Noelo

DELVE ▸ SEEK OUT ▸ VERIFY

HAWAIʻI NATURAL ENERGY INSTITUTE
SHAPING HAWAIʻI'S ENERGY TRANSFORMATION

RESEARCH AND INNOVATION AT THE UNIVERSITY OF HAWAIʻI - 2017

UNIVERSITY of HAWAIʻI® SYSTEM

University of Hawai‘i System

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President

Vassilis L. Syrmos, PhD
Vice President for Research and Innovation

NOELO, WHICH MEANS "TO DELVE, SEEK OUT OR VERIFY" IN HAWAIIAN, IS THE RESEARCH REVIEW OF THE UNIVERSITY OF HAWAI‘I SYSTEM PUBLISHED ANNUALLY BY THE OFFICE OF THE VICE PRESIDENT FOR RESEARCH AND INNOVATION.

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PHOTO: RICHARD WAINSCOAT

A MESSAGE FROM THE VICE PRESIDENT

It is now an exciting time to be in Hawai‘i and in particular at the University of Hawai‘i (UH)—as our expanding research enterprise is beginning to help drive innovation, develop new internal and external partnerships, and lay the groundwork for a more diversified economy for our state.

The University of Hawai‘i is one of the largest enterprises in the state and one of its most important assets. As the state's only major public research university and one of only a few land, sea, sun and space-grant universities in the nation, we have a dual mission to forge ahead with new discoveries and to energize economic development, both here in Hawai‘i and around the world.

To do so, UH is shifting the focus of our world-class research to maximize on our existing strengths and capabilities and to capitalize on emerging opportunities in targeted areas of growth. We have categorized these areas into "priority innovation hubs," which includes ocean and climate sciences, astronomy, health and wellness, digital economy and civil infrastructure security, and sustainable ecosystems and energy—to address critical research areas related to disease treatment and prevention, cybersecurity, climate change, secure food and water supplies, renewable energy, big data/data visualization, national defense and other areas of importance.

At the same time, our faculty's cutting-edge research and innovation activities are creating a vibrant and enriching learning environment for our undergraduate and graduate students. With unparalleled opportunities for "hands-on" experience outside the classroom in one of the most diverse regions in the world—we are confident that our students will be well-prepared to take the mantle as future researchers, entrepreneurs and problem-solvers.

Please sit back and enjoy a snapshot of our innovative, exciting and purposeful research that makes the University of Hawai‘i—like no place else on Earth.

Vassilis L. Syrmos, PhD

Vice President for Research and Innovation
University of Hawai‘i System

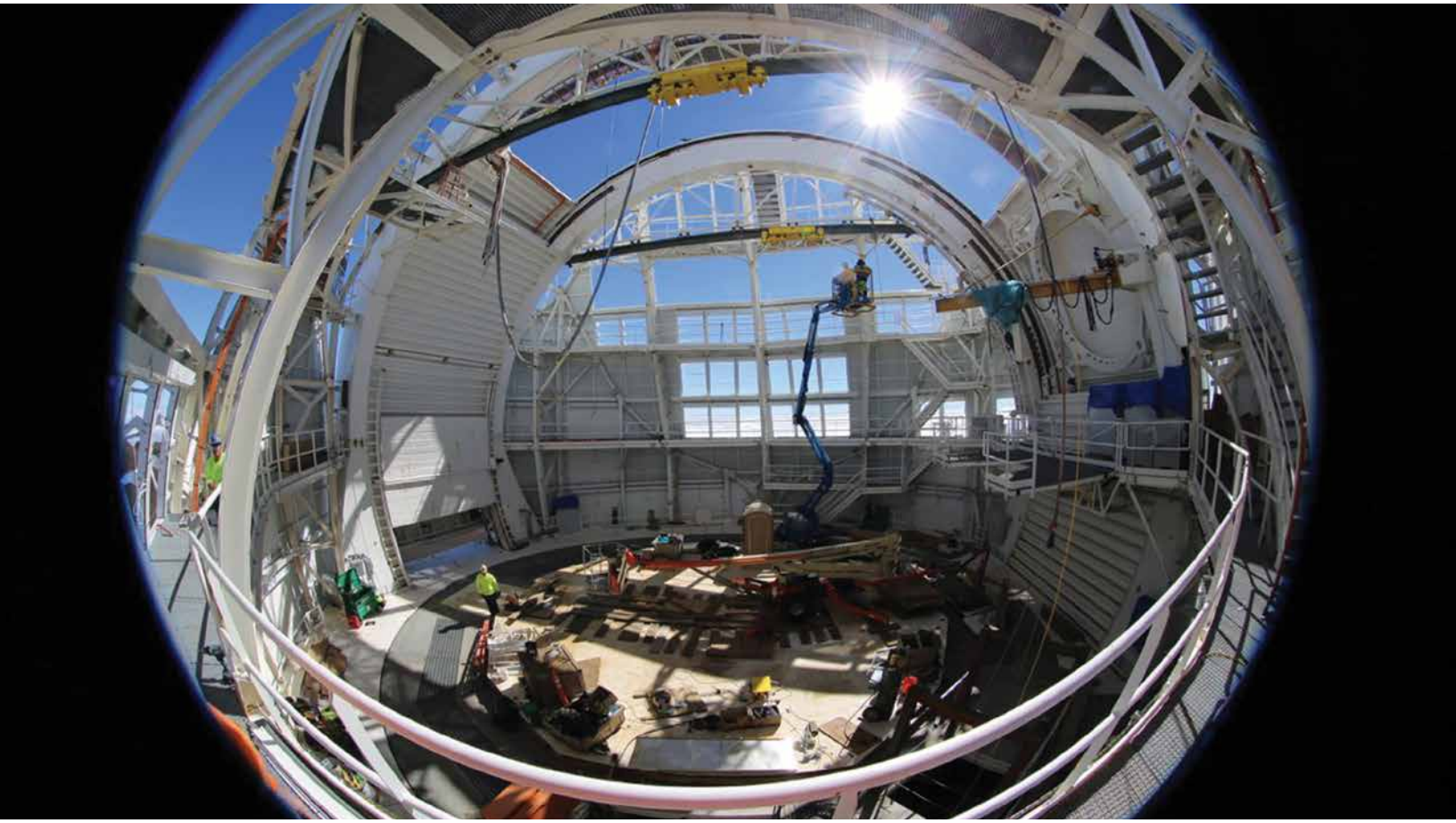
DANIEL K. INOUYE SOLAR TELESCOPE

TAKING OUR UNDERSTANDING OF THE SUN INTO THE FUTURE

The Daniel K. Inouye Solar Telescope (DKIST) is set to revolutionize the field of solar physics once it begins operations in 2019. The National Solar Observatory (NSO) project is managed by the Association of Universities for Research in Astronomy (AURA) through a cooperative agreement with the National Science Foundation (NSF) and is currently under construction at the summit of Haleakalā on the island of Maui. While construction continues, scientists and engineers are busy developing and building the instruments that will change the face of solar physics.

PHOTO: NSF/AURA/NSO

ONCE COMPLETED, DKIST WILL BE THE MOST POWERFUL GROUND-BASED SOLAR TELESCOPE IN THE WORLD.



PHOTOS: NSF/AURA/NSO

Its 4-meter primary mirror will more than double the diameter of the current largest solar telescope—a position now held by the 1.6 meter New Solar Telescope at Big Bear Solar Observatory (BBSO) in California. The University of Hawai'i at Mānoa's Institute for Astronomy (IfA) is leading the development of two critical first-light instruments for DKIST. Both of these instruments will be pushing the boundaries of technology and solar science, providing never before seen views of the solar corona—the outermost layer of the Sun's atmosphere.

The Diffraction Limited Near-Infrared Spectropolarimeter (or DL-NIRSP) is a specialized instrument designed to study the magnetic fields of the solar corona, chromosphere, and photosphere, and is led by Dr. Haosheng Lin of IfA. Leveraging technological advancements in telecommunications, this instrument utilizes specialty optical fiber bundles and ultra-narrow band filters to gather both spectral and spatial data from the Sun simultaneously. This is the first time the field of solar physics will have a facility-class instrument capable of providing simultaneous multi-wavelength data across a two-dimensional field.

The Cryogenic Near-Infrared Spectropolarimeter (Cryo-NIRSP) will also be focused on the coronal magnetic fields. Unlike DL-NIRSP, this instrument will be cryogenically cooled to reduce the thermal background produced by the optics and electronics themselves, facilitating observations into the mid-infrared. This is a region of the solar spectrum that has largely been ignored until now. This instrument team is led by Dr. Jeffrey Kuhn at IfA, who is a co-investigator of DKIST, and has the potential to obtain precise measurements of the Sun's coronal magnetic field strength with fidelity never before achieved. Until now, scientists have depended on mathematical models and surface extrapolations to theorize the magnetic field strength in the corona. Cryo-NIRSP will revolutionize this process by actually measuring the Sun's coronal magnetic field, providing a vital leap forward in understanding solar activity that leads to space weather predictions.

"The DL-NIRSP and Cryo-NIRSP are the largest and most complex astronomical instruments built by IfA," said Guenther Hasinger, director of the Institute for Astronomy. "We are proud of our contributing efforts led by Drs. Lin and Kuhn and their respective teams in helping to bring the world's largest daytime telescope on-line."

Three other instruments will complete DKIST's first-light suite. The Visible Broadband Imager (led by NSO), the Visible Spectropolarimeter (led by the High Altitude Observatory) and the Visible Tunable Filter (led by the Kiepenheuer Institute for Solar Physics (KIS) in Germany) will round out the observatory's initial complement of instruments.

The technological advancements required for a 4-meter primary mirror on a solar telescope are numerous, with cooling challenges at the top of the list. Up to 12,000 Joules of energy (12 kilowatts) will need to be removed from the prime focus of this telescope each second, requiring a combination of advanced materials and powerful heat exchangers. The observatory will produce multiple large vats of ice every night that will chill the air and liquid coolants running throughout the observatory. At the prime focus heat-stop, a unique metallic sponge is continuously cooled by fire-hoses worth of dynalene flowing through its fibers. Should the coolant stop flowing, there would be only a few minutes before the entire system would overheat causing significant damage. Thus, the series of rigorous emergency shut-offs and automated monitors are as essential to the success of the project as the cooling systems themselves.

Another vital technological achievement involved the adaptive optics (AO) systems, developed by a team of NSO, BBSO and KIS scientists. These are feedback systems that enable deformable mirrors to adapt to changes in the Earth's atmosphere 1000s of times a second, resulting in significantly clearer images. DKIST is pioneering a Multi-Conjugate Adaptive Optics system that employs three sequential deformable mirrors, allowing us to observe more detail on the Sun's surface than any other ground-based technique. Classical adaptive optics systems can provide a clear area of approximately 7,000 x 7,000 km (about the size of the smallest sunspots), but the mastery of the DKIST system has increased this area to 40,000 x 40,000 km on the Sun's surface.

"OVERALL, DKIST WILL BE A TECHNOLOGICAL MASTERPIECE, WITH SYNERGIES BETWEEN HARDWARE AND SOFTWARE KEEPING THE ENTIRE SYSTEM IN BALANCE," SAID DR. THOMAS R. RIMMELE, PROJECT DIRECTOR OF DKIST. "BUT IT IS THE HUMAN UNDERSTANDING THAT WILL PUSH IT INTO THE FUTURE."

ABOVE, RIGHT: *Dr. Haosheng Lin, DL-NIRSP instrument project lead.* PHOTO: UH

ABOVE, LEFT: *The Cryo-NIRSP instrument undergoing tests in its clean-room environment. From left, Drs. Andre Fehlmann, Jeff Kuhn and Isabelle Scholl.* PHOTO: UH

HI-SEAS
HELPING TO KEEP SPACE EXPLORERS HAPPY, HEALTHY AND SAFE

On December 28, 1973, NASA's Mission Control lost all radio communications with the crew of Skylab 4 in orbit around the Earth. The cause was not due to equipment failure or the effects of a powerful solar flare. The crew simply decided to refuse communications and spent the entire day relaxing, instead of carrying on their duties under the strain of a heavy workload. Fortunately, the crew re-established communications and the event infamously became known as the Skylab mutiny.

Aptly after the incident, preventing behavioral problems on long-term missions became paramount for NASA, with astronauts on board the International Space Station (ISS) and especially as it sets it sights on future manned missions to Mars. Currently, scientists estimate that a manned, roundtrip journey to the Red Planet will take approximately three years to complete.

In an effort to find more definitive answers to different emotional and psychological factors that could play a key role in the success or failure of a mission, NASA turned to the University of Hawai'i and Cornell University to conduct research on food, morale, crew dynamics, behaviors, roles, stress-management, performance, problem-solving and other daily activities associated with long-term, isolated space flight.

The project, known as the Hawai'i Space Exploration Analog and Simulation (HI-SEAS), is self-contained habitat located on an isolated slope of the Mauna Loa volcano on Hawai'i Island. It consists of a solar-powered dome that is 36 feet in diameter, with the first floor serving as a kitchen, dining area, bathroom, shower, lab, exercise area and common spaces. A second floor loft features six tiny bedrooms and a half bath.

"Our HI-SEAS site on the Big Island is unique among space analog locations, because it is easily accessible year-round, allowing for longer-duration isolated and confined environment studies," said UH Mānoa Department of Information and Computer Sciences Professor Kim Binsted, principal investigator for HI-SEAS.

"THE MARS-LIKE ENVIRONMENT AT 8,000 FEET ELEVATION ON MAUNA LOA OFFERS THE POTENTIAL FOR HIGH-FIDELITY SPACE ANALOG TASKS, SUCH AS GEOLOGICAL FIELD WORK BY HUMAN EXPLORERS OR ROBOTS. IT'S AN IDEAL LOCATION TO MODEL THE CHALLENGING CONDITIONS THAT ASTRONAUTS ARE LIKELY TO ENCOUNTER DURING THEIR STAY ON MARS."

The initial HI-SEAS mission in 2012 focused on new forms of food and food preparation strategies in deep-space travel, to combat issues like menu fatigue—which can lead to nutritional deficiencies, loss of bone and muscle mass and reduced/impaired physical capabilities. Studies included comparisons in the palatability of instant foods and crew-prepared food, changes in food preferences over time and whether food intake and satisfaction improved with crew-prepared meals. As a result of the mission's initial successful food study, HI-SEAS was awarded an additional $1.2 million by NASA's Human Studies Program in 2013 to support three more HI-SEAS missions of varying duration. Last August, six crew members of HI-SEAS IV, emerged from the solar-powered dome after a record-setting 365 days, with UH researchers collecting data on wide range of cognative, social and emotional factors.

"Longer missions help us to better understand the risks of space travel," said Binsted. "HI-SEAS IV built upon our current understanding of the social and psychological factors involved in long duration space exploration and will provide NASA with solid data on how best to select and support a flight crew that will work cohesively as a team while in space."

Building on the project's success and NASA's confidence in the UH-led study, HI-SEAS was awarded a third grant in 2015 that will fund the missions until 2018—including HI-SEAS V, which began an eight-month study on team dynamics. "Our tools and technology for space exploration are very good, but we still must contend with the 'soft side' risks of space travel. The risks are greater the farther we hope to explore and the longer we have to keep people in space. We need to determine the best way to pick and train a crew with the right psychological makeup and supports to deal with the pressure. We also need to understand how ground crews can best assist astronaut teams that are operating under a high degree of autonomy over time," added Binsted.

FACING PAGE, L-R: *Simulating EVAs outside the habitat; the comforts of crew-prepared pizza; crew life inside the habitat.* PHOTOS: HI-SEAS

PROJECT OTIS

OCEANOGRAPHIC TECHNOLOGICAL INNOVATIONS AND SOLUTIONS

Technological advancements have exploded in the past five years, and the costs of emerging sensors and instruments have drastically decreased. Most of these advancements have not yet been applied to environmental sciences or oceanography, or have only been developed for use by highly trained scientists with access to considerably large budgets for research and development. Even undergraduate research assistants, graduate students, and postdoctoral fellows in highly productive research-focused departments are often intimidated by expensive and overly complex commercially available sensors and equipment.

For many oceanographic researchers, and for most non-expert audiences (e.g., community college STEM students, non-profit environmental management organizations), such ocean observing technology is as foreign and inaccessible as Mars Rover innovations, but it need not be. Brian T. Glazer, an associate professor and oceanographer in the University of Hawai'i at Mānoa's School of Ocean and Earth Science and Technology, and his lab group and collaborators are developing new technologies and methods at the confluence of a growing interest in low-cost do-it-yourself (DIY) electronics and the widespread acknowledgement that aquatic systems are woefully undersampled.

"Two years ago I became frustrated with paying $25,000 for a multi-parameter instrument package that didn't necessarily measure all the things we need to monitor to understand a coastal system, and it didn't stream data in real time to the web," said Glazer. "Even with significant federal research funding in hand, only a limited number of such instruments can be deployed, so we really don't have a full picture of spatial or temporal variability within dynamically changing coastal systems."

Glazer is not an engineer, but his research in coastal biogeochemistry and deep-sea volcanoes has always allowed him to work closely with engineers and programmers to develop new sensors for making various chemical measurements in the field rather than collecting samples and bringing them back to a lab for analyses. Tackling custom lower cost electronics to enable deploying more autonomous sensors has been a natural progression.

Through some initial seed funding from the University of Hawai'i Sea Grant College Program in 2014, Glazer was able to build a prototype wireless sensor package for measuring dissolved oxygen in He'eia Fishpond. Paepae o He'eia is a private non-profit organization dedicated to caring for He'eia Fishpond, an ancient Hawaiian fishpond located in Ko'olaupoko, Oahu. Glazer, additional collaborators at UH, and managers at Paepae o He'eia have worked together on various projects for more than a decade, establishing an interesting and productive blend of indigenous knowledge coupled to contemporary oceanographic techniques that helps to understand how the pond ecosystem functions today. The seed funding to show proof of concept for a low-cost wireless sensor of importance to traditional Hawaiian aquaculture enabled Glazer to collect enough preliminary data to submit a proposal to the National Science Foundation which was awarded in 2015. "We've been building functionality and robust networked sensor capabilities since then," added Glazer.

Glazer claims that he knows just enough about building electronics and programming to be dangerous, so that's why he hired Stanley Lio, a recent electrical engineering and computer science graduate from the University of Southern California. Together, Glazer and Lio have worked with a handful of undergraduate students in the Global Environmental Science undergraduate degree program, the staff at Paepae o He'eia, and collaborators at the Hawai'i Institute of Marine Biology to deploy and maintain up to 14 sensor packages measuring meteorological data, tides, water temperature, light extinction, salinity, dissolved oxygen, pH, chlorophyll and turbidity. All of the data are wirelessly transmitted back to shore using radio frequency, thus avoiding costly cellular or satellite data transmission charges. Real-time graphs and all the time-series datasets for every sensor package are freely available through Glazer's website: http://grogdata.soest.hawaii.edu/project_info/

Recently, Glazer received additional funding from philanthropists Eric and Wendy Schmidt to continue this approach to democratizing access to oceanographic sensor technology.

"Fundamentally, access to low-cost electronics and open-source software now allows for a diversity of participants to design, build, deploy, maintain, and gather data from environmental sensors, but there still exists a need for developing a robust platform to increase numbers and types of sensors deployed while also maintaining highly rigorous data standards," said Glazer. "A 'mentored citizen science' approach is at the heart of the work we're trying to do in partnering with local non-

LEFT: *A low-cost custom submersible pressure sensor for measuring tides and waves.* **MIDDLE:** *3D printing technologies allow for rapid, low-cost prototyping of sensor designs.* **RIGHT:** *A completed sensor cage: costs $0.18 in materials, takes only 40 minutes to build, and stands ready for embedding of a high-resolution temperature sensor for coral bleaching studies.* PHOTOS: BRIAN GLAZER

profits, and we're incredibly fortunate to have support from the Schmidt Family Foundation during a time when federal funding agency budgets are particularly stressed."

Robust, accurate and precise sensors that once required extensive electrical and computer engineering experience to build, test, package and deploy can now be rapidly prototyped, organized into DIY kits, assembled by non-experts, and incorporated into research monitoring programs and laboratory manipulative experiments. There are obvious advantages to the research community for accessing lower cost, more widely deployable observation platforms to better understand conditions in the environment—but the research community may be just the beginning.

GLAZER ENVISIONS A DAY WHEN SITE-SPECIFIC TIDE GAUGES AND OTHER OCEANOGRAPHIC DATA ARE AS WIDESPREAD FOR COASTAL COMMUNITIES AS ROOFTOP ANEMOMETERS COUPLED TO MOBILE PHONE APPS ARE AMONG WEATHER ENTHUSIASTS.

"The National Weather Service only maintains about 12,000 meteorological stations nationwide, whereas Weather Underground crowd sources sensor data from over 250,000 personal weather stations globally to provide data redundancy, local microclimate information, and satisfaction for the curious weather observer who may want to know exactly how fast a gust of wind at their house was," said Glazer. "Just three years ago it was cost prohibitive to dream of a similar platform for coastal oceanographic measurements, even for something relatively simple like water level. But now, thanks to emerging lower cost electronics and sensors, I think we can begin to really tackle the problem of an undersampled coastal marine environment."

TOP, LEFT: *Dr. Brian Glazer at He'eia Fishpond.*

BOTTOM, LEFT: *View of the He'eia Fishpond kuapa (wall).* PHOTOS: RIAN DEVOS, 11TH HOUR PROJECT

TOP, RIGHT: *Stanley Lio, embedded systems engineer, conducts installation and wireless communication range-testing of a new low-cost telemetry buoy.*
PHOTO: BRIAN GLAZER

UH MĀNOA

A WORLD LEADER IN THE STUDY OF THE EARTH'S MICROBIOME

Through advances in molecular technology, researchers now know that microbes occur across all of Earth's major habitats, and that they are important for the health of essentially all living things—including humans and other animals.

In response to this newfound recognition of the importance of microbes, the White House Office on Science and Technology endorsed the National Microbiome Initiative (NMI) in 2016 and its goal of understanding the structure and function of the Earth's microbial partners—and the University of Hawai'i at Mānoa (UH Mānoa) is poised to take a leading role in the development of this effort.

Dr. Margaret McFall-Ngai searches for the Hawaiian bobtail squid, essential to UH Mānoa's microbiome research. PHOTO: PBRC

Across the UH Mānoa campus, over a dozen recent faculty hires have been made in this important research field that include junior and senior tenure-track appointments in the School of Ocean and Earth Science and Technology, College of Natural Sciences, College of Tropical Agriculture and Human Resources, College of Engineering and the John A. Burns School of Medicine. These new faculty join a distinguished group of leaders in the field of environmental microbiology. Together, this group of internationally recognized individuals contributes significantly to emerging global directions in the field of biological research as well as in biology education.

"UH MĀNOA IS A POWERHOUSE IN THE REALM OF MICROBIOME RESEARCH," SAID MICHAEL BRUNO, UH MĀNOA VICE CHANCELLOR FOR RESEARCH. "THERE ARE FEW, IF ANY, UNIVERSITIES WITH THE NUMBER OF WORLD LEADERS IN THIS DOMAIN. UH MĀNOA HAS THREE MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES (NAS) WHO SPECIALIZE IN THIS FIELD."

Microbes are, by definition, those life forms that we cannot see with the naked eye, including such entities as viruses, bacteria and fungi. They can exist as independent organisms in the water, soil, air, and the deep subsurface of the Earth, or they can occur in intimate symbiotic alliances with animals and plants. Microbes have shaped the evolution of the biosphere, driving such major milestones as the diversification of the animals and the colonization of the land by plants.

One major focus of study at UH Mānoa is the exploration of how evolving in a microbe-rich environment has influenced the form and function of animals, including humans. In this field, UH Mānoa researchers are studying a broad array of topics, including how microbes drove evolution at the dawn of animal radiation, hundreds of millions of years ago; how they influence the structure of the reef communities of the oceans today; and the role that microbes play both in maintenance of human health and in the onset of diseases, such as cancer and diabetes.

In each and every one of the study areas mentioned above, UH scientists seek research subjects that promise to provide insight into how a given biological process works. Consider the research being done with the model symbiosis between the Hawaiian bobtail squid and a bioluminescent bacterial species at the UH Mānoa's Pacific Biosciences Research Center (PBRC). This squid, a night-active predator in the shallow waters of the Hawaiian archipelago, uses bioluminescence produced by its microbial partner to camouflage against moonlight and starlight, so that it is not seen by predators. Research work on this mutually beneficial symbiosis is being carried out by a group of about a dozen biologists at UH's Kewalo Marine Laboratory.

The squid-bacteria symbiosis has provided, and continues to provide, insight into the basic rules of the phenomenon of host-microbe interaction. Its power lies in its basic features: (i) it is simple, comprising one host and a population of one microbial species; (ii) it lends itself to experimental manipulation; and (iii) interactions between a live animal and its bacterial partner can be observed directly by microscopy. In addition, the bacterial symbionts are acquired anew each generation, similar to the way in which humans obtain their microbial partners. Also, the vibrios take up permanent residence along the surfaces of the animal's tissues, which is the most common way in which microbes associate with their animal hosts. For example, the human intestine, skin and respiratory system, each have essential microbiomes on their surfaces. The major difference between the squid and humans is that, in humans, the interaction is very complex, involving dozens to hundreds of different microbial types on any given surface, and these surfaces are often inaccessible to observation. As such, unlike the squid-vibrio system, in the human condition, it is very difficult to decipher what any given type of microbe is doing, and nearly impossible to observe them in a living specimen. Experimental analyses of the squid-vibrio system over the last 20 years has provided the biomedical community with insights into how the right bacterial partners are chosen each generation, i.e., those that will lead to health throughout life, and then the steps that are required for a persistent partnership to flourish.

The University of Hawai'i at Mānoa is in a position to provide leadership for the NMI and the squid-bacteria system provides only a taste of the richness of symbiosis research on the Earth's microbiomes that is being conducted at on campus. By harnessing it's talent. UH Mānoa will be able to further provide research contributions at the very highest level of quality to this exciting biological frontier.

"Major challenges facing mankind, including sustainability of the environment, human health, and energy and food production, have the microbial world as a principal driving force in both the creation of the problems as well as strategies for the development of solutions," said Margaret McFall-Ngai, NAS member and director of PBRC. "We have a great opportunity here in Hawai'i to participate as pioneers in the research of our microbial biosphere."

LEFT: *Dr. Margaret McFall-Ngai.* **RIGHT:** *The Hawaiian bobtail squid.* PHOTOS: PBRC

NEW LIFE SCIENCES BUILDING

BRINGING 21ST CENTURY CHANGES

The future landscape of university research is evolving. In that future, increasingly complex problems faced by the nation and the world will be resolved primarily by multi-disciplinary teams of researchers. Some will involve collaboration with other universities and institutions, while others will be formed between schools, colleges and departments within the universities themselves.

To help better position its faculty for the 21st century and to enhance the necessary interdisciplinary collaboration, the University of Hawai'i (UH) has plans well underway for a new $50 million, 45,000-square-foot, state-of-the-art Life Sciences Building to be built on its flagship campus at the University of Hawai'i at Mānoa (UH Mānoa). It will house teaching and research laboratories, laboratory support and office spaces. Estimated completion date of the new building is fall 2019.

"The Life Sciences Building will provide open, flexible, modular, high-density lab spaces ideally suited for collaborative, multidisciplinary research—a critical need that is not being met by our current biological science facilities," said UH Mānoa Vice Chancellor for Research Michael Bruno. "The new space will enable us to ensure that our world class faculty and students have the state of the art facilities they require to conduct leading edge and impactful research on many of society's most pressing problems."

In addition to modern research and instructional space, the cutting-edge facility will serve as a new home for the biology, microbiology and botany departments under the UH Mānoa's College of Natural Sciences. Joining those units will be the School of Ocean and Earth Science and Technology's Pacific Biosciences Research Center (PBRC) and its Biological Electron Microscope Facility— which operates the state's only transmission electron microscope and services 60 UH Mānoa labs.

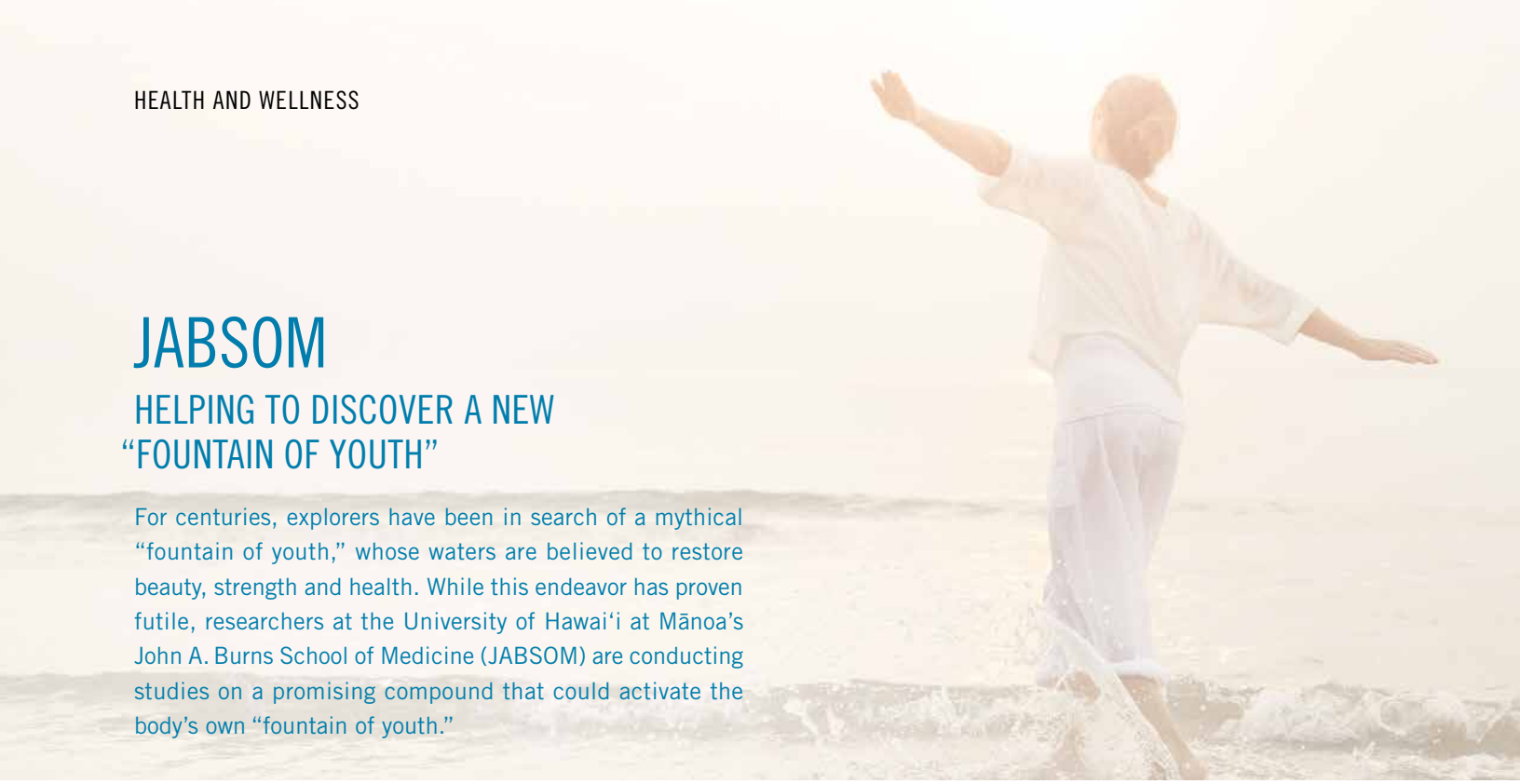
"The future of biology and for university research in general will be about breaking down the boundaries and silos of individual departments to enable engagement in more collaborative efforts," said PBRC Director Margaret McFall-Ngai, who is leading a multi-discipline team of UH researchers on the study of microbiomes.

To make room for the new Life Sciences Building, one of the oldest buildings on campus and former home of the UH Mānoa School of Social Work, Henke Hall, will be demolished over the summer. As part of the same project, the aged Snyder Hall, which has housed microbiology, biology and PBRC, will also be razed. The move is expected to eliminate $19 million from UH Mānoa's deferred maintenance backlog.

Representing one of the most significant capital projects in the past 10 years, the new Life Sciences building will also have the distinction of being UH's first design-build project. "Design-build" is an integrated delivery process that maintains a single contractor and contract for both the design and construction with a fixed, upfront cost. As a result, design-build projects are more likely to be completed on time and result in fewer cost overruns as compared to the typical design-bid-build process.

"The Life Sciences Building project represents a different approach to the way UH has been undertaking major capital improvement projects," said UH President David Lassner. "Through design-build, we are now able to quickly and efficiently deliver a 21st century facility that supports multi-disciplinary research that will enable UH students, faculty and staff to improve on their current successes and to flourish in their future endeavors."

ABOVE: *Renderings of the new Life Sciences Building on the UH Mānoa campus.* *COURTESY OF G70.*



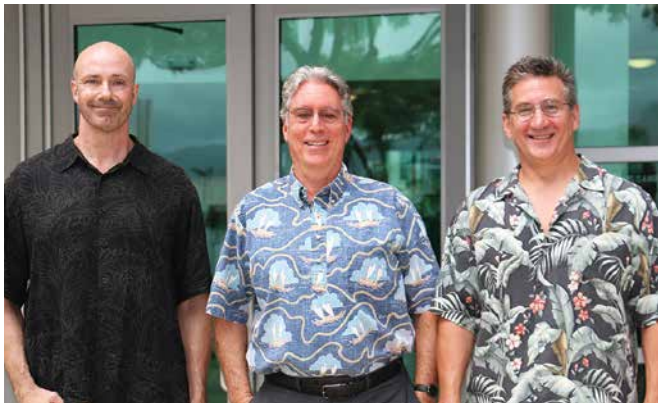
JABSOM

HELPING TO DISCOVER A NEW "FOUNTAIN OF YOUTH"

For centuries, explorers have been in search of a mythical "fountain of youth," whose waters are believed to restore beauty, strength and health. While this endeavor has proven futile, researchers at the University of Hawai'i at Mānoa's John A. Burns School of Medicine (JABSOM) are conducting studies on a promising compound that could activate the body's own "fountain of youth."

In March, JABSOM and Cardax, Inc., a Honolulu-based life sciences company, jointly announced results of a preliminary animal study indicating that the Astaxanthin compound CDX-085 displayed the ability to significantly increase the expression of the FOX03 gene, which is known to play proven role in human longevity. Astaxanthin is a carotenoid compound found in marine organisms, such as like lobsters and salmon that has shown to reduce inflammation and cholesterol in human studies. While Cardax's CDX-085 is not currently available on the market, it sells a less potent version called Zantho-Syn.

"All of us have the FOXO3 gene, which protects against aging in humans—but about one in three persons carry a version of the FOXO3 gene that is associated with longevity," said Dr. Bradley Willcox, professor and director of research at the Department of Geriatric Medicine at JABSOM and principal investigator of the National Institutes of Health-funded Kuakini Hawai'i Lifespan and Healthspan Studies. "By activating the FOXO3 gene common in all humans, we can make it act like the "longevity" version. Through this research, we have shown that Astaxanthin 'activates' the FOXO3 gene."



Dr. Richard Allsopp, Cardax CEO David Watumull and Dr. Bradley Willcox

In the study, mice were fed either normal food or food containing a low or high dose of the Astaxanthin compound CDX-085, developed by Cardax. The animals that were fed the higher amount of the Astaxanthin compound experienced a significant increase in the activation of the FOXO3 gene in their heart tissue.

"This preliminary study was the first of its kind to test the potential of Astaxanthin to activate the FOXO3 gene in mammals," said Richard Allsopp, associate professor, and researcher with JABSOM's Institute of Biogenesis Research. "We found a nearly 90 percent increase in the activation of the FOXO3 'longevity gene' in the mice fed the higher dose of the Astaxanthin compound CDX-085."

Willcox and Allsopp hope to continue their research to study further effects of Astaxanthin on mice, including if the compound can actually extend the life of mice. Future clinical trials could focus on whether CDX-085 can improve cognitive function in patients diagnosed with early stage dementia or Alzheimer's disease.

"This groundbreaking University of Hawai'i research further supports the critical role of Astaxanthin in health and why the healthcare community is embracing its use," said Cardax, Inc. CEO David G. Watumull. "We look forward to further confirmation in human clinical trials of Astaxanthin's role in aging."

"We are extremely proud of our collaborative efforts with Cardax on this very promising research that may help mitigate the effects of aging in humans," said Vassilis L. Syrmos, UH vice president for research and innovation. "This is a great example of what the Hawai'i Innovation Initiative is all about—when the private sector and UH join forces to build a thriving innovation, research, education and job training enterprise to help diversify the state's economy."

THE MULTIETHNIC COHORT STUDY

24 YEARS OF EPIDEMIOLOGICAL RESEARCH IN CANCER PREVENTION

Each year more than 6,000 Hawai‘i residents are diagnosed with cancer, and more than 2,000 will die from the disease. These numbers are on the increase due to the growth and aging of the state’s population.

Cancer is now the second leading cause of death in Hawai‘i, and accounts for one of every five deaths statewide. The disease is also a large and growing burden on the economy with the cost of care in the United States projected to rise from $125 billion in 2010 to $158 billion in 2020—and this does not include the additional costs of the emerging drugs that are transforming cancer care today.

Although primarily known as a picture-postcard travel destination for travelers worldwide, Hawai‘i plays a key, but much less publicized role in cancer research. Because the burden of cancer varies markedly among populations, Hawai‘i offers opportunities unmatched anywhere else in the world to study ethnic/racial differences in cancer rates because of its multiethnic population, excellent cancer registration and high level of healthcare.

Seminal studies conducted in the 1980s among Japanese migrants to Hawai‘i established the predominant role of lifestyle (i.e., smoking, diet, alcohol, exercise, etc.) over genetics in causing cancer. These and other broad comparative studies among populations showed that as much as 40 percent of cancers could be prevented by lifestyle changes alone. However, identifying which specific dietary patterns or lifestyle are beneficial in lowering risk of cancer required much more detailed and long-term studies.

In 1993, the Multiethnic Cohort (MEC) study was established with a research grant from the US National Cancer Institute by Dr. Laurence N. Kolonel at the University of Hawai‘i Cancer Center (UH Cancer Center) and Dr. Brian Henderson at the University of Southern California to study diet and nutrition among 215,000 Hawai‘i and Los Angeles residents aged 45-75. More than 70 percent of the survivors are still filling out questionnaires every five years, a testament to the high level of interest that the study has received.

“This is the most ethnically diverse and one of the largest epidemiologic studies of cancer

and other chronic diseases in the world,” said Dr. Loïc Le Marchand, principal investigator of the study for the past five years and lead researcher of the UH Cancer Center’s Cancer Epidemiology Program. “Its findings have been used all over the world to make recommendations to the public about nutrition and cancer.

Because a blood sample was collected for more than 75,000 participants, the study has more recently focused on the understanding of genetics in cancer and especially on the combined effect of genetics and lifestyle on cancer risk.

“Novel technologies have allowed us to identify cancer biomarkers that vary in frequency across populations and may help in predicting risk of the disease,” said Le Marchand. “This is important in order to select high-risk individuals for intense screening. We may also be able in the near future to provide more personalized lifestyle recommendations to lower cancer risk based on one’s unique risk profile.”

Using the MEC last year, Le Marchand and this team discovered new genetic markers associated with a fast rate of nicotine metabolism, which can potentially lead smokers to increase their smoking, leading to an increased risk of lung cancer. In 2015, UH Cancer Center epidemiologists identified genetic variants associated with an increased risk of colorectal cancer. In all, MEC investigators have brought to UH more than $100 million in research funding and published over 500 research articles elucidating the nutritional and genetic risk factors for cancer and other chronic diseases.

“THE MEC STUDY IS AN EXCEPTIONAL RESOURCE FOR UNIVERSITY OF HAWAI‘I CANCER CENTER INVESTIGATORS AND HAS LED TO SEMINAL FINDINGS IN THE AREA OF CANCER ETHNIC DIVERSITY,” SAID DR. RANDALL HOLCOMBE, DIRECTOR OF THE UH CANCER CENTER. “THE RESEARCH HAS TRULY BENEFITTED THE PEOPLE OF HAWAI‘I AND LED TO A BETTER UNDERSTANDING OF CANCER AMONG OUR DIVERSE POPULATION.”

LEFT: *Dr. Lynne Wilkens and Dr. Loïc Le Marchand review data from their research.*

RIGHT: *Dr. Le Marchand observes MEC Biorepository Project Director Wileen Mau extract blood samples from the liquid nitrogen freezers.*

HNEI

INTEGRATING POLICY AND TECHNOLOGICAL INNOVATION TO DRIVE HAWAI'I'S ENERGY TRANSFORMATION

Since the formation of the Hawai'i Clean Energy Initiative (HCEI) in 2008, Hawai'i has emerged as a national leader in energy policy and deployment. At more than one-quarter of the way towards its ultimate goal of achieving total energy self-sufficiency in the electricity sector, it has become clear that effectively integrating energy policy and technological innovation is the key to ultimate success.

There are distinct challenges Hawai'i faces when interconnecting more intermittent energy such as roof top and utility scale solar, and utility scale wind. Hawai'i's energy stakeholders also have growing concerns about losing momentum for future investments in grid improvements and technologies necessary to realign the daily mismatch in electricity supply and demand on many circuits throughout the state.

The Hawai'i Natural Energy Institute (HNEI) has been directly involved in investigating and offering solutions to the technical questions of wind and solar integration and other hurdles to achieving high rates of renewable penetration. For many years, HNEI has been testing technology and strategies to make renewable generation more affordable and resilient. Its GridSTART team, led by former Hawaiian Electric Company engineers Leon Roose and Marc Matsuura are designing and testing smart grid systems on a microgrid and community level.

HNEI is now also addressing ways to align and improve energy policy and regulatory proceedings and to incorporate technological innovation in taking the next steps to fulfilling HCEI's ambitious energy agenda. Its Energy Policy and Innovation Team, established by HNEI Director Richard Rocheleau, includes former Hawai'i Public Utilities Commissioner John Cole and past Hawai'i State Energy Administrator Mark Glick. According to Glick, who led Hawai'i's energy transformation initiative for five years before joining HNEI is December 2016, this formative group of energy administrators is forging a renewed focus better positon HNEI to assist the state and other areas achieve their clean energy goals. With this group in place, HNEI is increasing its focus to guide systemic energy transformation in Hawai'i, Asia Pacific nations, and islanded and remote jurisdictions to achieve significant improvements in the economic and environmental health of our communities and planet," noted Glick.

With Rocheleau, Glick and Cole, HNEI's approach today can be described as offering vigorous thought leadership to decision-makers and energy stakeholders on the policies and plans to drive energy transformation and the impacts that can be achieved to abate climate change, stimulate economic growth, improve energy security and reduce energy costs. Rocheleau added, "The HNEI policy team has a great desire to combine the assets of the University of Hawai'i System like the University of Hawai'i Economic Research Office (UHERO), the Colleges of Engineering and Social Sciences, and the Laboratory for Advanced Visualization and Applications on analysis, research, engineering, economics and policy to achieve an optimal energy transformation."

HNEI is seeking to ride the wave of energy transformation investments in technological and

A schematic representing the detailed grid models of Moloka'i's distribution circuits developed by the GridSTART team to assess the impacts of high penetrations of renewable energy.

policy innovations that are in large measure driven by the urgency to enhance energy security and mitigate climate change. In doing so, HNEI hopes to contribute to economic growth resulting from efforts to develop and deploy solutions that are critical to remote and islanded nations and states like Hawai‘i, which are even more susceptible to the impacts of climate change, price volatility and energy imports.

HNEI's Energy Policy and Innovation Team intends to market its expertise in overseeing design and deployment of renewable energy and energy efficiency measures as a proven and highly efficient methodology for achieving climate mitigation. It is forming alliances to offer guidance and systems support to political jurisdictions that are urgently pursuing energy transformation based its own unique circumstances: geopolitical, demographic, and economic policies.

Glick and his colleagues believe that by forming robust partnerships and staying true to a clean energy pathway informed by analysis and greater policy understanding HNEI will have contributed to its vision of building stronger, sustainable communities in a new carbon-free world.

LEFT (L-R): *Mark Glick, Richard Rocheleau and John Cole discuss Hawai‘i's energy future near HNEI's solar panels atop Holmes Hall at UH Mānoa.*

ABOVE, TOP: *U.S. Navy Wave Energy Test Site (WETS), supported by HNEI research, off Kane‘ohe, O‘ahu.*

ABOVE, BOTTOM: *One of two Net-Zero buildings managed by HNEI at UH Mānoa's College of Education.*

PHOTOS: UH

ʻIKE WAI

RALLYING COMMUNITY AND ACADEMIA IN SUPPORT OF HAWAIʻI'S WATER SUSTAINABILITY

As an island state, Hawai'i is dependent on its subsurface aquifers for its freshwater supply, recharged by rainwater that is naturally filtered through porous volcanic rock. Surprisingly, little is known about the relationship between various aquifers or the complex network of subsurface geological features that affect the flow of groundwater. However, due to an increasing population, changing land use practices and a range of issues relating to climate change—there is now an increased concern over water quality and quantity in the state.

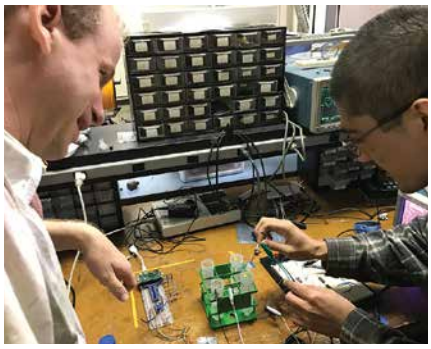
Approximately 99 percent of Hawai'i's potable water supply is pumped from poorly understood subsurface aquifers, and a lack of regional data makes the future of this supply hard to predict. Stressors on the water supply are also emerging: 75 percent of the islands were abnormally dry in 2013; rainfall has decreased by 28 percent between 1973 and 2009; the population continues to increase at approximately one percent each year; and tourism reached an all-time high of over nine million visitors in 2016.

To help address this critical issue, the University of Hawai'i (UH) was awarded $20 million by the National Science Foundation (NSF) to conduct a five-year, groundbreaking study on water sustainability in the islands. Through NSF's Established Program to Support Competitive Research (EPSCoR), which is designed to attack major challenges that face individual states, UH's winning proposal on water sustainability was placed in the forefront by a governing committee representing academia, the community and various federal, state and county agencies. Funded for 2016-2021, the project is now closing out its first successful year.

Named 'Ike Wai—which in Hawaiian symbolizes knowledge ('ike) of water (wai), the project establishes an unprecedented water research coalition in Hawai'i, supplementing currently fragmented efforts with new technologies, cutting edge cyber-enabled knowledge gains and a new level of focus on accountability and stakeholder engagement. The partnership also includes the Hawai'i State Departments of Health and Land and Natural Resources, Honolulu Board of Water Supply, Hawai'i County Department of Water Supply, U.S. Geological Survey and other community partners.

"It was clear that this could not be a UH-stand alone effort. Water sustainability is such a complex problem that we needed to assemble a large team that includes community advocates, economists, federal agencies, and representatives from state and local government," said Dr. Gwen Jacobs, 'Ike Wai principal investigator and Director of Cyberinfrastructure for the UH System. "This project is unique in my experience at UH in that it combines cutting-edge science with community and stakeholder perspectives."

'IKE WAI IS BRINGING A CADRE OF GEOLOGISTS, GEOPHYSICISTS, HYDROLOGISTS, MICROBIOLOGISTS, ENGINEERS, ECONOMIC MODELERS AND COMPUTATIONAL SCIENTISTS TOGETHER IN A 'TEAM SCIENCE' FRAMEWORK.



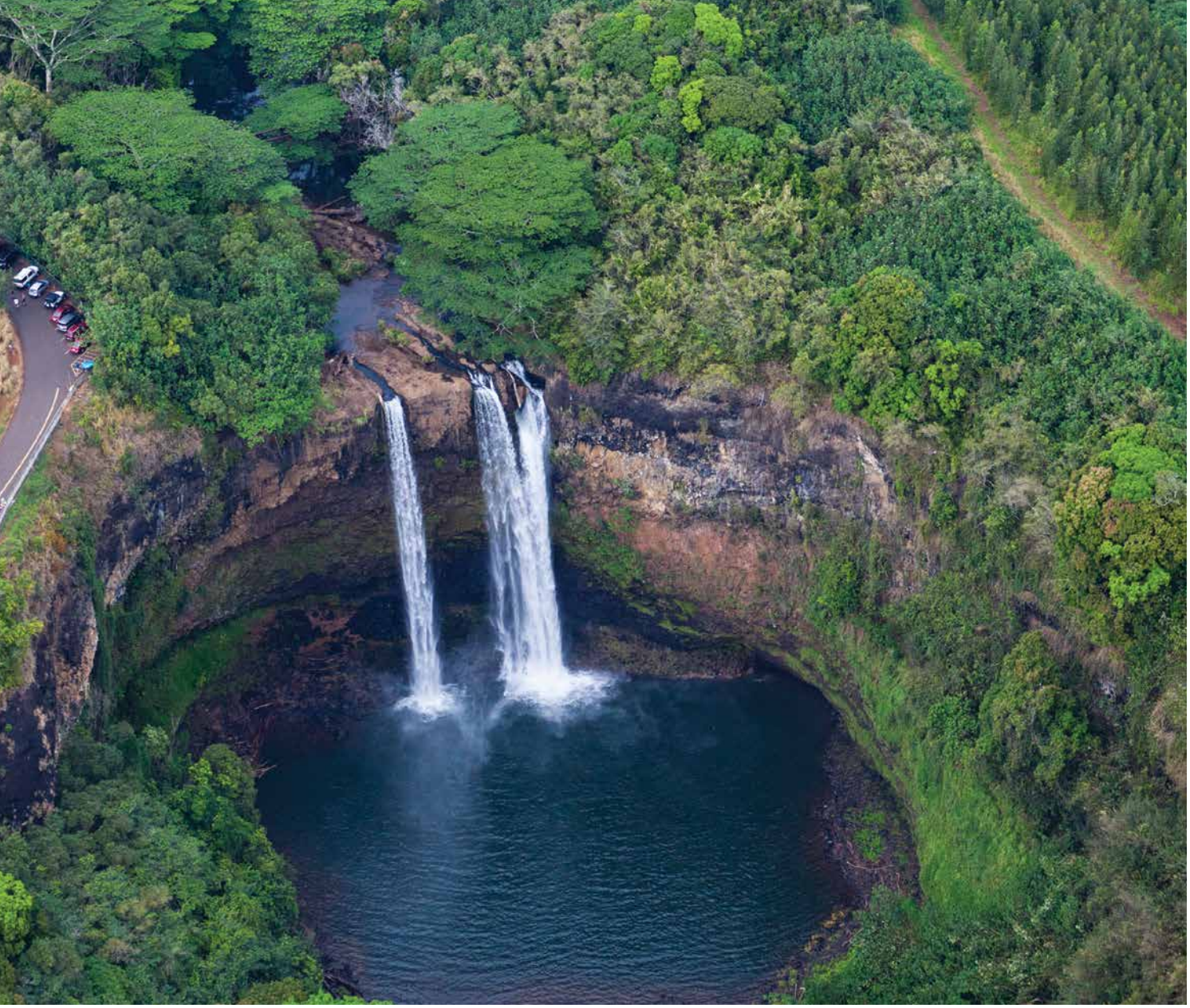
The project leverages recent UH investments in high performance computing and the world's best hybrid data visualization system, the Destiny-class CyberCANOE, developed by Dr. Jason Leigh of UH Mānoa's Laboratory for Advance Visualization and Applications.

The multifaceted research program is focused on attaining a comprehensive understanding of subsurface water in Hawai'i, its location, volume and flow paths as well as the current threats to sustainability from climate

TOP: *Graduate student Diamond Tachera samples water at Honolulu Country Club with Dr. Robert Whittier from the Hawai'i State Department of Health's Clean Water Branch.*

BOTTOM: *Dr. David Garmire works with his undergraduate student Taylor Viti to design and build a customized sensor that will be used in the field to obtain water temperature measurements from deep in wells on Oahu and Hawai'i island.*

PHOTOS: BURT LUM



change, increasing population and development, contamination and fragile state infrastructure. The overall goals of the project belie its tremendous complexity.

"Simply put, the goal is decision support," said team member Greg Chun, associate specialist at UH Mānoa's Social Science Research Institute. "We will produce complex hydrological models of water location and flow that can inform decision making by a wide range of community, business and governmental stakeholders."

Chun leads the 'Ike Wai effort in community and stakeholder engagement, ensuring the fidelity of the project's research to state needs, and brokering relationships with landowners to allow research to take place in critical yet poorly understood areas of Hawai'i. As data emerges, he will lead a team that supplies the project's findings to a range of audiences, with the goal of informing policy and decision-making in an unbiased fashion. The program also seeks to build capacity in the state for both water research and policymaking.

"We will be building capacity in a new degree certificate and degree program in data science and through new faculty hires in mathematics, natural sciences, computer sciences and social sciences," said Dr. Matt Platz, vice chancellor for academic affairs at UH Hilo. "We will be initiating a new summer bridge program in math and data science focused on attracting promising high school students to pursue their undergraduate degree here."

These transformative hires and program development at UH Hilo will be paralleled at UH Mānoa, where 'Ike Wai will look to hire new faculty in engineering, social science and earth sciences and fund a comprehensive undergraduate program focused on research and professional development in Science, Technology, Engineering and Math (STEM) fields.

"Preparing the next generation is central to 'Ike Wai—they are both the researchers and stakeholders of the future when it comes to water science in Hawai'i," said Dr. Barbara Bruno, education team leader. The program will also delve into the past, integrating Hawaiian traditional ecological and cultural knowledge into its research process. A team led by Dr. Puakea Nogelmeier of the Hawai'inuiākea School of Hawaiian Knowledge is mining Hawaiian language newspapers and cultural sources such as mele (songs) to add the richness of the Hawaiian historical and cultural understanding of water dynamics to the EPSCoR project.

"'Ike Wai science efforts for the first year are starting to coalesce and our relationships with agency partners are coming into focus," said Jacobs. "Data collection using geochemistry, microbiology and custom-engineered well sensors is starting in earnest. By this time next year, we will be awash in data and we can't wait to see the insights they deliver."

UH WEST O‘AHU

ADVANCING SUSTAINABLE COMMUNITY FOOD SYSTEMS

As an isolated volcanic archipelago in the Central Pacific and host to a population of over 1.4 million, the state of Hawai‘i is heavily dependent on imports of raw materials, manufactured goods, fuel for energy and most importantly—food supplies.

This reliance on imports can easily be disrupted by natural or man-made events, such as storms, climate change, dockworker strikes or even war—making them a credible threat to Hawai‘i’s food security, particularly to the most economically vulnerable in the state.

For the Native Hawaiians and Pacific Islanders living in the historically underserved areas of West O‘ahu, their greatest threat is already a stark reality. Compared to other ethnic groups in Hawai‘i, Native Hawaiians and Pacific Islanders suffer from higher rates of poverty and health disparities, including cardiovascular disease, obesity, hypertension and diabetes. These health problems are compounded by behavioral risk factors for diseases, including higher rates of smoking, alcohol consumption and dietary fat intake, compounded by low levels of fruit and vegetable intake and low levels of physical inactivity.

Born out of pressing community needs, as well as concern over Hawai‘i’s food and agricultural sustainability, the University of Hawai‘i -West O‘ahu (UH West O‘ahu) launched the Bachelor of Applied Science in Sustainable Community Food Systems (BAS-SCFS) in 2015, an innovative community-university collaboration designed to provide a critical, transdisciplinary, and applied education in agri-food studies to the communities of West O‘ahu and beyond. The now established program emerged from a collaboration between the leadership team at MAO Organic Farms, Kamehameha Schools and UH West O‘ahu and draws students from many parts of the continental US and Hawai‘i.

“Because the agri-food system is a complex socio-ecological system, the BAS-SCFS curriculum emphasizes the integration of the natural science, social science and the humanities to develop students who are able to comprehend and address real-world problems,” said Albie Miles, assistant professor of Sustainable Community Food Systems at UH West O‘ahu. “The program places particular emphasis on a critical historical analysis of the impact of colonial and plantation agriculture in reshaping the economy, people and landscapes of Hawai‘i, as well as its parallels in the development of global agriculture.”

At the heart of the BAS-SCFS program is the study of agroecology, a burgeoning academic field that applies ecological knowledge to the design and management of sustainable agro-ecosystems. Agroecology uses a whole-systems approach to studying not only agriculture and farming, but the entire food system. As a multi-disciplinary academic field and an international social movement, the aim of agroecology is to advance greater ecological sustainability, resiliency and social justice in the food and agriculture system.

To understand the agri-food system from a transdisciplinary and multi-cultural perspective, BAS-SCFS students are required to:

- take complementary courses in biophysical sciences, social sciences and the humanities each relating to agriculture and the food system
- study the history of agriculture in Hawai‘i from the pre-contact era to the present
- work alongside commercial and traditional farmers as part of a year-long senior practicum course
- spend a full semester working with a local or national NGO learning to advance food system change through education, advocacy and public policy
- map the food system of O‘ahu using GIS and conduct assessments of the food environments in different districts of the island
- learn social science and natural science research methods
- measure food security in the student population
- study the ecological and social costs and benefits of different farming regimens
- read, write and deliberate on environmental ethics and the implications of human values for the future of food and agriculture

“In addition, courses in indigenous natural resources management offer unparalleled opportunities for students to study alongside traditional practitioners and consider how the integration of traditional ecological knowledge and western science may be applied in the pursuit of more ecologically sustainable, socially just and culturally-relevant food and agricultural systems for Hawai‘i and beyond,” added Miles.

FROM ITS INCEPTION, THE BAS-SCFS PROGRAM WAS DEVELOPED IN PARTNERSHIP WITH KEY NATIVE HAWAIIAN INSTITUTIONS AND MULTIPLE COMMUNITY STAKEHOLDER GROUPS THAT HAVE BEEN INVOLVED IN ALL STAGES OF FUNDING, DEVELOPMENT AND IMPLEMENTATION OF THE PROGRAM.

Initial funding to support the program was provided by Kamehameha Schools, a large, private educational foundation established to serve students of Hawaiian ancestry. The foundation’s ongoing support has enabled hiring of new instructors in the field of indigenous natural resources management, provided research funding, and enhanced student opportunities for experiential education—including the UH

West O‘ahu Student Organic Garden. According to Miles, bi-weekly ‘work parties’ are held in the garden to bring together students, faculty and staff to prepare soil, build compost, plant fruit trees, install irrigation, sow seed, weed and harvest.

MA’O Organic Farms, a 25-acre organic farm and social enterprise, has provided key guidance into the development of the program curriculum, community outreach, fundraising and student recruitment. Under its Kahale Youth Leadership Training Program, qualified West O‘ahu area students are able to receive tuition support to either UH West O‘ahu or Leeward Community College in exchange for working on the MA‘O farm located in Wai‘anae. Critical insight into to the development of the BAS-SCFS course work in indigenous food and farming systems have been provided by the Hawai‘inui‘kea School of Hawaiian Knowledge at the University of Hawai‘i at Mānoa.

“With our reliance on importing an estimated 90 percent of food, fertilizer, energy and seed, the Hawaiian Islands are uniquely vulnerable to statewide food insecurity—and food insecurity and diet-related health disparities have long impacted the Native Hawaiian and Pacific Islander communities of Hawai‘i,” said UH West O‘ahu Chancellor Maenette Benham. “These are some of the pressing issues in food security that we continue to explore systematically in our BAS-SCFS program—as we train the next generation of food/agriculture system professionals to think across traditional disciplinary boundaries to solve the problems facing us today.”

ABOVE: *Students learn traditional techniques of taro cultivation at Ka Papa Lo‘i ‘o Kānewai Cultural Garden at UH Mānoa’s Hawai’inuiākea School of Hawaiian Knowledge.*

RIGHT, TOP TO BOTTOM: *Dr. Albie Miles speaks to visitors about Sustainable Community Food Systems; the Biology 124: Environment and Ecology class engages in experiential and hands-on learning in sustainable farming systems, Fall 2016; UH West O‘ahu Garden Manager Tasia Yamamura leads a garden-to-table workshop with students and staff; lettuce growing in UH West O‘ahu’s Student Organic Garden.*

UH HILO'S ADOPT-A-BEEHIVE PROGRAM

A RECIPE FOR SWEET SUCCESS

Take one farm-to-table local chef, combine gently with beekeeping courses at the University of Hawai'i at Hilo (UH Hilo) and allow the mixture to set. Voilà! The Adopt-A-Beehive with Alan Wong program at UH Hilo.

Alan Wong and Lorna Tsutsumi met in the 1970's in school then set off on different paths; one becoming an international acclaimed pioneer of Hawai'i Regional Cuisine and the other earning her doctorate at University of Hawai'i at Mānoa (UH Mānoa) in entomology then returning to her native Hilo to teach beekeeping at UH Hilo for the next thirty years. In 2009 on a trip to a renowned specialty vegetable farm called The Chef's Garden in Ohio, Wong was inspired with their program that allowed the public to adopt a beehive and wanted to do something similar in Hawai'i. He turned to his friend, UH Mānoa alum and well-known graphic artist Kurt Osaki to find a beekeeper. "Kurt told me about a UH Hilo professor of beekeeping, and when he said it was Lorna Tsutsumi, I couldn't believe it!" Wong laughed.

In 2011, the public-private Adopt-A Beehive with Alan Wong program was officially born. To date the program cares for over a million bees and has attracted over one hundred donors each year who choose among three annual adoption levels ranging from $300 to $1,000 raising more than $300,000 in total. The funding is used to support student course needs such as equipment and supplies, scholarships (three $1,000 scholarships are offered yearly), and outreach promotion of the importance of honey bees, not only for their harvestable products, but for their pollination services to many important agricultural crops in the islands.

"THE GOAL OF THE PROGRAM IS TO REACH OUT TO THE WHOLE COMMUNITY AND PROMOTE EDUCATION AND AWARENESS ABOUT SUSTAINABILITY AND THE ENVIRONMENT." TSUTSUMI EXPLAINED.

"Our university classes are almost always full, but we wanted to build awareness beyond the classroom. Alan's concept was to have people adopt hives to help provide resources and make it interactive, so everyone who adopts feels like a part of the program." (*Hanai Hives,* Hana Hou!, Oct./Nov. 2014).

"Hilo is the only UH campus in the state to offer a three-credit course in beekeeping" said Tsutsumi, whose introductory course enrolls thirty-two students per semester. "Now, due to the donor support, we've added an advanced course that can take sixteen to twenty more students, leading to an optional UH Hilo beekeeping certificate." (*Hanai Hives,* Hana Hou!, Oct./Nov. 2014).

Much of the success of the program can be attributed to the adopters. Adopters like the Shigekunis who have been with the program since the first season when Vince adopted a hive for his wife Alison as a gift. Over the years, they have enjoyed the student letters that update them on their hive, the invites to events and of course—the honey. In 2016, they created an endowment in honor of Alison's parents, the Ben and Fusae Fujise Beekeeping Endowment Scholarship that provides scholarships for beekeeping students at UH Hilo.

Kawaikapuokalani Genovia is a student who will be graduating this fall with a BS in agriculture, a minor in English, a certificate in teaching English as a second language and of course—a beekeeping certificate. He initially took the Introduction to Beekeeping course as an elective because it sounded interesting, but after being surrounded by 10,000 honey bees on a weekly basis, he decided to add a beekeeping certificate to his full list of a major, minor and certificate. Genovia said "The beekeeping courses are very hands-on and provides me with the practical skills needed to care for honey bee hives on my own as well as share my knowledge with others." In February 2017, he helped to teach 20 students from Tokyo Kasei University about beekeeping when they visited the UH Hilo apiary.

"I feel a deep connection to the bees because I tend them for adopters whom I send monthly letters to and who provide the beekeeping students with adequate resources so that we can learn proper beekeeping techniques," said Genovia. "Then I get to pass that skill and knowledge on to students of all ages and from many places."

Born and raised in Waipio Valley on the Big Island, Genovia has had to support himself throughout college. This year he was selected as one of the recipients of the Adopt-A-Beehive scholarship for $1,000. "This money will definitely help me to finish my schooling and I am truly grateful to receive this scholarship," he noted.

The program is all about partnerships. A local farming company, Wailea Agricultural Group (WAG), has UH Hilo hives on their property and have been working with the UH Hilo program for many years. "We have definitely seen an increase in our fruit harvests because of the bees." said co-owner Michael Crowell of WAG. Another connection is with Sodexo on the UH Hilo campus. Sodexo promotes the use of local products and has been showcasing UH

Hilo's honey in many of their dishes. "We want to use the honey because it is harvested from the UH Hilo hives by UH Hilo students and is used to make dishes that are consumed by UH Hilo students in our cafeteria," said manager Bridget Awong.

The most recent partnership is between the program and Kapi'olani Community College's (KCC) Culinary Innovation Center. Last year, KCC's Research Chef Lauren Tamamoto and Dean Bruce Mathews of UH Hilo's College of Agriculture, Forestry and Natural Resource Management represented the UH System at U.S. Senator Mazie Hirono's food and products showcase Hawai'i on the Hill in Washington D.C. This year, the duo teamed up once again and integrated UH Hilo's honey with the KCC's culinary creativeness for the event held in June.

Who would have imagined some 40 plus years later that two friends would reconnect to form a unique and successful program that would positively impact UH students and the local community and in doing so—would bring more global awareness to the importance of the honey bee? Now that is a recipe for sweet success.

ABOVE: *Kawaikapuokalani Genovia (right) showing a frame of bees to several Tokyo Kasei University students.*

RIGHT, TOP: *Chef Alan Wong (left) and Dr. Lorna Tsutsumi (right) planting a commemorative tree initiating the start of the Adopt-A-Beehive with Alan Wong program with UH Hilo.*

RIGHT, MIDDLE: *2013 Adopt-A-Beehive with Alan Wong scholarship recipients Samuel Clubb, Laurie Jahraus and Shohei Yamaki, were presented with a $3,000 check by Chancellor Don Straney (far left) and Chef Alan Wong (far right).*

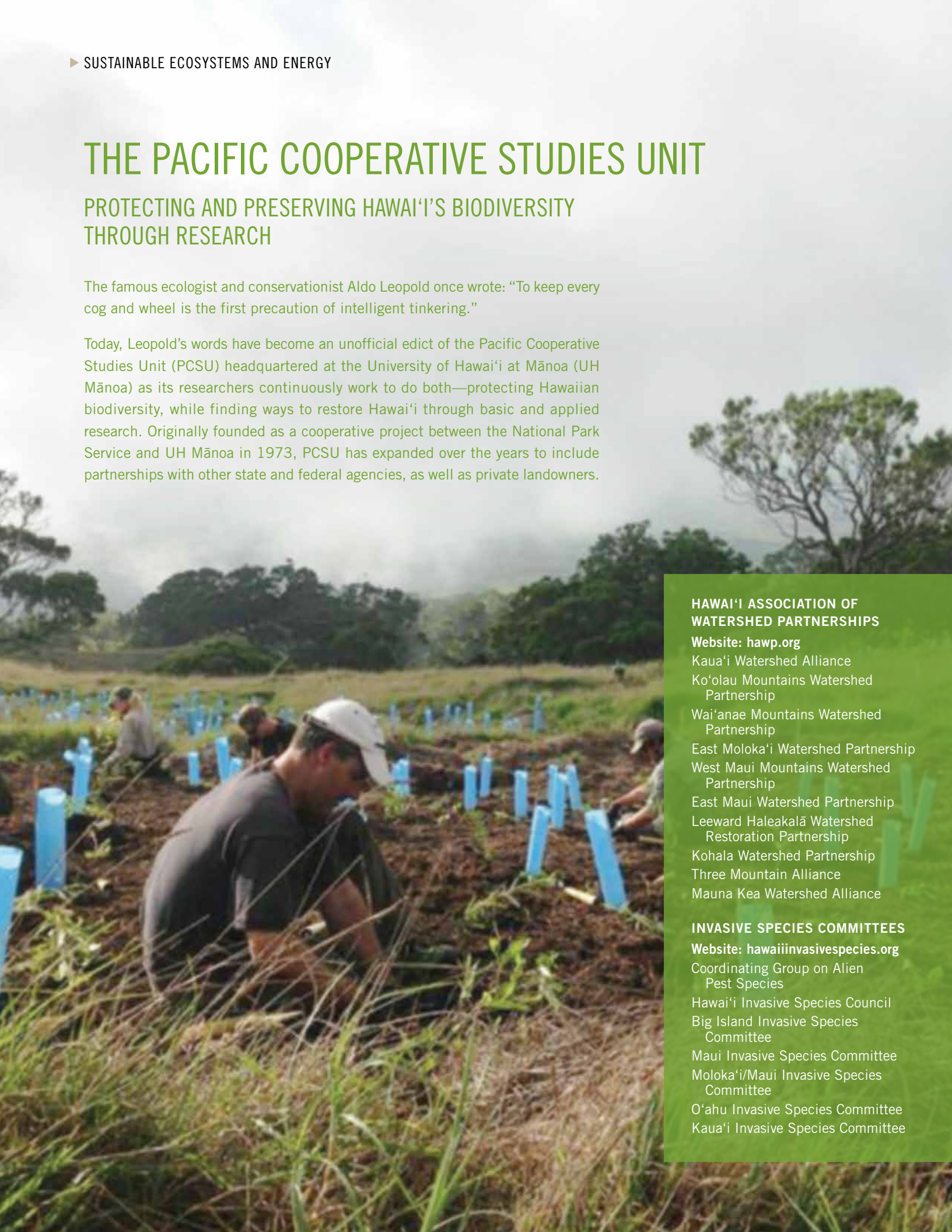
RIGHT, BOTTOM: *Bottles of honey from the UH Hilo hives show the special relationship of this public-private partnership.*

THE PACIFIC COOPERATIVE STUDIES UNIT

PROTECTING AND PRESERVING HAWAIʻI'S BIODIVERSITY THROUGH RESEARCH

The famous ecologist and conservationist Aldo Leopold once wrote: "To keep every cog and wheel is the first precaution of intelligent tinkering."

Today, Leopold's words have become an unofficial edict of the Pacific Cooperative Studies Unit (PCSU) headquartered at the University of Hawaiʻi at Mānoa (UH Mānoa) as its researchers continuously work to do both—protecting Hawaiian biodiversity, while finding ways to restore Hawaiʻi through basic and applied research. Originally founded as a cooperative project between the National Park Service and UH Mānoa in 1973, PCSU has expanded over the years to include partnerships with other state and federal agencies, as well as private landowners.



HAWAIʻI ASSOCIATION OF WATERSHED PARTNERSHIPS

Website: hawp.org

- Kauaʻi Watershed Alliance
- Koʻolau Mountains Watershed Partnership
- Waiʻanae Mountains Watershed Partnership
- East Molokaʻi Watershed Partnership
- West Maui Mountains Watershed Partnership
- East Maui Watershed Partnership
- Leeward Haleakalā Watershed Restoration Partnership
- Kohala Watershed Partnership
- Three Mountain Alliance
- Mauna Kea Watershed Alliance

INVASIVE SPECIES COMMITTEES

Website: hawaiiinvasivespecies.org

- Coordinating Group on Alien Pest Species
- Hawaiʻi Invasive Species Council
- Big Island Invasive Species Committee
- Maui Invasive Species Committee
- Molokaʻi/Maui Invasive Species Committee
- Oʻahu Invasive Species Committee
- Kauaʻi Invasive Species Committee



The National Park Service/PCSU relationship helped to prove the feasibility and benefits of fencing large areas of forests to prevent the modification and degradation of habitat by ungulates and allow recovery of native ecosystems. A key discovery aided by PCSU science involved the ecologically disastrous relationship between the feral pig and strawberry-guava, and their role in the extermination of many native bird species from the lowlands. The seeds of the invasive plant were carried into pristine forest areas by the pigs, forming dense thickets that destroyed the native plants and habitat. At the same time, the pigs left pits from rooting and wallowing, that formed stagnant ponds to aid in the reproduction of mosquitos and the spread of avian malaria and poxvirus.

"MANY OF TODAY'S PROJECTS PROVIDE BOTH SCIENCE AND LOGISTICS TO ISLAND-LEVEL COLLABORATIONS THAT ADDRESS ENVIRONMENTAL PROBLEMS THAT CANNOT BE ADDRESSED BY SINGLE LAND OWNERS OR JURISDICTIONS," SAID DAVID DUFFY, PROFESSOR OF BOTANY AND UNIT LEADER OF PCSU. "THROUGH INDIVIDUAL WATERSHED PARTNERSHIPS RUN BY PCSU, EACH ISLAND MANAGES ITS OWN NATIVE LANDSCAPES."

Similarly, the invasive species committees (ISCs), located on each island, feature local steering committees that identify incipient invasive species of community or ecological concern. This allows local "buy in" and support as PCSU provides the science and the "boots on the ground" that undertake eradication, documenting the effectiveness of various approaches and sharing the results among the islands. The ISCs have eradicated several invasive species from each island before they could become established and have collaborated with state agencies in surveying and monitoring invasives such as Miconia, a shallow-rooted forest tree that can take over whole forests and coqui frogs that have destroyed the silence of night on the Big Island and significantly lowered property values. On the other islands, ISCs continue to work with state agencies to prevent further coqui colonizations.

The Pacific Cooperative Studies Unit has also responded to crisis situations. Originally introduced to Hawai'i in 1868 as a gift to King Kamehameha V, the axis deer has become a major problem on Maui. In 2009, the deer was illegally introduced to the Big Island and its eradication became a priority. Using methodology developed by PCSU using FLIR (Forward Looking Infrared Radar) equipment, officials were able to quickly and successfully remove the deer.

One of the biggest threats in recent years has been the Little Fire Ant that has become established on the Big Island. It threatens native invertebrates, agriculture and even the eyes of domestic pets because of its stings. The Hawai'i Ant Lab, a collaborative project between the State of Hawai'i Department of Agriculture and PCSU, developed control treatments that are eradicating incipient invasions of the ant on Kauai, Maui and O'ahu and are providing training and support to communities and businesses to control these ants on the Big Island.

The Pacific Cooperative Studies Unit also provides the staff for The Coordinating Group on Alien Pest Species (CGAPS), a partnership of agencies and non-governmental organizations that focuses on policy issues that impede the unit's ability to prevent or control invasive species. Many of their projects also have active outreach programs that participate in community events such as county fairs, parades, flower shows and children's workshops, as well as working with teachers and students in schools

In another collaborative effort with the National Park Service, PCSU is involved in monitoring and managing the critically endangered hawksbill turtle on the Big Island. Along with state and federal agencies, PCSU scientists have been satellite-tracking mountain-nesting seabirds on Maui, Kaua'i and Lāna'i to study their movements at sea and assessing and managing threats on their nesting grounds. Other projects on Kaua'i and Maui have been studying the ecology of Hawai'i's critically endangered endemic forest birds, determining their ecological requirements, assessing the threats to them, and measuring the effectiveness of different approaches to their management. Through the Plant Extinction Prevention Program, PCSU works to identify and protect species that have fewer than 50 individuals still remaining in their natural habitats—over one-tenth of the native flora. Leaving no stone unturned, PCSU scientists, in partnership with the O'ahu Army Environmental program, have led the development of protective enclosures for endangered tree snails on the island.

With a staff of 400 and total awards in 2016 of almost $22 million, PCSU is a proven model for protecting the archipelago's unique biodiversity through science, hands-on efforts and collaboration. Amazingly, PCSU receives no general fund support from the University of Hawai'i and depends entirely on soft money for its operations.

"Many efforts in the state are top down, run from O'ahu," said Duffy. "However, PCSU projects have roots on each island, responding to local needs, with local staff, and generating local support and funding from the counties."

FACING PAGE: *Technicians conduct seabird habitat restoration under the Maui Forest Bird Recovery Project.*

ABOVE, L-R: *East Maui Watershed Partnership staff transporting materials to a backcountry field site by helicopter to remove invasive ginger from an important watershed area; close up of the Little Fire Ant; gel bait application demonstration conducted by the Hawai'i Ant Lab.*

PHOTOS: PCSU

CYBERHAWAIʻI

CULTIVATING HAWAIʻI'S CYBER ECOSYSTEM

Sony Pictures. JPMorgan Chase. Anthem. Target. Yahoo!

These companies are symbols of everyday corporate America—large, successful, financially sound and secure. However, events occurring in recent years have shown that even these pillars of corporate America are susceptible and vulnerable to sophisticated cyberattacks that have exposed personal, financial and other types of information affecting the companies and millions of households.

Cyber threats are among the gravest national security dangers to the United States—as citizens and those in the private sector and government are increasingly confronted by a range of actors attempting to do harm through identity theft, cyber-enabled economic espionage, politically motivated cyberattacks and other malicious activity. It is also one of the most strategic threats that federal, state and private sector industries face in Hawaiʻi. Operation-critical systems in every sector have a dependency on cyber, which expands capacity and range of capability—but also introduces new and evolving forms of vulnerabilities that threaten the security infrastructure.

While these corporations and organizations are expanding their cybersecurity efforts, they are also facing an increasing shortage of information security professionals worldwide. According to recent results from the Global Information Security Workforce Study, employers can expect a cybersecurity workforce shortage of 1.8 million by 2022.

In an effort to help mitigate some of the threat from this double-edge sword, the University of Hawaiʻi is spearheading efforts with local federal, state, county, private industry, professional organizations and academia to plan, develop and implement a "cyber-ecosystem" to be known as CyberHawaiʻi. The purpose of CyberHawaiʻi will be to coordinate and support cyber activities related to readiness and resilience, education and workforce development, economic development and innovation throughout the state.

"By bringing together like-minds, sharing ideas and resources, and building upon the collective energies and efforts, Hawaiʻi will be able to build a strong and resilient cyber community," said UH Vice President for Research and Innovation Vassilis L. Syrmos. "CyberHawaiʻi will enable all sectors to be better positioned to defend and withstand cyber attacks, and at the same time—help to grow cyber-related innovation and jobs to fuel and sustain a new economic sector in the state."

A SIGNIFICANT COMPONENT OF THE CYBERHAWAIʻI PARTNERSHIP WILL BE THE ESTABLISHMENT OF THE UH CENTER FOR APPLIED CYBERSECURITY, A VIRTUAL CENTER THAT WILL INCORPORATE MANY OF UH'S CYBERSECURITY RESEARCH, EDUCATION AND WORKFORCE DEVELOPMENT ACTIVITIES ALREADY ESTABLISHED UNDER ITS EXISTING HAWAIʻI CYBERSECURITY WORKFORCE INITIATIVE. THE AIM OF THE NEW CENTER WILL BE TO COMBINE BASIC PRINCIPLES OF CYBERSECURITY WITH THE PRACTICAL SKILLS AND HANDS-ON EXPERIENCE NECESSARY IN EXPLOITING AND PROTECTING THESE SYSTEMS.

The University of Hawaiʻi has participated in and hosted a number of high-profile cybersecurity exercises, including the Maritime Cybersecurity Exercise conducted by the U.S. Coast Guard Sector Honolulu in January 2015 and the annual Poʻoihe Cyber Defense Exercises conducted by the Department of Defense. Since 2015, UH has partnered with the National Security Agency (NSA), the National Science Foundation and the University of Alaska to host GenCyber Hawaiʻi, a free week-long summer camp for high school students and teachers designed to help encourage STEM pathways in cybersecurity. The event is held at Honolulu Community College's Pacific Center for Advanced Technology Training (PCATT).

"Our purpose is to develop a clear education pathway into the cybersecurity profession by charting academic requirements to industry certifications and mapping out the knowledge and skills required for the various positions in the cybersecurity field," said Steve Auerbach, director of PCATT. "Students need to be introduced and exposed to cybersecurity as a potential career early in their primary and secondary education to ensure that they have the appropriate math and science background to pursue a postsecondary degree in cybersecurity."

Additionally, UH is also home to three designated NSA designated Centers of Academic Excellence in Cyber Defense & Research at the University of Hawaiʻi at Mānoa, Honolulu Community College and at the University of Hawaiʻi at West Oʻahu. These prestigious designations represent UH's commitment to provide cutting-edge research and education in cybersecurity.

"This designation is demonstrative of the quality and substance of the education the University of Hawaiʻi has to offer, and more importantly underscores justification for additional grant and research capacity to be brought to bear on information assurance and cybersecurity related curricula," stated Captain Cliff Bean, former commander of National Security Agency/Central Security Service Hawaiʻi. "Increasing the number of students majoring in science, technology, engineering and mathematics (STEM) related fields is critical to federal government agencies, the State of Hawaiʻi, local industry and businesses."

FACING PAGE, LEFT: *Students and teachers at the 2016 GenCyber camp held at Honolulu Community College.* PHOTO: HCC

RIGHT: *Poʻoihe Cyber Security Exercise*

CyberHawai‘i

Hawai‘i’s Cyber “Ecosystem” to coordinate and support cyber activities related to Economic Development, Innovation,Education & Workforce Development, and Readiness & Resilience.

UH CENTER FOR APPLIED CYBERSECURITY

Applied Research
Projects
Education
Workforce Development
Innovation

ORGANIZATIONS

MAC
HBR
CIO Council
Infragard
ISSA
CyberHul

GOVERNMENT

State of Hawai‘i
State DoD
City & Counties
PACOM
FBI
NSA
DHS

PRIVATE INDUSTRY (*critical infrastructure)

HECO*
Matson*
Young Bro*
Hawaiian Telcom*
Oceanic
Referentia
Booz Allen Hamilton
financial institutions
healthcare

ECONOMIC DEVELOPMENT & INNOVATION

HTDC
HSDC
MEDB
KEDB
incubators
accelerators

ACM SYSTEM

UH'S CREATIVE MEDIA PIPELINE

Ku'u enrolled at the University of Hawai'i-West O'ahu (UH West O'ahu) as a freshman majoring in English and when the creative media program was established, she switched her major to up her career game. UH West O'ahu's boutique-style and ala carte approach to tailoring students' academic programs enabled Ku'u to graduate with a double major in English and creative media in four and a half years that included two internships.

The first was at Oceanit in Honolulu, an innovative, creative science-technology-engineering firm highly respected for its extraordinary success in cutting-edge style of problem-solving and advancement. Her second internship was with *The Jimmy Fallon Show* in New York City. Today, less than a year after receiving her bachelor's degree in a program designed to develop 21st Century skills in students, Ku'u—of Micronesian and Native Hawaiian ancestry—is manager of social media at The Kroc Center of Hawai'i.

As the first academic program intentionally designed with connectivity throughout all ten campuses, the Academy for Creative Media System (ACM System) is a synergistic breakthrough in the University of Hawai'i (UH). For at least three decades, UH urged its campuses to act as a system. With its uniquely purposeful and deliberate collaboration among the UH campuses, ACM System made that goal a reality as illustrated by UH West O'ahu's formally completed articulation agreements with all seven UH community colleges, creating a two-plus-two pathway for community college students to complete their bachelor's degree in two years after earning their Associate of Arts or Associate of Science degrees.

Creative media specializations vary widely among the ten campuses. They range in remarkably diverse combinations from UH Mānoa's cinematics and film and video production in creative media and its nationally-renown data visualization Cyber-enabled Collaboration Analysis Navigation and Observation Environment (CyberCANOE)system; to digital photography and video and 3-D animation at Leeward Community College; to integrative multidisciplinary team approach to realistic problem-solving in design, storytelling, and technology at Honolulu Community College; to game, graphic, interface design and mobile media at UH West O'ahu; and many more.

With state-of-the-art equipment and technology access, students at the campuses have been locally and nationally recognized for their award-winning projects. ACM Mānoa has annually produced over 150 student short films and award-winning feature films—including the documentary *State Of Aloha and Go For Broke,* co-produced with the 442nd Foundation—and top recognitions at international film festivals. Honolulu Community College's students in the Music and Entertainment Learning Experience (MELE) program applied what they learned in class to a real-life experience of compiling and producing the CD *Island Music: Gifts of Aloha,* made possible through a generous contribution by former Bank of Hawai'i CEO Al Landon and his wife Sue Landon.

Unique real-world experience, often accompanied by access to state-of-the-art equipment, facilities, and internships, enable ACM students early-on to cultivate rare and coveted networks of professional contacts. Reflective of the industry, students are acculturated in academic learning environments that inspire collaboration and teamwork on projects from concept to completion.

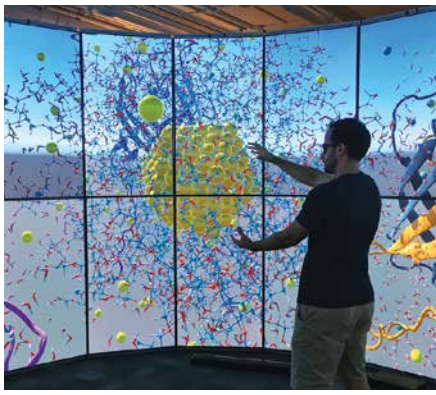
THE SKILL SETS THEY DEVELOP—IN SETTINGS WHERE TECHNOLOGY AND CREATIVITY INTERSECT—ARE HIGHLY SOUGHT OUT BY PROFESSIONALS. THUS, ACM GRADUATES FIND THEMSELVES AS STANDOUTS AMONG OTHERS VYING FOR POSITIONS IN THE INDUSTRY.

Creative media's interdisciplinary approach provides a solid foundation for students transitioning to career choices in a rapidly changing and dynamic field.

The Academy for Creative Media began at UH Mānoa in 2004 and expanded to other campuses through the years. The UH Mānoa program now hosts 450 students in its courses, 140 of whom have declared creative media as their major. UH West O'ahu has seen the largest growth of majors and is viewed as the most rapidly growing program, increasing from five majors in 2014 to 107 in 2017. Leeward Community College, with over 200 creative media majors and a long history of video and digital project-based entrepreneurship, hosts the largest number of majors on any campus and deserves its claim as the leader among the campuses in creative media.

One of the earliest ACM System programs at UH West O'ahu is 'Ulu'ulu, the State of Hawai'i's official Moving Image Archive and now one of the premiere digital archives in the world. 'Ulu'ulu is dedicated to the preservation, digitization and dissemination on-line of Hawai'i's analogue visual history, comprised primarily of film and tape formats documenting island history with everything from local television news broadcasts, indigenous films, documentaries, feature films made in Hawai'i, as well as home movies. As most analogue systems are now obsolete, 'Ulu'ulu is engaged in a race against time to save these priceless visual memories, storing the originals in the state's only humidity and temperature controlled vault with a fire suppression system. Digitized copies are available on line at uluulu.hawaii.edu, while frequent seminars and conferences are held in the 'Ulu'ulu exhibition area at UH West O'ahu's library.

The visionaries of ACM System are Chris



Lee—motion picture and television producer, studio executive, media consultant, venture capital entrepreneur, educator, and pioneer of creative media in Hawai'i—and the late Roy Takeyama—former chair of the UH Board of Regents, highly respected attorney, president of the law corporation of Roy Y. Takeyama and RYT, Inc., consultant on real estate matters, and influential community leader in Hawai'i. Both entrepreneurs envisioned ACM System as a synergist for a critical new film and television industry in Hawai'i. Lee raised millions of dollars from private and public sources, including the Hawai'i State Legislature. Takeyama himself made the largest single private donation of $1 million in the name of Roy and Hilda Takeyama. Other donors include Roland Emmerich, Jay Shidler, Servco, The Campbell Family, The Kosasa Foundation, Ko Olina Foundation, The MacNaughton Group and others.

Research grants have significantly augmented ACM System. Through the pioneering and entrepreneurial efforts of UH Mānoa Professor of Information and Computer Sciences Jason Leigh and co-principal investigator Chris Lee, the CyberCANOE received financial support of over $5.2 million in funding to the Laboratory for Advanced Visualization & Applications (LAVA) from the National Science Foundation and matching funds from UH Mānoa.

Academy for Creative Media graduates have initiated numerous digital production start-up companies, worked as crew on television series and films including *Hawaii Five-0, Lost, The Descendants, Pirates of the Caribbean 4, Off the Map,* and others. Recognizing ACM as a catalyst for a film studio that would help bolster economic development in the state, the Hawai'i State Legislature appropriated $35 million for a new state-of-the-art creative media building at UH West O'ahu in 2016.

There is more to come as ACM System continues to further develop programs on UH campuses and as the state's economy adapts to new prospects of creative media, including internships and newly-created positions for other Ku'us who are in the UH creative media pipeline.

ABOVE: *The Roy and Hilda Takeyama Foundation's $1 million gift to ACM at UH West O'ahu in 2015, made the Roy and Hilda Takeyama Creative Media Lab possible.*

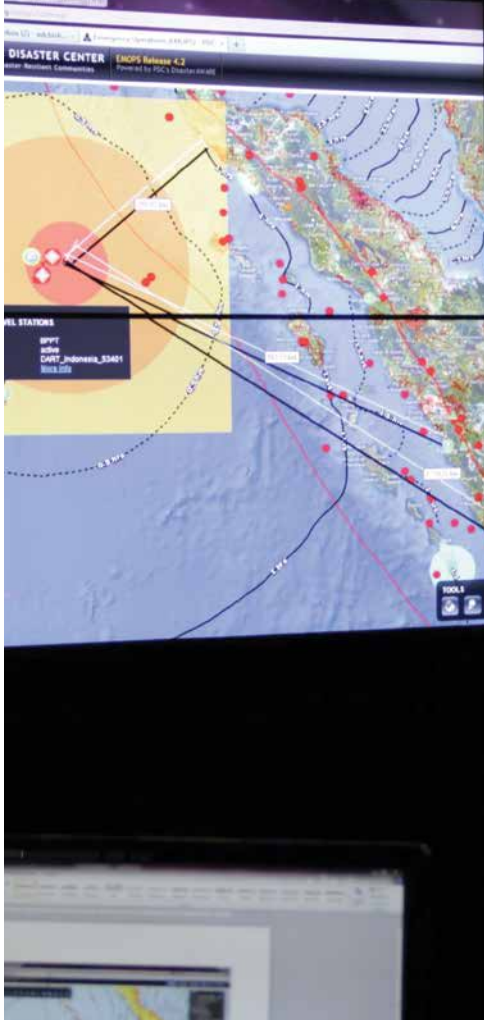
RIGHT, TOP TO BOTTOM: *Destiny class CyberCANOE at UH Mānoa's LAVA,* PHOTO: UH MĀNOA; *video shoot at UH West O'ahu; Waianae High Searider Productions UH West O'ahu Early College ACM students.*

PHOTOS: UH WEST O'AHU

PACIFIC DISASTER CENTER

HELPING TO COMBAT ZIKA AND OTHER GLOBAL THREATS

The Zika virus is just one of the latest threats the Pacific Disaster Center (PDC)—managed by the University of Hawai'i—is helping to combat using an array of research and technology solutions.



Among their many global projects, research analysts at PDC have been monitoring and mapping outbreaks of the dangerous virus associated with severe birth defects and offering critical insight about its spread throughout Latin America and the Caribbean. Partnering with U.S. and foreign agencies to combat the mosquito-borne virus, which first sparked global attention during the 2016 Olympic in Games in Rio de Janeiro, the center is using public data to highlight areas most affected and map those most vulnerable to its continued spread.

"Knowing where cases are concentrated and how quickly they're spreading is only one part of the picture," said Ray Shirkhodai, executive director of the Pacific Disaster Center, adding that PDC is taking a proactive approach to look at areas with heavy rainfall, densely populated urban centers, and places with standing water where mosquito extermination and public health outreach is likely to be most effective. The center is also using its powerful disaster information system, DisasterAWARE™, to map the location of hospitals, public access to health services, and other policy-related information that could improve response capabilities during a future outbreak.

Comparative analysis tools and map visualizations like those created with DisasterAWARE™ for the Zika outbreak can help nations gain crucial insight about their capacity to cope with disasters. Helping nations to increase their risk resilience—protecting people, property, and economic prosperity—is one of the key missions of PDC. The risk assessment tools within DisasterAWARE™ support this aim by allowing nations to work proactively to reduce their risk of exposure, plan for future events, and avoid the incredible human and economic toll of an unmitigated catastrophe.

The Pacific Disaster Center has long partnered with U.S. Government Agencies (such as the U.S. Departments of Defense, State, Homeland Security, Health and Human Services, NASA, NOAA, etc.), United Nations agencies (such as UN-OCHA, IAEA), regional organizations (such as ASEAN in South East Asia, CDMA in the Caribbean, etc.), and numerous foreign government national disaster management agencies from the Asia Pacific to the Latin American regions to undertake projects that help nations mitigate disasters and reduce their risks and vulnerabilities.

By applying scientific research and technological innovation to solving the greatest disaster challenges, the center is constantly finding new ways to make its DisasterAWARE™ products more useful. For instance, during the Nepal's devastating 7.8M earthquake in April 2015, PDC's collaboration with the global community to map the relief efforts within the impacted area helped the international responders better coordinate presence and aid. Similarly, the center has been present and supporting every major disaster worldwide, from 2004 Indian Ocean Tsunami, to the more recent 2010 Haiti Earthquake, 2011 Tohoku, Japan Earthquake, Tsunami, and Nuclear Emergency, 2013 Typhoon Haiyan in the Philippines, 2015 Ebola outbreak, and 2016 Hurricane Matthew, to name a few.

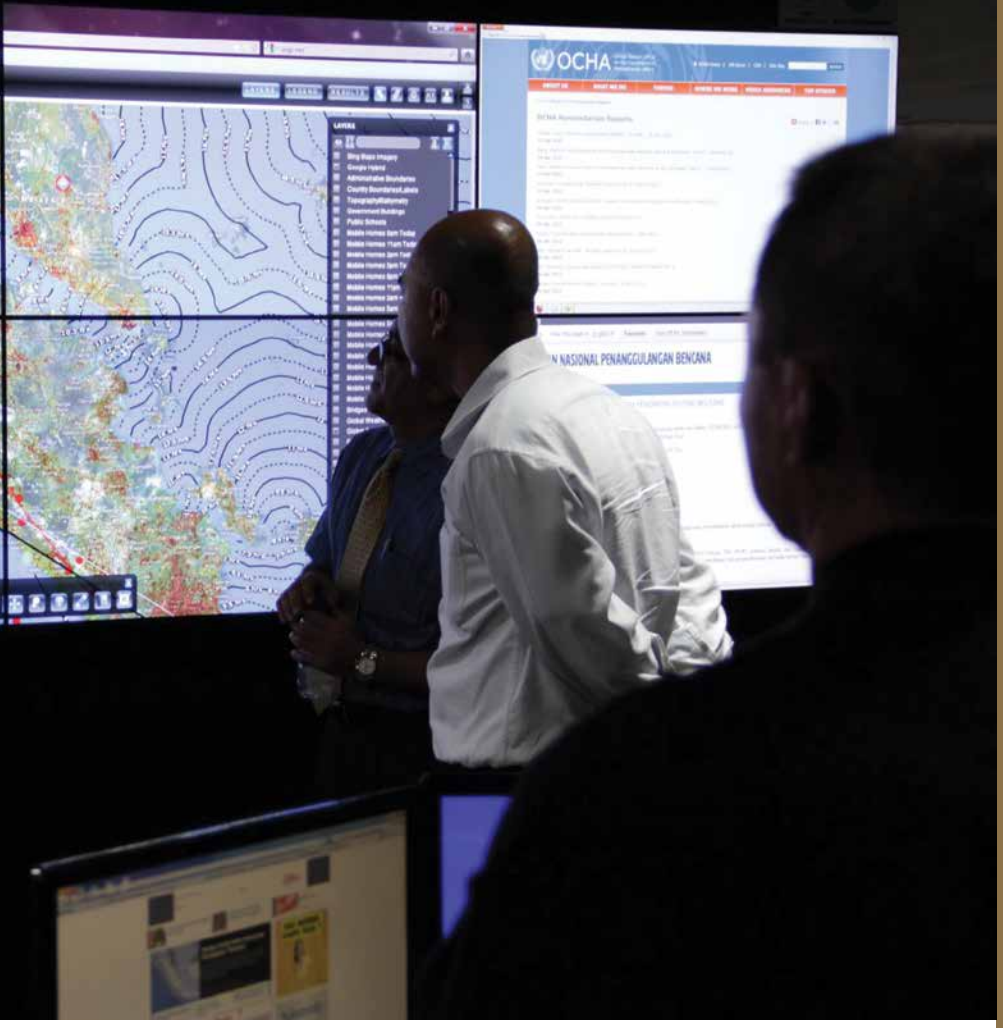
During Hurricane Matthew in November 2016, PDC produced numerous situational analysis products estimating impacts of the tropical cyclone as it moved across Jamaica and Haiti prior making landfall. Susan Hendrick, agency spokeswoman for the Federal Emergency Management Agency, said FEMA works closely with PDC to map storms and other hazards and to estimate the impact of disasters on local communities.

PDC's joining the fight against Zika from the early emergence of this global threat, by mapping transnational occurrences and outbreaks, vulnerable populations, and predictive spreads was only one of the more notable efforts catching international news attention. The center produced and updated hundreds of maps and products, continually referenced by the domestic and international responding agencies, and all featured on the UN's ReliefWeb.

However, PDC's efforts are not all concentrated within its own headquarters in Hawai'i. The center has also collaborated with other nations to extend the use of its customizable platform, and enhance capabilities of the national aid agencies in Thailand, Vietnam, Indonesia and the Association of South East Asian Nations.

Over the past decade, PDC has been recognized for its work nationally and throughout the world. It continues to expand international projects and technological advancements and currently offers its flagship technology, DisasterAWARE™, at no cost to disaster management professionals. It has also widened its services to include a free new mobile application, Disaster Alert™—allowing the people and their loved ones to stay safe anytime, anywhere they may be around the world.

The Pacific Disaster Center was established by the U.S. Government in 1996 with a mission to provide applied information research



and technology to aid the worldwide disaster management and humanitarian assistance community. The University of Hawai'i has served as PDC's managing partner since 2006, when it was selected through a competitive process to manage the center. Over the years, PDC has expanded from serving the Pacific Rim to reaching out to the world. Based on the success of PDC, a new cooperative agreement was established in 2015 under the University of Hawai'i, providing expanded funding opportunities to guide future innovations in disaster management research and technology.

University of Hawai'i President David Lassner reflected on the work being done at PDC and its future by saying, "Science and technology play a pivotal role in advancing the well-being of people throughout the world and PDC has taken the lead in finding quicker, better, and less expensive ways to solve some of the toughest problems facing humanity in the twenty-first century. As extreme weather and other human-inflicted disasters remain on the rise, the need for reliable technology and advanced warning systems is even more pressing; as is the work of PDC to protect communities at home and abroad with new disaster science and technological innovation."

LEFT: *A watch officer with Indonesia's national disaster management agency, Badan Nasional Penanggulangan Bencana (BNPB), demonstrates a customized version of PDC's DisasterAWARE™ technology called InAWARE.*

ABOVE: *AHA Centre Director Said Faisal and Pacific Disaster Center Executive Director Ray Shirkhodai use DMRS DisasterAware to evaluate the distance from epicenter of 8.6 magnitude earthquake to coast of Aceh on April 11, 2012.*

PDC'S DISASTER ALERT™ APP

Early warning systems save lives and the Pacific Disaster Center (PDC)'s global coverage of multiple hazards is no longer just available to disaster management agencies at real-time speed, but free to the public through PDC's mobile app, Disaster Alert™.

Available in both iOS, Android, and on the web, Disaster Alert™ provides a way for people and their loved ones to stay safe anytime, anywhere with instant access to 18 different types of active hazards including: drought, earthquake, flood, high surf (Hawai'i), high wind (Hawai'i), marine, storm, cywclone, tsunami, volcano, landslide, wildfire, biomedical, man-made hazards and more.

Lending to its user-friendliness, Disaster Alert™ presents information on a map which gives users the ability to observe hazards in their specific location and sign up for relevant alerts. Mobile users receive up-to-the-minute information about current and real-time incidents compiled by authoritative sources on events from around the world. Disaster Alert™ brings all this information together into a single useful interface with the most comprehensive and up-to-date situational analysis of current conditions on the ground, as well as detailed reports projecting the future or present impact of a disaster. At users' fingertips are numerous map overlays including population densities, rainfall, day and night indicators, and more. And, with Disaster Alert™ on the web, users can perform their own hazard analysis with overlays such as the location of public infrastructure, roads, hospitals, and other geographic visualizations. New information is continuously being added to Disaster Alert™ making it the most reliable and complete source of global disaster information in mobile format.

The application is available through Google's Play Store, iTunes, or on the web at: http://disasteralert.pdc.org/disasteralert.

*INNOVATE*UH

A SHOWCASE OF UH-BASED RESEARCH

Imagine an emergency patient having critical blood coagulation information transmitted to the hospital from the ambulance, allowing lifesaving blood products to be ready upon the patient's arrival. Thanks to iFirst Medical Technologies, the technology for a mobile lab is already here.

"We can determine the level of trauma associated with trauma patients and get proper blood components to those patients," said Luke Joseph, creator of iFirst. "We utilize smartphone technology to immediately analyze a patient's blood."

Joseph presented his innovation at XLR8UH's inaugural *Innovate*UH showcase in March. He and the rest of XLR8UH's fifth cohort were the focal point of a jam-packed two-hour event that also featured startups tackling diverse issues ranging from sports-related concussions, to biomedical ed-tech using the latest in VR/AR technologies, to natural resource management software.

Although it sounds like a vanity plate belonging to a sports car, XLR8UH is all business as the University of Hawai'i's award-winning proof of concept center/venture accelerator that was launched in 2015. A public-private partnership between the University of Hawai'i and boutique venture firm Sultan Ventures, XLR8UH has already trained and invested in 24 companies and worked with hundreds of founders. More than half of applicants are UH students and another third are faculty. Up to a third of the XLR8UH cohort teams are led by women, far surpassing national averages.

"XLR8UH was started to provide an on-ramp connecting innovation and entrepreneurial initiatives at UH to the commercial sector," said Omar Sultan, managing partner of XLR8UH. "We are pleased to present events like InnovateUH to increase awareness and to help bring exciting innovations from UH's stable of talented researchers to market."

A trio of University of Hawai'i at Mānoa researchers further energized the audience with their interactive and lively conversations on healthcare, agriculture and energy. Joe Ramos, interim associate director of administration at the University of Hawai'i Cancer Center, was thrilled to see the program generating a broad spectrum of innovations crossing multiple disciplines, including work in big data, diagnostics and drug development.

"Programs such as XLR8UH and *Innovate*UH are essential in bringing together faculty, students, and experts to help spark new ideas and further ongoing research," said Ramos. "Hawai'i is a hot-bed for exciting innovations."

College of Tropical Agriculture and Human Resources (CTAHR) Associate Dean and Director for Research J. Kenneth Grace was excited to describe their research with molecular interactions between plants, pests and disease that can lead to plants with natural resistance to multiple threats such as insects and fungus—as the college is assisting with the state's goal of doubling food production. CTAHR is also looking into natural compounds with uses beyond agriculture, such as corn silk, which is showing some impact on Alzheimer's disease. A recent innovation includes freezing without icing, which also has biomedical implications.

On the sustainable energy front, the Hawai'i Natural Energy Institute (HNEI) in the School of Ocean and Earth Science and Technology is focused on linking technology with policy and integration of renewable energy resources. As an example, HNEI Director Richard Rocheleau explained that battery life is currently impossible to determine. However, they are involved in a Hawai'i-based project to do so—with the potential to go commercial and make a global impact.

"I was pleased with the large turnout and the amount of synergy in the room," said Vassilis L. Syrmos, UH vice president for research and innovation. "Showcasing the variety and depth of the exciting research we have going on at UH is essential to secure the support of key stakeholders in the local innovation and business communities to help diversify the state's economy through the Hawai'i Innovation Initiative."

XLR8UH COHORT 5:

HEALTHTECH APPS
A mobile technology platform that provides athletes and physicians ways to identify, measure and monitor sports concussions reducing the risk of re-injury. **healthtechapps.com**

HERBAVORE
A horticultural hand tool company for professional and hobbyist growers that offers customizable, ergonomic and more efficient products. **herbavoretools.com**

iFIRST MEDICAL TECHNOLOGIES
A lifesaving blood analysis and management smartphone platform. **ifirstmedtech.com**

NATURAL RESOURCE DATA SOLUTIONS
A platform for data collection and project management for conservation and agriculture customers saving time and money. **nrdsdata.com**

OIOIOT
Provides smart and IOT solutions on connected community projects through a patented secure bi-directional communication method.

RADIAL3D
A web and mobile store app that facilitates shared viewing of medical images by clinicians and their patients within a Mixed Reality environment. **radial3d.com**

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