
1865 THE UNIVERSITY OF MAINE
2022
RESEARCH
REPORT
R1
Global Impact | Local Relevance

Maine's Research University at Work

Developing solutions to grand challenges of global impact and local relevance

We are delighted to present the 2022 Research Report for the University of Maine. This year marked the realization of a historic accomplishment by Maine's land, sea, and space grant university. In January 2022, UMaine ascended to the highest tier of national research universities by earning a Carnegie R1 classification and joining the ranks of the nation's top doctoral universities with very high research activity.

The R1 designation is a well-recognized standard of excellence for top-tier research universities. Earning it is a significant endorsement of UMaine's advancement as a premier modern 21st-century research university, with nationally and internationally recognized programs of global impact and local relevance that address the workforce needs and advance the social and economic development of Maine and beyond. It comes on the heels of the university's research enterprise for the third consecutive year achieving all-time high record levels in growth and impact, as measured by multiple indicators, including R&D funding and graduate enrollment.

Specifically, in 2022, externally sponsored R&D funding generated and expended reached $147.8 million and $225.1 million, respectively, and which as compared to the previous year correspond to 11% and 25.5% increases, respectively. Moreover, over the past three years the university has set all-time high records for graduate enrollment, including an all-time high record of 553 doctoral students in 2022.

Currently, there are only 146 R1 institutions out of 3,982 post-secondary, degree-granting institutions in the U.S., placing UMaine in the top 3.7% of universities in the nation. Additionally, of the 146 R1s, only 55 have no medical schools out of 3,790 institutions in the U.S., placing UMaine in the top 1.4% of universities in the nation that are R1s with no medical schools. As part of this, UMaine per number of faculty, has elevated itself to be among the highly productive universities in the nation in conducting externally funded research of great social and economic impact, in awarding graduate degrees in nationally and internationally recognized master's and doctoral programs, and in providing bachelor's degrees in a comprehensive set of undergraduate programs, which are uniquely distinguished by their research-based features and taught by outstanding faculty researchers.

This annual report provides examples of the latest achievements by our university research community. We hope that you will enjoy reviewing it. Moreover, to obtain additional information about the impactful research and scholarly achievements realized at the University of Maine, we invite you to visit our research webpage, or contact us at research@maine.edu.

Joan Ferrini-Mundy
President

Kody Varahramyan
Vice President for Research and Dean of the Graduate School

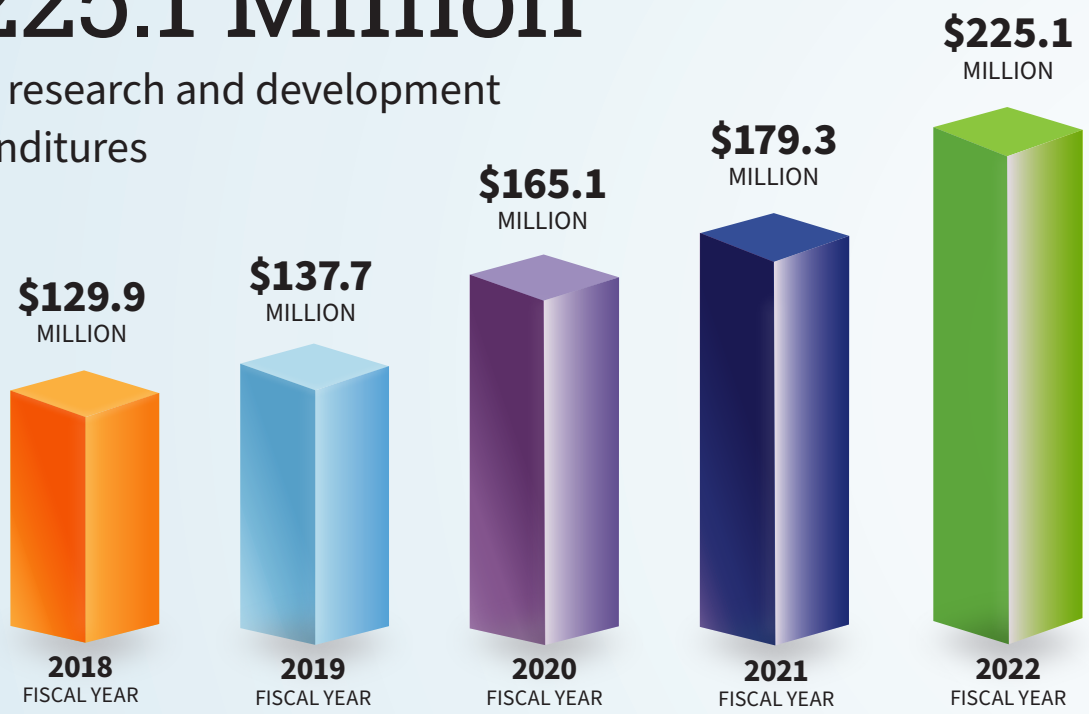
Top 150

of institutions for National Science Foundation funding

2022 ALL-TIME HIGH
RESEARCH AWARDS AND EXPENDITURES

$225.1 Million

Total research and development expenditures



$147.8 Million

Total research and development funding

88% Increase

in federal funding over five years

Top 16%

of universities for research expenditures by NSF HERD ranking

A Modern 21st Century Research University

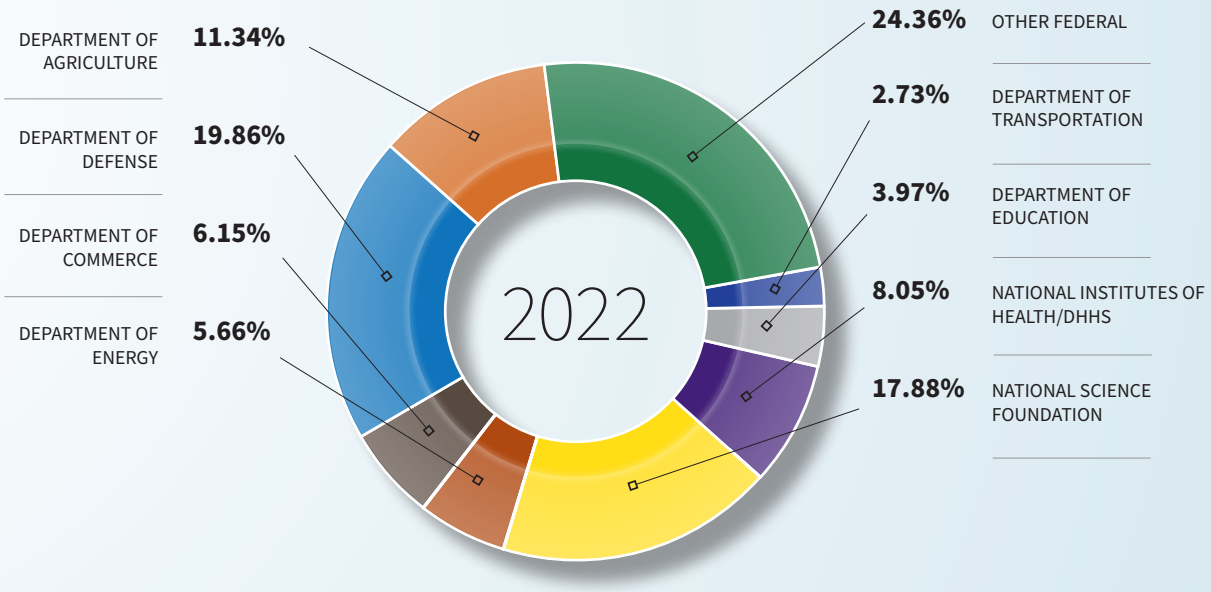
75% Increase

in awards greater than $1 million over 5 years

150+

research institutes, centers, and labs

Total Awards



93%

of Ph.D.s conferred in Maine*

**Reported on the 2021 NSF Survey of Earned Doctorates*

88%

of all university research in Maine

72

new faculty hired

Researching and innovating into the future

Maine's research and innovation reputation takes a monumental step forward as the state's public research university earns the R1 Carnegie Classification. The University of Maine joins the ranks of the nation's top 146 doctoral research universities engaged in very high research activity.

Early in 2022, the University of Maine was designated an R1 university by the prestigious Carnegie Classification of Institutions of Higher Education. The R1 designation signifies "very high research activity" in recent years and it is the highest possible tier a doctoral research university can achieve in the Carnegie Classification. There are currently only 146 R1 institutions out of 3,982 post-secondary degree-granting institutions in the U.S., placing UMaine in the top 3.7% of universities in the nation.

"The research enterprise at the University of Maine is a vital state economic and educational asset," said University of Maine System Chancellor Dannel Malloy. "The R1 designation is the world standard for research universities. With it, we will attract more talent, investment and innovation to Maine. Thanks to the dedication of our research faculty and staff at our flagship university, and the strategic leadership of President Joan Ferrini-Mundy, Vice President for Research Kody Varahramyan, and their teams, Maine is becoming a global destination for discovery and innovation."

The goal of achieving R1 status was articulated in the UMS Research and Development Plan FY20-FY24 published in May 2019. UMaine President Ferrini-Mundy, lead author of the plan, reported that faculty and staff had begun meeting to address the steps that would lead to a top-tier research designation. Building on the work of these research colleagues and others, Ferrini-Mundy was able to present an investment and development plan for Carnegie R1 status by Fiscal Year 2024 at the Board of Trustees May 2020 meeting.

"Recognition as a top-tier research university is a testament to how hard our faculty and staff work pursuing understanding and creating knowledge," said Ferrini-Mundy, who is President of UMaine and its regional campus, the University of Maine at Machias, and UMS Vice Chancellor for Research and Innovation. "We are honored to be an R1 university because of what it means for Maine, and invite all communities, students, innovators and entrepreneurs to join us on our journey to define tomorrow."

UMaine's research enterprise spans the entire state, including the newly launched UMaine Portland Gateway. And in the University of Maine System's unified accreditation environment, faculty at other UMS universities have the opportunity to partner with UMaine researchers, allowing them to expand their own research along with the reach and impact of the flagship's well-established research infrastructure.

Earning the Carnegie R1 designation is a significant milestone in UMaine's vision as a modern 21st-century research university. To earn the designation, UMaine increased its annual research expenditures, expanded its graduate studies, and increased national and international recognition for its research.

Over the last five years, research and development expenditures at UMaine have grown to an all-time high of $225.1 million for 2022. External funding in support of R&D increased to $147.8 million, and UMaine has achieved record graduate and doctoral student enrollments.

"The R1 designation affirms that UMaine has reached the highest Carnegie Classification that identifies top doctoral-granting national universities with very high research activity," said Kody Varahramyan, UMaine Vice President for Research and Dean of the Graduate School. "This is also in recognition that at UMaine, we have been creating a modern 21st-century research university, with nationally and internationally recognized programs of global impact and local relevance that address the workforce needs and advance the social and economic development of Maine and beyond." ■

As an R1 university, UMaine's education community will continue to attract top talent, create new research opportunities and ultimately drive further innovations. We commend the University of Maine on its well-deserved designation as one of the nation's elite research universities, which recognizes the groundbreaking achievements and commitment to excellence by UMaine faculty, scientists, students and staff. **— Senators Collins and King and Representatives Pingree and Golden**

"The age of climate decision is here, and our actions will define the course of civilization and the health of the planet. The Climate Change Institute is playing an important role in this process."

— Paul Andrew Mayewski, Director and Distinguished Maine Professor, Climate Change Institute

Paul Mayewski stands atop Nun Kun Plateau in the Himalayas.

Rising to the challenge

The Climate Change Institute fosters learning and discovery through excellence in graduate academic programs, addresses local and global needs through basic and applied research, and contributes research-based knowledge to make a difference in people's lives. It is dedicated to improving the quality of life for people in Maine and around the world, and promoting responsible stewardship of human, natural and financial resources, now and in the future.

The University of Maine's Climate Change Institute celebrates its 50th anniversary in 2023, marking a half-century of research and education related to climate change in Maine, New England and across the planet.

In 1973, professor emeritus Harold Borns, whose research focused on glaciers and glaciation in Maine, founded the Institute for Quaternary Studies with the goal of conducting interdisciplinary research studying the last 2 million years of Earth's physical, chemical, biological and social characteristics. In 2002, the institute was renamed as the Climate Change Institute (CCI).

Since then, the CCI has spearheaded important projects leading to groundbreaking discoveries. Scientists at CCI first mapped the difference between climate during the Ice Age and today in the 1970s; discovered the importance of marine-based ice sheets in the 1980s; connected acid rain to human causes in the mid-1980s; uncovered the concept of abrupt climate change through studying ice cores in Greenland in the mid-1990s; and led expeditions traversing Antarctica to determine the impact of human-sourced pollutants into the 2010s.

Along the way, students at UMaine played a focal role in research and participated in other hands-on learning opportunities through the institute. Many have gone on to become leaders in fields studying the physical, chemical, biological and social aspects of climate change around the world.

Paul Mayewski, world-renowned polar explorer, climate scientist and glaciologist, has served as the director of the CCI since 2002. He has led more than 60 expeditions to some of the planet's most remote areas, including an expedition to Mount Everest with National Geographic and Rolex in 2019.

Mayewski says that the CCI is one of the first — if not the first — truly interdisciplinary groups at UMaine with a worldwide reach.

"Doing interdisciplinary science is not such a simple thing; it really requires an openness to other disciplines' methodologies and the problems that they care about. For a problem like climate change, you need to have a multidisciplinary approach. It's not enough to just have people in silos; you want people to be talking to each other and developing responses to the challenge together. This is bigger than an individual research and/or academic unit," says Mayewski. "We give our graduate students and many undergraduate students a life-changing experience through our approach to research and field expeditions throughout Maine, the polar regions, high mountains, deserts and oceans."

The next half-century of the institute promises even more discoveries and contributions to tackling the all-encompassing challenge of climate change around the world. ■

50TH ANNIVERSARY
CLIMATE CHANGE INSTITUTE

University of Maine students participate in Culturefest, an annual event that celebrates countries and cultures from around the world.

Graduate School sets new records for doctoral and international graduate student enrollment

The University of Maine's graduate enrollment has consistently increased over the past few years. Of the 2,457 graduate students enrolled this fall, 554 are in doctoral programs, a record high for UMaine. This is the third consecutive year that UMaine has established a new mark for doctoral enrollment.

In addition to the record doctoral enrollment, the University of Maine also set a new high for international graduate student enrollment, topping 300 international graduate students for the first time, driven in large part by an increase in applicants from West Africa.

This fall's enrollment records follow an all-time high number of graduates degrees conferred during the previous academic year. The Office of Institutional Research and Assessment (OIRA) reported that a record high 84 doctoral degrees and 695 master's and specialist degrees were conferred during the 2021-22 academic year.

Vice President for Research and Dean of the Graduate School Kody Varahramyan notes the importance of these achievements. "Now that UMaine has attained ranking as a Carnegie R1 research university, the record doctoral enrollment and international graduate student enrollment are both important in terms of the University's research, graduate, and DEI goals."

While overall graduate enrollment was down slightly due to a dip in master's level enrollment, the total number of graduate student credits hours generated was at the same level as last year's record numbers, but with a 15% increase in nonresident student credit hours.

The Graduate School also received a record 2,964 applications to its graduate programs for Fall 2022 — a result of expanded marketing and recruitment efforts, locally, nationally and globally.

Associate Vice President for Graduate Studies Scott Delcourt attributed the enrollment increases to a heightened effort of the Graduate School and UMaine's graduate programs to connect with potential students coupled with the advantage of the university's new classification as an R1 top-tier research institution under the Carnegie Classification. ■

Safeguarding Maine's wild blueberries

Rafa Tasnim receives Janet Waldron Doctoral Research Fellowship.

Like many crops across the world, wild blueberries face several threats posed by climate change, including rising temperatures. Rafa Tasnim from Dhaka, Bangladesh, is trying to pinpoint new ways growers can protect one of Maine's most iconic crops by using resources from the state's backyard.

Since joining the University of Maine in 2019, Tasnim, a Ph.D. candidate in ecology and environmental sciences, has led studies that revealed that wild blueberry fields in Down East Maine are warming faster than the state as a whole, and that fields experience warming differently, depending on their location, the season and the time of day, among other factors. Her work has garnered state and national media attention.

These studies, however, are only the beginning of what Tasnim hopes to accomplish while at UMaine. Another recent study that Tasnim co-authored found that wild blueberries are more sensitive to dry conditions over a long period of time, meaning proper soil moisture management is more essential than previously expected. Tasnim is evaluating materials that may improve water retention in the soil that would protect the plants during dry periods in blueberry fields, particularly those once considered waste products like compost and biochar to help create more sustainable food systems. She also has been assessing soil amendments, foliar fertilizers — those applied directly to leaves, and nanocellulose.

"I'm trying to study materials that are available here," she says. "My idea is to use whatever recyclable waste we have around us so that we don't pressurize the landfills anymore."

Tasnim conducts her research in the lab of YongJiang Zhang, her adviser and an assistant professor of applied plant physiology, and at UMaine's Blueberry Hill Farm in Jonesboro.

Tasnim began her academic career in civil engineering, earning her bachelor's degree from the Military Institute of Science and Technology (MIST) in her hometown and a master's degree from the Hong Kong University of Science and Technology (HKUST), with a specialization in geo-environmental engineering.

Her passion for safeguarding food systems from a warming planet ignited while she was working on a slope stability project during her postgraduate studies in Hong Kong. In particular, she was investigating the effects of increased carbon dioxide levels on vegetation that grows along slopes, which helps stabilize them by removing excess moisture through transpiration. Tasnim found that rising carbon dioxide levels reduce transpiration of those plants, which she says can lead to more water pressure in those slopes during rainfall, further decreasing soil stability and putting slopes at greater risk of landslides.

Graduate student Rafa Tasnim conducts research on blueberries in climate boxes at UMaine's Blueberry Hill Farm in Jonesboro.

While conducting her project, Tasnim says she realized she enjoyed researching plants, and how greenhouse gasses and climate affect the plant-soil interaction more than traditional civil engineering research areas. "That's how things changed for me," she says. "That was the time in my master's program that really sparked and helped me to understand what I really wanted."

While at UMaine, Tasnim has mentored undergraduate students for their own research projects, taught courses, presented and judged at the 2019 and 2021 UMaine Student Symposium, presented her research at the 12th International Vaccinium Symposium last year, and served as a technical reviewer for multiple journals.

She also has earned several fellowships, grants and other awards. This year, she received the Doctoral Student Graduate Research Excellence Award from the College of Natural Sciences, Forestry, and Agriculture; the Janet Waldron Doctoral Research Fellowship from the Graduate School; and the BioME Seed Grant from the Bioscience Association of Maine.

After she receives her doctoral degree, she hopes to continue helping growers, conducting soil and plant science research under a changing climate, and supporting more sustainable food systems by working as a faculty researcher, an employee of a federal agency or in research and development. ■

Transformative solutions for PFAS pollution

UMaine PFAS+ Initiative lays foundation for interdisciplinary collaborations.

The University of Maine has established the PFAS+ Initiative, a university-wide multidisciplinary effort to address the per- and polyfluoroalkyl substances (PFAS) pollution crisis and its cascading environmental and societal impacts.

The new initiative is led by a steering committee made up of four members including Onur Apul, assistant professor of civil and environmental engineering; Jason Bolton, an associate Extension professor and food safety specialist; Sharmila Mukhopadhyay, a professor of Mechanical Engineering and director of the Frontier Institute for Research in Sensor Technologies (FIRST); and Ali Abedi, a professor of electrical and computer engineering and associate vice president for research.

Commonly called "forever chemicals" because they tend to break down very slowly or not at all, this group of chemicals is widely used in industrial and consumer products such as nonstick pans, takeout food containers and firefighting foam. Over time PFAS can build up in the environment, impacting soil and water.

Current scientific research suggests that exposure to high levels of certain PFAS may lead to adverse health outcomes, including immune system disorders, thyroid hormone disruption and cancer.

The purpose of the initiative is to foster strategic planning of PFAS mitigation efforts, coordinate high-quality PFAS analysis and conduct cutting-edge research driven by the needs of government agencies, UMaine researchers and impacted stakeholders.

"The PFAS+ Initiative is a unique, collective effort of UMaine researchers to make Maine a nationwide leader in PFAS research. The new initiative will bring academics, government, industry, and community partners together to solve the complex environmental and public health problems caused by PFAS pollution. This is a solid first step in resolving Maine's contemporary and stigmatic PFAS pollution in a transformative, safe, and sustainable way," Apul says.

Long-term goals of the initiative are to unravel PFAS pollution pathways and develop safe and sustainable mitigation approaches involving new materials, devices, technologies, and processes for food, water and environmental safety. The initiative also aspires to create a transparent PFAS communication framework to minimize public health hazards.

The initiative's plus sign indicates the breadth of the impact that PFAS has on society, other emerging environmental pollutants and the transformative and novel approach that UMaine realizes.

Forever chemicals represent a grand challenge with local and global impact. UMaine Vice President for Research and Dean of the Graduate School Kody Varahramyan says, "The UMaine PFAS+ Initiative is part of a series of university-wide initiatives that have been strategically created as part of the University of Maine System's Research and Development Plan, and are supporting the realization of making Maine the best state in the nation in which to live, work and learn by 2030. This involves finding solutions to grand challenges that affect people both locally and around the world."

The new initiative builds on efforts by the Cooperative Extension and Senator George J. Mitchell Center for Sustainability Solutions PFAS Research Initiative to provide communities with important information regarding PFAS. Additionally, there are many ongoing collaborative projects across UMaine engaged in the assessment, impact and mitigation of these chemicals.

Apul is hopeful that research will result in progress. "At the pace and the resources that are spent for PFAS mitigation, I see a light at the end of the tunnel. Meaning that we may be understanding the pathways better. We may find better mitigation technologies. We may be slowly phasing out the fear of PFAS with the knowledge-building," he says. ■

Assistant Professor of Civil and Environmental Engineering Onur Apul serves as the chair of the steering committee for UMaine's new PFAS + Initiative.

Linking space to Maine's economy

UMaine Space Initiative establishes pathways for enhanced partnerships.

The University of Maine has a long history of space-related research and development activities dating back to the early 1990s.

Supported by National Aeronautics and Space Administration (NASA) and Maine Space Grant Consortium (MSGC), our fellowship and scholarship programs have been running continuously for over 32 years, training the future workforce, generating intellectual property, and contributing to the state economy. In the past decade, UMaine has been the unique host research institution for NASA's first inflatable lunar habitat and test site for the next generation of hypervelocity decelerators to support NASA's goal to take humans to the Moon and Mars. UMaine's research led to the development of a Wireless Leak Detection System for the International Space Station, which was launched and installed inside the International Space Station in December 2016.

Our space research outreach goes beyond the university community and into the K-12 system. The first small satellite in the state of Maine was developed at UMaine from 2019 through 2022 to support several science missions defined by middle and high school students and teachers across the state. Internship programs at NASA field centers resulted in several of our students being recruited by NASA, SpaceX, and other space technology companies.

Earlier this year, the UMaine Space Initiative managed a new seed grant program created to encourage innovative and interdisciplinary collaborations that result in rapid planning, team development, and research coordination. Eight projects have moved forward in the first two rounds of funding. Chosen projects support multidisciplinary and multi-institutional teams convening around a topic relevant to the MSGC, aerospace research broadly, and the economic vitality of Maine. Project PIs are current participants in the MSGC Ideas Lab. UMaine Space administers the Ideas Lab program for the state of Maine, supported by NASA, the MSGC Ideas Lab, and UMaine's Office of Vice President for Research and Dean of the Graduate School.

The Ideas Lab is a program that brings together a diverse group of researchers for a few days to brainstorm and develop innovative approaches for advancing Maine's involvement in space exploration. Its goal is to identify and support multidisciplinary, team-based R&D and education projects that align with the priorities of NASA Mission Directorates and MSGC's priority topic areas.

The Initiative provides centralized support to take these successful research programs to the next level, through cohesive strategic planning and infrastructure enhancement. ■

Setting Records with the world's largest 3D printer

The Advanced Structures and Composites Center continues to innovate with the manufacturing of two 3D-printed logistics vessels and the first 100% bio-based home.

The University of Maine Advanced Structures and Composites Center (ASCC) achieved groundbreaking milestones in composite manufacturing in February 2022 with the production of two 3D-printed prototype logistics vessels for the U.S. Department of Defense and again in November when it unveiled BioHome3D, the first 3D-printed house made entirely with bio-based materials.

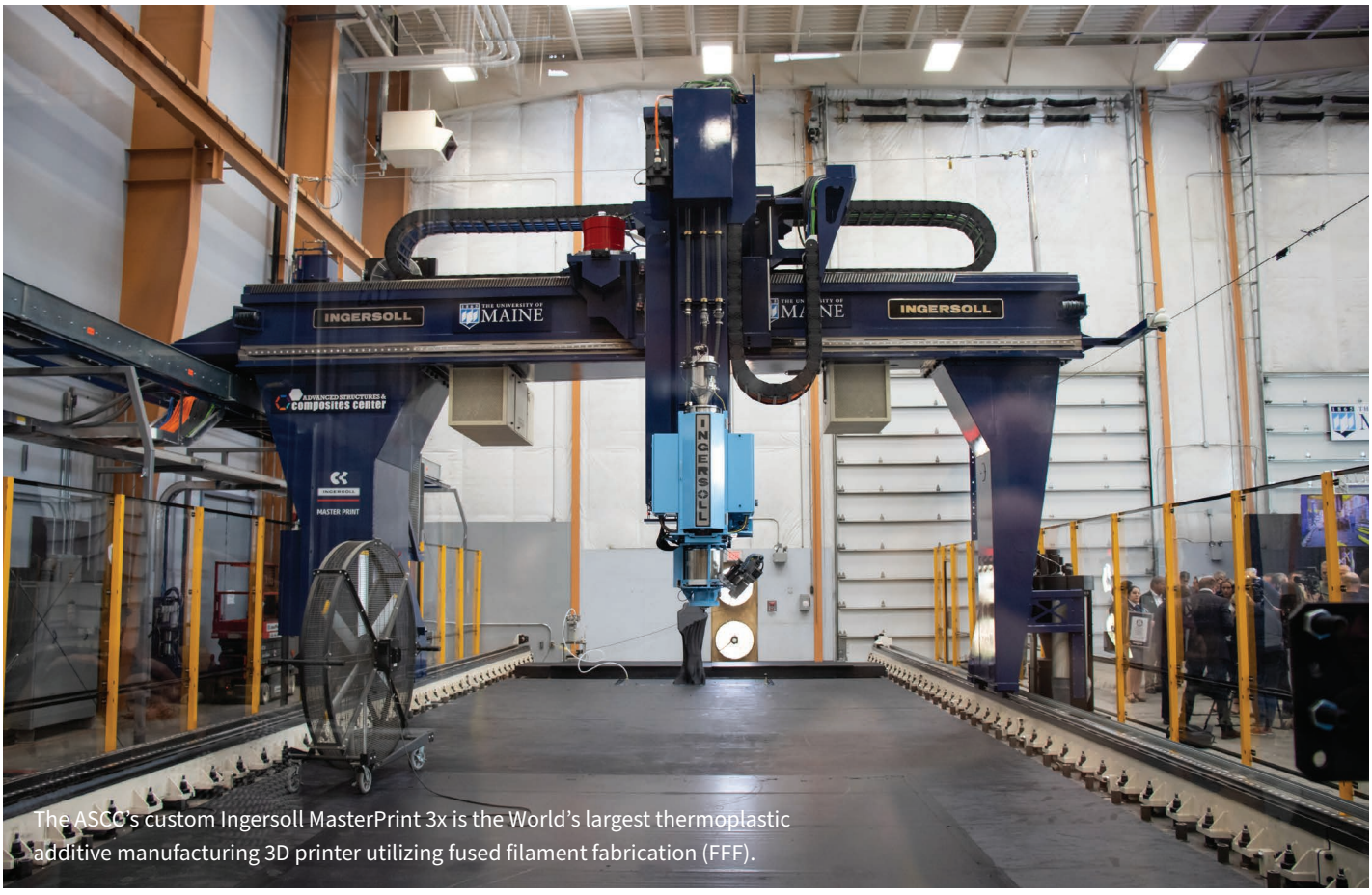
Logistics vessels

Marine Corps Systems Command's Advanced Manufacturing Operations Cell (AMOC), in collaboration with the ASCC, used advanced manufacturing techniques to successfully develop the expendable polymeric composite ship-to-shore vessels. The longer of the two vessels, the largest ever 3D-printed, simulates ship-to-shore movement of 20-foot containers representing equipment and supplies. The second vessel can transport a Marine rifle squad with organic equipment and three days of supplies. The prototypes can be connected, maximizing the transport capability of a single-tow vehicle.

The vessels align with the 38th Commandant of Marine Corps Gen. David Berger's vision to "seek the affordable and plentiful at the expense of the exquisite and few when conceiving of the future amphibious portion of the fleet," due to relatively low-cost, speed and ease of production.

Using traditional materials and methods, landing craft utility vessels can take over one year to produce. The UMaine Composites Center printed and assembled one of the two vessels in a month. The vessels were produced using the world's largest polymer 3D printer, which the center commissioned on October 10, 2019, earning three Guinness World Records. The printer, with both additive and precise subtractive manufacturing capabilities, enables rapid prototyping for both defense and civilian applications.

"As the Marine Corps seeks to modernize logistics to better respond to current and future conflicts, advancements in additive manufacturing will ensure we remain agile, lethal and expeditionary," said William Williford, executive director of Marine Corps Systems Command.



The ASCC's custom Ingersoll MasterPrint 3x is the World's largest thermoplastic additive manufacturing 3D printer utilizing fused filament fabrication (FFF).

Bio-based home

BioHome3D was developed with funding from the U.S. Department of Energy's Hub and Spoke program, a partnership between the UMaine and Oak Ridge National Laboratory.

The 600-square-foot prototype features 3D-printed floors, walls and roof of wood fibers and bio-resins. The house is fully recyclable and highly insulated with 100% wood insulation and customizable R-values. Construction waste was nearly eliminated due to the precision of the printing process.

The prototype is currently sited on a foundation outside ASCC, equipped with sensors for thermal, environmental and structural monitoring to test how BioHome3D performs through a Maine winter. Researchers expect to use the data collected to improve future designs.

BioHome3D was printed in four modules, then moved to the site and assembled in half a day. Electricity was running within two hours with only one electrician needed on site.

The technology is designed to address labor shortages and supply chain issues that are driving high costs and constricting the supply of affordable housing. Less time is required on-site building and fitting up the home due to the use of automated manufacturing and off-site production. Printing using abundant, renewable, locally sourced wood fiber feedstock reduces dependence on a constrained supply chain. These materials support the revitalization of local forest product industries and are more resilient to global supply chain disruptions and labor shortages. ■

"Our state is facing the perfect storm of a housing crisis and labor shortage, but the University of Maine is stepping up once again to show that we can address these serious challenges with trademark Maine ingenuity. With its innovative BioHome3D, UMaine's Advanced Structures and Composites Center is thinking creatively about how we can tackle our housing shortage, strengthen our forest products industry, and deliver people a safe place to live so they can contribute to our economy. While there is still more to be done, today's development is a positive step forward — one that I was proud to support through my Maine Jobs & Recovery Plan and my budget. I extend my congratulations and thanks to the University of Maine and its partners, and I look forward to continuing to tackle these problems with innovative solutions."
— Maine Gov. Janet Mills

Meeting student demand and employer needs

New Ferland Engineering Education and Design Center ushers in a new chapter.

With the grand opening of the E. James and Eileen P. Ferland Engineering Education and Design Center (Ferland EEDC) at the University of Maine, a new chapter begins in engineering education to better meet the needs of students and employers, including the innovation to advance research and economic development.

Ferland EEDC is home to the Department of Mechanical Engineering and the Biomedical Engineering Program, and includes teaching laboratories for the Mechanical Engineering Technology Program.

The Student Project Design Suite is the best of its kind in the Northeast, with 44 workbenches that will be assigned to students; and shops for biomedical engineering, electronics, 3D printing, vehicles, metals, wood and composites. The building also houses the Campus Welcome and STEM Outreach Center, which will be the starting point for campus tours, and five collaborative classrooms that will serve the entire campus.

The facility will have the capacity to increase engineering enrollment by a third — 600 additional students a year — to meet the demand of students and employers in the state.

Approval of $50 million in public investment over 10 years by the Maine Legislature and then-Gov. Paul LePage in 2017 helped to catalyze the campaign. Since then, a record $25 million in private support was raised from more than 500 alumni, friends, foundations and corporate donors for this capital priority of UMaine's $200 million Vision for Tomorrow comprehensive campaign, led by the University of Maine Foundation.

In the years since, subsequent state Legislatures and Gov. Janet Mills have sustained this support and in May, appropriated additional debt service that will help modernize other engineering and related facilities at UMaine and across the University of Maine System to advance a goal to double the output of engineers and computing and information science professionals to meet the demands of Maine employers for world-class talent and innovation.

Construction of the 115,000-square-foot facility began in May 2020. WBRC Architects Engineers, based in Bangor, and Ellenzweig of Boston designed Ferland EEDC; Consigli Construction of Milford, Massachusetts and Portland, Maine led its construction. Over the two years of the design and two years of the construction of Ferland EEDC, more than 70 UMaine alumni are estimated to have worked on the project.

This is an exciting, pivotal time for engineering education in — and for — Maine, said UMaine College of Engineering Dean Dana Humphrey. "The Ferland Engineering Education and Design Center is a capital investment in the future of engineering education that will impact Maine and beyond, made possible by the vision and leadership of hundreds of donors and corporate partners who know the difference that this facility will make in workforce and economic development. Coupled with the transformational investment in the Maine College of Engineering, Computing and Information Science by the Harold Alfond Foundation, we are positioned to provide critical industries, communities, and employers with the skilled workers and innovation needed to meet demand and move Maine forward."

The building's $10 million naming gift, the largest capital gift in UMaine history, came from Skowhegan natives E. James "Jim" Ferland '64 and Eileen P. Ferland. "We'd like to acknowledge Dean Dana Humphrey's leadership, as well as the dedicated design and construction team," said the Ferlands. "It's an honor to have the Ferland Engineering Education and Design Center bear our family name. It's what we expected — a place that will inspire and prepare the next generation of UMaine engineers." ■

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*"This **state-of-the-art center at our R1 university** will allow us to produce more engineering and computing and information science professionals that Maine needs to grow its economy and be competitive in the world. This facility is a tribute to the forward thinking and leadership of three Legislatures and two Governors on behalf of the people of Maine and stakeholders who know the value of a UMaine education and hands-on research learning and the difference it makes in the success of its students, alumni and the state."* **— President Joan Ferrini-Mundy**


Fenlon Engineering Education
and Design Center

Advancing coastal ecosystem sustainability

UMaine is leading the way in an emerging field that combines environmental science and genetics, revolutionizing how scientists understand and monitor our state's 3,500 miles of coastline.

The five-year Maine eDNA initiative is co-led by researchers from UMaine and the Bigelow Laboratory alongside local industry leaders and collaborators in education and government agencies across the state. The state-wide, multi-institutional initiative establishes Maine as a national leader in environmental monitoring, ecological understanding and sustainability of coastal ecosystems through research, education and outreach. "It addresses the statewide workforce needs in critically important areas including biotechnology, ecology, environmental and data sciences," says principal investigator Kody Varahramyan, UMaine vice president for research and dean of the graduate school. Co-PIs include Kate Beard-Tisdale, David Emerson, Michael Kinnison and Heather Leslie.

Organisms leave traces of DNA called environmental DNA, or eDNA. These traces can be collected, identified and linked to those species. Analyzing tiny fragments of DNA in the air, water and soil provides scientists with information that can help inform policymakers and industry leaders of rapid changes to critical ecosystems.

The program focuses on two pressing issues for the coast of Maine: sustainable fisheries and harmful species. Sustainable fisheries research includes studying the outcomes of large-scale restoration efforts and unraveling the complex early life cycles of economically important species like lobster. Work on harmful species includes developing early warning systems for toxic algal blooms and forecasting the spread and impacts of invasive species.

Researchers quickly identified the need for advanced testing services that serve academic, government, industry and non-governmental organizations and leveraged the RII Track-1 award to establish the Environmental DNA Laboratory through UMaine's Coordinated Operating Research Entities (CORE).

"The lab plays a major and enduring role in the eDNA analysis pipeline that can support data sharing and reanalysis for current and future research. Establishing the pipeline is a major step to not only achieving the project's goals but also for eDNA to achieve its long-term potential," explains Kinnison, a professor of Evolutionary Applications at UMaine's School of Biology and Ecology.

Kinnison also serves as the director of the Maine Center for Genetics in the Environment (MCGE). The center was established to provide infrastructure for interdisciplinary research, innovation and training and will serve as a permanent home for collaborations and partnerships build under the Maine eDNA program. "The Maine Center for Genetics in the Environment is first and foremost a community of researchers and others who see the transformative value of genetics and genomics in environmental sciences," Kinnison says.

The center is establishing a growing reputation for translating cutting-edge science into real-world applications. Kinnison says that environmental genetics can do a lot to support Maine's current natural resources industries, from fisheries to forestry, agriculture, energy production and tourism, while at the same time building Maine's capacity in biotechnology and information technology. Recently MCGE was awarded funding that moves beyond their typical marine research—monitoring mosquito expansion and disease outbreaks through eDNA.

Through its robust network, the program has also created opportunities for statewide outreach. Members with expertise in K-12 education work to deliver eDNA curriculum toolkits for teachers to use in classrooms and help to educate students about STEM career pathways. Over the course of the five-year grant, thousands of Maine students will be engaged.

Heather Leslie, professor in the School of Marine Sciences and director of the Darling Marine Center, noted that the prominent role of social science research within the Maine-eDNA project has not only been exciting for the team but also for the National Science Foundation.

"From the very beginning of this project, the social sciences and social scientists have been integral to how we have formulated our research projects, student training, and also engagement with community, government and private sector partners," Leslie observed.

Kate Beard-Tisdale says, "For Maine-eDNA we have developed a comprehensive metadata database that tracks information covering field sampling, wet lab processing, sequencing and bioinformatics analysis steps. We did not find any similarly comprehensive metadatabases in the field so we feel this is a key contribution not just to Maine-eDNA but to the broader community." Beard-Tisdale is a professor in the School of Computing and Information Science and a research faculty member with the Spatial Data Science Institute.

With these tools, researchers can study the structure and function of marine food webs, and shifts in species, and evaluate fisheries stocks and restoration efforts around the state. These findings set the stage for many future studies of commercially, recreationally and culturally important species in the Gulf of Maine.

In just three years, the Maine-eDNA grant has had a profound impact. The new program has brought greater focus to sustaining coastal ecosystems and provided opportunities for new collaborations. "I think the most exciting thing about Maine-eDNA is that it brings together institutions that have similar aspirations to learn more about the environment," says Peter Countway, a senior research scientist at the Bigelow Laboratory for Ocean Sciences.

The program reflects a major interdisciplinary research achievement uniting educators, researchers and students. It sets the stage for long-term monitoring of biodiversity patterns and changes along the coast, a vital part of Maine's economy. ■

Supported by RII Track-1: Molecule to Ecosystem: Environmental DNA as a Nexus of Coastal Ecosystem Sustainability for Maine (Maine-eDNA), a National Science Foundation award to Maine EPSCoR.

Modeling change to an iconic industry

Researchers investigate climate-induced changes in lobster abundance and distribution.

Investigating how a rapidly warming Arctic will affect American lobster populations and the communities that depend on them in New England and Atlantic Canada will be the focus of a UMaine-led study backed by a $3 million award from the National Science Foundation's Navigating the New Arctic Program (NNA).

Richard Wahle, director of the university's Lobster Institute and professor in the School of Marine Sciences, is spearheading the project, dubbed the NNA Lobster Network, joined by 18 other researchers from UMaine, the Gulf of Maine Research Institute, Columbia University, Florida State University and Memorial University of Newfoundland. Building on long-standing partnerships with the fishing industry, government and academic organizations, the team will investigate how climate-induced Arctic change alters lobster abundance and distribution from coastal Rhode Island to Newfoundland.

NSF funded the study not only as part of its NNA initiative, but also as one of its 10 Big Ideas. The NNA Lobster Network will support investigations into the influence of past and future climate and management scenarios on various physical, biological and socio-economic conditions at different scales; all through cross-sector and cross-border partnerships.

The results of this project could help improve models for lobster population distribution forecasts, as well as an understanding of the economic dependence of coastal communities on this fishery and, therefore, their vulnerability to future change. Researchers hope that new data on Arctic ice melt trends will give the team unprecedented lead time to anticipate ocean ecosystem changes that influence lobster distribution and abundance.

"The project is well timed to meet the urgent need to understand the increasingly apparent links between a rapidly warming Arctic and the rapid ecosystem changes in the Gulf of Maine, the Gulf of St. Lawrence, their fisheries and communities that, in some cases, are perilously reliant on the American lobster," Wahle says.

Other UMaine faculty involved in the study include Damian Brady, associate professor of oceanography; Christine Beitl, associate professor of anthropology; Joshua Stoll, assistant professor of marine policy; and Heather Leslie, professor of marine sciences and director of the Darling Marine Center. Outreach and communication staff support is provided by Chris Cash, assistant director of the Lobster Institute; Natalie Springuel, Marine Extension program leader with Maine Sea Grant; and a technical liaison yet to be hired. The project also includes four postdoctoral fellows and two graduate students.

To determine how changes in the Arctic affect lobster populations in the Northwest Atlantic, Wahle and his team plan to create a climate vulnerability assessment that focuses on the lobster fishery's northward range shift as the ocean warms. They also will develop a coupled atmosphere-ice-ocean-ecosystem model to examine how changes in ocean circulation and the Arctic cryosphere, the frozen parts of the region, affect fishery and ecosystem productivity in New England and Atlantic Canada. Researchers will use existing field datasets, including some co-produced with the fishing industry, to validate their model.

Arctic warming poses several threats to the world's oceans. Melting glaciers, icebergs and ice sheets are increasing sea levels and altering ocean circulation, a crucial driver of heat movement around the globe that, when disrupted, can increase or decrease water temperatures and cause unpredictable weather and climatic changes. Additionally, thawing permafrost in the Arctic is releasing more carbon into the atmosphere.

Wahle is one of many UMaine faculty members conducting research involving the Arctic and the implications of its climate-induced warming. In 2018, the UMaine Arctic Initiative was formed to build on their work and enhance collaboration in the campus community and with outside stakeholders. ■

"The lobster fishery is a heritage industry that is essential to the island and coastal communities of Maine. Knowing more about future climate conditions in the Gulf of Maine will allow the fishery to adapt practices so that they can see continued success." **— Executive Director of the Maine Lobster Marketing Collaborative Marianne LaCroix**

Left to right: Associate Professor Jianjun Hao with Katie Ashley and Ross Sousa.

Testing lobster shells to thwart potato soil pathogens

Scientists are evaluating if lobster shells can cultivate beneficial microbial communities that ward off soilborne potato pathogens. The novel shell-to-spud combination may connect two cornerstones of Maine's food system and enhance the state's circular economy.

Potatoes are Maine's top agricultural commodity with a value of more than $215 million in 2021, according to a National Agricultural Statistics Service report. The crop's value is in its roots, making it especially susceptible to soilborne diseases. Early potato dying syndrome, a fungal pathogen present in Maine, can decimate as much as half of a crop in severely affected fields.

Katie Ashley, a plant science Ph.D. student in the lab of Associate Professor Jianjun Hao, is assessing how different concentrations of cooked, dried and ground lobster shells may prevent potato disease. Ross Sousa, a fourth-year botany major from Somerset, Massachusetts, has also worked on the project as a laboratory technician. In addition to disease resistance, the team is also tracking soil microbial communities, overall crop yield, and plant emergence, vigor, biomass and height.

"We're very fortunate to have both rich agricultural production and a blue economy. It puts Maine in a very unique position," says Ashley, who earned her master's in plant pathology from UMaine.

The team completed a greenhouse trial with 90 plants on UMaine's campus this fall. A field-scale trial in the 2023 growing season will compare plots with different concentrations of chitin, compost and chemical fumigation at Aroostook Farm in Presque Isle. ■

Dried lobster shells are processed in a blender and then grain mill, rendering them the texture of cornmeal.

Aerial view of the University of a Maine at Machias and the surrounding community.

Supporting the local economy through research

The University of Maine at Machias is home to researchers with deep connections to the local community.

Professor of Marine Ecology Brian Beal has been a leader of marine research throughout the state of Maine and the University of Maine community for over 30 years. Growing up in Jonesport, Beal developed a deep connection with the sea that has fueled a lifelong interest in marine science.

In the mid-1980s as local fishermen in Washington county became concerned about a decrease in soft-shell clam harvests, Beal worked together with the group to learn how to spawn clams, raise larvae, and grow them into seed clams that can be planted in mudflats. In 1987 the joint venture became Maine's first public shellfish hatchery, formally called the Beals Island Regional Shellfish Hatchery, which evolved in the early 2000s to become the Downeast Institute (DEI), where Beal currently serves as the director of research.

The institute serves as the University of Maine at Machias Marine Science Field Station and local experiential classroom, where students can develop their own research projects or become engaged in existing research. It is the easternmost marine research laboratory and education center in the country and houses a commercial-scale marine research hatchery, running seawater labs, and educational classroom and housing facilities that are available to researchers. The facility cultures commercially important shellfish seed, restoring and creating economic opportunities for harvesters, aquaculturists and other entrepreneurs throughout coastal Maine and beyond.

Beal has cultured most of Maine's commercial marine shellfish species, examining their growth and survival under field conditions in a variety of nearshore habitats. He says that one of the most exciting parts of his research is when he is able to deconstruct a field experiment to collect data that has been accumulating for months at a time. "The experiment is designed to produce an answer, and typically does; that will help me and others better understand what happened or what is happening in a particular marine ecosystem," he says. "It is exciting to understand the mechanisms that are in play that tend to regulate natural populations."

Professor of Marine Ecology Brian Beal is a marine benthic (bottom) ecologist.

A year before he created the clam hatchery that would become DEI, he helped establish Maine's first lobster hatchery in the town of Cutler. In 2000-2001 Beal was a Fulbright scholar at the National University of Ireland, Galway, where he worked with local fishermen and researchers to develop new economic opportunities through shellfish mariculture.

In 2019, Beal was named one of Maine Magazine's "50 Mainers" creating a brighter future for the state for his "pivotal role in enhancing Maine's marine economy since the 1980s." He has not only dedicated his life to his community but has also trained the next generation of researchers to sustain and enhance Maine's marine ecosystems, a vital part of the state's blue economy. ■

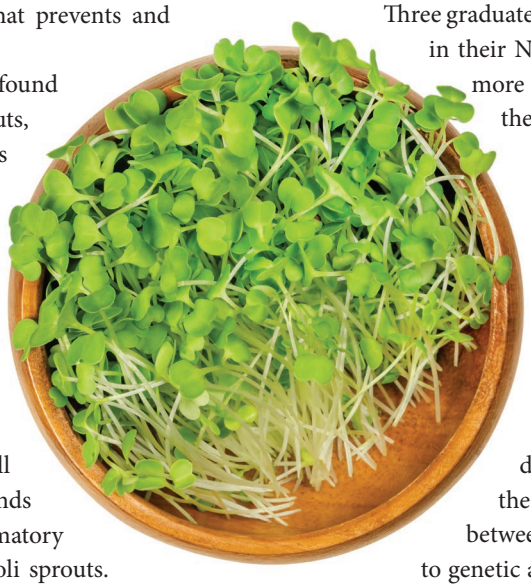
The Downeast Institute is located in Beals, Maine on Great Wass Island.

Preventing and treating disease in humans

Researchers study the anti-inflammatory benefits of broccoli sprouts.

Researchers are investigating whether broccoli sprouts can help prevent and treat inflammatory bowel disease in humans.

Through multiple studies, Yanyan Li, assistant professor of human nutrition; Sue Ishaq, assistant professor of animal and veterinary sciences; and researchers from other institutions will explore how human gut microbes could use a compound from broccoli sprouts to generate a new one that prevents and reduces inflammation.



Previous research from Li and others found that when mice ate steamed broccoli sprouts, the microbes in their gastrointestinal tracts — in particular those in the colon — used the sprouts to create anti-inflammatory compounds that prevented and treated colitis, a type of inflammatory bowel disease, and an infliction similar to Crohn's disease in humans.

In one study, Li and Ishaq will conduct diet trials over 18 months to determine if the microbes in healthy humans' colons will produce more anti-inflammatory compounds — ones that could help prevent inflammatory bowel disease — when fed steamed broccoli sprouts. The Allen Foundation provided a $114,359 grant to support the research.

Li also is participating in research led by University of Michigan Medical School researcher Grace Chen to determine if steamed broccoli sprouts can help people who already have ulcerative colitis, how that would change their gut microbes and inflammation status, and how many servings would be needed to produce positive results.

For the study, supported by an $800,000 award from the U.S. Department of Agriculture National Institute of Food and Agriculture, Chen, Li and Duxin Sun, also a Michigan Medicine faculty member, will conduct clinical trials in which they incorporate broccoli sprouts in their participants' existing diets; measure the anti-inflammatory compounds and changes in their gut microbes; and evaluate the effects on peoples' conditions.

"Broccoli sprouts contain a uniquely abundant group of compounds, and they can get activated into anti-inflammatory compounds by certain enzymes. Some recent studies have shown that mammalian gut microbes may be able to produce these enzymes to carry out the bioactivation," Li says. "We wanted to see if broccoli sprout feeding in humans can change gut microbes and result in production of more anti-inflammatory compounds. These studies will provide useful information for us to develop dietary approaches for prevention and management of inflammatory bowel disease."

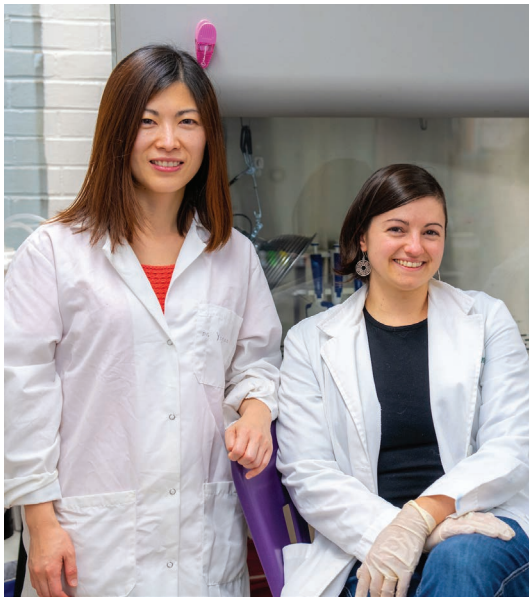
In addition to holding human trials, Ishaq and Li will conduct a study funded by a $436,046 grant from the National Institute of Health/National Institute of Diabetes and Digestive and Kidney Diseases to explore how different preparations and concentrations of broccoli sprouts affect the ability of gut microbes in mice to prevent and mitigate inflammatory bowel disease.

Three graduate students from Ishaq's and Li's labs will assist in their NIH-backed study. They also plan to recruit more graduate students and undergraduates for their research.

These studies build on years of individual and collaborative research into the correlation between nutrition, gut microbiota and inflammation by Li, Ishaq and their colleagues from the University of Michigan, Husson University, the University of Vermont and the State University of New York at Binghamton.

The cause for inflammatory bowel disease remains unknown, but the prevailing theory involves a disruption of the connection between gut microbes and the immune system due to genetic and environmental forces. Li and Ishaq also say a growing body of evidence from them and other scientists indicate that "gut microbiota have significant impact on human health and thus impact susceptibility to disease, such as inflammatory bowel disease."

"There is so much about nutrition, gut microbes and health that researchers are still trying to understand. Being able to run multiple projects together, and work with researchers in different specializations, is an enormous help to tease apart the complicated process by which these microbes could be used to promote health," Ishaq says. ■



Assistant Professor of Human Nutrition Yanyan Li (left) and Assistant Professor of Animal and Veterinary Sciences Sue Ishaq.

Leading collaboration and building partnerships in health and medicine

Institute of Medicine hosts first statewide symposium on biomedical research and engineering.

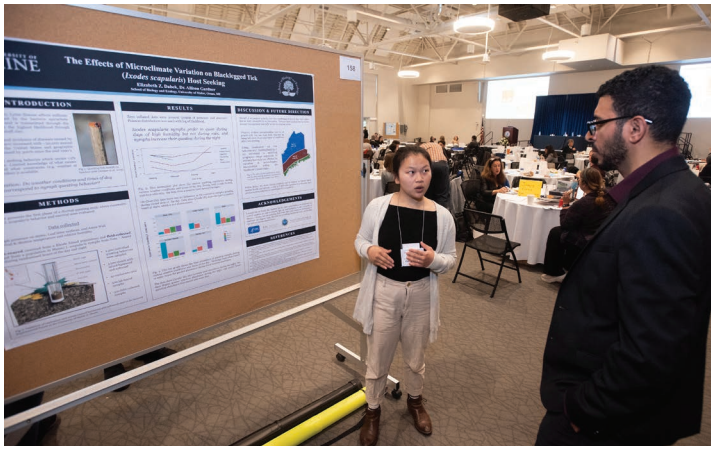
Maine's First Annual Research Symposium on Biomedical Science and Engineering drew over 225 researchers from across the state. The event was organized by UMaine's Institute of Medicine in collaboration with The Jackson Laboratory, MDI Biological Laboratory, MaineHealth, the University of New England (UNE), the Roux Institute, Northern Light Health and the University of Southern Maine.

Held from October 13 to 15, the event took place at UNE's Innovation Hall on the university's campus in Portland, Maine. Around 85 students presented their research at the symposium, capitalizing on valuable opportunities for networking with faculty and industry leaders across the state, and representatives from biomedical and healthcare organizations.

Highlights of the event included addresses from U.S. Senator Susan Collins, UMaine President Joan Ferrini-Mundy and UNE President James D. Herbert, along with presentations and panel-led sessions related to research on health care, artificial intelligence, public health and rural disparities, and innovations in technology.

Senator Collins emphasized the value of Maine's growing leadership in these fields and the impact of current research. "There simply is no investment we can make that provides greater returns for Americans than our investment in biomedical research," she said. "It is not an exaggeration to say that biomedical research improves and changes lives and can change the world.

The event was sponsored by UMaine and the Graduate School of Biomedical Science and Engineering, MDI Bioscience, the Bioscience Association of Maine, IDEXX Labs, Maine Technology Institute and Environments for Health. ■



Maine's First Annual Research Symposium on Biomedical Science and Engineering featured presentations, panel discussions and an interactive mentoring workshop with participation from students, faculty and industry leaders in the audience.

Enhancing the quality of life of older adults

In March 2022, UMaine achieved full membership to the Age-Friendly University (AFU) Global Network. The AFU initiative aims to expand age-friendly inclusiveness throughout higher education. The new designation is a culmination of two decades of extensive work and progress, brought about by the Center on Aging.

The Center on Aging (CoA) at the University of Maine is dedicated to improving the lives of older adults. Led by Director Lenard Kaye, a professor of social work and UMaine Trustee Professor, the center conducts research, offers services, and provides educational opportunities to tackle the various challenges faced by aging populations, including healthcare, housing, isolation, and loneliness. These issues have been further exacerbated by the COVID-19 pandemic.

There are no easy solutions to these complex issues, says Kaye. "We have a rather comprehensive charge," he says. "Our mission speaks to not only conducting research and discovering new knowledge that will improve the quality of life of older adults, but we also realize the importance of connecting directly with older adults and their families and caregivers in the community."

Since establishing during the winter of 2001-2002, the CoA has made great strides. Senators Susan Collins, Angus King and Representative Jared Golden recently commended the center on their extensive work and impact on the community. "UMaine's Center on Aging is an invaluable resource for Maine seniors as well as for students and researchers working to improve quality of life for older adults in our state," they said in a joint statement.

Part of the center's success stems from their effort to secure funding. Over the last two decades, the CoA has received almost $20 million, which has allowed it to conduct a range of research, education, and service activities that benefit the entire state of Maine and prepare the next generation of the workforce to improve the quality of life of older adults.

The CoA conducts training needs assessments and uses the findings to develop curricula, training programs, and conferences to fill identified knowledge gaps. "Our research is practical. It has application value, and it aims to transform the healthcare system so that it's more person-centered, sensitive, effective and age-friendly," Kaye says.

Jennifer Crittenden, an assistant professor of social work and CoA's associate director, specializes in translating academic research into professional and public education programs, events and activities. "As an applied researcher, I'm looking for solutions and innovations that help older Mainers better manage their health, care for their family members and give back to their communities as volunteers," Crittenden says.

This year the center collaborated with at least 42 partner organizations, including the Red Cross and Northern Light Health, and is closely connected with the University of Maine's Institute of Medicine due to their shared focus on health.

It has been an exciting year for the center. In March, UMaine announced that it had achieved full, endorsed membership to the Age-Friendly University (AFU) Global Network. The AFU initiative aims to expand age-friendly inclusiveness throughout higher education. The center offers many programs and services that encourage older adults to involve themselves in campus life. Participants take courses, volunteer, participate in research studies, sit on boards and advisory groups, and attend social and recreational activities.

The network includes 90 higher education institutions around the world. UMaine is the first public university within Maine to achieve this designation. "Being recognized as an age-friendly university drives home our commitment. The age-friendly movement is alive and well on campus," Kaye says.

The new AFU designation fuels UMaine's ongoing commitment to expand opportunities for older adults on campus by cultivating new opportunities to participate in campus life, developing inclusive marketing that promotes their presence on campus and expanding university programming to improve access. ■

Professor of Social Work Lenard W. Kaye has served as director for the Center on Aging for twenty years, shaping the center into what it is today.

Maine is the oldest state in the U.S. based on median age and is home to the largest percentage of baby boomers in the country. As a state-funded institution, the University of Maine works to support all the people of Maine. That includes the 21% who are 65 and older. Throughout its history, the focus of the Center on Aging has been constant: to support the needs of older adults.

Shaping indigenous collections for the future

Hudson Museum project replicates 19th-century artifact using 3D printing and intermedia techniques.

A 19th-century clan helmet of carved yellow cedar in the Northwest Coast collection of the Hudson Museum at the University of Maine has been introduced to 21st-century 3D printing technology in an attempt to replicate the artifact for future repatriation and educational purposes.

The museum, in collaboration with UMaine's Advanced Structures and Composites Center and Intermedia Program, received a $14,600 seed grant from the UMaine Arts Initiative for the project, "Technology and Tradition: Shaping Indigenous Collections for the Future." The funding supports the creation of a 3D printed prototype replica, and the work of UMaine student intermedia artists to do final surface finishing and treatment, and painting to match the original artifact.

The object, a Frog Clan Helmet painted in green and red pigments and inlaid with abalone shell discs that were originally attached to a textile, is subject to tthe Native American Graves Protection and Repatriation Act. The Hudson Museum has repatriated unassociated funerary remains and this piece is part of a ongoing request from the Central Council of Tlingit and Haida Indian Tribes of Alaska.

Harold Jacobs, cultural resources specialist for the Central Council, granted permission to do the prototype project, which has the potential to facilitate the return of the artifact to the Indigenous community and allow the Hudson Museum to retain the culturally important replica for educational purposes.

The project also allows the Hudson Museum to develop a proof of concept for collection replication projects, helping to create protocols for replication projects with Indigenous communities and to provide other collecting institutions with technical information on 3D scanning, printing and techniques for creating surfaces that resemble the original artifact or object, says director Gretchen Faulkner. The project draws on UMaine's world-class expertise in 3D printing at the Composites Center and engages UMaine Intermedia Program students' skills in a museum setting.

Composites Center research engineers Jonathan Roy and Alexander Cole led the scanning, digitizing and 3D printing of the prototype, created out of a durable thermoplastic that can be sanded to a smooth finish. Intermedia graduate students Luke McKinney, Reed Hayden and Anna Martin are collaborating on the model

*The **University of Maine Hudson Museum** has opened a new exhibit showcasing a **3D-printed replica of a 19th-century clan helmet from the Northwest Coast** and photography that documents its creation. The exhibit is located in the museum's Minsky Culture Lab. The original Tlingit Frog Clan Helmet, carved out of yellow cedar, painted in green and red pigments and inlaid with abalone shell discs that were previously attached to a textile, sits alongside its identical replica. The 3D printed model was created by engineers from UMaine's Advanced Structures and Composites Center and graduate students from the Intermedia Program.*

finishing, painting and surface treatment to replicate the appearance of the original carving.

The creation of the Frog Clan Helmet replica, including photos and time lapse video of its scanning and printing, was the focus of a Hudson Museum exhibit in late July.

The Frog Clan Helmet was part of a 1982 bequest to UMaine from the estate of William P. Palmer III, which included an extraordinary gift of Precolumbian objects that ranged from Olmec to Aztec, and an assemblage of Northwest Coast masks, potlatch bowls, Chilkat textiles and items made for sale outside the community. The Hudson's Northwest Coast Collections include deaccessioned museum holdings and objects acquired from Native American art dealers. Collection documentation indicates that Palmer acquired the Frog Helmet from a California collector.

Tlingit clan hats and helmets were crest objects, referred to as at.oow, displaying either clan symbols or crest animals. Among the Tlingit, such helmets are communally owned and kept in the possession of the head of the clan, and the tribe has actively worked with museums throughout the United States for their return.

Objects of cultural patrimony returned through the Native American Graves Protection and Repatriation Act have been reintegrated into federally recognized Native American tribes and Native Alaskan and Hawaiian villages and organizations' ceremonial and religious practices.

Hats are worn and danced by clan leaders on important ceremonial occasions, the death of clan leaders and potlatches. In the late 19th and early 20th century with efforts to eradicate Indigenous languages, traditions, and ceremonial and religious practices, many were collected by museums or sold to collectors, according to Faulkner. Today, the return of these objects has brought healing to Tlingit communities and reconnected them to their cultural traditions of their ancestors.

"Technology and Tradition: Shaping Indigenous Collections for the Future" was one of five funded projects to receive seed grants as part of the new Arts Initiative launched in 2021 by the UMaine Office of the Vice President for Research and Dean of the Graduate School. The Initiative's mission is to increase resources and support for the arts, reinforcing their significance and enhancing their visibility on campus and beyond. ■

Interdisciplinary Ph.D. Candidate Anna Martin used acrylic paint, pencil and various techniques to replicate the artistry and wear of the original helmet.

2022 NSF CAREER Award Recipients

Five faculty members were selected for the National Science Foundation (NSF) CAREER Award, considered one of the most prestigious awards for junior faculty members in the U.S. Awarded to early career researchers who have demonstrated the potential to serve as academic role models and to lead advances in the mission of their department or organization, the award provides funding for up to five years to support the research and educational activities of the recipient. This support can be critical for faculty members who are just starting their careers and trying to establish themselves in their field. In addition to providing funding, the NSF CAREER award also serves as recognition of the recipient's achievements and potential, which can help to boost their career and increase their visibility in the scientific community.

Justin Dimmel

Assistant Professor of Mathematics Education and Instructional Technology

Justin Dimmel received an award for his project to investigate the transformative educational potential of using virtual reality technology.

The emergence of extended reality (XR) technologies, such as virtual and augmented reality, offers a profound shift in our capacities for representing and interacting with information. Three-dimensional figures can now be represented as diagrams that appear to extend into space in ways that are free of material or physical constraints. They can be rendered at any size, in any orientation, and at any position in space, and can thereby realize a far more varied set of mathematical concepts than what is possible with physical models.

The goal of Dimmel's project is to investigate the transformative educational potential of these representations and to generate a knowledge base that teachers, teacher educators, and researchers can use to reimagine the learning and teaching of geometry. ■

Salimeh Yasaei Sekeh

Assistant Professor of Computer Science

Salimeh Yasaei Sekeh's project investigates three desirable properties when developing deep networks, including performance, efficiency, and robustness. Her project also includes a comprehensive plan to integrate research results into inclusive, diverse, and cross-disciplinary educational multilevel programs by funding graduate research assistants, summer research fellowships for high-school students and teachers, and organizing a hybrid (online and in-person) deep-learning boot camp.

The overall goal of her research program is to develop a comprehensive and fundamental understanding of the robustness and computational aspects of deep networks by leveraging tools and concepts from probability, information theory, and statistics.

The project aims to make critical advances in areas such as proper formulations of subnetwork adversarial robustness, characterizing transferability via curriculum learning, and in developing efficient approaches for reducing computational complexity involved in training, among others.

The theoretical and methodological outcomes of this cross-disciplinary project will broaden the prior knowledge of deep learning, a type of machine learning, and will improve prediction, exploration and detection applications of machine-learning models. ■

Babak Hejrati

Assistant Professor of Mechanical Engineering

Through his award by the NSF Disability and Rehabilitation Engineering (DARE) program, Babak Hejrati will establish a framework for helping people with mobility issues — such as older adults with mobility decline and those who have had a stroke — to improve their walking ability using wearable robots.

People with walking problems due to aging or neurological disorders such as stroke and Parkinson's disease often participate in gait training therapy to improve their walking ability. Walking is a complex skill that requires highly coordinated leg and arm movements. Current methods for gait training often focus on improving leg movements, but often overlook the importance of arm movement, particularly arm swing, which impacts stability, balance and the efficiency of energy use while walking.

Hejrati plans to develop two new wearable robotic devices to examine how the neural circuits that control limb movements interact while walking at different speeds to produce coordinated arm and leg movements in subjects without mobility issues. In patients with mobility issues, the robotic devices will be able to help induce proper whole-body response and enhance their walking ability. ■

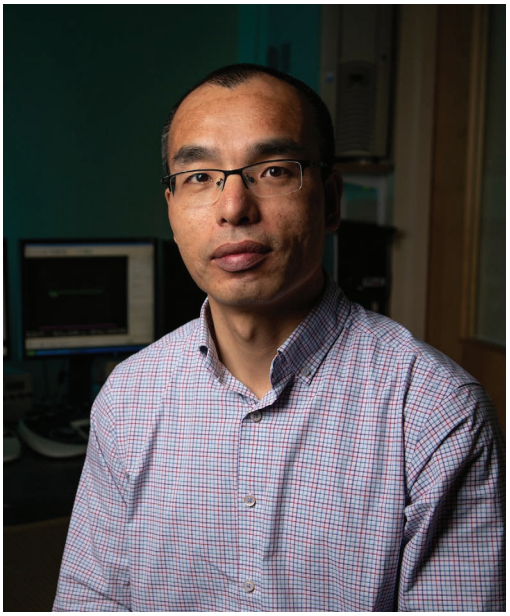
Qian Xue

Assistant Professor of Mechanical Engineering

Assistant professor of mechanical engineering Qian Xue researches the sensing ability of seal whiskers, which have attracted increasing research interest because of their exceptional sensitivity and accuracy. Previous studies have shown that blindfolded seals can use their whiskers to track the disturbances left behind by moving objects in the water, known as hydrodynamic trails, that were generated several minutes before, as well as discriminate the size and shape of upstream objects through their wakes.

However, relatively little is known about the mechanisms of seal whisker sensing. Xue's research looks at how the unique geometry of seal whiskers responds to different vibrations in the water, including self-induced vibrations in calm water and wake-induced vibrations from other objects at both the single-whisker and whisker-array levels.

Xue will use a tool known as an immersed-boundary-method based fluid-structure interaction computer model to simulate the vibrations of a single whisker and multiple whiskers in a wide range of parameters. The simulation results will be validated by comparing them to the previously obtained experimental measurements in order to better understand how the whiskers respond to fluid vibrations. ■



Yingchao Yang

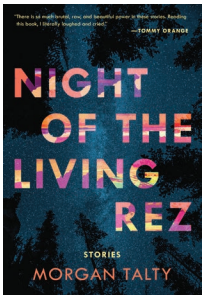
Assistant Professor of Mechanical Engineering

Ultrathin two-dimensional (2D) nanomaterials have been extensively researched for use in devices like electronics, photonics, batteries and more. The stability of components made from the materials is critical to their reliability, but toughening the brittle materials — making them more resistant to fractures, for example — often comes at the cost of their mechanical strength. What's more, 2D high-entropy materials (HEMs), nanomaterials that consist of multiple elements, are asymmetrical, and thus harder to fracture.

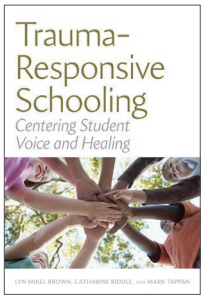
Yingchao Yang's research goal is to study the asymmetrical fractures of 2D HEMs. He will use the NSF funding to pursue four research objectives: fabricating stable 2D HEMs; conducting in situ tensile testing in a scanning electron microscope to visualize the deformation and fracture scenarios of 2D HEMs and their ripple effects understand the various impacts on the materials' mechanical behaviors; developing and applying a multiscale framework to simulate fracture behaviors of 2D HEMs with focus on crack initiation and crack propagation; and visualizing crack evolutions at the atomic level via in situ tensile testing using transmission electron microscopy. ■

Publication Spotlight

A Sample of Works by UMaine Faculty

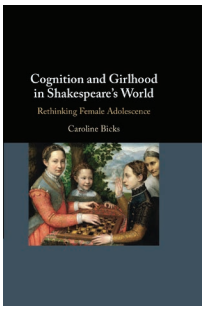


NIGHT OF THE LIVING REZ
Morgan Talty
Tin House
2022
Literature

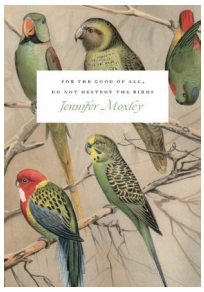


TRAUMA-RESPONSIVE SCHOOLING: CENTERING STUDENT VOICE IN HEALING
Catharine Biddle
Harvard Education Press
2022
Education

DELEGATING RESPONSIBILITY: INTERNATIONAL COOPERATION ON MIGRATION IN THE EUROPEAN UNION
Nicholas Micinski
University of Michigan Press
2022
Political Science



COGNITION AND GIRLHOOD IN SHAKESPEARE'S WORLD: RETHINKING FEMALE ADOLESCENCE
Caroline Bicks
Cambridge University Press
2021
Literature



FOR THE GOOD OF ALL, DO NOT DESTROY THE BIRDS (ESSAYS)
Jennifer Moxley
Flood Editions
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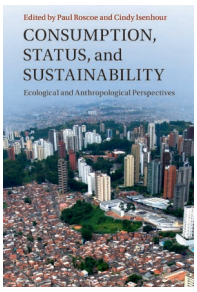
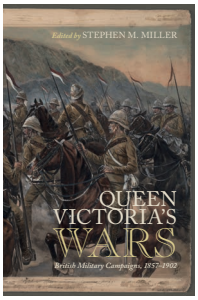
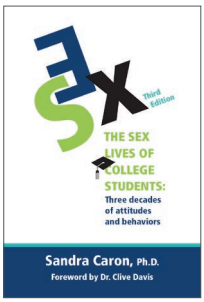
Poetry



CONSUMPTION, STATUS, AND SUSTAINABILITY
Paul Roscoe
Cindy Isenhour
Cambridge University Press
2021
Environmental Science



QUEEN VICTORIA'S WARS: BRITISH MILITARY CAMPAIGNS, 1857-1902
Stephen Miller
Cambridge University Press
2021
History



THE SEX LIVES OF COLLEGE STUDENTS: THREE DECADES OF ATTITUDES AND BEHAVIORS
Sandra Caron
Maine College Press, Inc.
2021
Human Sexuality

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