THE UNIVERSITY OF MAINE

2023 RESEARCH REPORT

Global Impact | Local Relevance

Maine's Research University at Work

Developing solutions to grand challenges of global impact and local relevance.

We are happy to present the 2023 Research Report for the University of Maine. This has been another remarkable year for research and scholarly achievements at Maine's land, sea, and space grant university.

As a Carnegie R1 institution with very high research activity, UMaine's research and development efforts have been of global impact and local relevance, addressing the workforce and economic development needs of Maine and beyond. These efforts have taken place as the university's research enterprise for the fourth consecutive year has realized all-time high record levels in growth and impact, as measured by multiple indicators, including research and development funding received and expended.

Specifically, in 2023, the total research and development funding received from external sources reached $189.7 million, as compared to $147.8 million for 2022, resulting in a 28% increase over the previous year and 108% increase over five years; and the total research and development expenditures reached $245.7 million, as compared to $225.1 million for 2022, resulting in a 9.2% increase over the previous year and 78% increase over five years.

This annual report underscores the commitment of our university community to advancing the creation of new knowledge, driving innovation, and making an impact on the social and economic advancement of Maine and beyond. As part of this, the report provides insight into UMaine's comprehensive and cutting-edge research and development talent and capabilities, and major university-wide programs and initiatives in diverse areas ranging from artificial intelligence, space exploration, climate change and environment, to arts and humanities, life sciences, health, and medicine.

As highlighted in the report, in 2023 we celebrate the 100-year anniversary of the formation of our Graduate School, while the University of Maine has been conferring graduate degrees since 1881. Today with over 150 graduate program offerings, including 91 master's and 31 doctoral programs, the University of Maine provides the most extensive set of graduate degree programs in Maine, attracting students from all over the world.

We hope that you will enjoy reviewing the report. Moreover, to obtain additional information about the impactful research and scholarly achievements realized at the University of Maine, we invite you to visit the UMaine Research website, or contact us at research@maine.edu.

Joan Ferrini-Mundy
President, University of Maine and
University of Maine at Machias
Vice Chancellor for Research and
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Kody Varahramyan
Vice President for Research and
Dean of the Graduate School,
University of Maine

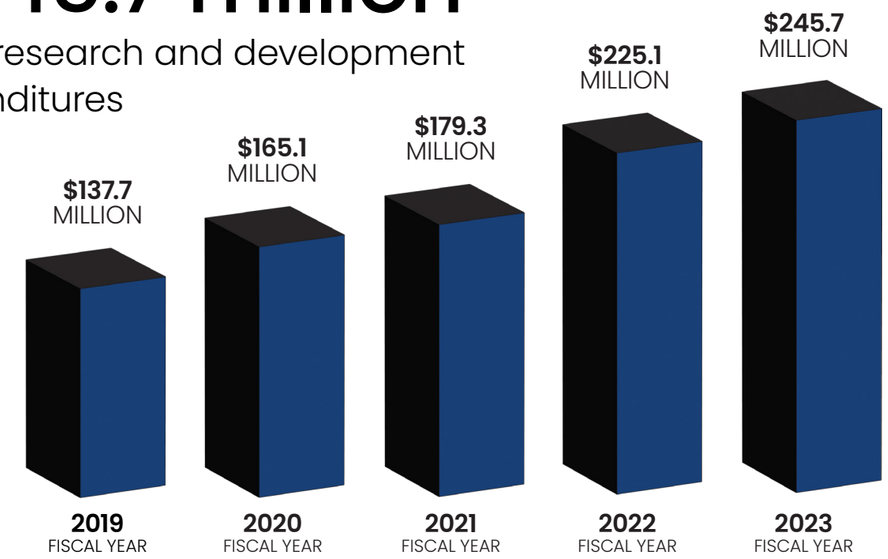
A Modern 21st-Century R1 Research University

Top 150

of institutions for National Science Foundation funding

$245.7 million

Total research and development expenditures



Total federal awards

$189.7 million
total research and development funding in 2023

Top 22%
of universities for research expenditures by NSF HERD ranking

86% increase
in awards greater than $1 million over five years

89%
of all university research in Maine

98% increase
in federal funding over five years

150+
research institutes, centers, and labs

97%
of Ph.D.s conferred in Maine*

**Reported on the 2022 NSF Survey of Earned Doctorates*

150+
graduate programs

Celebrating a century of impact and leadership

UMaine continues to build on its legacy as Maine's premiere research institution and center of higher education.

The Graduate School at the University of Maine celebrated its 100th anniversary in 2023. This milestone marks a rich history of advancing graduate education and enhancing student experiences through collaborative efforts. True to its mission, UMaine's Graduate School has supported more than 150 degree programs, financial aid, and diverse academic guidance.

The school capitalizes on UMaine's status as a flagship research institution with R1 status and propels the university's mission to drive state and national economic growth through research and development. UMaine's R1 status is the highest honor designated by the Carnegie Classification of Institutions of Higher Education and places the institution among the top 3.7% of top-tier doctoral research universities nationwide. Only 146 of the nation's 3,982 degree-granting postsecondary institutions hold this classification.

From its inception in 1923, the Graduate School has built on tradition dating back to when UMaine granted its first graduate degree in 1881. From the Graduate School's origins with just five disciplines, including agriculture, chemistry, and engineering, UMaine's graduate education has expanded to encompass a wide range of research areas led by internationally recognized faculty. This legacy of excellence in research and scholarship continues to enrich every facet of the UMaine experience.

A look into the present and future

The centennial year of the Graduate School provides us with a wonderful opportunity to celebrate a century of graduate education that has advanced both individuals and society and to plan for the next 100 years of world-class graduate education that will have global impact and relevance to our local communities. Today, with 154 opportunities for graduate study, consisting of 32 advanced certificates, 91 master's, and 31 doctoral programs, the University of Maine provides the most extensive graduate degree programs in Maine, attracting students from all over the world.

"Marking the centennial of the University of Maine's Graduate School, we honor a history of innovation and its pivotal role in shaping Maine's workforce. Our commitment to research excellence and graduate education remains strong as we continue to empower leaders for tomorrow's challenges."

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

A timeline of graduate education

1881

Walter Balentine
First graduate degree recipient

Walter Balentine earned the first graduate degree conferred by Maine State College, now the University of Maine System, in 1881. The Board of Trustees granted Balentine a Master of Science for completion of his thesis. He first graduated from Maine State College in 1874 with studies in agriculture. He pursued postgraduate studies at Wesleyan, the Connecticut State Experiment Station, and a research fellowship to study agricultural chemistry in Germany before returning to Maine to serve as Chair of Agriculture at his alma mater. After receiving his M.S. degree, Balentine became a professor of agriculture and, in 1885, was named founding director of the first Agricultural Experiment Station in Maine, supporting the growth of agricultural pursuits in the region and throughout the world.

1882

Percia Ann Vinal White
First female graduate degree recipient

Percia Ann Vinal White, an Orono native, made history at UMaine as the first woman to earn a Master of Science in Literature in 1882. She was also among the university's first female undergraduates. White published many short stories and a novel under the pseudonym A. Steele Penn. She founded the Women's Club of Orono, contributed to the Maine Writers' Research Club and was involved in other local organizations, leaving a legacy in academia and her community.

1923

In 1923, the Division of the Faculty of Graduate Studies was formally established as a distinct administrative unit at the university, solidifying the institution's commitment to advancing graduate education.

1965

The Graduate School underwent a significant transformation in 1965, during the University of Maine's Centennial Year, when its name changed from the Division of Graduate Study to the Graduate School. This milestone coincided with an era of innovation and growth, advancing the institution's role as a leader in graduate education.

Engineering students demonstrate a model floating wind turbine in the Alfond W2 Ocean Engineering Lab at the Advanced Structures and Composites Center.

R1 drives undergraduate research opportunities

When UMaine earned R1 Carnegie classification in 2022, the designation inspired a dramatic increase in undergraduate research experiences for UMaine students.

The R1 designation, bestowed by the Carnegie Classification of Institutions of Higher Education, is the highest honor offered, reserved for institutions with very high research activity. When the University of Maine earned R1 status in 2022, the designation brought new focus to the work of faculty, researchers, and graduate students, and strengthened the financial magnitude of their grants. The R1 classification benefits student and faculty research and notably helps undergraduate students at UMaine engage in research and gain the tangible experiences they need to become leaders in their fields.

The funding level dedicated to undergraduate research is a meaningful measure of these engagements. Since 2017, undergraduate support from sponsored research projects rose by 118%, with almost half of that growth following the R1 designation in 2022. As UMaine attracts more and larger grants, additional support is available for undergraduate research opportunities.

These experiences initiate students' journey from knowledge consumers to knowledge producers. UMaine students who participate in these experiences report a greater sense of belonging, higher morale and more confidence in their abilities.

Building on the momentum from UMaine's R1 designation, the university has expanded numerous initiatives to foster learning driven by discovery for undergraduate students.

Center for Undergraduate Research

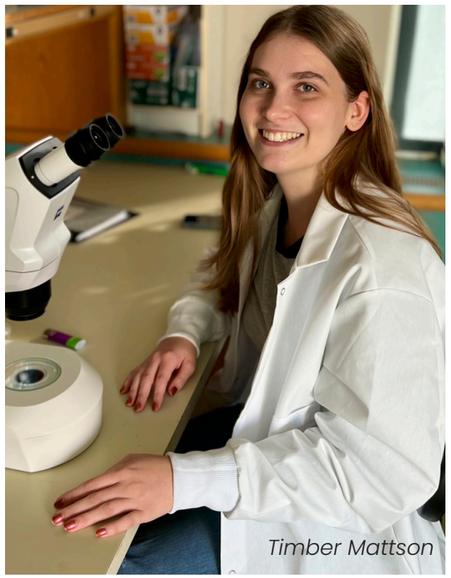
UMaine's Center for Undergraduate Research (CUGR) supports and funds faculty-mentored research, scholarship and creative activities for undergraduate students across all academic disciplines.

Its flagship event, the Student Symposium CUGR hosts every April, showcases the power of student innovation. More than 2,000 people typically attend and benefit from shared research and creative activities from hundreds of students at the University of Maine and the University of Maine at Machias.

Many of the projects featured at the Student Symposium were made possible, in part, by CUGR fellowships. These grants help undergraduate students advance their education through research.

Timber Mattson, a CUGR fellow and biochemistry major, is studying the effects of toxins, stress and diet on the powerhouse of cells, mitochondria, in the lab of Suzanne Angeli, assistant professor of molecular and cellular biology. According to Mattson, the faculty mentorship she receives is one of the most valuable aspects of the experience. "Working with Dr. Angeli has given me a chance to work independently while also having a mentor to rely on if I need guidance or have questions," she said.

Emilie Casey, an earth science major who advances glaciology research through a CUGR fellowship, echoed Mattson's comments that direct faculty mentorship is the highlight of joining research projects so early in her education.



Timber Mattson

"Dr. Doughty is an excellent teacher, my experience wouldn't be the same without her. I am new to coding, but with her guidance and patience, I have really gotten a grasp on the concepts and I'm finding a lot of fun in it," said Casey.

In the lab of Golden Undergraduate Coordinator and Lecturer Alice Doughty, Casey studies tropical glaciers present during the Last Glacial Maximum, about 25,000 years ago. "Using moraine and elevation data collected from the Rwenzori mountains in Uganda, I create visual models to recreate the ancient glaciers. From there, I can extract pertinent information relating to mass balance and freeze levels, which is the elevation at which glaciers start to either freeze or melt," Casey said.

National Science Foundation EPSCoR

Researchers at UMaine have a proven record of securing external federal funding, such as funding from the National Science Foundation (NSF), to support undergraduate research fellowships. The NSF EPSCoR Research Infrastructure Improvement (RII) Track-1 Maine-eDNA grant was awarded in 2019 to UMaine through NSF's Established Program to Stimulate Competitive Research (EPSCoR).

The five-year Maine-eDNA Initiative aims to transform the understanding and sustainability of Maine's coastal ecosystems via environmental DNA innovations that unlock new scales of inference and collaboration. The $20 million grant has been a boon for aspiring undergraduate researchers as well. In the 2022 fiscal year, Maine-eDNA provided direct support to 32 undergraduate researchers at UMaine as well as to undergraduates at other institutions in Maine.

Caitlin Howell mentors bioengineering undergraduates.

Experiential Programs Innovation Central

Integrated, high-impact experiential learning offered through UMaine's Experiential Programs Innovation Central (EPIC) exposes students to research, interdisciplinary experiences, new technologies, innovation, design and prototyping.

EPIC developed new certificates and courses that foster problem-solving skills and cultivate awareness of resources and the pursuit of research among undergraduate students.

"I wanted to continue the project I started in the EPIC course to make it a reality," said Noah Lambert, a computer engineering student at UMaine. "Applying what I learned, and with the help of all the wonderful people I had made contact with, I was able to apply for and receive fellowship funding for my project through the Center for Undergraduate Research this past year, and present my findings at the UMaine Student Symposium in 2022."

Through EPIC, students from arts, humanities, engineering, sciences, education and business learn to work on multi-disciplinary projects, develop soft skills and complete required trainings in ethics and responsible conduct of research.

The office of the Vice President for Research and Dean of the Graduate School established EPIC in close collaboration with the Center for Undergraduate Research and several other centers and institutes at UMaine. Other UMS campuses have adopted the EPIC model and the program is beginning to earn recognition at the national level.

Research Learning Experiences

Research Learning Experiences (RLEs) introduce UMaine's first- and second-year students to research early in their academic careers. These unique courses begin with a weeklong immersive experience for incoming, new students, followed by a semester-long course where students actively advance the research process. The program is open to students regardless of their major, allowing exploration of research outside of their declared disciplines. When RLEs were first introduced at UMaine in fall 2021, 242 students enrolled. Two years later that number has more than doubled to 590 students.

"RLE courses are designed with open-ended inquiry in small cohorts. They help first-year students wrestle with questions that have no known answers and come up with strategies for uncertainty and setbacks," explained Brian Olsen, director of the RLE program and a UMaine professor of ornithology. "By the end of their first semester, RLE students at UMaine report higher morale, a greater sense of belonging at UMaine, and greater confidence with self-reflection and thinking of themselves as researchers."

Through RLEs, students engage with research that seeks to solve pressing issues. In its first year, students in an RLE course tested if environmental DNA (eDNA), which is genetic material shed by organisms into their environment, was an effective tool for detecting eels in Maine rivers. American eel populations have declined nationwide and in Maine due to overfishing, infrastructure and climate change. The lack of research on the species has left experts with limited understanding of the location and population of eels in Maine's rivers. The RLE's eleven students helped design the research process, with particular attention to how this research helps inform stakeholders like the Maine Department of Marine Resources. Through the course, they gained hands-on experience in the field, endured cold mornings sampling water in the Penobscot River and sought eel DNA in their samples. This RLE also provided incoming students with hands-on experience in identifying potential shortcomings in a project's design, building a research process and then conducting that research.

A new era in engineering and computing

The Maine College of Engineering and Computing pioneers interdisciplinary learning and technological advancement.

The Maine College of Engineering and Computing, officially launched on April 1, 2023, marked a significant stride in the region's workforce development, research and economic growth. The college's E. James and Eileen P. Ferland Engineering Education and Design Center (Ferland EEDC) and interdisciplinary focus embody UMaine's commitment to fostering learning environments that propel engineering advancements.

The new reimagined college addresses growing demand for skilled professionals in engineering and computing. With an emphasis on interdisciplinary learning, the college aims to populate the workforce with technically qualified individuals who can collaborate across business sectors. Biomedical engineering is a testament to this interdisciplinary approach, merging fields like mechanical and electrical engineering with computing, artificial intelligence and biomedical science.

The Ferland EEDC, a state-of-the-art facility that opened in 2022, encourages collaborative learning among engineering and computing students by providing design suites, labs, and collaboration spaces that foster knowledge-sharing among students and faculty as they engage in innovative projects. The investment is a testament to UMaine's commitment to hands-on, curiosity-driven education, which is vital to staying at the forefront of technological advancement.

Biomedical engineering at UMaine goes beyond traditional boundaries, focusing on societal impacts, particularly in Maine's predominantly rural settings. By learning through projects that aim to develop vests for extreme conditions and create devices for athletic enhancement, UMaine students also learn practical applications in research findings. These initiatives contribute to the health of Mainers and provide students with real-world experiences, preparing them for future growth in the industry.

The Maine College of Engineering and Computing is also a hub for industry collaboration and research. The college capitalizes on research for its students by integrating scholarly activities with learning. This approach ensures that students are both academically proficient and ready to meet the evolving needs of the industry. Partnerships with entities such as the Maine Grant Space Consortium and The Jackson Laboratory compound UMaine's impact and offer students opportunities for internships and co-ops, further enhancing their learning experiences.

Promotion of diversity and inclusion

The Maine College of Engineering and Computing recognizes the value of diverse perspectives, especially in problem-solving fields like engineering, and actively works to attract a diverse range of students. The college collaborates with the College of Education and Human Development to use data-driven strategies to broaden the appeal of engineering and computing to all population segments. By making engineering accessible and relatable, the college hopes to inspire a diverse generation of thinkers and problem-solvers to join its community.

As the college takes shape, it is setting a standard for engineering and computing education centered on inclusion, interdisciplinary collaboration, and innovation. With facilities such as the Ferland EEDC and frontier programs in biomedical engineering, the college is well-positioned to meet its growth expectations. The college's emphasis on real-world applications, industry collaboration, and student-driven learning ensures its graduates are ready for evolving job markets and equipped to lead and innovate within their chosen fields.

These advanced facilities and unique programs poise the Maine College of Engineering and Computing to become a hub of economic and educational development in New England. By fostering an environment of collaboration, innovation, and inclusion, the college is preparing tomorrow's problem-solvers and innovators to actively shape the future of engineering and computing.

"I firmly believe that our institution is more than just a place of learning; it's a catalyst for transformative progress. By intertwining interdisciplinary education with cutting-edge facilities, we are not merely teaching but empowering a new generation to push the frontiers of engineering and computing into new realms of innovation and impact."

— Giovanna Guidoboni,
Dean of the Maine College of Engineering and Computing

Ferland Engineering Education and Design Center

2023 R

Developing Maine's aquaculture industry

The Aquaculture Research Institute drives the development of Maine's aquaculture industry and working waterfronts.

The Aquaculture Research Institute (ARI) at the University of Maine is charting the future of aquaculture through research and development, extension programs and workforce training. By fostering innovation and nurturing talent, ARI reinforces UMaine's reputation as a national hub for sustainable aquaculture.

ARI, which is directed by Deborah Bouchard, associate professor of aquatic animal health, advances research and development initiatives that are broad, integrated and pivotal to industry sustainability. The research spans from enhancing sustainable feeds and boosting climate change resilience to improving hatchery technologies. An example of the technology that powers ARI's innovation is a new state-of-the-art photobioreactor at the Darling Marine Center. The photobioreactor cultivates algae efficiently under controlled conditions, reduces reliance on wild kelp and supports high-density growth. It also nurtures gametophytes that growers can use to enhance strains for traits such as growth and nutritional value. Such technology illustrates ARI's commitment to sustainable aquaculture amid a changing climate.

A critical dimension of ARI's work stems from its partnership with the U.S. Department of Agriculture's (UDSA) Agricultural Research Service (ARS). This collaboration, supported by programmatic funding, advances research in critical areas such as Atlantic salmon health, emerging pathogens, and nutritional advancements in feed. A recent significant outcome of this collaboration is the development of a method for efficiently detecting a serious viral pathogen affecting salmon. This advancement, crucial for managing the health of salmon populations, positively impacts the industry enabling a faster response to preventing disease outbreaks, improving both economic and animal welfare outcomes.

In the realm of shellfish aquaculture, ARI collaborates with USDA to develop disease-resistant strains and introduce new species in both hatchery and field settings at the Darling Marine Center. These strategies aim to boost the vitality and yield of shellfish stocks. This collaborative work enhances the sector's resilience to climate variability, which is vital to Maine's blue economy. Beyond advancing fundamental science, ARI research also develops practical enhancements in aquaculture techniques and production, improving operational efficiency and reducing environmental impact.

Workforce development is also a cornerstone of ARI's mission, empowering the next generation of aquaculture professionals with practical skills and knowledge. Through internships, capstone projects, and fellowships, ARI faculty are actively involved in mentoring both undergraduate and graduate students. Through fellowship programs like our new Research and Extension Experiences for Undergraduates (REEU), ARI provides students with immersive research opportunities that let them tackle real-world problems in aquaculture while engaging with indigenous knowledge. These hands-on experiences are essential for bridging the gap between academic learning and practical application, ensuring students are prepared to excel in the fast-evolving aquaculture landscape.

Researchers check oyster traps in the Damariscotta River.

Students visit the Darling Marine Center's aquaculture site.

Through its strategic participation in key industry advisory boards and partnership with the USDA's ARS and Animal and Plant Health Inspection Service, ARI aligns its research efforts with the evolving needs of the industry. This collaborative model is instrumental in the sector's employment surge, supporting more than 700 jobs. Since 2017, efforts have led to a doubling of the sector's revenues, directly benefiting more than 1,000 households, demonstrating ARI's role in not just advancing research, but also in bolstering economic growth and enhancing the wellbeing of numerous communities.

Looking forward, ARI is preparing for the ground breaking of the Sustainable Aquaculture Workforce and Innovation Center (SAWIC), which represents a significant step toward sustainable aquaculture advancement. This new facility will be a hub for pioneering research and specialized workforce training, aimed at equipping the aquaculture industry with innovative solutions and skilled professionals in Maine. SAWIC will address critical sustainability challenges through focused research on fish health, feed efficiency, and breeding methods. It will also serve as a catalyst for workforce excellence, offering programs that combine theoretical knowledge with practical skill-building. This will expose students to cutting-edge aquaculture practices and position them to lead in an evolving industry. SAWIC demonstrates ARI's commitment to driving aquaculture's growth and sustainability through innovation and workforce development, positioning ARI as a leader in the industry's future.

AquEOUS: Aquaculture Experiential Opportunities for Undergraduate Students, *led by the UMaine Wabanaki Center and Aquaculture Research Institute (ARI), is one of 23 Research and Extension Experiences for Undergraduates awarded in 2023 by the U.S. Department of Agriculture (USDA). The UMaine fellowship program is offered for five years.*

Undergraduate students from across the nation are learning about sustainable aquaculture in Maine through the lens of Indigenous science and knowledge in a new University of Maine initiative funded by the USDA's National Institute of Food and Agriculture.

Through the program, students and staff complete 10-week research projects and participate in training that enhances inclusive science communication skills, Indigenous knowledge and field techniques.

UMaine School of Nursing expands programming for aspiring family nurse practitioners

The University of Maine School of Nursing received a $1.96 million grant to provide financial assistance to and new educational opportunities for aspiring family nurse practitioners who can help improve access to primary care in Maine's rural and underserved regions.

The four-year grant from the Health Resources and Services Administration's Advanced Nursing Education Workforce (ANEW) Program allows UMaine to provide financial support to approximately 40 students pursuing a Master of Science in Nursing degree with a family nurse practitioner concentration. It also supports a new preceptor training program, continuing education and enhanced learning offerings that will train these students to help address critical health care gaps in Maine, including LGBTQ+ care, substance use disorder treatment, and services for childhood obesity and other weight-related issues.

With the offerings funded by this grant, UMaine Nursing aims to strengthen its recruitment and graduation of diverse family nurse practitioners. The grant also supports clinical education expansion initiatives within Maine's Indian Health Service locations and Federally Qualified Health Centers.

"Our nurse practitioner students and alumni have always been dedicated to the care of Mainers; this support means more nurses advancing their education to address our urgent primary care needs in the state," said Sean Sibley, clinical assistant faculty and ANEW program director at UMaine.

UMaine Nursing is committed to educating family nurse practitioners who provide essential primary care services in all parts of Maine, including rural and underserved areas.

The program's successful track record and dedication to excellence is reflected in its 100% first-time pass rate for family nurse practitioner program graduates. Since graduating its first cohort of master's-prepared practitioners in 1994, the school has consistently demonstrated its commitment to improving healthcare access and quality in the state.

"UMaine Nursing is excited about the opportunities presented by this grant and remains committed to improving health equity and access to quality health care for all Mainers," said school Director Kelley Strout. "By expanding clinical education experiences, enhancing educational offerings and strengthening partnerships, UMaine Nursing is taking significant strides toward creating a brighter and healthier future for rural communities in Maine."

This ANEW Program is supported by the Health Resources and Services Administration (HRSA) of the U.S. Department of Health and Human Services (HHS) as part of an award totaling $485,641. The contents are those of the author(s) and do not necessarily represent the official views of, nor an endorsement by, HRSA, HHS, or the U.S. Government.

School of Nursing students learn how to flush IVs for patients.

Achieving breakthroughs in predicting PFAS absorption in microplastics

UMaine's PFAS+ Initiative unveils a model for predicting the contaminant's absorption in microplastics, leading to innovative solutions for water pollution.

The University of Maine's PFAS+ Initiative developed a novel model for predicting the absorption of per- and polyfluoroalkyl substances (PFAS) by microplastics in 2023.

PFAS are human-made chemicals linked to a growing list of medical concerns and can bioaccumulate in plants, animals and people. They have been used widely in industrial and consumer products since the 1940s for their resistance to grease, oil, water and heat, characteristics that also make them persistent pollutants.

The model developed at UMaine marks a significant breakthrough for efforts that aim to address this challenge, as microplastics in rivers, lakes, and oceans can absorb toxic substances, including PFAS, posing risks to ecosystems and human health.

A team of researchers, led by UMaine, designed a model that predicts the interaction between various types of microplastics and PFAS in freshwater and saltwater environments. This model reveals how different factors, such as the characteristics of microplastics and the water's chemical composition, influence the absorption process.

Dilara Hatinoglu, a Ph.D. student in civil and environmental engineering at UMaine, played a pivotal role in this work. Her research was guided by her adviser, Onur Apul, assistant professor of environmental engineering at UMaine, and François Perreault, associate professor at the Arizona State University School of Sustainable Engineering and the Built Environment.

The team's findings streamlined the process of assessing PFAS absorption by microplastics and opened avenues for developing more effective water treatment solutions. Their research revealed several crucial insights, such as the absorption rates of long-chain PFAS by polystyrene microplastics and the various absorption mechanisms in different water types.

The success of this project showcases the collaborative efforts undertaken by the UMaine PFAS+ Initiative. The initiative, steered by a multidisciplinary team of experts, aims to address the growing PFAS pollution crisis through innovative research and solutions.

"We are pioneering academic knowledge and trying to lead the world by setting up an example while aligning our efforts to meet the needs of the state. We are training our researchers as they are making cutting-edge discoveries. Our mission happens to be at the forefront of national needs."

— Onur Apul,
Assistant Professor of Civil and Environmental Engineering

A student from the School of Earth and Climate Sciences sampling streams in Acadia National Park for microplastics.

Forging new frontiers in partnership and innovation

UMaine SPACE Initiative propels leadership in aerospace technology and education.

The University of Maine's SPACE Initiative soared to new heights in 2023, reinforcing its legacy as a pioneering force in space exploration and research. The SPACE Initiative expanded academic and research frontiers and fortified its role in shaping the future of aerospace technology and education.

UMaine SPACE is at the forefront of space-related research and development. Through continuous support from NASA and the Maine Space Grant Consortium (MSGC), UMaine's fellowship and scholarship programs continue to prepare a skilled workforce, foster intellectual property creation, and bolster Maine's economy for over 33 years.

Beyond academia, UMaine actively engaged the K-12 educational system in space research. The state of Maine's first small satellite, developed at UMaine from 2019 to 2022, involved middle and high school students and teachers in defining its scientific missions. This initiative, along with internships at NASA field centers, has led to the recruitment of UMaine students by NASA, SpaceX, and other leading space technology companies.

The UMaine SPACE Initiative launched a seed grant program in 2023 that aims to foster innovative and interdisciplinary collaborations. The first of two funding rounds propelled eight projects, supporting multidisciplinary teams in aerospace research and contributing to Maine's economic vitality. These projects are a part of the MSGC Ideas Lab, which is managed by UMaine SPACE and supported by NASA, MSGC, and UMaine's Office of the Vice President for Research and Dean of the Graduate School.

The Ideas Lab fosters team-based research and development, and educational projects to develop groundbreaking approaches in space exploration that align with NASA's priorities and MSGC's areas of interest. This collaborative approach manifests UMaine SPACE's commitment to multidisciplinary research and education in space sciences.

Looking ahead, UMaine SPACE aims to elevate successful research programs through strategic planning and infrastructure enhancement. This centralized support system is poised to further UMaine's impact in the realm of space exploration and research, cementing its role as a leader in the frontiers of space exploration.

Groundbreaking insights in AI legislation

UMaine's AI Initiative marks a pivotal year in artificial intelligence ethics, advancing responsible development and usage.

In a landmark year for artificial intelligence (AI) ethics, the University of Maine's AI Initiative made novel contributions to conversations regarding the responsible development and use of AI technologies.

Manuel Wörsdörfer, assistant professor of management and computing ethics at UMaine, analyzed the world's first major legislative attempt by a government entity to regulate AI in a paper published by the journal AI and Ethics. In "The E.U.'s Artificial Intelligence Act: An Ordoliberal Assessment," Wörsdörfer delved into the complexities of the European Union's Artificial Intelligence Act (AIA). The research focused on socio-political implications of emerging generative AI, including large-language models and chatbots, which became increasingly influential in 2023.

The AIA is examined through the lens of the ordoliberalism 2.0—which was previously underrepresented in scholarly discourse—offers a unique critique of the AIA, assessing both its strengths and limitations from an ordoliberal standpoint.

Wörsdörfer's paper also suggests concrete reform measures to enhance the AIA. These recommendations aim to ensure the act can effectively safeguard against potential negative impacts of AI technologies, while fostering positive contributions to society.

UMaine's AI Initiative, through this publication, demonstrates its role as a leader in the AI-related research field. The university continuously fosters interdisciplinary research and dialogue, bridging gaps between technology and ethical governance. As AI evolves, UMaine remains steadfast to its commitment to exploring and addressing the ethical, social, and political challenges that develop as a consequence of this technology.

Wörsdörfer's publication highlights the dedication of UMaine's AI Initiative to shaping a future where AI is developed and used responsibly, benefiting society as a whole. Through such advancements, UMaine Research and the AI Initiative will continue to steer the global conversation on AI toward a more ethical and inclusive future.

A landscape rendering of the Wyman's Wild Blueberry Research and Innovation Center. Image by Peter Greeno Photography.

Protecting Maine's wild blueberries

UMaine researchers are working to understand how climate change will impact wild blueberries, a staple of Maine agriculture and culture, and protect this important industry.

The U.S. Department of Agriculture (USDA) National Institute of Food and Agriculture (NIFA) has awarded $650,000 to a University of Maine project investigating the impacts of climate change on wild blueberry ecosystems and economics.

Wild blueberry fields provide important crops for the state of Maine. They also support ecosystems by providing water regulation, nutrient cycling, carbon sequestration, pollination and food for wildlife. Climate change is altering these wild blueberry agroecosystems, but the exact effects are unclear.

Rachel Schattman, assistant professor of sustainable agriculture at the School of Food and Agriculture, is the principal investigator of the study. The project will investigate how probable future climate scenarios will impact the ecosystem services provided by wild blueberry fields. The researchers, including graduate and undergraduate students, will conduct climate manipulation experiments at the Wyman's Wild Blueberry Research and Innovation Center in Old Town. They will test temperature and precipitation to see how it impacts soil-water dynamics, crop health, the relationship to root fungi, pollinators and disease.

The results of these experiments will be used to validate a new model to project possible future outcomes based on changing climate scenarios. Maps produced through the modeling will be shared with wild blueberry growers and processors. The researchers will also hold grower focus groups to identify perceptions of production and financial risks, as well as the benefit of climate risk mitigation strategies like supplemental irrigation.

"Our approach to this work is transdisciplinary in nature, meaning that we are pulling from the expertise and experience of our diverse team to answer big questions that no single discipline could answer on its own. It's a project grounded by the needs of wild blueberry growers and their communities," Schattman said, whose lab is part of the Maine Agricultural and Forest Experiment Station.

The Wyman's Center was established in 2022 through a gift from Wyman's, a 149-year-old, 5th generation, family owned wild blueberry grower and processor based in Milbridge that is the nation's top frozen fruit brand in retail. The center offers unprecedented precision to scientists who study Maine's state fruit. The 144-square-foot raised beds of wild blueberries at the center help researchers control for precipitation, temperature, and plant genetics. This unique approach is essential to improving predictions about how the berries, which are cultivated in their natural environments, will respond to emerging field conditions like drought.

Additional UMaine researchers on the project include YongJiang Zhang, assistant professor of plant physiology; Lily Calderwood, assistant professor of horticulture and Extension wild blueberry specialist; Jonathan Malacarne, assistant professor of economics; Brian McGill, professor of biological science; Phil Fanning, assistant professor of agricultural entomology; Seanna Annis, associate professor of mycology; Sean Birkel, Maine state climatologist and assistant professor; and Stephanie Miller, postdoctoral research assistant. Bruce Hall, director of agroecology at Wyman's, is also a collaborator.

Institute of Medicine awards nine graduate summer fellowships for 2023

The University of Maine's Institute of Medicine announced the recipients of its prestigious 2023 summer fellowship in May, recognizing nine outstanding scholars for their contributions to medical research and education.

Spotlight on Sean R. Sibley

Among the distinguished awardees is Sean Sibley, a Ph.D. candidate in the field of nursing education, whose project garnered significant attention for its innovative approach and potential impact on nurse practitioner training.

Sean Sibley

Sibley, under the mentorship of UMaine School of Nursing Director Kelley Strout, leads a project that aims to assess the efficacy of specific simulation techniques in advanced nursing education—a field with limited studies compared to its medical counterparts.

The project uses Objective Structured Clinical Examinations and Standardized Patient simulations in nurse practitioner education. While common in medical training, these methodologies are relatively unexplored in advanced-practice nursing. Sibley's systematic review investigates the impact of these simulations on learner knowledge and clinical competency compared to traditional teaching methods.

Sibley's research led to what is known as an "empty review," finding no studies that met the stringent criteria set for the review. This outcome highlights the significant gap in the existing literature and underscores the need for further research. It brings to light the necessity for more rigorous, controlled studies to evaluate the effectiveness of these educational tools in nurse practitioner programs, particularly in the family nurse practitioner specialization.

The implications of Sibley's research are far-reaching, especially in the context of the current healthcare landscape. The United States, particularly states like Maine, face challenges in healthcare access, especially in rural and underserved areas. Sibley emphasizes the critical role of family nurse practitioners in addressing these disparities and the importance of effective educational strategies to prepare them for the field.

The Institute of Medicine's recognition of Sibley's work through the summer fellowship award is a testament to the importance of educational research in advancing healthcare outcomes. His work, soon to be published in the Nursing Education Perspectives journal, will influence future research directions and funding in nurse practitioner education.

Sibley's journey reflects the dynamic intersection of healthcare practice, education and research. Though focused on a specific aspect of nursing education, his project has broader implications for healthcare delivery, particularly in rural and underserved communities. The University of Maine continues to be at the forefront of this endeavor, with its commitment to healthcare education and research that resonates with the state's needs.

Institute of Medicine
2023 Summer Fellowship Awardees:

Lucas Bennett: Biochemistry Ph.D. candidate. Cellular receptor remodeling during viral infection.

Bailey Blair: Biomedical Science Ph.D. candidate. Identifying Candida immune evasion mechanisms.

Joshua David Hamilton: Biomedical Engineering Ph.D. student. Breast cancer study for NCI grant renewal.

Bright Obeng: Biochemistry and Molecular Biology Ph.D. candidate. CPC effects on immune cell function.

Kathryn Patenaude: Biomedical Ph.D. graduate. Effects of glucose on Streptococcus agalactiae and Candida albicans co-infections.

Liz Saavedra Perez: Microbiology Ph.D. candidate. Chemokine signaling in immune response to Pseudomonas aeruginosa infection.

Krutika Rathod: Clinical Psychology Ph.D. student. Social determinants of substance use and sleep health.

Sean R. Sibley: Nursing Ph.D. candidate. Systematic review on student learning in family nurse practitioner education.

Morgan Tallman: Clinical Psychology Ph.D. student. Mindfulness intervention for cognitive decline study.

Microbes and social equity

UMaine researchers are asking hard questions about the right every human has to a healthy microbiome, and how these tiny organisms impact human health at large.

There is a world of microscopic organisms living in and on our bodies that make up our microbiome. The balance of these complex ecosystems are governed by our diets and the environments we inhabit. They influence our health in many ways, some of which are little understood.

Suzanne Ishaq is an assistant professor of animal and veterinary sciences in the School of Food and Agriculture at the University of Maine and founder of the Microbes and Social Equity Working Group. She studies the microbes that live in or on humans and animals. Her research explores both how microbes contribute to host health or disease, and how the host's behavior and environment influence their microbial community. Ishaq is particularly interested in using microbes to inform broader conversations about social equity and human health.

The ubiquity of microbes makes them instrumental to life as we know it. "Microbes are everywhere, they are in our intestinal tract, in our mouth, on our skin, in this office, in the air," Ishaq said. "We almost never think of them unless they are causing us trouble, but they are critical for life on this planet."

So what makes a healthy microbiome? According to Ishaq, almost everything we do. "If you think about what makes a human healthy—fresh foods, plenty of sleep, safe secure housing, not too much stress, plenty of vacation time—most of those affect the microbes we interact with."

Ishaq first became interested in this conversation when working with architects researching the built environment. They were looking at the microbes that inhabit the buildings we live and work in, which prompted conversations about social and spatial justice. In relation to microbes, food deserts are a clear example of how your environment can impact your microbiome. If your diet is governed by where you live and that environment restricts your access to fresh food, your microbiome will likely suffer because of it. Ishaq sought to advance these conversations with other researchers.

"Sometimes I would get a lukewarm reception when I talked to established researchers about microbes and social equity because they did not understand where the connection was," Ishaq said. "They said, 'Okay it makes sense but you would never be able to prove it.' I said, 'Challenge accepted.'"

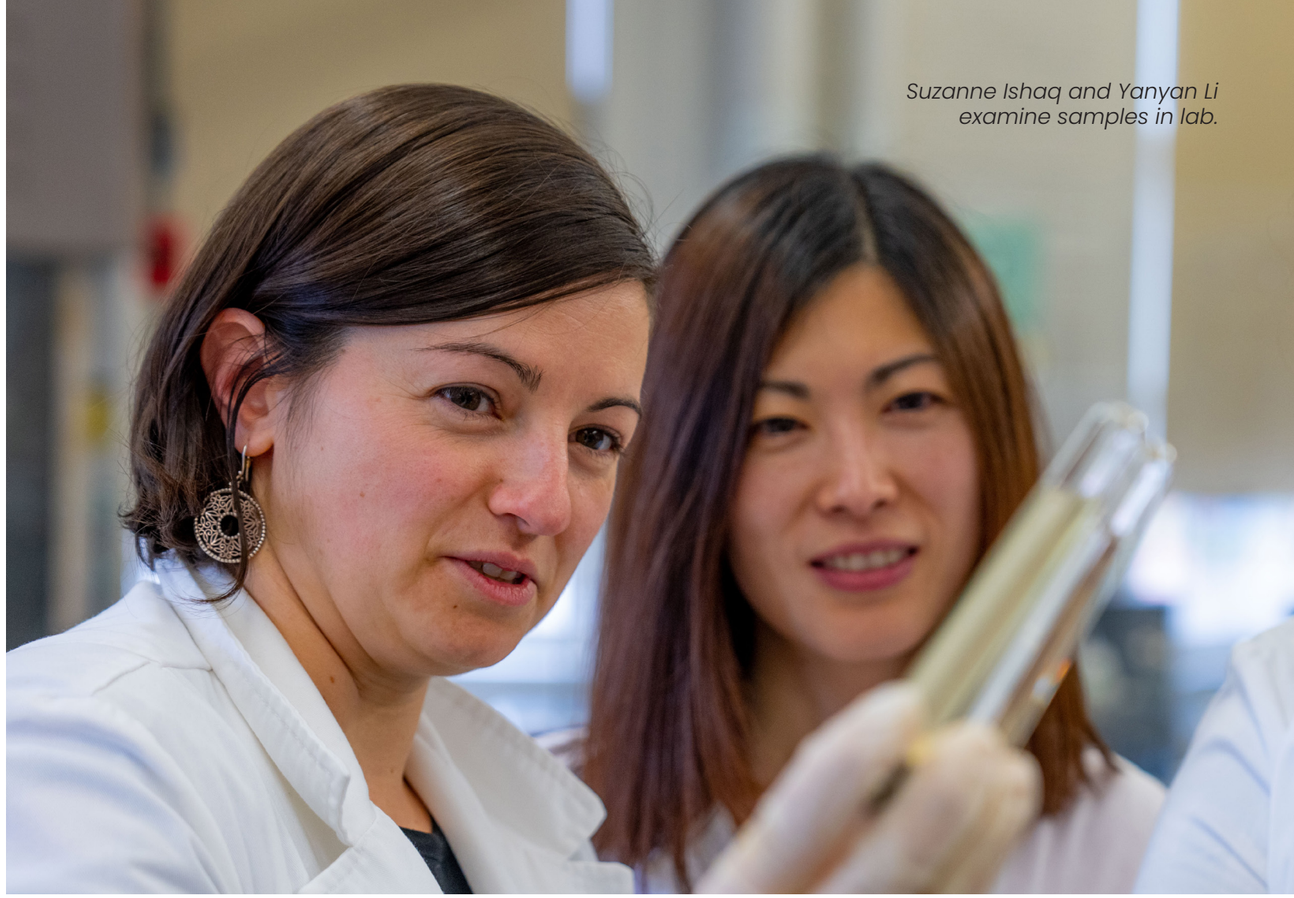
Ishaq founded the Microbes and Social Equity Working Group to connect with other researchers doing similar work or trying to have similar conversations. At first the group was primarily composed of graduate students, postdoctoral fellows, and early career researchers, but as they continued meeting more people joined and the group became more diverse. Members used these meetings as a sounding board to explore ideas or collaborators as they pursued their individual research projects. In 2021, the group launched a speaker series and a research symposium that persists to today. Currently, the group has more than 300 members spread across the globe.

the Microbes and Social Equity working group

At UMaine, Ishaq draws from the group's conversations to shape research and courses. Ishaq teamed up with Yanyan Li, assistant professor in food science and human nutrition at UMaine, Tao Zhang, an assistant professor at Binghamton University, and others, to study a compound in 10-day-old broccoli sprouts. Glucoraphanin is inert, but can be transformed into something that works as an anti-inflammatory in our intestines. For people with inflammatory bowel disease (IBD), Crohn's disease, or another intestinal disease, this could be hugely beneficial and cheaper than the cost of a medicine that does the same thing. Humans themselves do not have the enzyme needed to process glucoraphanin, but the microbiome in our intestines does. Ishaq and collaborators research the best cooking methods for broccoli sprouts in order to deliver glucoraphanin to our intestines intact where our microbiome can capitalize on its anti-inflammatory potential.

"I think there are a lot of benefits we can all have on a small scale, changing our personal lives, changing our professional lives, and changing our communities."

— Suzanne Ishaq,
Assistant Professor of Animal and Veterinary Sciences



Suzanne Ishaq and Yanyan Li examine samples in lab.

Ishaq's work with the Microbes and Social Equity Working Group changed how she approaches these research projects. She ensures human subjects understand what they are being asked to do and the ramifications of participation.

"You learn what people ask, what they are worried about, how you present information to them so they understand the risk to their confidentiality or essentially what they are giving away. We try to be a lot more inclusive and equitable in how we create these things," Ishaq said.

"I have changed the way I think about how I communicate and where I communicate this information. There is tons of research on IBD. We know a lot but that does not necessarily mean it gets to anyone and in a way they can understand."

Now the research team works to communicate their findings through social media and blog posts to provide an alternative to information behind a paywall or simply not written in an accessible way.

In her course, Ishaq tries to introduce UMaine students to this work by providing further context and asking them to engage in building a diverse research team. Historical microbiology needs context because it was done by certain people at a certain time and place in history. Understanding how science got to where it is can inform how to move it forward in an equitable way. She also asks students to assemble mock research teams for projects. This helps them consider the different voices that should be included in research, like social scientists.

When speaking with others about this work, Ishaq admits it can be daunting to consider how to affect change, but stresses that these conversations do not have to be at a large scale. People can focus on making changes in their own lives, or at the local and state levels, like Maine's right to breastfeed.

"The ability to breastfeed anywhere means you are now able to provide nutrients and breast-milk microbes to infants that are really helpful and can sometimes reduce your risk to allergies long term, inflammatory disease long term, and the amount of antibiotic resistant bacteria in your gut," Ishaq said. This is a change built on quality research that could offer long-term benefits to Mainers' health and microbiomes.

Microbes are everywhere and play an important part in our lives. People can find that intimidating but as Ishaq remarked, "Don't panic. Microbes were here long before us and they will be here long after us." Change happens at a personal level overtime. One meal or one new activity is not going to immediately change our microbes for better or worse.

"I think there are a lot of benefits we can all have on a small scale, changing our personal lives, changing our professional lives and changing our communities," Ishaq said.

Innovating the roads of tomorrow

The Transportation Infrastructure Durability Center generates innovative solutions to build sustainable transportation infrastructure.

The Transportation Infrastructure Durability Center (TIDC) at the University of Maine is committed to developing innovative, transformative, and implementable infrastructure solutions that extend the life and improve the durability of transportation assets.

In addition to UMaine, TIDC's consortium of six New England universities includes the University of Connecticut, the University of Vermont, the University of Massachusetts Lowell, Western New England University, and the University of Rhode Island in collaboration with the Departments of Transportation (DOTs) in six New England states. Funding for TIDC was secured through a six-year grant awarded by the U.S. DOT following a New England-wide competition among university consortiums.

TIDC is a U.S. Department of Transportation University Transportation Center (UTC) based within the University of Maine's Advanced Structures and Composites Center (ASCC). The program, which is led by a team at ASCC, includes Habib Dagher, who is principal investigator on the project; Senior Program Manager James Bryce; Advisory Board Chair Dale Peabody; and Research Areas Leads Bill Davids, Aaron Gallant, Eric Landis, Roberto Lopez-Anido and Jonathan Rubin.

With more than 70 faculty and 200 student researchers, the TIDC has advanced more than 75 transportation research projects since 2018. Many projects focus on newer, more sustainable materials that lower carbon emissions including novel structural composites, large-scale additive manufacturing, and innovative structural assessment and monitoring techniques. Research topics include:

- Fiber Reinforced Polymer (FRP) Composite Tub Girders as a lightweight, corrosion-resistant alternative to concrete and steel girders
- 3D-printed diffusers for the rehabilitation of highway culverts
- Reusable 3D printed formwork for the placement of concrete ballast retainers
- Analysis of rail and highway structures using Unmanned Aerial Vehicles (UAV) and Artificial Intelligence (AI) technology

TIDC also partners with other UMaine groups, like the VEMI Lab, to pursue cutting-edge mobility and accessibility research, as well as with external organizations such as Advanced Infrastructure Technologies Composites, Hubbel, Vanasse Hangen Brustlin, and Superior Concrete—all subject matter experts in transportation infrastructure research.

The success of TIDC research, developments and project deployments stem from collaboration between the member universities, state DOTs, industry partners, and the robust culture of innovation within the ASCC that unites student achievement with innovation.

Industry professionals also benefit from TIDC through research dissemination events and activities. Three annual forums, the TIDC Annual Conference, the TIDC New England Railroad Symposium and the TIDC Student Poster Contest, disseminate research findings from both the TIDC and related organizations. These events engage hundreds of participants from industry, DOTs and academia. During the events, TIDC researchers and students discuss their research findings and learn from other industry experts about challenges within the transportation industry. The TIDC team also participates as an exhibitor and presenter at regional and national transportation events to disseminate and demonstrate research findings to broad audiences.

TIDC also hosts and participates in K-12 educational activities, interacting with thousands of students from around the State of Maine each year. In addition to hosting the Maine Summer Transportation Institute (MSTI) and participating in career fairs, TIDC engages rural students in live project demonstrations and presentations, as well as bridge-building and breaking competitions.

A key mandate of the TIDC mission is to ensure the successful engagement of the future transportation workforce by providing them with exposure to real-world transportation infrastructure opportunities; not just as engineers, but as educators, communicators, technicians, and many other career pathways required for a reliable transportation system.

Aging assets and unsustainable infrastructure practices are an issue nationally and here in New England. Through the development of novel infrastructure technologies, dissemination of findings and commitment to educating the next generation of transportation professionals, TIDC partners with agencies and industry to solve current and future transportation challenges.

Installation of TIDC codeveloped FRP Composite Girders on U.S. Route 1A in Hampden, Maine. The girders are designed to be lighter, lower maintenance and longer lasting than traditional highway bridge construction and replacement girders. They also have a smaller carbon footprint.

Researchers explore the life cycle of North America's last Atlantic salmon population

Researchers at the University of Maine at Machias are using a new survey method, environmental RNA, to understand the life cycle of Atlantic salmon.

Maine's Atlantic salmon population has experienced significant decline due to stressors including dams, overfishing and pollution. The Atlantic salmon teeters on the brink of extinction in the Gulf of Maine, and comprise the wild populations of their species in the United States.

Atlantic salmon are anadromous fish, meaning they hatch in freshwater, migrate to saltwater where they spend most of their lives and return to freshwater to spawn. These fish have several life stages before they become adults. When they live in freshwater they are called parr; once they are ready to move to saltwater they are called a smolt. Knowing when and where Atlantic salmon smolt swim is vital to conservation efforts. For several decades, efforts worked to restore their population. However, new research at the University of Maine at Machias (UMM) may offer new insights and hope for Maine's endangered Atlantic salmon population.

Gerard Zegers is an associate research professor of biology at UMM studying Atlantic salmon. He served as a board member and past president of the Downeast Salmon Federation (DSF), as well as a board member and past president of the Maine Council of the Atlantic Salmon Federation (MCASF). Zegers is working on a seed grant alongside Sherrie Sprangers, co-chair of UMM's Integrative and Marine Sciences Division, and undergraduate students Ollie Kyllonen and Grace Pine to test environmental RNA (eRNA) as a tool to detect specific life stages of Atlantic salmon. This seed grant project was funded by the NSF EPSCoR RII Track-1 Maine-eDNA project.

Environmental DNA (eDNA) and eRNA are genetic materials shed by organisms in the environment and are useful tools for environmental research. All living organisms have DNA and RNA that carry genetic information but differ in their structure and function. In an environmental context, researchers can extract eDNA from a sample of water and analyze the DNA to discern which organisms live in it. Techniques using eDNA were frequently used over the past decade to detect the presence of certain organisms. Now, eRNA is an emerging tool that offers a finer spatiotemporal resolution.

Salmon, like any organism, have the same DNA throughout their lives. RNA, meanwhile, changes through that animal's life cycle as different genes are expressed. Through eRNA techniques, researchers can pinpoint when and where certain life stages occur. "For certain species such as Atlantic salmon, detecting the presence or abundance of a particular life history stage is more relevant than only knowing of their presence," Zegers said.

Zegers first read about eRNA research with zebrafish. From there, Zegers explained, "I thought about how salmon do something different. They have to prepare themselves to go from freshwater to saltwater. They turn on different genes and up-regulate genes to do that. That's the kind of signal you ought to be able to measure." With eRNA, scientists may be able to detect smoltification in Atlantic salmon. The non-invasive nature of the method is also a benefit.

"The beauty of this is that Atlantic salmon are an endangered species. We are only collecting a water sample. We're not looking at their RNA directly, we are looking at RNA from shed cells," Zegers said.

The ability to detect salmon smoltification offers widespread applications to both aquaculture and conservation efforts. In aquaculture, salmon are typically raised in freshwater facilities, and eventually moved out to sea. If an operation knows when salmon have smoltified, they can reduce the risk of mortality when they are moved to a saltwater environment.

Different hatcheries produce smolts in different ways. Federal hatcheries produce smolts in just one year. In wild settings, salmon generally spend two years in freshwater before they transform into smolt and leave the river. Unlike many hatcheries, the DSF develops their fish slower, which is helpful for testing eRNA methods.

"The DSF produces a hatchery product that's advertised to be more like a wild fish than the fish produced at the federal hatcheries. So if we have access to salmon cells throughout this process, we can compare salmon cells captured from hatchery water at the federal hatcheries and also at the DSF," Zegers said.

The eRNA technique, once refined, may offer a boon to salmon conservation. "Knowing when smolts are coming out of a river as well as how many are important metrics for conservation," Zegers said.

Understanding which parts of rivers produce smolt can inform land acquisitions or other protections. The Maine Department of Marine Resources (DMR) monitors smolts with small traps to estimate their numbers in a given river. The trapping approach, however, is expensive and limited to the main stem of rivers, which excludes small tributaries. eRNA is free of these constraints. "You can collect samples from anywhere in the watershed if you use a water sample," Zegers said.

While the eRNA techniques the UMM team are refining focus on detecting life stages in Atlantic salmon, the approach can be applied to other species.

"There are all sorts of species that undergo transitions and dramatic changes in their life cycles, and it might be important to measure that," Zegers said.

Zegers' team has developed a DNA aptamer that helps isolate the salmon cells so RNA can be extracted. They are now working to turn the DNA aptamer into a tool and operationalize it. In the lab, they are working to determine how many salmon cells need to be captured to detect an organism's complete RNA record. In coming years, they plan to collect water samples from hatcheries, smolt traps, and river locations with high parr densities to determine if the technique is effective in those settings.

In time, this eRNA will provide insights into their lifecycle and movement of Atlantic salmon in Maine through non-intrusive methods, ideal for an endangered species.

"This is sort of the ultimate extension of what I think is possible with this technique. We are not there yet, but I think it's possible to get there," Zeger said about the potential for this research to ultimately advance a wider understanding of our environment.

Susan Smith in home studio.

Where science and the arts meet

UMaine arts and STEM students engage in interdisciplinary research and learn how to become better scholars.

In academia and beyond, fields are becoming less and less siloed. This is especially true at the University of Maine, where the administration and researchers prioritize interdisciplinary research projects because of how they are able to approach large problems and questions. Chemists, engineers, economists and educators often team up on such projects. UMaine is going a step further and working to incorporate the arts.

Susan Smith is an associate research professor who serves as director and graduate student coordinator of UMaine's Intermedia Program. In these roles, she teaches and works with Intermedia students pursuing MFA, M.A. and interdisciplinary Ph.D. degrees. The program is designed to involve students in interdisciplinary research, and Smith stresses the significance of that to her students.

"I want to foster with the students a realization that whatever we are making as artists does not function in a vacuum," Smith said. "It is in relation to whatever is happening around us, whether that be the university and research or inclusivity and diversity. Whatever they are making has a connection to and an impact on the world."

She points to the establishment of the UMaine Arts Initiative as a key development for this work. Funding from the initiative helped put arts on an even playing field with other disciplines. The initiative helped advance conversations and establish projects as artists and scientists connected.

"This funding started to elevate the way we thought about the arts at UMaine," Smith said. "There are common threads between arts and sciences. The boundaries between arts and science are more diffuse than we thought."

Smith worked with Assistant Professor of Civil and Environmental Engineering Onur Apul, who she had previously collaborated with, to bring interdisciplinary work into the classroom. With a combined curriculum, students in Smith's Social Practice class worked with Apul's students, meeting throughout the semester in both the studio and lab. Students formed groups to develop collaborative projects focused on PFAS nanotechnology. The semester's work was displayed at the Innovative Media Research and Commercialization Center and as Smith explained, brought a diverse group of community members together around the work.

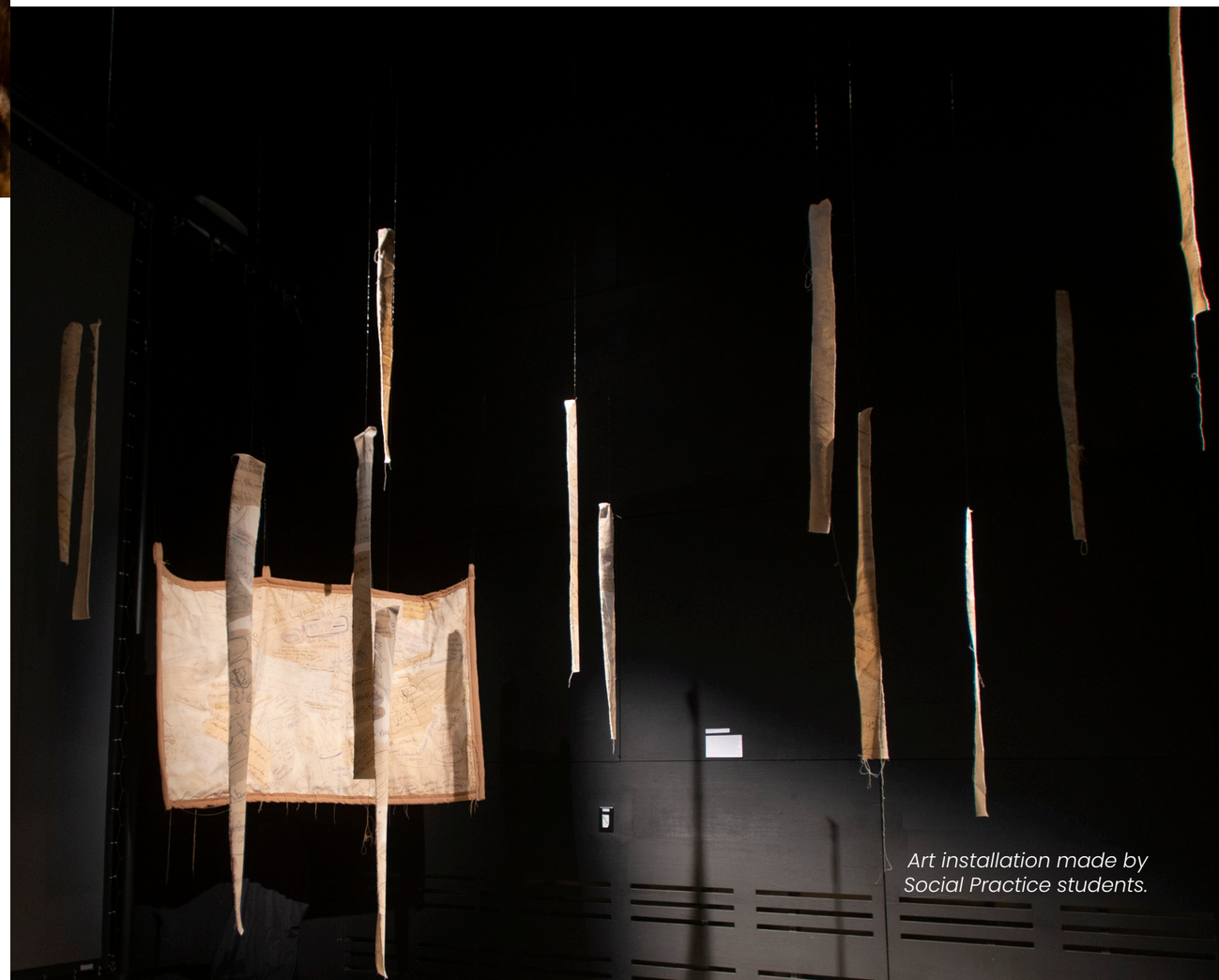
The class demonstrated to the students how art can be used to communicate, and how art, much like science, is a process. "Art can provide a way of communicating with the wider world. It can show science through an emotional lens that is sometimes left out," Smith said. "It is challenging for them to acknowledge that they are not experts in both fields, but you do not need to be an expert in both. We need to acknowledge that it is a process and that they bring new perspectives to it."

Intermedia students also worked with researchers at UMaine's Process Development Center to explore the application of nanocellulose fibers as a new medium for artists. Nanocellulose is a natural polymer and promising biomaterial derived from wood pulp. This sustainable material has a wide range of applications, from paper and packaging to insulation. Through this collaboration, students investigated nanocellulose as a potential component of artistic research, and how they can contribute to the field of knowledge concerning this innovative material. Students engaged in research-based practice, an approach many artists are not familiar with, which fostered new discussions and ways of looking at both their physical work and the process of creating art in a way that could be communicated to researchers.

Interdisciplinary practices like those spearheaded by Smith are increasing in education and research at UMaine and nationwide. "I think the fact that major NSF grants and external grant funding consider art aspects relevant is a huge step," said Smith. "Do I think we are there? No, but I am gratified that it is being recognized that collaborative work is an important component."

UMaine strives to be a leader in interdisciplinary collaboration. This work brings together disciplines and asks them to think differently about their research and engage with it in new ways. It enriches the educational experience for students helping make them well-rounded scholars and cultivates the diverse teams needed to tackle large research projects.

"A reciprocal relationship between science and art in and of itself can be the pathway to innovation and solutions to the current crisis we face as a society," Smith said.



Art installation made by Social Practice students.

Bringing new understanding to the Holocaust through digital humanities research

UMaine researchers leverage Geographic Information System technology to examine the spatial relationships between German occupation and genocidal actions.

The Holocaust is widely understood to have been a horrifying genocide that affected millions of people during, and long after, World War II. What may surprise some readers is that scholars continue to unearth new information and new ways to comprehend what happened under the Nazis' brutal regime.

University of Maine McBride Professor of History Anne Kelly Knowles dedicated the past 16 years to revealing the geographies of the Holocaust. Mapping Holocaust sites and understanding how the nature of places influenced victims' experiences are central concerns in her research. Her current digital humanities project, a public website, will share data on more than 2,200 camps and ghettos along with personal accounts of nearly one thousand Holocaust survivors.

Knowles is a professor in UMaine's History Department, but she calls herself a historical geographer. Over the past 60 years, the United States witnessed a decline in university geography departments, even as Geographic Information Systems (GIS) and spatial studies in the social sciences and humanities proliferated. Some bastions of the discipline remain, but the situation has left historical geographers to feel, according to Knowles, "A bit like a unicorn in American academia."

Historical geography focuses on the ways people perceive and shape human and physical environments across the globe. Within this field, archival research is used to discover how places differ and change over time. Maps are crucial sources for this kind of research, and making maps is an essential medium for communicating geographic understanding of the past.

Historical geography is inherently interdisciplinary. In addition, Knowles said, "Geography takes any academic study and brings it down to ground." Seeing where events took place, or how ideas diffused across space, or the specific conditions that affected people's lives, makes history more tangible.

Cultivating geographic awareness is all the more important today because people's connection to place is dwindling, especially in the United States, Knowles said. "Humans living in urbanized, industrialized, and digitized societies are losing their awareness of the places where they live and how the qualities of those places, good and bad, affect them."

By looking at historical events and focusing on their spatial qualities, Knowles hopes that her research can help people recognize changes in the environment, like poverty, pollution and injustice, and why those changes occur. "In a time when history is a disputed subject," Knowles said, "the physical world provides really important clues to the consequences of human actions in the past."

As a digital humanist, Knowles also sees great value in visualizing data, whether in maps, charts, diagrams, or other forms. GIS provides many of the digital tools she and her research teams use most. Bringing diverse layers of information into a common geographical space makes it possible to explore relationships in time and space. It also enables comparisons between places, regions, and nations that would be impossible to do by hand. According to Knowles, this is a key reason why the spatial turn is beginning to reshape Holocaust studies.

Anne Kelly Knowles

"GIS enables us to study just a few ghettos or hundreds. Our work is inspiring other researchers to examine the spatial relationships between German occupation and genocidal actions, like mass shootings," said Knowles. "At the other extreme, scholars are also paying attention to how Holocaust survivors describe the places where they were sent, where they labored, and so on, to understand how physical circumstances contributed to their plight."

Knowles and her colleagues began this work in 2008 when the Holocaust Geographies Collaborative received their first large grant from the National Science Foundation to apply historical GIS to the Holocaust. Collaborative work on this subject was a radical change for Knowles, who previously had worked as a solo archival scholar studying 19th-century immigration to the Midwest. Since coming to UMaine in 2015, Knowles has received a series of grants from The National Endowment for the Humanities Office of Digital Humanities (ODH) to build digital infrastructure and develop new modes of analysis and representation of Holocaust geographies.

Her third and most recent project funded by ODH is a public website called Placing the Holocaust. This site will weave together two ways of studying the Holocaust—mapping traits of camps and ghettos, and developing a search tool to identify and show the context of hundreds of kinds of places in Holocaust survivor testimony.

The GIS mapping side of the website holds information like how long camps and ghettos existed, the kinds of people held in such sites, incidents of disease and what type of work prisoners had to do. More than 100 variables in total have been manually entered into the camps and ghettos datasets Knowles's teams have built. Making the data visible in maps is a crucial component of this project.

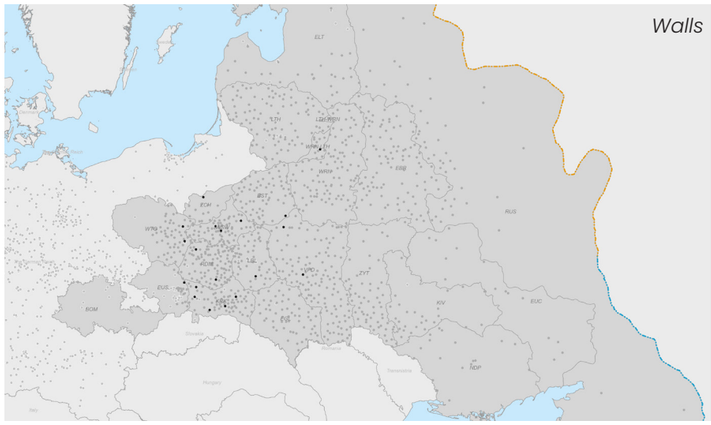
"Different parts of the brain are activated when people look at maps than when they read or solve a mathematical problem," Knowles said. Maps can also spark new questions, particularly if they suggest previously undetected relationships. The goal of the project is to encourage and enable researchers, educators and students to understand the Holocaust in new ways, and to think about the importance of geography in the human experience.

"Memory is anchored in places," said Knowles. "The whole project highlights that every crucial event in a Holocaust survivors' experience was tied to some type of place. For every individual, particular places profoundly shaped their experience."

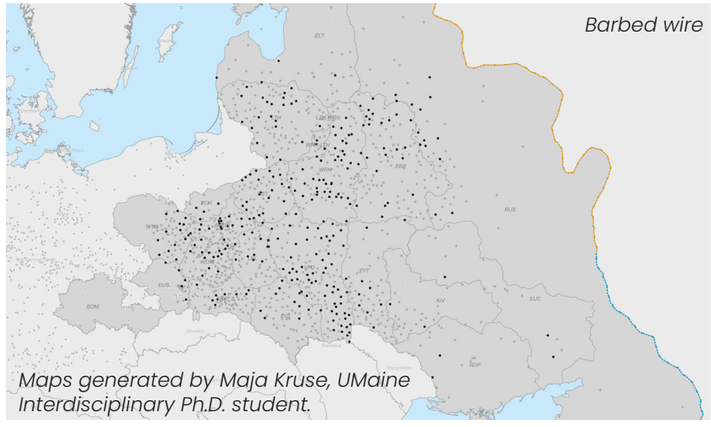
Knowles thinks that "Placing the Holocaust" is the first digital humanities project to directly link GIS data to oral histories. The linkage is the most challenging part of the project technically, which makes it interesting for computer scientists. If the team succeeds, their work could provide a model for other large-scale GIS + linguistic projects.

The project also has significance for Holocaust scholars. "We are trying to achieve something that Holocaust scholars have been striving for since the 1990s, which is to bridge the gap between perpetrators and victims, two groups that have often been studied separately because the sources they left behind are so different," Knowles said. "By bringing both into the same website and making it possible to go back and forth between the places where they were brought together, we hope to facilitate more integrated histories of the Holocaust."

The final website will provide users with a unique experience, enabling them to search in various ways and, in many instances, link searches together to gain a deeper understanding of the Holocaust through the myriad places where it happened. The data and transcripts will also be downloadable, as will the maps users make as they explore the site. Not only will this provide teachers, students and scholars a new way to communicate the history of the Holocaust, but it will allow anyone to explore their own inquiry into the Holocaust through maps and testimonies.



Walls



Barbed wire

Maps generated by Maja Kruse, UMaine Interdisciplinary Ph.D. student.

Most people think of ghettos as walled-in spaces, before and during the Holocaust. During WWII, however, less than two percent of Jewish ghettos had walls. Barbed wire—inexpensive, easy to put up and take down—was used at over 26 percent of ghettos in German-occupied territory. Each form of enclosure had consequences for captive Jews.

National Institutes of Health COBRE award

The National Institutes of Health awarded UMaine $11.3 million to spearhead biomedical research.

A Center of Biomedical Research Excellence (COBRE) awarded to the University of Maine by the National Institutes of Health (NIH) positions the flagship university as a leader in the biomedical field within Maine and beyond. The $11.3 million achievement was developed through the UMaine Institute of Medicine and showcases the institute's commitment to pioneering scientific inquiry.

The COBRE award places UMaine at the forefront of exploring the intricate mechanisms that regulate cellular behavior. This research delves into understanding how cells respond to external cues, ranging from the impact of persistent viral infections to the intricacies of muscle cell development. The implications of this research are vast, offering potential breakthroughs in treating infectious diseases, neuromuscular disorders and challenges in muscle aging and regeneration.

"One of the most exciting aspects of this grant is the explicit integration of research with training of the next generation of biomedical scientists," said Clarissa Henry, professor of biological sciences at UMaine's School of Biology and Ecology, who leads the project. "The University of Maine has a phenomenal cluster of early career biomedical faculty, and I am thrilled that this award will propel their research careers, increase campus and statewide collaboration, and add meaningful undergraduate and graduate research experiences."

The award supports five critical research projects led by emerging scientists from UMaine and the Mount Desert Island Biological Laboratory (MDI Bio Lab). UMaine's COBRE team includes Melissa Maginnis, Jared Talbot, Joshua Kelley, and Benjamin King, all faculty at UMaine, as well as Romain Madelaine from the MDI Bio Lab. Their collective work spans the field of biomedical research, promising to offer novel insights into cellular and molecular biology.

A significant focus of the COBRE award is to foster UMaine's role as the academic leader in biomedical research through the Institute of Medicine and College of Earth, Life, and Health Sciences. This includes establishing a Microscopy and Image Analysis Core under the guidance of Robert Wheeler, associate professor of microbiology at UMaine's Department of Molecular and Biomedical Sciences. The core facility will offer state-of-the-art super-resolution microscopy that supports sophisticated image analysis and bolsters the university's research infrastructure.

The award will also nurture emerging biomedical researchers through assistantships in the Graduate School of Biomedical Science and Engineering. "Integrating research with the training of upcoming biomedical scientists is one of the most exhilarating aspects of this grant," Henry said. "We're thrilled to see how this award will propel the careers of our early-career faculty, foster collaboration across the campus and state, and enrich both undergraduate and graduate research experiences."

When the award commenced in April 2023, UMaine embarked on a new chapter in biomedical research and innovation. The COBRE award represents a leap forward in biomedical research and education, placing UMaine at the forefront of scientific discovery and innovation.

NSF Research Traineeship Award recipients

Explore the cutting-edge environmental and ecological research programs at UMaine, funded by the National Science Foundation's Research Traineeship (NRT).

Joshua Stoll

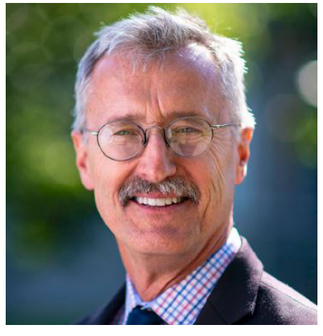
Associate Professor of Marine Policy

Stoll studies how the design and maintenance of formal and informal institutions support sustainable fisheries and the communities that depend on them. The NRT award he leads aims to train a new wave of scientists, managers, and policymakers in ecosystem-based management and climate resilience. At least 45 graduate students will learn to address rapid ocean changes in the Gulf of Maine through transdisciplinary knowledge.

Sandra De Urioste-Stone

Associate Professor of Nature-Based Tourism
Assistant Vice President for Research

De Urioste-Stone studies the factors that affect rural health and wellbeing, community resilience, and natural resource stewardship. The NRT award she leads supports a new graduate education model at UMaine that integrates social and biophysical sciences. It prepares 25 M.S. and Ph.D. students to tackle conservation challenges through an interdisciplinary curriculum. The program includes active learning, professional development, and collaborative research, focusing on socio-ecological resilience and science communication.



Mario Teisl

Professor, Director of the School of Economics

Teisl's research aims to identify opportunities to produce knowledge that helps solve urgent sustainability challenges by improving collaboration between academic institutions and community leaders, policymakers and citizens. The NRT award he leads supports training in the One Health approach, which studies disease dynamics across human, animal, plant, and environmental health. The program anticipates training 71 M.S. and Ph.D. students as they conduct interdisciplinary research on issues like pathogen transmission and disease vector spread, preparing them for challenges in environmental health.

Jasmine Saros

Professor of Paleolimnology and Lake Ecology
Associate Director of the Climate Change Institute

Saros uses diatom fossil records in lake sediments to reconstruct environmental change over time and pose testable hypotheses about mechanisms driving observed changes. She also studies how modern lake ecosystems respond to climate change. The NRT award she leads aims to train 57 M.S. and Ph.D. students in the interdisciplinary field of Arctic systems science. Trainees will develop skills and competencies across environmental, social, and knowledge systems that are essential to understanding and adapting to the most rapidly changing environment in the world—the Arctic—and enhancing training of the broader STEM workforce.

2023 NSF CAREER Award recipients

In 2023, the University of Maine secured three National Science Foundation (NSF) CAREER Awards for faculty members Evan Wujcik, Seth Campbell, and Sepideh Ghanavati. These prestigious awards recognize their potential as academic role models in their fields.

Evan Wujcik

Assistant Professor, Department of Chemical and Biomedical Engineering and the Advanced Structures and Composites Center

Evan Wujcik, was awarded $523,438 for his project "Autonomous, rapid self-healing and ultra-stretchable electronic polymer research and education for outreach and student success in STEM."

Wujcik's project, rooted in polymer science, is redefining the potential of electronic materials with its focus on stretchable, self-healing polymers. This research has significant implications for healthcare, robotics, and entertainment, where flexibility and durability are crucial. The project also includes educational outreach, creating an avenue for underrepresented groups in STEM and enhancing engineering education through engaging digital content.

Seth Campbell

Associate Professor, School of Earth and Climate Sciences and the Climate Change Institute

Seth Campbell was awarded $623,881 for his groundbreaking project, "Improving estimates of changing firn meltwater storage and flux in temperate glacier systems."

Campell's work tackles the pressing issue of climate change by examining the storage and movement of meltwater in glaciers. This research is vital for understanding how climate change affects water storage in glacier systems, particularly in rapid melting regions like Alaska and Canada. The project's educational component, including the development of an interactive video game, exemplifies the project's commitment to make science accessible and engaging to a wider audience.

Sepideh Ghanavati

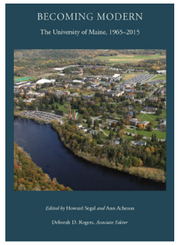
Assistant Professor, School of Computing and Information Science

Sepideh Ghanavati was awarded $674,804 for her project "A holistic developer-centered approach to enhance privacy for data-driven applications."

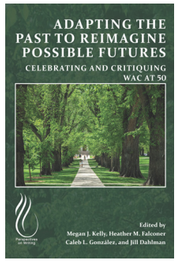
Ghanavati's project addresses the increasingly critical issue of privacy in the modern digital age. Her research focuses on embedding privacy protections in software development, a proactive approach to mitigating privacy breaches. The innovative work, involving collaborations with industry and legal experts, demonstrates a forward-thinking stance to tackling modern technological challenges.

Publication spotlight

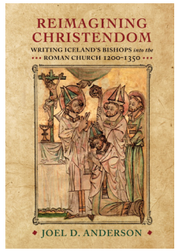
A sample of works by UMaine faculty



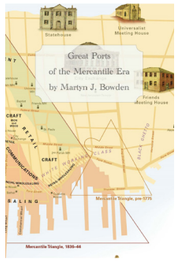
BECOMING MODERN: THE UNIVERSITY OF MAINE, 1965-2015
Segal, Howard; Acheson, Ann; Rogers, Deborah
University of Maine Press



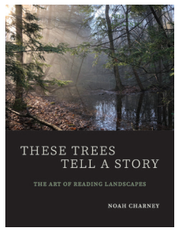
ADAPTING THE PAST TO REIMAGINE POSSIBLE FUTURES: CELEBRATING AND CRITIQUING WAC AT 50
Falconer, Heather
The WAC Clearinghouse



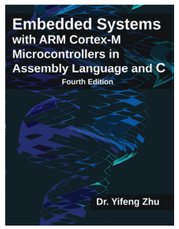
REIMAGINING CHRISTENDOM: WRITING ICELAND'S BISHOPS INTO THE ROMAN CHURCH, 1200–1350.
Anderson, Joel D.
University of Pennsylvania Press/Gigi Lamm



GREAT PORTS OF THE MERCANTILE ERA
Hornsby, Stephen
University of Maine Press



THESE TREES TELL A STORY: THE ART OF READING LANDSCAPES
Charney, Noah
Yale University Press



EMBEDDED SYSTEMS WITH ARM CORTEX-M MICROCONTROLLERS IN ASSEMBLY LANGUAGE AND C
Zhu, Yifeng
E-Man Press LLC

Global Impact
Local Relevance

Maine's Research University at Work

Office of the Vice President for Research
and Dean of the Graduate School

umaine.edu/research

Contributors: Staff from the Office of the Vice President for Research and Dean of the Graduate School, Maine EPSCoR, Advanced Structures and Composites Center, Aquaculture Research Institute, Center for Undergraduate Research, Fogler Library, Division of Marketing and Communications, and the many faculty, staff and students who contributed their time and attention to the production of this publication.