp., *Anaplasma* spp., and *Ehrlichia* spp., among others. The interdisciplinary team of researchers joined partners from Universidad del Valle de Guatemala and the local Trifinio site to study the prevalence and spread of these diseases.

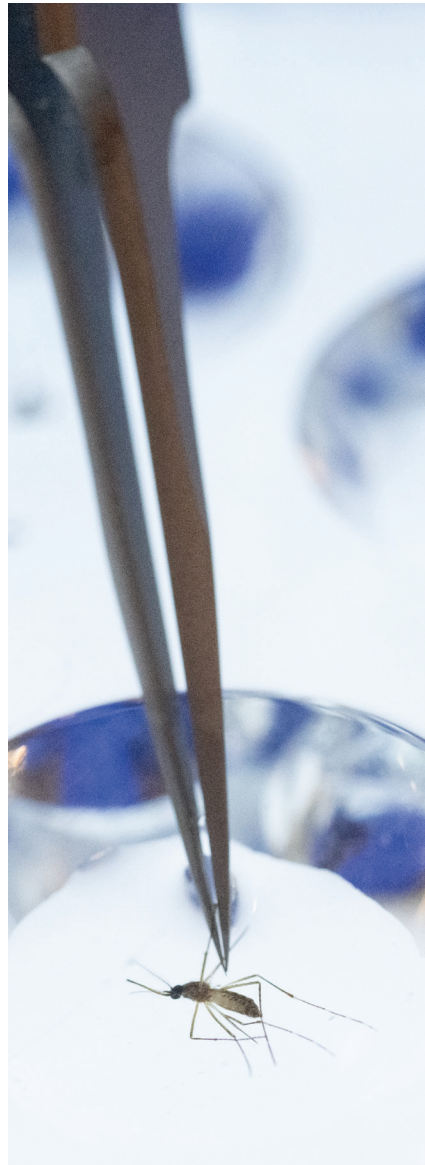
Blood samples, ticks, and fleas were collected from humans and animals (dogs, cats, pigs, turkeys, chickens, ducks), examining the presence of diseases across each species. Blood-fed mosquitos were collected from

households to assess pathogens circulating in the blood of animals and people. Local partners were trained to lead sample acquisition in various domestic animals living in the region, developing critical relationships to support research into the future.

The preliminary data has revealed pathogen burden in animals and their fleas and ticks, and has extended our pioneering use of mosquito sampling to assess the burden of disease in the region. The sampling of humans and animals in the same study has proved invaluable to show linkages in disease transmission. Future work includes testing for additional agents such as SARS-CoV-2 and influenza viruses, expanding the program to include soil, manure, and watershed samples, and building local capacity around disease detection, prevention, and treatment. The group has recently been awarded funds from the National Institutes of Health, with the long-term goal of developing community-based interventions to reduce the burden of zoonotic disease.

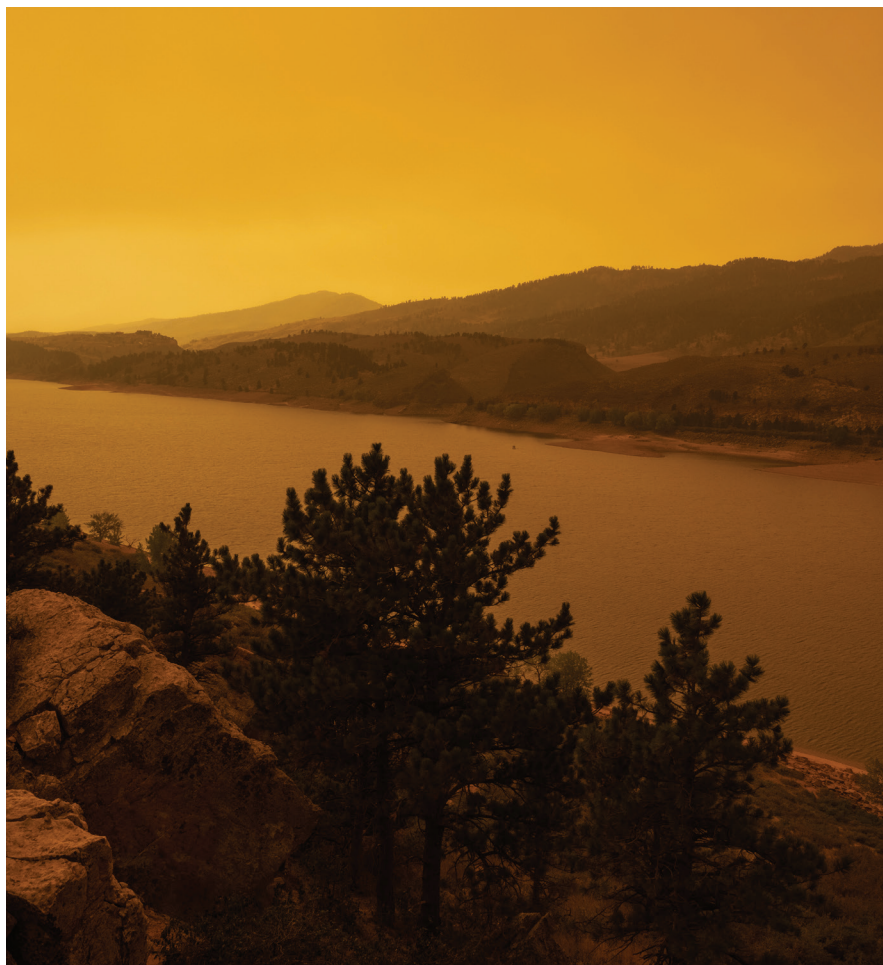
THE WORK AHEAD

The One Health Institute and the Office of the Vice President for Research are committed to the future of research that transcends single disciplinary boundaries to serve specific community needs. The project outlined here illustrates the importance of developing partnerships with many stakeholders to achieve relevant, translatable, and tangible outcomes. ■



Rebekah Kading's research staff studies mosquito-transmitted diseases in her lab at Colorado State University's Center for Vector-Borne Infectious Diseases.

Photo: John Eisele, CSU Photography



The Cameron Peak Fire smoke plume descends on Horsetooth Reservoir, west of Fort Collins, Colo., Sept. 7, 2020.

Photo: William A. Cotton, CSU Photography

THE AIR WE BREATHE

ALAN S. RUDOLPH

In the last two years in Colorado, we have experienced historic wildfires and a pandemic that has brought attention to the air we breathe like never before. Many of us share personal stories that relate to the air we breathe and our health. More frequently, we are challenged with poor air quality due to wildfires and, with the outbreak of the SARS-CoV-2 virus, we are now understanding how or when friends or family were exposed or got sick from transmission through the air.

Understanding the air around us has long been a subject of CSU research

discoveries and impacts. Our University is home to leading national atmospheric science assets, most recently installing the GOES-r weather satellite in our Cooperative Institute for Research in the Atmosphere, a National Oceanic and Atmospheric Administration national center of excellence for extreme weather predictions, including release of the annual U.S. hurricane prediction. Our Department of Atmospheric Science is also nationally ranked and trains the next generation of leaders in fundamentals of our climate at a time when our planet's climate will need

new leaders to address the climate challenges of our future. We have added key thought leaders, including two new Walter Scott, Jr. Presidential Endowed Chairs, Dr. Jim Hurrell and Dr. Tami Bond, who bring further attention to models to better understand global climate change and indoor air dynamics and quality.

The pandemic brought the air we breathe from the global and national scale right to the front of our masked faces.

Across our campus, we have pursued understanding and counteractions of a harmful virus and how it travels from one person to another indoors or outdoors. Our public health laboratory at the Energy Institute has tested mask designs and studied the transmission of the virus in indoor settings and specific-use cases, such as in orchestral instruments and singers in collaboration with our School of Music, Theatre, and Dance. They have also characterized and tested indoor air quality and exposure related to indoor cooking with cookstoves used around the world.

Our continued research achievements in air quality and health are enabled by significant strategic investments on our campus that have contributed to our understanding of air quality and its influences on integrated health. In 2016, we started the Partnership for Air Quality Climate and Health, an investment from SoGES and the Office of the Vice President for Research, to establish interdisciplinary research teams that address the interplay between air quality and health. The breadth of activity in these investments covered emissions from gas and oil, wildfires, disease, and industrial

pollutants. We doubled down on these investments in 2018 with a cluster hire of eight new faculty focused on new research topics in air quality and health, with particular attention to diversity, inclusion, social justice, and equitable access to quality air and health. An additional cluster hire of new faculty in the study of communities of microbes (called the microbiome) that reside in soil, water, animals, and people followed

The pandemic brought the air we breathe from the global scale right to the front of our masked faces.

this investment. The communication and interplay of microbes in our health are critical to issues across living systems, including nutrition, disease resistance, aging, soil health and crop yield, and our natural resources' health, including water, forests, and diversity of species on our lands.

These investments in new ideas and people contributed significantly

to our work on climate and health in responding to issues of our day, including the COVID-19 pandemic and to the wildfire smoke in our region. They enabled the creation of new facilities to characterize exposure in controlled environments, including specific exposures to humans and in the study of the passage of microbes in micro-simulated contained environments, such as wet markets or other unique ecosystems. These strategic investments will be critical to understanding the effects of air quality on animals, people, and our environment.

Our ability to address future air quality and health issues was recognized recently in the announcement of a new award from the National Science Foundation to CSU researchers and partners that will allow a multiyear interdisciplinary investigation to characterize and understand microbes in the atmosphere. This award is anchored in our One Health Institute under the direction of National Academy of Sciences member Sue VandeWoude. The institute focuses on the interplay between the health of the environment, animals, and people and will position the work on aerobiome for maximum impacts. This award will enable the pursuit of a new chapter in our understanding of the complex interactions of microbes in the air and how they contribute to many aspects of health on our planet. This exciting new award will allow CSU to continue to galvanize discoveries in climate and health and provide future applications to improving our health in the air we breathe in Colorado and around the world. ■



CREATING STRONGER TEAMS, CREATING STRONGER SCIENCE

MEG SUTER

Researchers at Colorado State University have never shied away from asking big questions: How do we cure disease? How do we feed 8 billion people? How do we build an equitable society? For centuries, scientists and researchers have pondered these questions and worked to address them. However, as our world becomes more connected – and inherently more complex – these questions become too large, too complex, and too multifaceted for any one discipline to tackle in isolation. It requires researchers from many areas to come together, combining their expertise across various fields, across perspectives, and across backgrounds to provide solutions to the world’s most pressing questions.

Interdisciplinary. Convergent. Collaborative. These and other similar terms have been the buzzwords across research universities for several decades. The importance of working across disciplines, connecting knowledge that had previously been siloed in a single field, is evident. But what is less clear is how to successfully bring researchers from different disciplines together so their collaboration is productive, effective, and impactful. Understanding and developing the strategies that guide and promote successful interdisciplinary research is encompassed within a new scientific discipline – the Science of Team Science.

CSU has been a leader in the SciTS. Dr. Jeni Cross, associate professor of sociology, has been leading efforts in studying and understanding the complex dynamics of interdisciplinary teams. In 2015, Cross and Dr. Hannah

Love, a former Ph.D. student with Cross, began a longitudinal study of interdisciplinary teams across CSU to better understand factors, behaviors, and practices to promote successful interdisciplinary research and effective academic team science.

One team within this multiyear investigation into the dynamics and

Graduate
students often
serve as the
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interdisciplinary
academic team
together.

interactions formed in early 2003. An interdisciplinary team of researchers came together to try to answer the type of problem that sits in between disciplines: How does urbanization and consequent fragmentation of wildlife habitat impact movement, interaction, and disease spread among domestic cats, puma, and bobcats. This project brought together two principal

investigators, Dr. Sue VandeWoude, University Distinguished Professor in the Department of Microbiology, Immunology, and Pathology and director of CSU’s One Health Institute, and Dr. Kevin Crooks, professor in the Department of Fish, Wildlife, and Conservation Biology and the director of the Center for Human-Carnivore Coexistence. Together, they lead a team of more than 40 fellow scientists, graduate students, and undergraduates. Over the team’s 18-plus years of collaboration, this interdisciplinary research team secured more than 33 extramural awards totaling more than \$5.6 million in funding, published nearly 60 peer-reviewed articles, and collaboratively trained more than 20 graduate students.

Cross and her SciTS team studied this exemplary team to understand the factors that contributed to this high level of success and, through surveys, interviews, and field observations of the team interacting, they identified several key factors and published these findings in a recent *Nature Communications* article. One of the study’s primary outcomes was the finding that interpersonal relationships are a crucial driver for scientific productivity. What does this look like in practice? It seems like a team where there is mentorship across all levels – faculty and students alike. It seems like a team where members turn to one another for both personal and professional advice. And it appears to be a team in which members use these trusted social networks as a pathway to building shared knowledge across disciplines, increasing their effectiveness and leading to greater scientific productivity.

TEAM SCIENCE continued

CSU is applying these same SciTS learnings and principles to catalyze and accelerate interdisciplinary teaming and impact. In 2015, the Office of the Vice President for Research launched a different kind of internal investment program, known as the Catalyst for Innovative Partnerships, where interdisciplinary research teams from across all eight colleges are seeded with a critical mass of funding, up to \$200,000 for two and a half years, to create and deliver novel solutions for some of our world's most important problems.

Modeled after the active management investment models of federal agencies such as the Defense Advanced Research Projects Agency within the Department of Defense, the CIP program provides more than just financial backing for innovative interdisciplinary research teams. Through the CIP program, interdisciplinary research teams work closely with leadership from the Office of the Vice President for Research and other resources across campus to overcome challenges along their path to scientific impact.

One of these resources is Cross and her SciTS team. Science of Team Science has been a pivotal component of the CIP program from the beginning, with Cross and her colleagues training all participants in the principles of conducting effective team science – including the importance of interpersonal relationships.

These teams also undergo a similar mixed-methods evaluation, as in the study conducted with the aforementioned feline disease team. They are provided with real-time data and findings to increase their effectiveness. From the review of the CIP teams, Cross and the SciTS

team are finding interesting trends, including that graduate students often serve as the critical glue that binds an interdisciplinary academic team together, and that women serving in leadership roles within a team leads to improved scientific productivity and outcomes.

And this investment in team science bears fruit. “The CIP program is a premier interdisciplinary program, providing significant resources to teams to empower them to pursue their passions and create new solutions for some of our most significant societal problems,” said Alan Rudolph, CSU’s vice president for research. “Our office mobilizes significant resources in facilitating these teams to achieve their dreams, and we are proud of the results of the first two cohorts that have led to substantial outcomes. The financial returns from these teams are significant, but the impacts far exceed these outcomes for our institution,” said Rudolph.

Since the Office of the Vice President for Research launched the program in 2015, CSU has invested \$2.1 million into two cohorts made up of 11 different teams, which has yielded more than \$23 million in research awards and nearly 170 publications. The CIP program recently welcomed its third cohort in December 2020, with five new teams joining the program. As with past cohorts, these new teams will be provided infrastructural support by the University to nurture the creation and delivery of solutions. “This unique program provides support for teams pursuing big ideas and creates uncommon collaborations for funding interdisciplinary and disciplinary depth,” said Rudolph. “The OVPR is pleased to be part of the new catalyst teams’ future success.” ■





Amy MacNeill, associate professor of microbiology, immunology, and pathology, explores a possible vaccine for COVID-19 at the Veterinary Diagnostic Laboratories. Photo: John Eisele, CSU Photography

CSU RECEIVES \$2 MILLION GRANT TO HELP PREVENT FUTURE PANDEMICS

JEFF DODGE

Building on its response to the COVID-19 pandemic, Colorado State University has received a \$2 million commitment from The Anschutz Foundation to further the development of new solutions for building resilience and agility in stopping infectious disease transmission among animals and people.

The grant is to be funded over two years and will be used to sponsor new interdisciplinary research teams and diverse graduate students, and it will fund one of the first comprehensive bio-cybersecurity programs in the nation, designed to protect health data.

CSU leaders say increasing diversity in these teams and graduate students will

be an important component of the gift, building greater equity in the response to infectious disease. Increasing greater participation among first-generation Colorado students will also be a goal of the investments made in building a diverse future workforce.

“This gift is a vote of confidence in the work that we’ve already done in preventing and minimizing the devastating impact that the transmission of disease between humans and animals can have,” said CSU President Joyce McConnell. “We are so thankful for this gift because it will advance our efforts in this area on several fronts, and it will be transformational in our ability to meet future public health challenges.”

KEY TO THE FUTURE

Christian Anschutz, president of The Anschutz Foundation, said CSU’s dedication to the One Health model – which is built around the interconnectedness of animals, humans, and the environment – was a key factor in making the contribution.

“We recognize that the integrated, interdisciplinary approach at CSU is key to the future of addressing infectious disease with resilience and agility,” Anschutz said. “This is a way to help ensure that the impact of the next outbreak is quickly minimized – or possibly avoided entirely. A multidisciplinary approach is the best way to stop a pandemic.”

GRANT continued

Areas of focus include enhanced monitoring and surveillance for the emergence of infectious disease threats that could lead to widespread consequences; more agile production and distribution of countermeasures, such as therapeutics and vaccines; social/cultural practices that could influence societal response to outbreaks; and the protection of critical health data used in research and response.

PLACING CSU AT THE FOREFRONT

Candace Mathiason, an associate professor in the Department of Microbiology, Immunology, and Pathology at CSU, quickly helped assemble an interdisciplinary team to respond to COVID-19 during Spring 2020.

“The most important asset we have in the continued search for answers to the threat of infectious disease outbreaks is our faculty, their students, and the passion to respond how we best respond as scientists, engaged with one another and our community partners,” she said. “The Anschutz Foundation investment will help sustain what has been built, placing CSU and Colorado – once again – at the forefront of the next health crisis, the next pandemic, should it arise.”

The effort will result in demonstrable outcomes and prototypes, such as new rapid diagnostics, tabletop equipment for manufacturing and rapid distribution of vaccines in areas where outbreaks are occurring, and better communication methods that inform the public of risks and practices that reduce damage from infectious disease outbreaks. The gift will result in investments in interdisciplinary approaches through a competitive process, according to CSU Vice President for Research Alan Rudolph.

“We received this generous gift because of the great work our faculty members have done responding to

COVID-19 and years of investment in these areas,” he said, citing his office’s Catalyst for Innovative Partnerships and Programs of Research and Scholarly Excellence programs, which have funded interdisciplinary projects in infectious disease outbreak research and response since 2015. “This funding will also let us continue to build capacity for groundbreaking infectious disease research on our Foothills Campus and advance our trajectory after being named one of the top universities in



Allison Vilander, assistant professor of microbiology, immunology, and pathology, works to develop a vaccine for the virus that causes COVID-19. Photo: John Eisele, CSU Photography

the country for our response to the pandemic. We are incredibly thankful for this support.”

A LONG-STANDING RELATIONSHIP

Kim Tobin, vice president for University Advancement at CSU, agreed.

“CSU is grateful for our longstanding relationship with The Anschutz Foundation, which has helped our students reach their academic goals and advanced groundbreaking research

that makes a meaningful difference in people's lives," said Tobin. "Through this gift, The Anschutz Foundation's continued generosity will ensure our exceptional research teams are supported in their quest to solve the public health challenges of our time."

Rudolph pointed to the fact that animal-to-human, or zoonotic, infectious disease outbreaks have been spiking in recent decades, exemplified by the Zika virus, swine flu, SARS, MERS and others, including COVID-19.

"We want to flatten the curve of animal or human losses from outbreaks," he said. "That's what this gift is all about, building resilience to future outbreaks and increasing our agility in our response to these threats."

COLLABORATION WILL BE KEY

The gift agreement calls on CSU to continue collaborating with other partners in Colorado on the work, including the University of Colorado Anschutz Medical Campus – with which CSU has launched a branch of the CU School of Medicine – and the Colorado School of Public Health, which involves CSU, the Anschutz Medical Campus, and the University of Northern Colorado.

"This support accelerates pandemic preparedness and response for the well-being of our communities and strengthens the existing collaboration between the Colorado School of Public Health, the University of Colorado Anschutz Medical Campus, and Colorado State University," said CSU

Chancellor Emeritus Joe Blake, who helped facilitate the gift.

Rudolph emphasized that research funded by the Anschutz gift will not be limited to the hard sciences of wet labs, but also social/cultural influences in

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– **ALAN RUDOLPH,
VICE PRESIDENT
FOR RESEARCH**

response, such as hesitancy to get the COVID-19 vaccine, which limit the ability to recover from outbreaks.

"The fact that we still have a significant percentage of people who are unvaccinated – that's a social sciences issue, and it may be best addressed by creating diversity in our research teams

and their approaches – and including the social sciences and cultural influences in our response," he said.

BIO-CYBERSECURITY

Rudolph added that what captured the attention of The Anschutz Foundation included CSU's current work on bio-cybersecurity. He cited recent security threats to health infrastructure, including recent ransomware attacks on human health data from hospitals and animal operations, such as the attack at JBS in Colorado. This growing area of bio-cybersecurity includes the accidental or intentional contamination of critical life sciences and health data such as DNA sequences. This can result in significant interruptions to biomanufacturing operations such as vaccine production and supply chains that support recovery from infectious disease outbreaks.

He cited several incidents – such as hackers accessing and changing DNA sequences identified in laboratories – that have heightened the need to improve bio-cybersecurity to protect data sets and reduce the vulnerability of pandemic response tools.

In the effort to become the national leader in the field, CSU will partner with other Colorado institutions with similar interests and continue training the next generation of the workforce that will find jobs in the growing area of cybersecurity, where the biomedical field is one of many evolving elements. ■



Aerial view of the CSU Powerhouse Building, along the Poudre River. Photo: CSU Drone Center

CSU ENERGY INSTITUTE AWARDED \$1 MILLION FROM DOE TO SUPPORT ENERGY INNOVATION

ALLISON VITT

Colorado State University's Energy Institute will receive \$1 million from the U.S. Department of Energy to support energy innovation and commercialization in Colorado and the region. The award is part of the DOE's Energy Program for Innovation Clusters.

The funding, announced jointly by Colorado state lawmakers, will help CSU create the Rockies/Plains Energy

Accelerator for Commercializing Hardtech, in collaboration with Innosphere Ventures, the Colorado Energy Research Collaboratory, and 22 other committed ecosystem partners. REACH is tailored to the specific needs of the Rocky Mountains Great Plains region – an area spanning more than 40% of the lower continental United States and producing 25% of the nation's energy

"Colorado's innovation ecosystem is well-poised for acceleration to meet the need for clean, low-carbon technologies in order to meet the nation's ambitious climate goals," said Bryan Willson, executive director of the CSU Energy Institute. "The REACH accelerator will allow us to work with early-stage companies to help transition their technologies into viable businesses that can help meet these goals."

EXECUTING A GROWTH STRATEGY

Innosphere and CSU will plan, develop, and execute a growth strategy for energy innovation clusters throughout the region in partnership with public, private, nonprofit, and higher education partners, and with support from the Collaboratory – Colorado’s inter-institutional partnership among CSU, University of Colorado Boulder, Colorado School of Mines, and the DOE’s National Renewable Energy Laboratory.

“Taking the energy hardtech innovation model developed by CSU and Innosphere over the past decade to support early-stage founders is very significant from a regional collaboration standpoint,” said Mike Freeman, CEO of Innosphere Ventures. “We’re excited to work with leading research universities in the U.S. Mountain Plains region to support their mission of advancing economic development and innovation.”

EPIC is a \$10 million funding opportunity created by the DOE’s Office of Technology Transitions to underscore the importance of regional clusters, which increase the productivity of area companies, drive the direction and pace of innovation, and stimulate the formation of new businesses, further reinforcing the cluster itself. CSU is one of 10 recipients of the EPIC funding award. ■

Colorado lawmakers react to CSU’s EPIC award



“Time and again, Colorado has proven itself as a leader in energy innovation. This award will foster a critical partnership between CSU, Innosphere Ventures, and partners across the West and Midwest to support economic growth and create jobs in the energy sector. I’m glad the DOE recognizes the hard work happening in Colorado to unlock new industries and technologies that benefit these communities.”

– U.S. Sen. Michael Bennet



“This is great news. CSU and communities across Colorado will benefit from investments in energy innovators and the growth of high-tech jobs.”

– U.S. Sen. John Hickenlooper



“I’m pleased to see Colorado State University awarded \$1 million to invest in energy innovation and meet the specific needs of the Rocky Mountain Great Plains region; the award recognizes the innovation and ingenuity found at Colorado State University and across Colorado. Colorado’s 2nd District is a leader in energy innovation and Earth science through world-class universities and laboratories, and these funds will help unlock new technologies and new opportunities, bringing jobs and opportunity to the Fort Collins community.”

– U.S. Rep. Joe Neguse



Rendering of the Hydro (water) building at the new CSU Spur campus in Denver. Photo: Hord Coplan Macht and SmithGroup

CSU SPUR BRINGS LEARNING TO LIFE FOR EVERYONE

GARY POLAKOVIC

Spur, defined (verb): “Something that makes you want to do something or that causes something to happen.” – Merriam-Webster dictionary.

In three new science-themed buildings near downtown Denver, Colorado State University System is building a portal for public engagement to help solve big global challenges in food, water, and health.

With CSU Spur, the CSU System is staking a claim to sustainability for the 21st century. It’s a high-visibility and big-inspiration campus, situated just east of the junction of interstates 25 and 70. Construction is well underway, with the first building (Vida) opened Jan. 7, to be followed by the Terra and Hydra buildings later this year.

Steel and stone now, the campus is in fact connective tissue. It is a bridge

between urban and rural worlds, between Colorado and the planet. It is science writ large into an urban center amid a Western landscape. It’s a people’s classroom, where science comes alive and is accessible to the public. It’s a showcase for a sustainable society, putting into practice principles taught in textbooks. It’s a place of melting boundaries among science and art, recreation, and ideation.



For CSU System Chancellor Tony Frank, the Spur campus is a long-awaited triumph that underscores the expanding reach of the state's higher education system.

"As this campus starts to come to life, we're excited to share it with you. And we're even more excited to open our doors in 2022 and to bring all the innovation, creativity, and fun of our three higher education institutions – CSU, CSU Pueblo, and CSU Global – directly to you," Frank said.

Steel and
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tissue.

CSU is one of the nation's top-tier research institutions, with more than \$447.2 million in annual research expenditures. The University is a national leader in sustainability research and facilities operations with a mandate to turn knowledge into practical solutions for the community. CSU is home to a nationally recognized veterinary program as well as the One Health Institute, where scientists study an ecosystem of health issues across human populations, wildlife and domestic animals, and the built and urban environments.

"The Spur campus will provide a window for Colorado and global

visitors to see and appreciate how a top-tier research institution benefits the community and CSU system," said Alan Rudolph, vice president for research at CSU.

Spur will play to CSU's strengths.

The Denver campus will consist of three main buildings focused on challenges to human and animal health, water, and food and agriculture.

The first building, Vida, is now open and will focus on animal and human health. Among its features is the second location of the Temple Grandin Equine Center, providing equine-assisted services, a Dumb Friends League veterinary hospital for companion animals to receive subsidized care, and underwater treadmills for horse rehabilitation. The entire CSU Spur campus will be open by the end of the year.

The second building to be completed, Terra, will focus on food and agriculture. Among its features will be rooftop greenhouses, a food lab, a teaching and commissary kitchen, and vertical gardens. Terra will be open to the public year-round starting in April. The final building, Hydro, focuses on water. Among its features will be Denver Water's new Water Quality Lab, a direct connection to the South Platte River, event space, artist studios, and a farm-to-table café. Hydro will be completed and open to the public in November.

Opportunities for learning and interaction with science will be up close and personal at Spur.

For example, people can see dogs and cats in surgery and watch people and horses interact at the Temple Grandin Equine Center's equine-assisted services. Kids can get their hands dirty in gardens and interactive exhibits and check out a growing green roof and rooftop garden to learn where food comes from before eating at the Spur café.

CSU SPUR continued

The center will offer youth programs, community classes, certifications, and select master's degrees, providing something for learners of all ages. In a single day at Spur, a visitor could check out a laboratory, veterinary clinic, market, museum, art studio, classroom, garden, and innovation center.

There will be concerts, festivals, conferences and cultural events, family activities, and dining. CSU Spur is home to eight major art installations, a flexible theater space, and studios to watch artists at work. Visitors can grab coffee, lunch, or a post-work cocktail.

The buildings are designed to meet LEED Gold standards while much of the heating will come from an underground wastewater heat recovery system, and on-site collected gray water will flush toilets. The site will include natural areas and a restored portion of the river, as well as murals and public art.

Spur is a \$200 million state-funded campus-within-a-campus, as it's part of the larger National Western Center, a 250-acre redevelopment project that will host the National Western Stock Show annually and be a year-round destination for concerts, conferences, and farmers markets.

Partners of the CSU System include the city and county of Denver, Western Stock Show Association, Denver Museum of Nature and Science, and History Colorado – the founding partners of the National Western Center redevelopment. Also, Denver Water and Dumb Friends League have become major programmatic partners within the CSU Spur buildings, and Together We Grow, the North American Agricultural Advisory Network, and the Salazar Center for North American Conservation will also be headquartered at CSU Spur.

At its core, Spur seeks to prepare people to reckon with the biggest issues of the 21st century. By the numbers, much of the world lacks adequate drinking water, and climate change

curtailed crop yields by 10% in the early 2000s. In the next 25 years, urban population growth is forecast to surge by 50%, prompting a 56% increase in demand in global energy consumption.



The Vida (human and animal health) building recently opened in January.
Photo: CSU System

Said Frank: “Food, water, the environment, energy, human health – these are the great global challenges of our day; these are the things that are at the sweet spot of what a land-grant university does. We’ve got great researchers in all of these areas who can study these issues in overlapping ways.”

In support of Spur, the Colorado legislature allocated \$200 million to the capital construction of the campus and \$50 million to CSU for facilities at the Fort Collins campus, including the Health Education Outreach Center, C. Wayne McIlwraith Translational Medicine Institute, and Johnson Family Equine Hospital. ■



An aerial rendering of the reimagined National Western Center and CSU Spur campus.
Photo: City and County of Denver



West-facing rendering of the in-progress Terra (food and agriculture) building.
Photo: Anderson Mason Dale Architects





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