

WINTER 2021-22

# UMaine Today

CREATIVITY AND ACHIEVEMENT AT THE UNIVERSITY OF MAINE



**NANOCELLULOSE:** Key ingredient for the next big thing(s)



In fall 2021, the University of Maine and University of Maine at Machias launched the Research Learning Experience (RLE) initiative, a pilot program that invites students to find their passion and make impactful connections through hands-on learning and the creation of new knowledge. RLE, focused on student retention and immersion learning, is supported by the \$240 million grant from the Harold Alford Foundation. Upward of 250 incoming and second-year students enrolled in the 26, one-credit courses that started a week before fall semester classes. Thirty-six UMaine and UMaine Machias faculty members taught the RLE courses throughout the fall, spanning disciplines from art, biophysics and business to engineering and the humanities.

Photo by Patrick Wine.



We are living in extraordinary times, with the health and well-being of our university community members our primary concerns in this pandemic. We are committed to providing the best learning experiences and working environments possible for our students, faculty and staff, all while keeping our UMaine and UMaine Machias communities — and our neighbors — as safe as possible, in accord with civil and scientific guidance. Now more than ever, there is a need for flexibility, compassion and common sense.

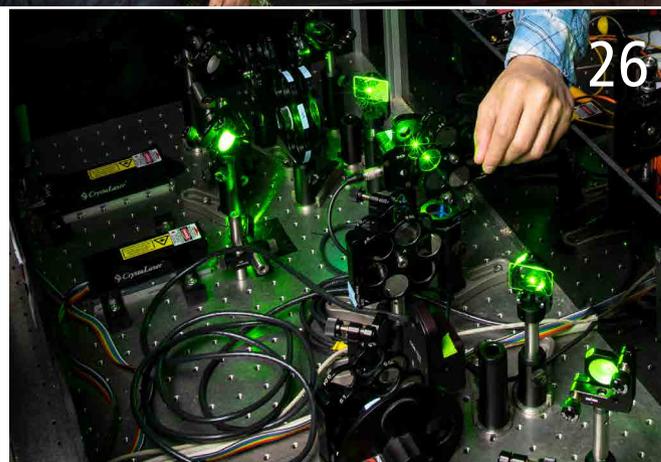
It also is in challenging times such as these that public research universities step up. As Maine's research university, UMaine responds to the greatest needs of the state and beyond, all while holding firm to the importance of continuity of learning and operations, and to the long view as a leader and engaged partner, dedicated to innovation, workforce development and outreach. Lessons from the past two years inform our work today and going forward.

Stories in this issue of *UMaine Today* magazine reflect our commitment to our university community and the state we serve, to the student experience, and to our institutional strategic vision and values. Our world-class faculty and staff make critical contributions that have local and global implications. Together, even in what will now be the third year of a pandemic, UMaine defines tomorrow.

Joan Ferrini-Mundy  
*President of the University of Maine and University of Maine at Machias*  
*University of Maine System Vice Chancellor for Research and Innovation*

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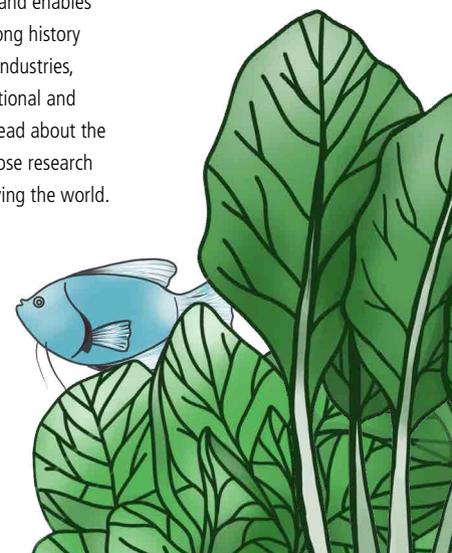
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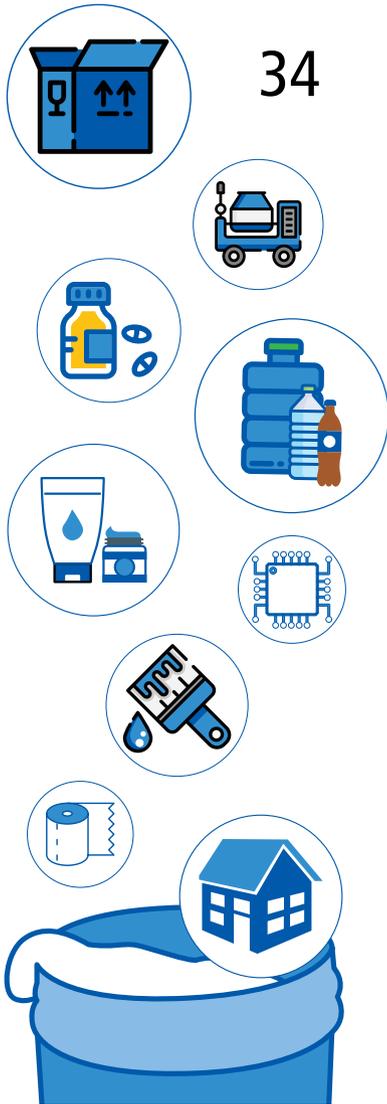
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### On the cover

The groundbreaking nanocellulose work that Maine’s research university leads and enables is possible because of UMaine’s long history with the state’s paper and forest industries, its tradition of innovation, and national and international R&D partnerships. Read about the university’s strength in nanocellulose research and development that is now serving the world. The story begins on page 34.

Photo illustration by Patrick Wine.





## UMaineToday online

[umainetoday.umaine.edu](http://umainetoday.umaine.edu)

*UMaine Today* magazine online provides web-exclusive features, including videos, photo galleries, full-length versions of articles and a comprehensive editorial archive.

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### Research centers

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## Focusing on Potato Virus Y

**GREATER UNDERSTANDING** of the biology of one of the most destructive plant viruses to potato crops will be the focus of a research hub at the University of Maine that is part of a new \$6.1 million institute focused on virology and host-virus dynamics.

The National Science Foundation awarded the grant to the University of Arkansas to establish the Host-Virus Evolutionary Dynamics Institute. Hub sites will be located at the University of Maine, University of Arkansas at Pine Bluff, Ouachita Baptist University and Universidad Interamericana in Puerto Rico.

Scientists will study multiple virus systems across all domains of life — Bacteria, Archaea and Eukarya. The goal is to establish fundamental “rules of life,” or laws of virology, that apply to all viruses — or at least large sets of virus systems.

The institute will be led by Ruben Michael Ceballos, assistant professor in the Department of Biological Sciences at the University of Arkansas, collaborating with an interdisciplinary team of geneticists, virologists, ecosystem ecologists and mathematicians. The UMaine hub will be led by E. Han Tan, assistant professor of plant genetics.

UMaine will receive more than \$446,800 to fund research led by Tan and Peter Nelson, forestry ecology director at the Schoodic Institute at Acadia National Park and a faculty associate in UMaine’s School of Forest Resources. Their research team will use hyperspectral and long-read sequencing methods to study Potato Virus Y (PVY), strains of which in Maine and elsewhere can result in severe losses in crop yield. The researchers also will use genomic tools at UMaine’s Maine Center for Genetics in the Environment to study PVY in potatoes.

“Not only will our research test a novel method to detect PVY-infected potato, which costs the potato industry substantial amounts of money for lab testing each year, we hope to better understand the arms race between PVY and potato, which will be integrated with other viral systems under investigation at this institute,” says Tan.

Tan is a co-principal investigator on the NSF Biology Integration Institute grant, along with other hub leaders: Anissa Buckner, University of Arkansas at Pine Bluff; Nathan Reyna, Ouachita Baptist University; and Elizabeth Padilla, Universidad Interamericana Aguadilla. ♦

“

By measuring potato plant light reflectance and color on the ground and from space, we can potentially provide a means to **rapidly and easily detect and manage viral outbreaks.**”

Peter Nelson

—————



## Diversifying the workforce in nursing

**INCREASING THE DIVERSITY** of Maine’s workforce in nursing is the focus of a more than \$1.7 million grant from the federal Health Resources and Services Administration to the University of Maine School of Nursing, in partnership with Northern Light Health and Morgan State University.

The four-year award by HRSA, an agency of the U.S. Department of Health and Human Services, will address the need to increase nursing education opportunities for individuals from financially disadvantaged and underrepresented ethnic and racial minorities in Maine, and, ultimately, help address the state’s shortage of nurses.

A priority of the initiative, Promoting Diversity in Nursing Education, is to capitalize on the social, cultural and ethnic resources for in-state student diversity, says Kelley Strout, director of the School of Nursing and principal investigator on the initiative that will include first-generation college students.

Targeted student recruitment in Maine will help ensure that graduating nurses join and remain a part of communities where their skills are most needed, Strout says. Increasing diversity of both students and faculty in the School of Nursing will prepare graduates to meet workforce needs fully.

The initiative’s goals align with the mission of the UMaine President’s Council on Diversity, Equity, and Inclusion.

The School of Nursing offers one of the university’s most sought-after degree programs, receiving upward of 1,400 applications for approximately 80 seats available in the fall semesters of the past five years. Nearly half of UMaine nursing students have been from out of state, and many do not remain in Maine after graduation. ♦



Place-bound and place-invested nurses are essential **to meet the long-term needs of Maine.**”

Kelley Strout



## The missing link

**ORIGINS OF ICE AGE** climate changes may lie in the Southern Hemisphere, where interactions among the westerly wind system, the Southern Ocean and the tropical Pacific can trigger rapid, global changes in atmospheric temperature, according to an international research team led by the University of Maine.

The mechanism, dubbed the Zealandia Switch, relates to the general position of the Southern Hemisphere westerly wind belt — the strongest wind system on Earth — and the continental platforms of the southwest Pacific Ocean, and their control on ocean currents. Shifts in the latitude of the westerly winds affect the strength of the subtropical oceanic gyres and, in turn, influence the release of energy from the tropical ocean waters, the planet’s “heat engine.” Tropical heat spreads rapidly through the atmosphere and ocean to the polar regions of both hemispheres, acting as the planet’s thermostat.

The Southern Hemisphere climate dynamics may be the missing link in understanding long-standing questions about ice ages, based on the findings of the research team from UMaine, Columbia University’s Lamont-Doherty Earth Observatory, the University of Arizona, and GNS Science in New Zealand, published in *Quaternary Science Reviews*.

For more than a quarter-century, George Denton, UMaine Libbra Professor of Geological Sciences, the journal article’s first author, has led research reconstructing the history of mountain glaciers in the Southern Hemisphere. In the late 1980s, he and Wallace Broecker, a geochemist at Columbia University, noted that a key question about ice ages remained unresolved — the link between ice age climate and the orbital cycles in the length and strength of the Earth’s season. Evidence showed that ice age climate changes were synchronous in both polar hemispheres, with rapid transitions from glacial to interglacial global climate conditions. They concluded that existing theories could not adequately account for changes in seasonality, ice sheet size and regional climate. ♦

Moraines constructed during repeated advance-retreat cycles of one of the glaciers that extended out from the Southern Alps in New Zealand during the last ice age. Around 18,000 years ago, the glacier rapidly retreated in response to a sustained global warming event that terminated the ice age, revealing the glacial valley that is occupied by present-day Lake Pukaki (seen in the far left). New Zealand’s tallest mountain, Aoraki/Mt. Cook, is in the background.

Photo courtesy of Aaron Putnam

# Warming barrens

**WILD BLUEBERRY FIELDS** in Down East Maine are warming faster than the state as a whole, according to a new University of Maine study on the effects of climate change on the barrens over the past 40 years.

The difference in rising temperature rates suggests the need to develop specific wild blueberry management strategies, such as irrigation and fertilizer use, to mitigate the effects of climate change on Down East fields, rather than using tactics devised from statewide climate patterns, according to researchers.

Rafa Tasnim, a Ph.D. student of ecology and environmental sciences, led the study that explored changes in climate change patterns, particularly in temperature and precipitation, at Down East wild blueberry fields in the past 40 years of growing seasons from 1980–2019, then compared them to aggregate changes in climate measured for the entire state. Yongjiang Zhang, an assistant professor of applied plant physiology, and Francis Drummond, professor emeritus of insect ecology and pest management, collaborated on the study, the first to assess climate change patterns for a fruit spanning different fields in a single production region.

Their findings also revealed that rising temperatures in Down East wild blueberry fields over the past four decades fueled increased potential evapotranspiration, or the combined loss of water through the plant's process of transpiration, and evaporation of water from the Earth's surface. The continuation of this could threaten water use by blueberries in the low-water holding capacity soils in which they grow. The coupling effects of warming and increased potential evapotranspiration could hurt wild blueberry health and yield, according to researchers.

Most of the 18,000 hectares of wild blueberry fields in Maine reside in the Coastal Climate zone, which has been experiencing faster warming than the interior and northern climate zones.

The variation in climate across the three zones could result in wild blueberry fields experiencing the effects of climate change differently, according to Tasnim and her colleagues. The notion brings the efficacy of using statewide climate statistics in management practices into question, prompting the researchers' study. ♦

Most of the 18,000 hectares of wild blueberry fields in Maine reside **in the Coastal Climate zone**, which has been experiencing faster warming than the interior and northern climate zones.



# Bridges of the future

**THE 75-FOOT** single-span Grist Mill Bridge in Hampden, Maine is the first in the nation to use the fiber reinforced polymer (FRP) tub-girders called GBeams™, designed at the University of Maine Advanced Structures and Composites Center.

The patented GBeam technology results from research and development at the UMaine Composites Center, which licensed it to Advanced Infrastructure Technologies (AIT) Bridges, the university's commercialization partner in Brewer, Maine.

The GBeam technology is corrosion resistant and designed to last over 100 years with little to no maintenance. The composite girders, which are one-quarter the weight of steel girders, are a promising, sustainable, low-cost, easy-to-install alternative.

The technology packs small, packs light, and can be deployed very quickly and easily, says Habib Dagher, executive director of the UMaine Composites Center. The girders are designed to be stackable, reducing transportation costs and lowering their carbon footprint.

The practicability of the GBeam technology is further enhanced by the bolt system that connects the girders to the concrete deck, allowing the deck to be quickly removed for future replacement after 50 years without jackhammers. The ease of deck replacement will lower construction costs and minimize disruptive road closures.

The many benefits of the composite GBeam technology are attracting interest from Departments of Transportation across the United States. The technology is already planned to be used in bridge replacement projects in Washington, California, Florida and Rhode Island. In Maine, the technology also will be used in the Hampden Twin Bridge project that will begin construction in 2022. Girders for these bridges will be fabricated by AIT and shipped to destinations nationwide.

Funding for the research was provided by the U.S. Army Engineer Research and Development Center and the U.S. Department of Transportation through the Transportation Infrastructure Durability Center led by UMaine. ♦



GBeams™ were used in the Grist Mill Bridge constructed in fall 2020.



## Training behavioral health workers for rural areas

“  
**In Maine, we have particularly high rates of mental health and substance use disorders,** but are challenged, especially in rural areas, to find enough trained mental health professionals to meet the profound need.”

Sandra Butler

**UNIVERSITY OF MAINE** researchers will train future behavioral health workers specialized in serving rural areas in the state with a new program funded by a four-year, \$1.48 million grant by the federal Health Resources and Services Administration.

The Rural Integrated Behavioral Health in Primary Care (RIBHPC) training program seeks to address the shortage of workers in mental health, addiction treatment, social work and other behavioral health fields in rural Maine. Ten out of 16 Maine counties, seven of which are nonmetropolitan, have areas with insufficient mental health care coverage, according to the Rural Health Information Hub (RHlhub). UMaine researchers say only about half of Maine adults and children who need mental health services receive them.

Sandra Butler, director of the School of Social Work, will lead the development and implementation of the RIBHPC program alongside Emily Haigh, director of clinical training for the clinical psychology doctoral program at UMaine. The program will emphasize the behavioral health care needs of children, adolescents and transition-aged youth in primary care settings, many of whom face financial and geographic barriers to the services they need.

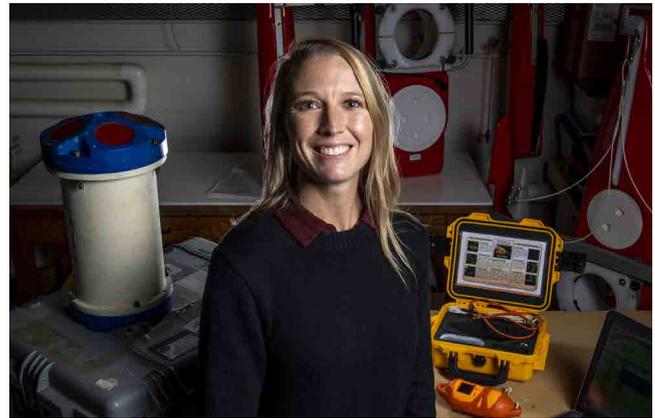
Each year starting in fall 2021, the program will support 20 social work students and one to two clinical psychology students. Butler and Haigh plan to recruit 87 students, seven from clinical psychology and 80 from social work, throughout the four-year project. To incentivize prospective participants, the program will offer \$10,000 annual stipends to social work students and \$25,000 annual stipends to clinical physiology students over four years.

Participants in the RIBHPC program will receive on-site and remote training from health care providers who serve high-need areas across the state to obtain the skills and knowledge necessary to serve in rural primary care settings. ♦



## Sheila Edalatpour

Sheila Edalatpour, assistant professor of mechanical engineering, studies quantum-size effects on radiative heat transfer (RHT), energy emitted from heated surfaces and transferred from one component to another in the form of electromagnetic waves. She will investigate how RHT changes when the materials involved are quantum size, or when they are separated by a gap of the same size as one or multiple atoms. Determining how material size affects RHT can help engineers design new materials to build more efficient, powerful and reliable devices for energy, computing, health care and other purposes.



## Lauren Ross

Lauren Ross, assistant professor of hydraulics and water resources engineering, is improving understanding of how estuary shape, river discharge and tides influence fresh and saltwater mixing. The extent of the mixing process can influence how long particles, such as contaminants, nutrients and larvae, remain in an estuary, and whether it experiences hypoxia — or low oxygen levels. She will use on-site data and numerical model simulations to quantify the mixing processes in more complex estuaries — Penobscot River Estuary in Maine, Reloncavi Fjord in Chile and Gironde Estuary in France.



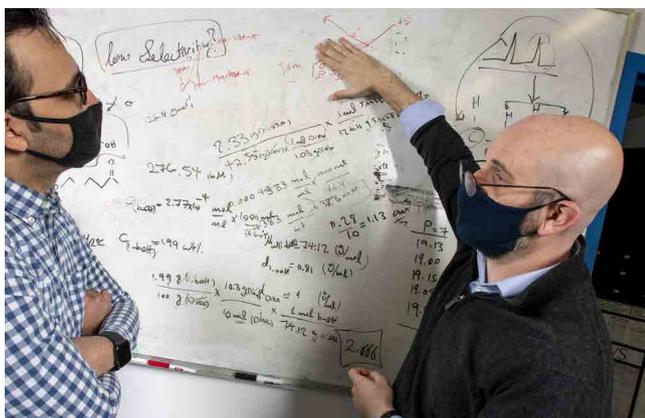
# NSF CAREER Award success

**UNIVERSITY OF MAINE** faculty have competed in the National Science Foundation CAREER program since 1996. The first faculty member to apply received an award, and since that time, there have been an additional 137 proposals.

A total of 22 CAREER awards have been received by UMaine faculty, including four from the most recently completed competition (2020 submission date). After 20 years of single-digit submission rates, 10 or more faculty have applied each year since 2017, due in large part to systematic outreach and proposal development support to eligible applicants provided by the UMaine Office of Research Development.

The awards, among NSF's most prestigious, support early career faculty "who have the potential to serve as academic role models in research and education and to lead advances in the mission of their department or organization," according to the website. Activities pursued by early career faculty are expected to build a firm foundation for a lifetime of leadership in integrating education and research. NSF encourages submission of CAREER proposals from early-career faculty at all CAREER-eligible organizations, and especially encourages women, members of underrepresented minority groups, and persons with disabilities to apply.

Photographs by Adam Kuykendall and Ron Lisnet



## Thomas Schwartz

Thomas Schwartz, associate professor of chemical engineering, is advancing his ongoing dissection of the Lebedev process. The well-known, multistep chemical reaction is used to make butadiene from biomass-derived ethanol, but little research has been conducted on the Lebedev process at the molecular level. Better understanding would help researchers create new catalysts, which are necessary for the chemical reactions to make goods from both petroleum and biomass, that would increase butadiene yield. The emergence of improved catalysts could help grow the development of biobased, renewable chemicals.



## Danielle Levesque

Danielle Levesque, assistant professor of mammalogy and mammalian health, studies temperature regulation in diurnal and nocturnal equatorial small mammals in an effort to describe the impacts of climate change on species living in aseasonal tropical environments. Since 2014, she has collaborated with scientists at the Universiti Malaysia Sarawak in Borneo, a hot spot for mammalian diversity. Her research will enhance understanding of the relationships between past and current environmental temperatures, and the life history and energetics of the island's small mammals. ♦



# Rural aging in the ‘oldest state’

## Quality of life for elders is at the core of Center on Aging leadership, research and advocacy

By Rick Mundy

In 2008, older adults in the United States ages 65 and older numbered 38.8 million. In just 10 years, that number swelled to 52.4 million — a 35% increase — and this cohort is expected to grow another 54% by 2040 to 80.8 million, sweeping in the last of the baby boomers born by 1964. And the climb will continue, with an estimated 94.7 million older adults in 2060, a 17% increase over 2040.

Certainly, that post-world-war baby boom is a key factor in these increases, but the U.S. also is seeing life expectancy increase as new health care technologies emerge and personal care improves. A child born in 1900 had a life expectancy of just 47.3 years. Compare that to 2018 when a newborn’s life expectancy had risen to 78.7 years.

Today, the percentage of older adults is 16% of the U.S. population, or about one in six. In Maine, the percentage is 21%, or more than one in five Mainers. Maine is one of just three states at 20% or more. (Florida is also 21% and West Virginia is at 20%.) The “oldest state” designation comes from identifying the median age of a state’s population. The median age of a Maine resident is 45.0, the next closest is New Hampshire at 43.1. The national median for all states is 38.2 years of age.

Longtime Mainers and even those who have immigrated to the state during their lives find great rewards in making this their home. There is the pristine natural beauty that defines the state — the extraordinary coast, mountains and waterways, opportunities for outdoor adventure and exploration. The relative quiet of the small towns and open spaces appeals to many. And then there is the lifestyle that may be difficult to define, but is summed up in Maine’s slogan: the way life should be. This speaks to a work/life balance that others envy. There is that sense of “everyone in Maine knows each other” that pervades daily interactions. And, as a result, one understands the helping inclinations of rural living. Life in Maine has been characterized as perhaps simpler and more personalized than one might find in other parts of the country, even other parts of New England. It is easy to see why rural living in Maine is a strong attraction for elders.

In spite of these positives, how do older adults in Maine maintain a healthy lifestyle and positive outlook in their lives considering the challenges that also come with rural living?

The University of Maine stands at the forefront in addressing the concerns of the burgeoning elder population in Maine. Twenty years ago, professor of social work Lenard Kaye identified the growing need for a dedicated unit at the university to help meet the growing demand for services and established the Center on Aging. The goal was to fill the gaps in resources offered by Maine’s public university system.

Kaye says his vision was not simply to conduct policy research, but instead to focus on a hands-on approach in providing real solutions to aging issues.

“From the outset, I knew the center needed to not only conduct academic research, but also provide a range of critical concrete services, including education and training for helping professionals, as well as providing practical information and guidance for older adults who wanted to age successfully in their communities,” says Kaye, who directs the center with more than 20 faculty, staff and students, plus 24 associates, both university colleagues and off-campus experts committed to supporting Maine’s elders.

Photo by Elyse Klysa



Photographs by David Levy, Elyse Klysa, Angie Devenney, Meghan Wakefield

### Elders coping in Maine's rural environment

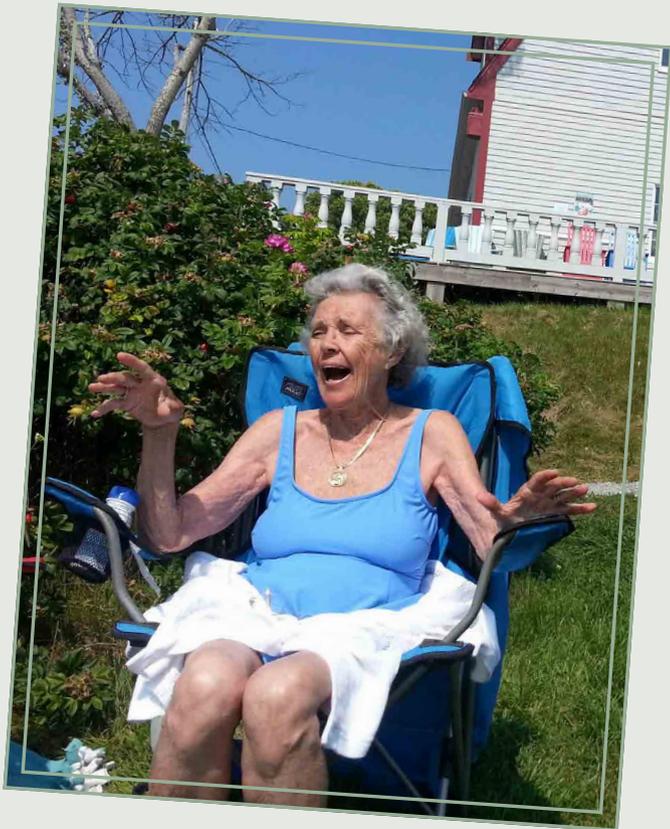
Maine is the most rural state in the U.S. with 61.3% of the population living in communities of 2,500 people or fewer. That fact, coupled with the high percentage of older adults in Maine, presents daunting challenges, now and into the future. Reflecting on the center's work over two decades, Kaye set out to catalog those challenges with the help of 113 other contributors. The *Handbook of Rural Aging* was published in 2021. At 471 pages, covering 79 issues pertinent to elders living in rural communities across the country, the book is a major resource to providing insight into the lives of our older citizens.

Consider just a few of the struggles that perplex our elder society — **Health care:** Does Maine have the capacity to care for its ever-growing older population living in largely rural areas? Significant health issues require specialized expertise. Gerontologists, gerontological nurses and pharmacists, and other medical practitioners are at a premium nationwide, as well as in Maine. As the older adult population grows, those scarcities are exacerbated. Hospitals, retirement and assisted-living communities, home and health care organizations' capacities are strained. Particularly overburdened is the caregiver.

"Caregivers in rural areas are more often reporting that they had no

choice in taking on care and also find the help they provide more difficult," writes Kaye in *The Handbook of Rural Aging*. "Furthermore, while they are typically working in an hourly job in addition to performing their caregiving duties, they are more likely than urban caregivers to report financial strain resulting in delaying plans for saving, assuming more debt, not paying bills or doing so after they are due, and borrowing money from family and friends. They are less likely to have health insurance and more likely to have trouble managing their own health than urban caregivers."

Over the past 18 months, we have been starkly reminded of **another huge pandemic beyond COVID-19**, that of isolation and loneliness that many, many older adults encounter.



## FOCUS ON REAL AGING

FOCUS ON Real Aging in Maine (F.R.A.M.E.) celebrates and promotes positive, realistic images of the diverse aging experience in Maine. It launched in 2021 with a statewide photography contest, sponsored by the Maine Gerontological Society and the University of Maine Center on Aging in collaboration with the Maine Community Foundation and the Elder Abuse Institute of Maine. Lisa White, a UMaine social work graduate student working in the university's Center on Aging, helped organize F.R.A.M.E. with the support of Patricia Oh, the center program manager.

The photo contest attracted 82 entries from amateur and professional photographers of people in Maine ages 50 and older. Prizes were awarded to three amateur photographers and three professional photographers. Six Maine amateur and professional photographers judged the respective entries. In addition, there was one People's Choice Award.

The goal was to bring a more positive perspective to older Mainers during the COVID-19 pandemic, which marginalized elder adults, according to the organizers. F.R.A.M.E. responded to the need for images showing the reality of aging in Maine, especially in our rural communities.

"The UMaine Center on Aging celebrates the public health success of Mainers living longer, healthier lives," says director Lenard Kaye. "We are all aging. However, it is hard to find free-use photos of older people enjoying life. With help from our partners, the Maine Community Foundation and the Elder Abuse Institute of Maine, we have created a library of photos that show older people doing the things we all do — working, volunteering, and having fun with family and friends. Our hope is that when nonprofits and local organizations start to use these photos to depict aging, we will all contribute to a more positive view of aging.

"These images are terrific and serve to smash negative aging stereotypes."

F.R.A.M.E. images are in a new Maine Gerontological Society online library. The relevant, age-friendly photos are available free of charge for limited noncommercial use on websites and in other publications by individuals and nonprofit organizations. ♦

**Transportation:** Older adults frequently struggle with access to the services they require. In a rural setting, where people and services are spread out, and especially if the elder no longer drives, every trip — doctors' appointments, grocery shopping, religious worship or cultural events — can be complicated. Public transportation is practically nonexistent in most rural areas, taxis or shared-ride services can be expensive, and elders' families have frequently migrated to other areas for new opportunities.

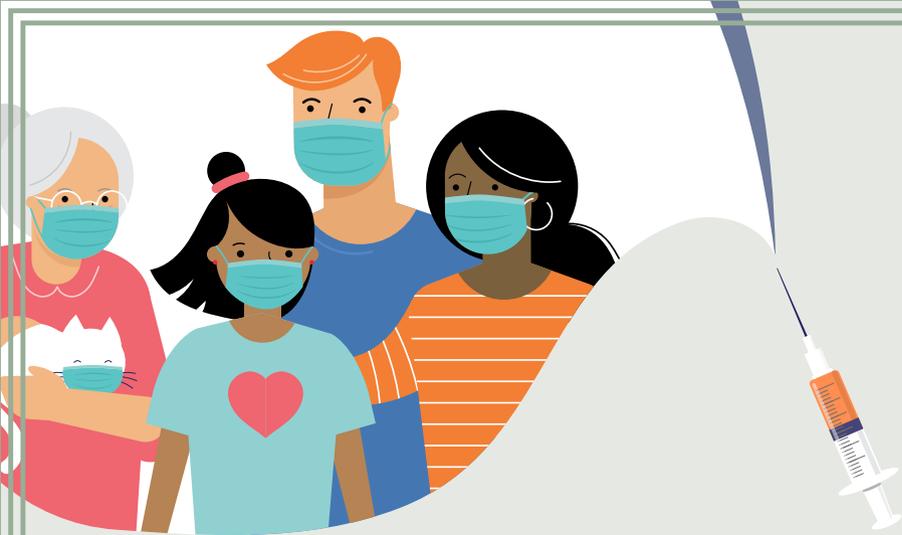
**Isolation and loneliness:** Over the past 18 months, we have been starkly reminded of another huge pandemic beyond COVID-19, that of isolation and loneliness that many, many older adults encounter. This debilitating, life-threatening condition was brought strongly into focus in 2020 and 2021, but existed prior to the pandemic and will undoubtedly continue post-COVID-19 crisis. Isolation and loneliness are not conditions exclusive to rural aging, but often made more prevalent by how people are spread out and how families have dispersed.

"Addressing social isolation as a major threat to the health and well-being of older adults in rural communities will require a multifaceted approach," according to Boston College professor emeritus James Lubben and University of Iowa professor Mercedes Bern-Klug, both in social work, writing in the *The Handbook of Rural Aging*. "Rural communities need

to be educated regarding the serious consequences of social isolation. Governments and various community organizations need to develop policies and programs to address the problem. Health and social service personnel need to be better trained and have available appropriate practice protocols to identify both those older adults at risk and those who are already socially isolated. Finally, rural older adults need to attend to this important health problem in their own personal lives."

**Digital access:** Another major, multifaceted obstacle in Maine is keeping older adults connected and informed. In many parts of the state, broadband service is simply unavailable. If access exists, many cannot afford the service. Also, many older adults have been reluctant to embrace the technologies enough to learn to use them. There are tremendous benefits to equipping our elders with new technologies, Kaye says, including helping to address health care shortages with telehealth applications, and reducing isolation and loneliness concerns through online visual communications.

**Mental health:** Reporting in the handbook, Jennifer Crittenden presents this sobering reality: "The impacts of mental health and substance use disorders reverberate throughout rural communities and have significant implications for older adults and their families," writes the UMaine assistant professor of social work and Center on Aging associate director.



## AGE-RELATED LESSONS FROM THE PANDEMIC

AT THIS TIME, there can be no discussion of rural aging without addressing the impact that COVID-19 has had on the older adult population since March 2020. All of the challenges that older adults experience in a rural environment have simply been intensified due to COVID-19, like food insecurity or access to services. From the start of the pandemic, impacts older adults have experienced include greater isolation and loneliness, a reduction in available services and a huge loss of mobility.

According to the Maine Center for Disease Control and Prevention, the number of Maine COVID-19 cases of older adults from March 2020 to July 30, 2021 approximately correlates with the total population: 13,879 of adults 60 and older compared to 70,261 total cases or 19.75%. But that same age group represents 92.2% of deaths due to COVID-19 (830 of 899 total deaths).

“(COVID-19) has exposed the best and worst of aging in Maine,” says Lenard Kaye, director of the University of Maine Center on Aging. “At its worst, it has proven fatal to many older adults, and disproportionately compared to others, especially those in long-term care. Our long-term care system was not prepared for such a public health crisis. The system could not respond quickly to the needs of older adults, such as getting the personal protective equipment needed, and locating scarce resources which were directed initially to acute care, not chronic care. Nursing homes were the last to get help, last to get training, last to get masks and everything else needed to protect our older adults.

“On the positive side, it taught us how critical it is that older adults get on the digital bandwagon to take advantage of available technology because it can be a lifesaver in protecting them from becoming isolated and lonely. It taught us how important social networks are in making connections for older adults such that they remain part of daily life. And it has created new approaches that we’re taking in reaching out to older adults. We want them to take advantage of technologies that support their health and well-being.”

Even prior to the pandemic, on April 27, 2017, Kaye presented testimony before the U.S. Senate Special Committee on Aging documenting the potentially lethal consequences of social isolation and loneliness.

“For older adults residing in rural communities and those who serve them, lessons learned center around being more aware in the future of the consequences that can be expected of pandemics and other public health emergencies for rural-residing older adults, their families, and community service and health care providers. Also learned is the imperative that policymakers, providers, and older adults themselves plan ahead more systematically and implement both common sense and creative strategies for ensuring that older rural Americans stay connected to others in their communities at the same time that the risk of increased isolation, loneliness and anxiety during challenging times is minimized.” ♦

“Rural areas have shouldered much of the burden of the opioid epidemic, which affects residents across the life span with rural residents having a greater likelihood of experiencing an overdose. While substance use disorder prevalence is similar across rural and urban settings, data suggest that the use of alcohol is higher in rural areas and the impacts of opioid use are more significant in rural regions. Furthermore, close to one in four rural older adults is considered at-risk for depression and suicide.”

Considering just these few major concerns of many, how can our Maine older adults navigate their lives in a healthy and productive manner?

## Support to thrive

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, Kaye says.

“Our research efforts have shifted in that time from studying diseases and the problems of an aging population to more progressive themes, including health care, technological advances, and productive aging — that is, positive dimensions of aging,” Kaye says. “We have always remained open to new opportunities and because we were small, we could turn on a dime. We have always worked with communities, local agencies, foundations and smaller community organizations.”

The Center on Aging provides the greatest share of UMaine elder services and programs, and is involved in multiple aging initiatives statewide. It maintains a partnership with the University of New England called AgingME Geriatrics Workforce Enhancement Project and partners with the five Maine Area Agencies on Aging. In addition, the center sponsors or is affiliated with numerous programs focused on interacting directly with the state’s older adults — Senior Companions, Retired Senior Volunteer Program, Senior College and more.

The center maintains a 5,000-subscriber monthly newsletter, keeping the community informed of initiatives, activities and resources statewide. Older adults can register for the Adult Research Registry, created by the Center on Aging to assist researchers by serving as “citizen scientists” and participating in pertinent research studies.

Individuals who work with elders can earn an Interprofessional Graduate Certificate in Gerontology through the Center on Aging, focused on enhancing understanding of the specific needs of older adults.

The center is working in partnership with The Cedars, a continuing care retirement community in Portland, in development of Designation of Excellence in Person-Centered Long-Term Care to identify high-quality long-term care communities across the nation. Another project will determine probable acceptance of a heart-assisting device (left ventricular assist device or LVAD) that keeps people alive. With University of

Southern Maine as the lead, they have simulated the operation in a mock LVAD to predict a patient's acceptance of the device prior to making a major commitment.

Every October, the center conducts a one-day Clinical Geriatrics Colloquium for participants to learn the latest information and trends. Last year, the focus of the 16th annual colloquium was advancing anti-racism, diversity, equity and inclusion in older adult health care.

Another major focus currently is age-friendly communities. Maine has among the highest number of such communities of any state in the U.S. — an eighth of all designated age-friendly communities. The Center on Aging has a contract with AARP to deliver training on implementing age-friendly communities nationwide.

The Center on Aging is committed to ensuring positive outcomes related to Maine's older adult population growth. "Adults are perceived as carrying with them increasing measures of wisdom, expertise and capacity into their later years. We are now talking about ways in which these personal assets can be harnessed and applied to benefit families, organizations, and communities," noted Kaye in 2015, writing in *Maine Policy Review*.

Six years later, Kaye is more determined than ever to enable and raise awareness of the fact that "older adults are the key to the solution."

"They have yet to contribute all that they can," he says. "Today they are more mobile, more active, and they are living healthier and longer lives than ever before. They can remain in the workforce, work part-time, volunteer, develop second or third 'acts.' There are so many new approaches to enable older adults to live fulfilling lives."

Crittenden couldn't agree more. In "Never too old to lead," a *Maine Policy Review* article, Crittenden and Lelia DeAndrade, vice president of community impact at Maine Community Foundation, report on older adults who receive training in leadership that they then "apply to team-driven projects, such as improving neighborhood quality, providing voter education, and offering juvenile offender rehabilitation." The center's Encorps program, a precursor to age-friendly communities, has been offered to "engage Mainers 50 and older in community-based leadership through volunteer projects," which might include serving on local committees, boards and town councils; revitalizing and developing downtowns; preserving, protecting and improving public and outdoor areas.



Photo by Elyse Klysa

In 2021, Crittenden suggests that ever-increasing use of technology will advance the support of older adults with everything from telehealth solutions, especially in rural areas, to increasing socialization and decreasing isolation as older adults become more comfortable with smart phones, tablets, and other electronics.

Indeed, the age-friendly community model appears to point positively toward the future for rural aging. Its guidelines address several of the challenges for older adults. Each community decides which needs to address with help from a grassroots committee made up of concerned citizens, older adults, nonprofits, town officials; in other words, people who have a shared interest in the vitality and future of their community. Everyone benefits.

“Each rural community is unique,” noted former assistant secretary for aging Kathy Greenlee, writing in *Generations*. “Rural people have to adapt. They take care of each other. Rural communities figure it out. ... Older

rural people are at risk for social isolation. But what they have going for them may be a lifetime of community involvement.”

The age-friendly community understands those concepts and opts for a supportive and inclusive environment for all. ♦

## ACTIVE ENGAGEMENT OF MAINE’S OLDER ADULTS

AS OLDER adults live longer and healthier lives, it is critical that they have opportunities to remain vital. Some may choose to continue working, some may embark on new careers, others may take up new hobbies, still others find time to volunteer. The Center on Aging offers engagement programs to help elders remain active.

“We want people to volunteer because it improves health, cognition,



## CARE FOR MAINE’S OLDER ADULTS

A KEY COMPONENT of the University of Maine’s contribution to research on healthy rural aging in Maine is the Cognition Aging Resiliency and Enhancement (CARE) Lab. It is directed by assistant professor of psychology Rebecca MacAulay, whose research focuses on understanding factors that increase risk and resilience to cognitive decline across the adult life span. She and her graduate and undergraduate students in the lab explore intervention approaches to improve wellness from both cognitive and mental health perspectives.

CARE Lab is currently working on two projects that address cognitive function in older adults. One is M-ABLE, the Maine Aging, Behavior, and Learning Enrichment study, focused on brain health and the tools used to measure thinking and memory in older adults. MacAulay’s research team is exploring how technology can improve cognitive assessment and reach underserved populations, and the relationship of gait and cognition impairment in older adults.

The lab’s other project, Maine Understanding Sensory Integration and Cognition (MUSIC) is a study that considers the connection between learning music and improved brain health. The research study explores novel ways to improve cognitive function through learning and playing music — one of the most mentally stimulating activities.

“Often in research we focus on one concern,” MacAulay says. “We often will look at cognitive health. We’ll look at vascular health. We’ll look at depression. My research is really trying to understand the intersections among these things. If you have vascular disease, you’re more likely to have depression and vice versa. For example, we see that over 75% of adults over the age of 65 have multiple chronic conditions.

“We’re really starting to think more about what the individual’s values are, how we honor that and I think that becomes particularly important in rural areas where rural has almost taken on a little bit of a negative connotation because we see the negative health outcomes,” says MacAulay. “There’s just a lot of health and financial disparities in these rural areas. But I think as Mainers, we also know there’s a lot of resilience in our rural communities. We’re a rural state and it’s that kind of grit, so to speak, that makes Maine, Maine.” ♦

CARE Lab researchers, professor Rebecca MacAulay, center, with her graduate students Amy Halpin, left, and Angelica Boeve. Photo by Patrick Wine



Photographs by KG Moates, Lisa DuFault and David Levy

well-being, socialization,” says Jennifer Crittenden, UMaine assistant professor of social work and Center on Aging associate director. “Volunteering has been associated with a lot of health improvements for older adults.”

The Senior Companion Program, an Americorps program administered by the center, enlists volunteers 55 and older to be companions to homebound or isolated adults. These individuals provide support by visiting, sharing information, helping arrange for home maintenance, reading aloud, facilitating time off for caregivers, providing transportation to appointments, or any other tasks that can help that person maintain the highest level of independence.

The Retired & Senior Volunteer Program (RSVP) is another Americorps-funded program, administered by the center since 2003. Nearly 100 RSVP volunteers in Penobscot, Piscataquis, Hancock and Washington counties are paired to projects, such as reading to children in HeadStart programs and child care centers, leading senior wellness activities and helping to fight food insecurity.

In a recent activity, RSVP volunteers worked on a telehealth simulation exercise designed to train nurse practitioner students to work effectively with older patients. “A lot of schools work with what are called ‘standardized patients,’ basically actors who come in and play the patient,” Crittenden says. “But we have these volunteers who’d been doing health and wellness volunteering, but had been sidelined by COVID-19. They were trained to serve as a patient or a caregiver for this simulation.”

Afterward the volunteers were interviewed about their experiences. They reported that they got so much out of it personally, bringing in their own experiences. Crittenden adds that “it taught them about questions they might bring in their own health care visits. The volunteers loved the inter-generational piece of working with the students.”

A new RSVP program, Walking Buddies, connects a volunteer with another older adult to encourage healthy exercise while providing socialization, all in support of healthy living. The objective is to meet and walk two to three times a week for at least six weeks.

Classes to help older adults maintain healthy bodies are offered at the UMaine New Balance Student Fitness Center. They include Fit Over 50, focused on mobility, balance and fitness.

Another form of engagement centers on educational pursuits. Penobscot Valley Senior College, established by the Center on Aging and part of the statewide Maine Senior College Network, offers noncredit courses in six-week sessions for two hours each week for adults age 50 and over. Classes in the arts, natural sciences, history, culture and more provide learning, socialization and intellectual stimulation without tests or grades.

In addition, older adults seeking academic rigor may enroll at the University of Maine with tuition waived for Maine residents who will reach the age of 65 years or older during the semester in which they enroll, who are seeking to take undergraduate university courses for personal enrichment and/or to attain their first undergraduate degree.

Older adults also have engagement opportunities to be involved in research at UMaine. The Center on Aging maintains a confidential Older Adult Research Registry of more than 200 elders interested in participating in research studies conducted by university faculty. Research projects may focus on older adult health issues, volunteering, testing products or discussing services for older adults. Registrants must be at least 50, interested in taking part in research, and must complete a questionnaire to enroll.

Other opportunities to participate in research may come directly from UMaine researchers. For example, UMaine assistant professor of psychology Rebecca MacAulay conducts several studies focused on cognition, including memory.

“If we want interventions, practices that serve all rural older adults, we need to figure out how to engage them in the research process,” Crittenden says.

One research method that can really engage older adults is participatory action research, Crittenden notes. Instead of researchers recruiting older study participants, in PAR initiatives, local committees may be formed to develop a research plan based on community needs.

While the opportunities for older adults are diverse across the university community, the goals are the same: to enable elders to maintain active, engaged lives to help themselves and to help others. They are in keeping with UMaine’s strategic vision and values to provide a diverse, inclusive environment that serves all people — fostering learner success, discovering and innovating, and growing and advancing partnerships. ♦

## AN AGE-FRIENDLY WORLD

*These Americans are the most peculiar people in the world. You'll not believe me when I tell you how they behave. In a local community in their country, a citizen may conceive of some need which is not being met. What does he do? He goes across the street and discusses it with his neighbor. Then what happens? A committee begins functioning on behalf of that need and you won't believe this but it's true. All of this is done by private citizens on their own initiative. The health of a democratic society may be measured by the quality of functions performed by private citizens.*

Alexis de Tocqueville, 1835

The World Health Organization launched the Age-Friendly (AF) Initiative in 2006 to address the concerns of population aging. In the United States, the Institute for Healthcare Improvement teamed with the John A. Hartford Foundation to promote AF health care systems, and AARP has adopted the role of promoting and designating AF communities and counties.

Currently, there are 572 U.S. communities or counties; Maine has 72 or one in eight of all designated communities. The University of Maine Center on Aging has been instrumental in advocating for the AF designation in Maine



Photo by Elyse Klysa

communities and has received an AARP contract to offer training in creating the AF communities nationwide.

In Maine, as more communities get involved in age-friendly initiatives, their efforts spread by word of mouth as nearby towns begin to see the possibilities. At the Center on Aging, Patricia Oh directs the efforts in promoting and supporting AF communities, where “older adults start to mobilize.”

“They have the time, energy, life skills to make change,” Oh says. “Maybe they are recently retired and are anxious to give to their communities.”

WHO’s eight domains of livability — housing, transportation, community support and health services, outdoor spaces and buildings, communication and information, civic participation and engagement, social participation, and respect and social inclusion — are designed to help older adults live healthier, more productive lives.

“When a community forms their AF group, they will read about those eight domains,” Oh says. “They are not expected to work on every area necessarily. They ask, ‘What are our strengths? What do we need in order to thrive?’ Such as a space to meet for coffee, or a volunteer transportation program, or a food delivery program. Then they build on their strengths to address those needs. They may not believe that the strengths exist in their community, but each community has what they need to thrive. It’s a matter of tapping into it.”

For example, a number of communities in Maine have started home repair programs. In its first year, Saco completed 150 service calls. Waldo County and Bowdoinham have both partnered with the Masons to provide nonlicensed services, but also worked with licensed providers to offer discounted services to older adults.

“These programs help folks to recognize how they can help their neighbors,” says Oh.

Currently, the Center on Aging is involved with two similar programs serving older adults — Lifelong Fellows and Lifelong Maine Americorps. Lifelong Fellows offers a \$3,000 stipend for one community to mentor another in its support of older adults. The Lifelong Maine Americorps program brings in part-time or full-time Americorps individuals to help a community ramp up what is already being done to support older adults. Communities that engage in the age-friendly process have two years to develop an action plan, and in five years submit an after-action report, reviewing and evaluating progress.

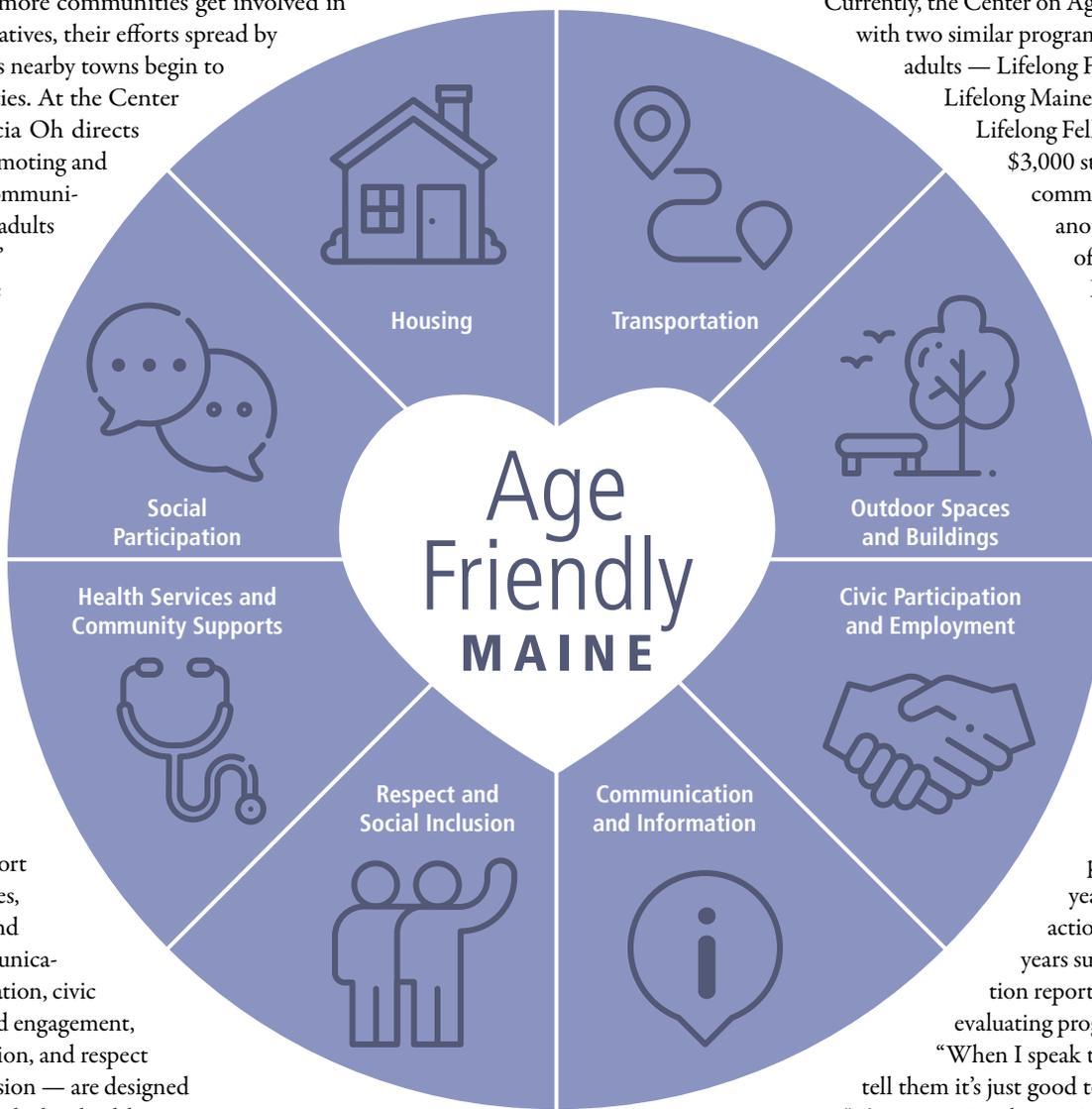
“When I speak to town managers, I tell them it’s just good town planning,” Oh says “It’s community the way it should be.”

UMaine’s Center on Aging provides AARP-supported training to drive age-friendly communities and counties nationwide. The multifaceted contract includes providing technical support to the network. A program called Rural Lab provides targeted technical assistance to rural communities.

Oh says the Center on Aging is not affecting age-friendly outcomes, but facilitating and supporting the momentum in communities focused on the needs of elders.

“The communities themselves are the drivers of change. In Maine, this represents a grassroots effort with community residents taking charge of their own program,” says Oh.

“You should be able to be engaged in every aspect of your community and you should be able to be as healthy as possible. Age-friendly practices are helping that to happen in a remarkable way.” ♦





Photographs by Elyse Klysa and Joseph Owen

## PARTNERING TO OPTIMIZE INITIATIVES FOCUSED ON ELDERS

MOST OF the University of Maine aging initiatives are collaborations with multiple entities. An outside institution may tap the university's expertise or someone at the university seeks to bring an idea to the field. Of the 36 initiatives currently undertaken by the Center on Aging, at least 30 are partnerships working with individual Maine communities, the Maine Community Foundation, UMaine researchers, a Maine long-term care community, the Eastern Area Agency on Aging, AARP, University of New England, University of Southern Maine and UMaine Augusta, for-profits, nonprofits, and state agencies.

Last year, the Mayer-Rothschild Foundation awarded funding to the University of Maine Center on Aging and The Cedars, a nonprofit retirement community in South Portland, to identify and promote the best practices for person-centered care in nursing homes, independent and assisted-living communities, and dementia and memory care residences. The foundation's first Designation of Excellence in Person-Centered Long-Term Care Award allows both organizations to develop a national standard for person-centered care and optimal strategies for long-term care communities to implement it. The designation of excellence they create will serve as a promotional tool for organizations that adopt best practices for this model

of care. Person-centered care promotes policies that allow residents of long-term care communities to advocate for services that best meet their individual needs and preferences. While a shift toward person-centered care has taken place over the last few decades in long-term care, there is no definition or standard guidelines for person-centered care. This award seeks to move care from a model that is medically or task-driven, to care that is driven largely by resident preferences, which are often not considered.

In 2019, an initiative of the University of New England in collaboration with the Center on Aging to improve the health and well-being of Maine's older adults through enhanced practitioner training received a five-year award of nearly \$3.75 million from the Department of Health and Human Services' Health Resources and Services Administration (HRSA) under its Geriatrics Workforce Enhancement Program.

A statewide collaborative called AgingME will focus on improving the health and well-being of Maine's older adults through training enhancements and practice transformation processes at the primary care level. The innovative collaboration, in partnership with Maine's health systems leaders at MaineHealth and Northern Light Health, and federally qualified health centers, will bring together practitioners, health professions students and educators from throughout the state to improve primary care for older adults and their caregivers.

The Center on Aging is the lead evaluator for the statewide geriatrics



training initiative, documenting the impact of its work by collecting input and data from students, partners, older adults and caregivers reached through program efforts.

At UMaine, AgingME efforts will entail the integration of geriatrics and specialized clinical content into simulation lab training for students in the School of Nursing Family Nurse Practitioner program and gerontology courses in the Interprofessional Graduate Certificate program for health and human service professionals who provide care to older adults in a variety of primary care practice and other settings.

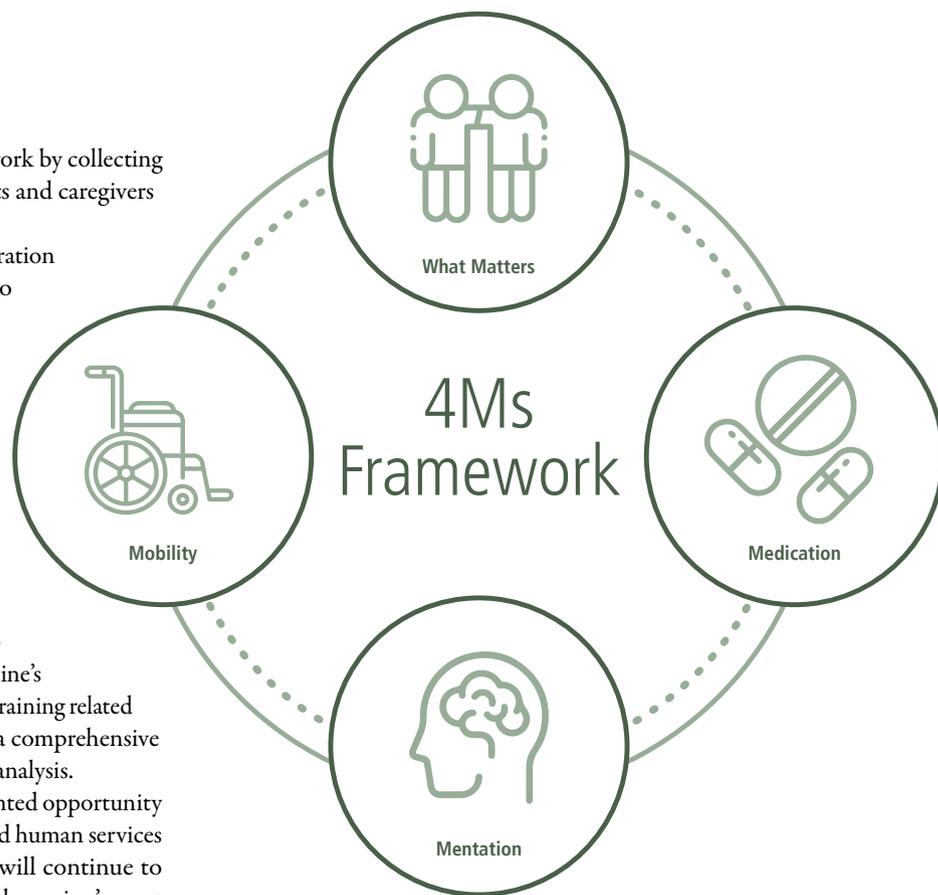
In addition, the UMaine School of Social Work will develop a geriatrics student social work field practicum unit, and the School of Food and Agriculture will incorporate a geriatrics nutrition practicum for upper-level nutrition majors and graduate dietetic interns. UMaine’s clinical psychology doctoral program also will advance its training related to the health and well-being of older adults, including a comprehensive supervised experience in gero-psychological review and analysis.

“This HRSA-funded project represents an unprecedented opportunity to significantly expand the geriatrics skill set of health and human services personnel across the state, and ensures that UMaine will continue to perform a critical function in this regard, especially in the region’s most rural communities,” says Lenard Kaye, Center on Aging director and UMaine professor of social work.

At UMaine, each of the involved departments has introduced courses or training to more fully understand the specific needs of elder patients and emphasize the interdisciplinary approach to care. That includes a focus on the 4Ms model of older adult care — mobility, medications, mentation and what matters. The 4Ms are key concerns in giving older adults the care they need. Talking with older adults about what matters most to them in their care and in their lives becomes the driving force for how a clinician considers their medical needs.

Mobility is concerned with moving daily to maintain function to be able to do what matters. Medication is concerned with prescribing what is appropriate for the older adult, and checking to make sure they are not over-prescribed or, if so, to de-prescribe, making sure not to interfere with the other areas of concern. Mentation is identified as a key concern to prevent or manage depression, delirium and dementia in older adults.

In psychology, clinical doctoral students have learned about the 4M model and gained hands-on training in cognitive and mental health assessments



from licensed clinical psychologists, professors Rebecca MacAulay and Fayeza Ahmed. In addition, a five-year curriculum for allied health field providers and UMaine and UNE students provides training workshops dedicated to improving understanding of the assessment and treatment of mental and cognitive health problems in older adults. Topics include differential diagnostic considerations for depression in late life, how to screen for memory problems, appropriate referral recommendations and resources, and factors that promote brain health (e.g., seminars on sleep health and mindfulness).

In the School of Nursing, training simulations now include RSVP volunteers to provide as realistic a hands-on learning experience for students as possible. The School of Social Work places up to five graduate students in field placements in collaboration with UMaine partners. Food science and human nutrition seniors now have a course in the nutritional care of older adults.

“A real point of this work is getting all these health-related programs working together,” says professor Mary Ellen Camire, who co-teaches the nutrition course. “When you’re working with people, you’re not just the nurse or social worker, the psychologist or the dietician, you’re all working together as a team to understand this person’s needs. We have to work together because we have so many older people now and there is a critical need for more professionals.” ♦

Talking with older adults about what matters most to them in their care and in their lives **becomes the driving force** for how a clinician considers their medical needs.

*Editor’s note: Rick Mundy recently started Thriving Elders, a project of idea-sharing for healthy aging. A bimonthly newsletter is available at [thrivingelders.com](http://thrivingelders.com).*

# In the legal system

## Melissa Jankowski participates in the nation's most competitive forensic training program

To become a forensic psychologist, Melissa Jankowski is participating in the most competitive internship in the country at the Federal Correctional Complex in Butner, North Carolina, a prison complex that houses several high-profile inmates, including Ted Kaczynski. The facility also holds defendants awaiting trial and mental health patients committed by court to its Federal Medical Center.

Jankowski, a University of Maine Ph.D. student in clinical psychology from Cassville, Missouri, conducts evaluations on all of them for the complex's Forensic Evaluation Service. She helps determine whether a defendant is competent to stand trial, can be found not guilty by reason of insanity and — if they are found not guilty by reason of insanity or unable to be restored to competency to proceed with their legal charges — whether they should be civilly committed to FCC Butner due to their dangerousness. She also is occasionally subpoenaed to testify in federal court on her findings.

Her additional responsibilities include attending treatment team meetings, presenting cases to the in-house risk panel, conducting locked housing rounds and leading competency restoration, illness management and recovery groups.

Working at FCC Butner reminds Jankowski of her desire to dispel a widely held belief that only bad people go to prison because they did bad things, a key reason behind her goal of becoming a forensic psychologist. Those bad things, she says, "are often the unfortunate sequelae of a plethora of other variables outside of inherent virtue," including developmental trauma, mental health issues and a lack of resources and privilege, she says.

"Working in a correctional setting has opened my eyes to

the historical and systemic complications that can result in incarceration, and has forced me to challenge many of my own internal assumptions and to acknowledge my own privilege," says Jankowski, who is participating in the competitive internship program offered by the University of North Carolina School of Medicine. "I find myself humbled each day."

When she isn't at the complex, Jankowski provides services for other organizations as part of her internship. She previously conducted neuropsychological assessments with retired professional football players for the National Football League Players' Association Brain and Body Health Program. Other current and future rotations include conducting gender-affirming evaluations and care at the UNC Gender Equity and Wellness Initiative Clinic, assessing and treating patients at UNC's Psychiatric Emergency Services, and administering forensic and neuropsychological evaluations at a state hospital.

Starting in March, her duties at FCC Butner will involve monitoring their well-being, providing individual and group therapy, and conducting suicide risk assessments, all of which she says should help inmates cope with prison life and tackle the behaviors and other mental health issues that may have resulted in their incarceration.

Jankowski has been a UMaine grad student in clinical psychology since 2015. In 2017, she received a three-year National Science Foundation Graduate Research Fellowship to support her research on peer relationships and their association with risk and resilience in adolescence. She received a master's degree in 2018, and will complete her Ph.D. this year. She will pursue a postdoctoral fellowship to become a board-certified forensic psychologist. ♦

## Clinical Psychology Program receives transformational gift from Judy Glickman Lauder Foundation

A TRANSFORMATIONAL gift from the Judy Glickman Lauder Foundation will support the efforts and initiatives of the University of Maine Clinical Psychology Program to help meet the increasing demand for high-quality, evidence-based mental health providers in Maine.

The gift, made through the University of Maine Foundation, will allow UMaine's accredited doctoral training program to increase its teaching, research and outreach capacity by nearly one-third. Two new faculty members and two doctoral students will be added to the program, and a professional staff member will be hired to coordinate field placements for undergraduate and graduate students statewide.

One of the faculty positions will bring additional expertise in the delivery of evidence-based interventions in health care and community settings; the other will focus on substance use and/or trauma — two critical areas of need in Maine and beyond.

UMaine's nationally recognized and highly competitive Clinical Psychology Program in the Department of Psychology prepares students for careers combining research and practice. As part of their training, students provide psychological services to the public through UMaine's Psychological Services Center on campus and at practicum sites in Maine and internships nationwide.

In addition to helping the department's clinical graduate program expand its mental health services, the Glickman Lauder gift will facilitate the Psychology Department's efforts to enhance career success for undergraduates through development of new courses, research opportunities and experiential internships.

The Glickman Lauder family donation to help improve the state's mental health resources was inspired in part by the Harold Alford Foundation's \$240 million challenge grant to the University of Maine System in 2020.

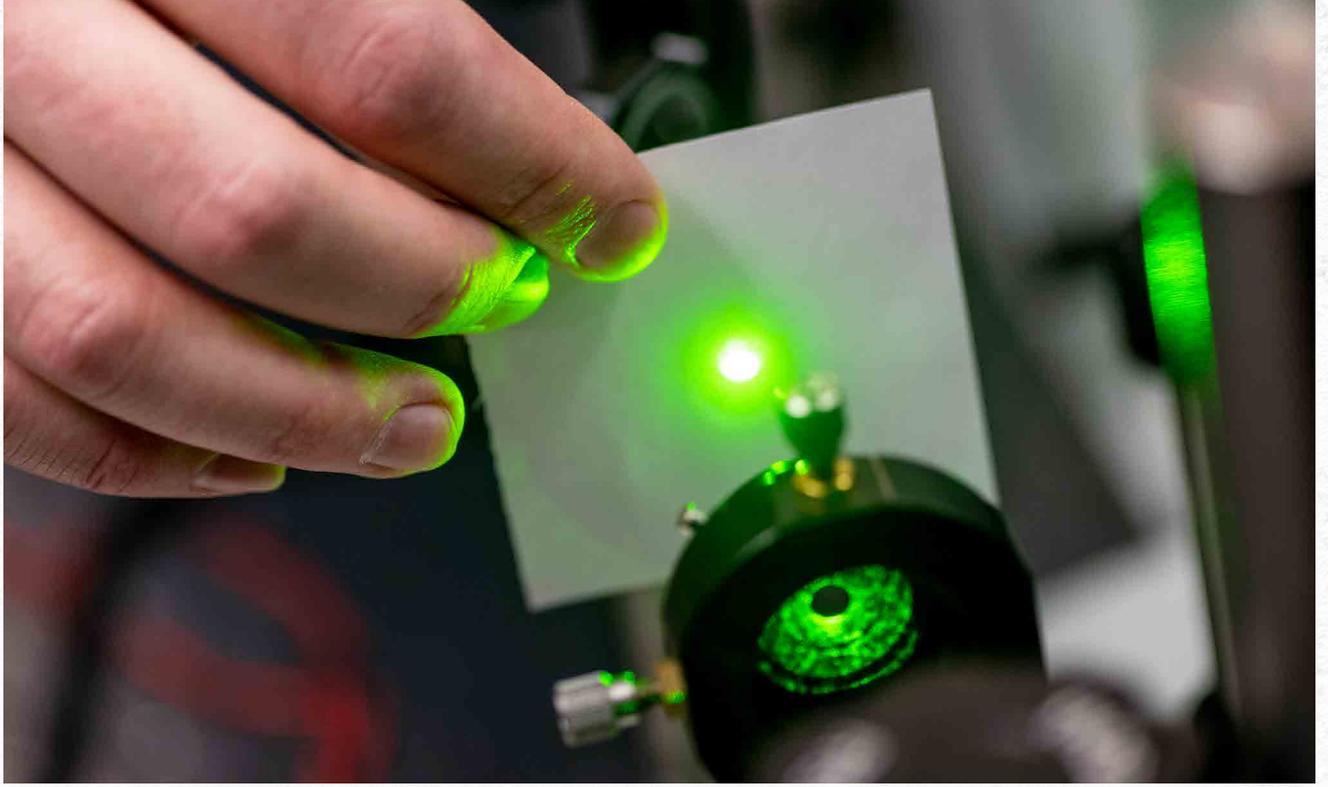
UMaine's program is the only American Psychological Association-accredited doctoral program in clinical psychology in Maine and was recently reaccredited for 10 years — the longest possible professional accreditation period granted to only the strongest programs. It is well-positioned to train the next generation of Maine's clinical psychologists. ♦

# VIRAL VIEWS

Sam Hess studies spike proteins in flu and COVID-19 viruses with the help of pioneering technology

By Margaret Nagle





In 2005, professors Sam Hess and Michael Mason led the development of a breakthrough microscope system called FPALM (fluorescence photoactivation localization microscopy) to image cells with membranes that contain the HA spike protein. FPALM uses photoactivatable dyes to identify individual molecules and separate them at the nanometer scale. The innovation was one of four groundbreaking advanced microscopy techniques that were able to achieve such single-molecule imaging capabilities in the mid-2000s. Announcements of the 2014 Nobel Prize in Chemistry honored three recipients and cited other researchers involved in similar pioneering research, including Hess. Photographs by Adam Küykendall.

**T**he scientist from Hong Kong came directly from the airport to the meeting at the National Institutes of Health. There, he told the packed boardroom about a coronavirus outbreak that would become the first pandemic caused by SARS-CoV-1.

Sam Hess, then an NIH postdoc, was in the audience.

"This was before (the news) had hit the mainstream media," says Hess, a University of Maine professor of physics, remembering the 2002 meeting. "That briefing made a big impression on me, that these things are not something we just read about in textbooks from 1918. These viruses are evolving now. We need to be prepared."

Hess had been invited to collaborate with renowned NIH biophysicist Joshua Zimmerberg, whose lab was working on HIV, dengue virus, malaria and influenza. And that's where Hess launched his research in infectious disease, with a focus on the flu.

"I realized we have not defeated infectious disease," says Hess. "Seeing all this work (in the Zimmerberg lab), it was like, 'You know what? This is something we need to figure out.'"

Influenza research was well-suited to his physics background, because protein clustering is central to the virus life cycle. Measuring clusters in different ways and understanding how they're evolving are critical in advancing treatment therapies.

In the last two decades, advances in super-microscopy led by the Hess lab have resulted in new insights — and sights — of influenza particle surface spikes. The surface structures of spike proteins are where the body's immune response to the virus begins.

Now, in the SARS-CoV-2 pandemic, what Hess and his undergraduate and graduate students have learned about surface spikes on

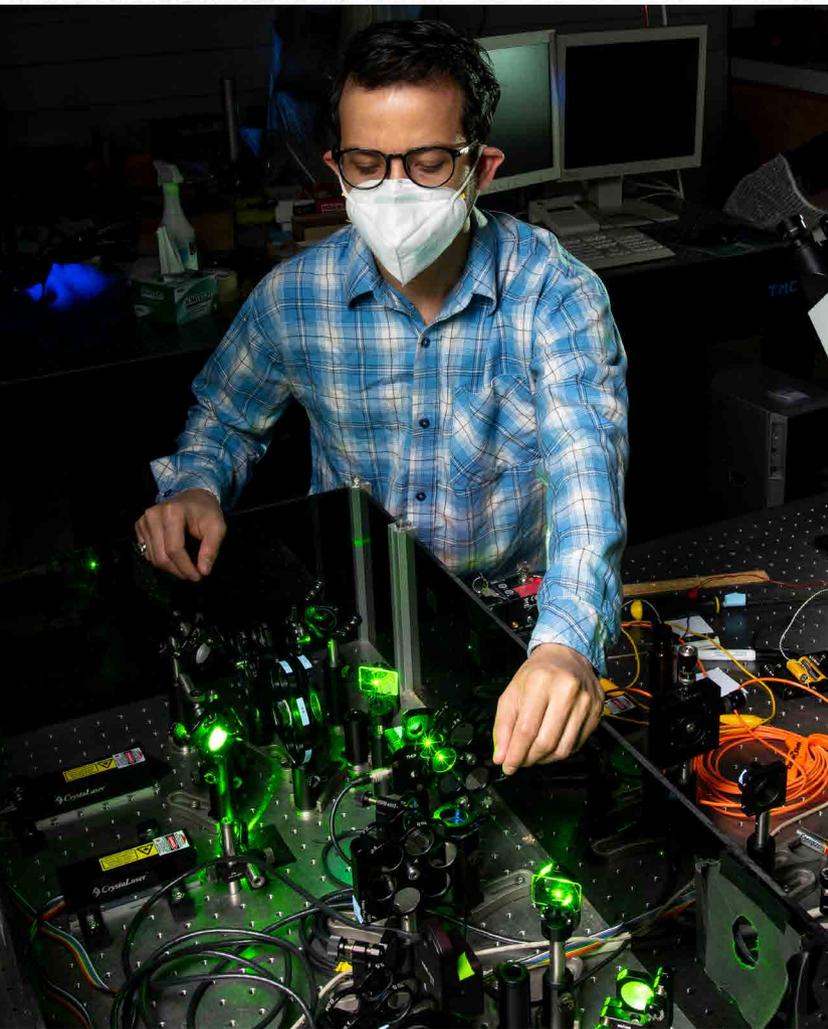
virus particles is contributing to our understanding of the COVID-19 spike protein. The spike protein from the influenza virus is hemagglutinin (HA); the spike protein from the coronavirus is called S. Basically, the spike proteins on the surface of the virus stick or bind to cells in the respiratory tract. Spikes also allow the virus to enter through a process called membrane fusion.

Membrane fusion depends very much on clusters of the spike protein. Hess has been studying that process of how the clusters form, looking at how the host cell might play a role in generating those clusters and, ultimately, how to disrupt that process.

"These clusters are crucial for the infection process, yet nobody knows why they arise," says Hess. "There were some theories at that time when I first came to UMaine about why clusters of viral proteins occur. Our data showed those theories to be wrong, which didn't make me very popular. It did lead us to ask new kinds of questions.

**Also key is the value of thinking about innovation — knowing that something else is possible, all the time.**

Sam Hess



Hess and the graduate students in his lab are studying spike proteins of influenza and coronavirus. The goal is to contribute to research and development of a new class of drugs that blocks the interaction between the spike protein and the host cell, disrupts clusters of the spike proteins, and stops the virus from entering the host.

“When the coronavirus pandemic started, I realized we’d probably have to find some new ways to fight the new virus,” he says. “There were some similarities and differences that I noticed between the SARS coronavirus and the influenza virus. I thought of using our molecular microscopes to look at similarities and differences between those two. We’ve been looking at two of the most important proteins involved in the beginning of infection — the spike proteins.”

Physics connects to so many things in the world — how things move around and have momentum, and interact with each other. And, importantly, how things interact with light, says Hess, who uses light microscopes to study viruses.

“Physics has allowed us to invent some new kinds of microscopes that can do amazing things,” he says.

In 2005, Hess and UMaine Professor of Chemical and Biomedical Engineering Michael Mason led the development of a breakthrough microscope system called FPALM (fluorescence photoactivation localization microscopy) to image cells with membranes that contain the HA spike

protein. Prior to such super-microscopy, it wasn’t possible to create images of molecules on a small enough scale in a living cell to test the biological models that predict how they may be organized. FPALM shattered the resolution limit of lens-based microscopes, known as the diffraction barrier, that had existed for more than a century.

The FPALM system, which uses photoactivatable dyes to identify individual molecules and separate them at the nanometer scale, was one of four groundbreaking advanced microscopy techniques that were able to achieve such single-molecule imaging capabilities in the mid-2000s. Indeed, announcements of the 2014 Nobel Prize in Chemistry honored three recipients and cited other researchers involved in similar pioneering research, including Hess.

“What we acquire with the microscope is a movie of those flashes of light that occur from different parts of the sample,” Hess says. “Then we use a computer algorithm to look at those images and find where each flash came from. That’s called localization. When we find all those locations of the molecules, then we combine them all together and make a final image out of it.”

“We’re taking many, many frames, 10,000 frames, 20,000 frames, from a movie of a single cell or a single area of something. Then we’re making a composite out of all of the locations of the molecules.”

FPALM technology is now used in UMaine research in toxicology and muscular dystrophy. In virology, it has led to not only a better view of spike proteins, but also their cytoplasmic tail, which seems to interact with host cell components connected to signaling.

Parts of those spike proteins mutate fairly rapidly over time, interfering with the function of the immune system to recognize that structure as dangerous and attack it, says Hess. That’s one reason influenza vaccines have to be reformulated annually.

However, there’s a portion of the spike proteins — the tail inside rather than on the surface of the virus — that does not change very quickly. “That,” Hess says, “is what we’re going after.”

“People overlook this tail,” Hess says. “It’s inside the cell. It doesn’t seem to have any role in the lock and key mechanism of entry, but certain sequence elements are always there. In 17,000 different sequences of flu virus, they all had a particular pattern in the tail. If something is unimportant, it’s not going to last like that through every single sequence. I think there is something very important about that. The same features are there in the SARS coronavirus spike.”

“

The urgency is there. The coronavirus right now is causing so much trouble. There are great vaccines available to protect us, but the viruses also mutate with time. We're hoping we can have some kind of a backup. **We want to have something to protect us even if infections happen.**”

Sam Hess

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“We noticed when we expressed one of these spike proteins in a cell that there were some interactions between the tail and some of the host cell components,” Hess says. “Then we started thinking about how we could disrupt that interaction — interfere with the function of the spike protein. Looking at that interaction and trying to figure out if there are drugs that could break that up, that’s been a thrust of our research for a few years.”

The result could be a new class of drugs that blocks this interaction between the spike protein and the host cell, disrupts those clusters of the spike proteins, and stops the virus from entering the host.

“The way viruses are mutating and the way sometimes you get breakthrough infections, having a backup (drug therapy) to help when an infection does occur is a real urgent need right now,” says Hess. “These viruses are quite sneaky. They have redundant mechanisms. You figure out a way to break something and stop it in one way, it adapts to sneak around and infect in a different way. They’re constantly changing.”

“The urgency is there. The coronavirus right now is causing so much trouble. There are great vaccines available to protect us, but the viruses also mutate with time. We’re hoping we can have some kind of a backup. We want to have something to protect us even if infections happen.”

Multidisciplinary research is crucial for tackling these very complex mechanisms of infection, says Hess. The research has involved collaborations with UMaine scientists in physics, chemistry, biology, computer science, engineering and virology, and NIH experts in computer science, biophysics and virology.

“It’s crucial because we don’t all think in the same ways. I might, as a physicist, think about attacking a problem in a certain way. On the other hand, a virologist would say, ‘We need to try this and control for this possibility.’ We’ve also started doing modeling of molecules using computers. That’s something that’s happened since the start of the pandemic for us.”

Also key is the value of thinking about innovation — knowing that something else is possible, all the time.

“I feel so lucky to have been able to see examples of people who invented things,” says Hess. “My doctoral advisor, Watt Webb, at Cornell was a big influence in that kind of thinking. He invented more than 10 different microscope methods and spectroscopy methods. There was this culture in his group of inventing new ways of doing things. I got to see other people in the middle of that creative process hashing out, ‘Could we do it this way? What about this way?’

“That then led to something that worked out, was a new thing, and was published. That was eye-opening to me. (It’s about) breaking that glass case around the idea of inventing something being inaccessible or too hard. Seeing people do it gave me inspiration,” says Hess, who now models that thinking for the undergraduates and graduate students who have been in his lab.

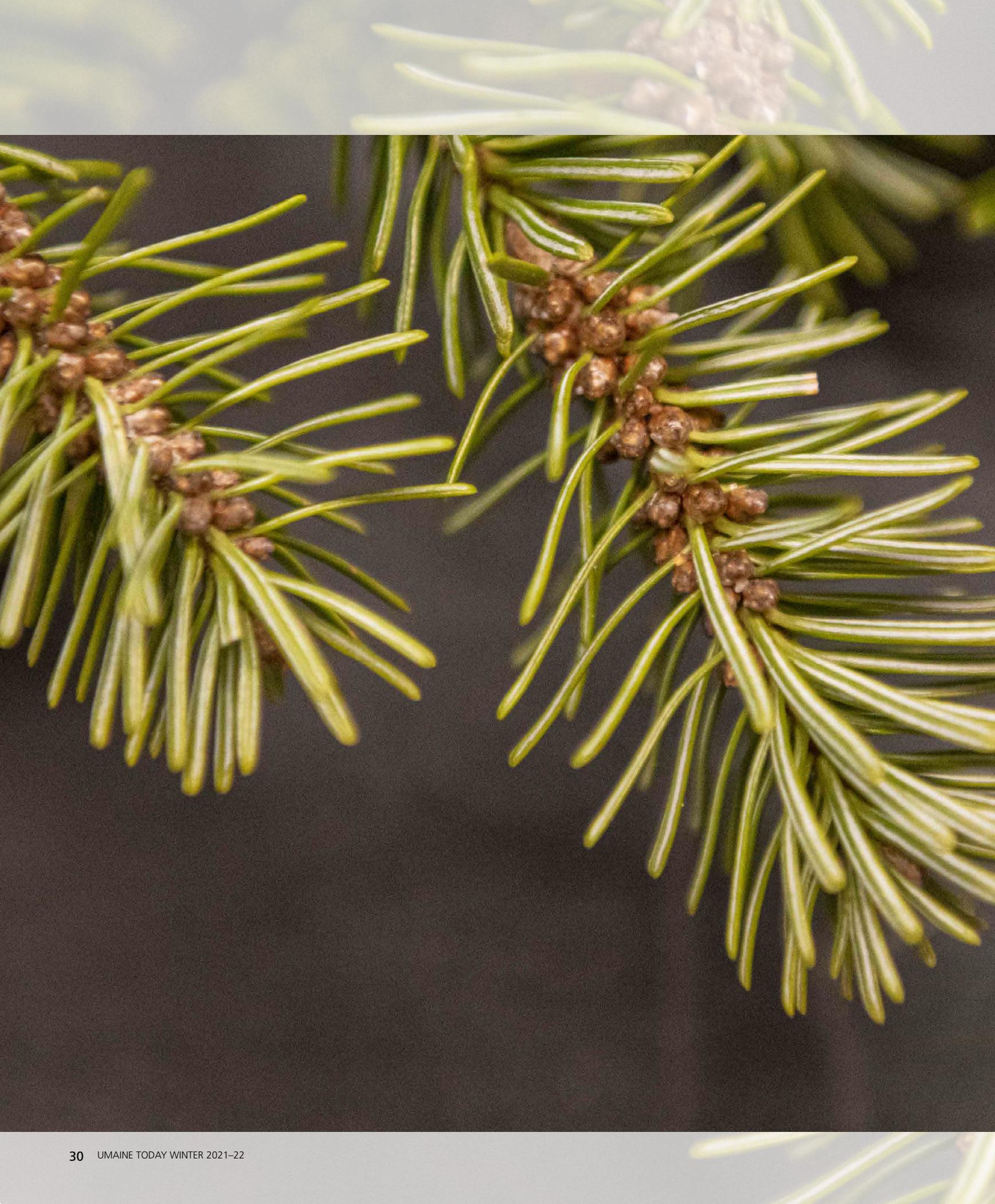
Students from his lab have gone on to postdoc positions at the Weill Cornell Medical School, Yale School of Medicine, NIH, and into jobs in the biomedical technology sector. That includes a former postdoc from the Hess lab working as a scientist for a company developing super-resolution microscopes using UMaine’s patented technology.

Ongoing improvements in advanced microscopy will one day allow researchers to look at the inner workings of molecules, not just where they are located, Hess predicts. Computer simulations of molecular structure could then be tested with super-resolution technology.

“Those are growing together like trees that were planted separately, but their branches are getting more intertwined,” Hess says. “I think that’s going to continue in the future. I’ve had this philosophy of going after a biological question and trying to invent the technology that I need to answer that question.

“Sometimes, that works out when we get an answer. That answer leads to new biological questions which then lead to new needs. I’ve been trying to keep the technology and the biology walking together and helping each other.

“In the long run, I am quite hopeful that we’re going to be able to find some drugs, find some treatments and maybe even find some cures for these infectious diseases that are causing us trouble right now,” Hess says. ♦



# Front-line defense

## New Spruce Budworm Testing Lab critical to mitigating impact of destructive insect

By Ashley Forbes

**A** new testing lab at the University of Maine is helping state landowners monitor their trees for the presence of the destructive eastern spruce budworm, a key step in tracking and mitigating a developing outbreak that could have severe impacts on Maine's forest land and economy.

Angela Mech, UMaine assistant professor of forest entomology, heads the lab, where a research team led by lab manager James Stewart tests branches collected from sites across Maine for the presence of spruce budworm larvae. The levels of larvae present in each sample provide a window into the insect's population in a given area that can inform management strategies and help landowners respond quickly.

Spruce budworm is a native insect that causes major damage to Maine's spruce-fir forests on a regular cycle. While its endemic population is low, every 30–60 years the insect emerges in epidemic proportions that can devastate spruce-fir stands through defoliation. Maine's last outbreak, during the 1970s–80s, killed millions of acres of trees, cost the state's economy hundreds of millions of dollars, and had long-lasting effects on Maine's forestry practices.

Since that outbreak, much has changed, but the spruce budworm's potential to cause widespread forest destruction remains a serious threat, and a spruce budworm outbreak in the Canadian province of Quebec that started in 2006

has now reached Maine. Currently, more than 24 million acres of forest have been harmed by the ongoing spruce budworm outbreak in Canada.

"This year, the red tinge of defoliation has been visible in hotspots throughout the St. John Valley for the first time since the 1980s," says Neil Thompson, forestry professor at the University of Maine at Fort Kent and program leader at the Cooperative Forestry Research Unit (CFRU). "We have data from the Canadian Forest Service that indicate large flights of moths from Quebec reached northern Maine on July 15 and 20, 2019. Maine Forest Service pheromone traps and monitoring sites coordinated by the CFRU both identified increases where those flights were expected to land. This isn't at the proportions of a major outbreak yet, but it's a serious concern."

Since 2013, when the Spruce Budworm Task Force was convened, Maine has been preparing to confront the next outbreak. A joint effort of the Maine Forest Service, Maine Forest Products Council, and University of Maine's CFRU, along with leading spruce budworm experts, the task force released a risk assessment report in 2016 that offered detailed preparation and response recommendations for Maine's forestry community.

"Although Maine's forest is much different than it was during the last spruce budworm outbreak, there are still a significant number of acres that are currently



at risk,” says Aaron Weiskittel, director of the university’s Center for Research on Sustainable Forests. “We have several ongoing research initiatives at UMaine to prepare for and address spruce budworm, yet when and where it arrives is highly uncertain. This highlights the importance of a strong monitoring program.”

Increased monitoring was chief among the Spruce Budworm Task Force recommendations, and UMaine’s Spruce Budworm Testing Lab helps fill that need for Maine landowners, who previously did not have an in-state option for sample testing.

“Maine has been sending their samples to processing labs in New Brunswick,” says Mech. “That was a good solution when we were just keeping tabs on the situation, but now that the outbreak is here, landowners need a rapid response to help them uncover how much area is affected and what kind of management strategies they might want to explore.”

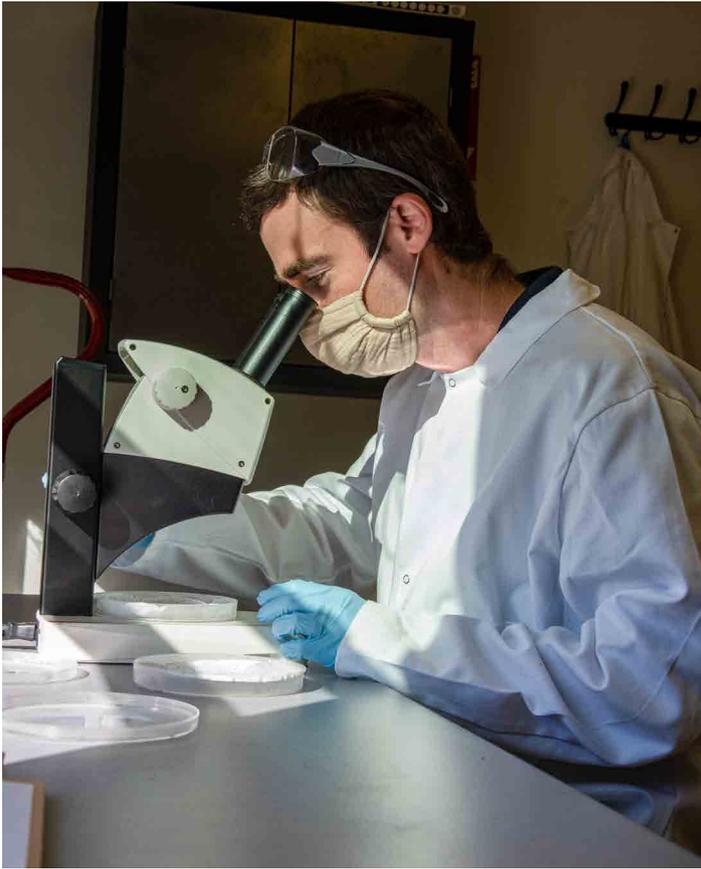
The process that Mech’s lab uses to test branch samples for spruce budworm at the second larval stage is central to an early intervention strategy that has been used in New Brunswick since 2014. Understanding how spruce budworms are growing and spreading allows forest managers to intervene sooner by adapting harvest activities to reduce the area available in high-risk stands of trees and consider targeted application of insecticide to protect foliage in small, infested areas that are not ready for harvest. Sampling and testing in the fall and winter are essential to identifying spruce budworm larvae during their hibernation period before they emerge to begin feeding on foliage in the spring.

“It takes months to prepare for management, so if you don’t find out you have a problem until February or March, it may be too late,” says Mech. “That kind of delay could cost that landowner a year of defoliation. By identifying hot spots early, they can control just that little spot rather than letting it expand and having a lot more area to treat. So far, they’ve been able to use early intervention strategies to keep the spruce budworm population in New Brunswick at bay during the current epidemic, and this gives the opportunity for Maine landowners to do the same.”

When it comes to spruce budworm mitigation, knowledge is power, and early intervention could help Maine avoid the potential worst-case scenario projection of 12.7 million lost cords of wood over the duration of a 40-year outbreak at a cost of \$794 million per year and nearly 1,200 total jobs lost in the forest sector, according to the 2016 Spruce Budworm Task Force Report.

The services provided by UMaine’s Spruce Budworm Testing Lab are just one aspect of a monitoring strategy that also relies on widespread pheromone trapping to track the influx of spruce budworm moths into Maine each summer.

Mech and Thompson are the principal investigators on a Cooperative Forestry Research Unit grant that provides more than \$400,000 in funding for spruce budworm monitoring in Maine over the next five years. UMaine’s Spruce Budworm Testing Lab is funded through that grant and will conduct the testing of 900 branch samples from 300 sites across Maine to provide a



Photos left to right: The UMaine Spruce Budworm Lab team includes graduate students Sierra Croney, Sadia Crosby, entomologist and professor Angela Mech, student research assistant Monica Mulligan and lab manager James Stewart. For their master's research Croney and Crosby are studying the hemlock woolly adelgid and browntail moth, respectively. Photographs by Ron Lisnet

yearly snapshot of spruce budworm population densities across the majority of the state.

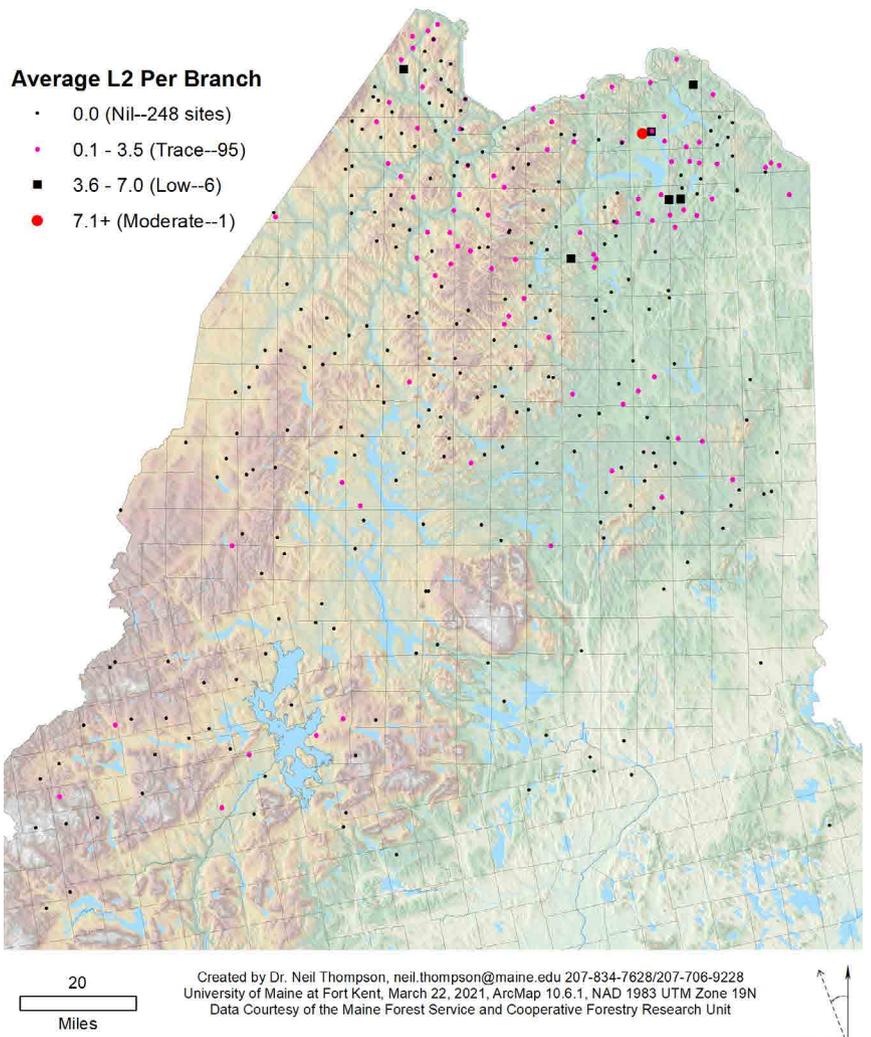
The lab also will conduct fee-for-service testing for landowners who are not CFRU members. To submit a sample, landowners must register their information on the Spruce Budworm Testing Lab website and then mail or drop off their branch samples to the university. The appropriate time to collect branches for testing is September through March, when spruce budworm is in its overwintering larval stage.

For each site, landowners select three mature spruce or fir trees and, using large pole pruners, clip one branch per tree from the mid-crown region. Each 30-inch branch is cut into smaller pieces for shipping.

“A spruce budworm lab in Maine is a critically important resource, supplying all forest landowners a needed capacity for rapid spruce budworm monitoring,” says Ian Prior, CFRU executive chair and forest inventory manager for the Seven Islands Land Company.

“This lab will be an important tool for managing and mitigating any future spruce budworm outbreaks and the economic impacts that result. It will allow for effective monitoring of hotspots and provide critical data for management decisions.” ♦

## 2020 Spruce Budworm L2 Survey





The most-requested nanocellulose products from the University of Maine Process Development Center are a slurry, left, that is 3% nanocellulose suspended in 97% water, and a freeze-dried nanocellulose at 98% nanocellulose concentration. UMaine nanocellulose in all its forms is distributed to more than 100 clients worldwide, and are used in on-site client trials at the Process Development Center and on campus by researchers.

# Maine's STRENGTH

## UMaine at the center of groundbreaking research into highly refined cellulose

By Ashley Forbes | Photographs by Adam Küykendall and Patrick Wine

**T**o understand what nanocellulose is and what it could be, all you have to do is look at the world around you.

That tree outside your window? The plants in your garden? The seaweed on the beach? The lettuce in your salad? That's where it comes from.

In the very fiber of every plant and tree is a building block like no other, with the potential to be the next material that changes the world. Think about the introduction of nylon, polyester or plastic. But this foundational material — nanocellulose — is natural, biodegradable, abundant and renewable.

When it comes to possibility, you have to think big. Really, really big. Not necessarily or exclusively in terms of size — nanocellulose's name gives away that it starts small — but of scope.

To narrow it down, start with your basic needs: water, food, shelter. How

could nanocellulose factor in? Filters made with nanocellulose could remove contaminants to provide clean, safe drinking water. Packaging made with nanocellulose offers properties that can keep food fresher longer. Materials made with nanocellulose could form the structure of your home and at least some part of nearly everything in it.

Sound far-fetched? It's not — and it's happening in Maine. All of the possible applications listed above are areas that University of Maine researchers are exploring today, and those represent only a fraction of the nanocellulose research that UMaine is conducting in Orono and fueling around the world through the manufacture and distribution of nanocellulose.

Colleen Walker, director of UMaine's Process Development Center and a pilot plant that can churn out 2 tons of nanocellulose per day, is the ultimate advocate for the material itself and for Maine's capacity to lead the societal transformation she knows it can bring.



Two of the laboratories on campus conducting nanocellulose research and development, including product development, are led by William Gramlich, left, associate professor of chemistry, who specializes in polymer chemistry, sustainable materials, paper coatings and biomedical materials; and Mehdi Tajvidi, associate professor of renewable nanomaterials, whose work focuses on utilization of cellulose nanomaterials in high-volume applications, such as coatings, packaging and building products.

“The opportunity is huge,” says Walker. “This is a great material with great potential. If you just look at the number of publications and innovations globally that make use of nanocellulose — Japan built a car from it — you get a sense of what could be possible. And Maine can lead that because we have the raw materials in our forests, the processing infrastructure both here at the university and in current and former mill facilities throughout the state, people who understand how to make it and how we could use it, and the entrepreneurial spirit to make it happen.

“That’s why I refer to Maine as ‘Nanocellulose Valley,’ because we have all the ingredients to make this state a hub of nanocellulose innovation. It’s already happening, but we need more venture capital and we just have to keep pushing it forward.”

Pushing it forward is what Walker and others at UMaine, plus partners in Maine and beyond, are working on every day. For the PDC director, it is almost an obsession.

“I don’t want Maine to miss the boat,” says Walker. “If we don’t invest in this, it will all be coming from somewhere else, and that would be a shame, because this could be the next chapter in Maine’s forest products history. There’s no place better suited to drive the changes that nanocellulose will bring.”

To understand why, you have to go back to the early days of nanocellulose research at UMaine, and consider how longtime leadership in forestry and pulp and paper processing paved the way for the material of tomorrow.

Less than two decades ago, some of the first nanocellulose produced at UMaine was made using a high-pressure benchtop homogenizer. If the word “homogenizer” makes you think of milk, you’d be on the right track. The equipment, not unlike a dairy homogenizer used to mechanically break down the fat molecules in milk, was then the standard for refining cellulose fibers, the kind used to make paper, to nanoscale.

“It was a nightmare,” remembers professor of forest operations, bioproducts and bioenergy Doug Gardner, who has been involved with UMaine’s nanocellulose research program since it started around 2006. “It kept clogging. A homogenizer is used to process milk or paint, and putting solid material in there was a mess.”

At around the same time, UMaine’s industrial-scale pulp and paper research facility, the Process Development Center, was beginning to produce nanocellulose for paper industry clients through repeated, energy-intensive mechanical refinement cycles that took days.

“We’d use our pilot refiner, and we would just sit there and run it over and over and over and over again for days, refine it down through brute



force,” says Mike Bilodeau, who served as PDC director from 2003–18 and now provides consulting services to industry clients as principal of Papyrus Consulting Group.

From those humble beginnings not even 20 years ago, UMaine’s nanocellulose research program is today one of the most advanced in the world and the university holds 87 patents on 12 technologies related to nanocellulose production and applications. Today, nanocellulose’s potential as a renewable, biodegradable, high-performance material is widely recognized as almost limitless.

UMaine’s Forest Bioproducts Research Institute (FBRI), which evolved from the National Science Foundation-funded Forest Bioproducts Research Initiative, is dedicated to helping realize that potential. The institute works to advance all manner of renewable materials derived from wood, and UMaine’s leadership in nanocellulose is a point of particular pride for FBRI director Hemant Pendse.

“We recognized very early on the promise of forest bioproducts, and built FBRI as a commitment to fostering R&D and encouraging commercialization,” says Pendse. “UMaine’s leadership in cellulose nanomaterials clearly shows the enduring impact of that commitment and reflects the deep dedication of an interdisciplinary group of researchers and scientists,

including many students. Our expertise has expanded to include non-woody plant fibers as starting materials, and where we initially used nanocellulose primarily as an additive for product enhancement, we’re now reaching into the development of novel nanocellulose composites.”

In the early aughts, research into highly refined cellulose was just beginning to take off in the United States, roughly three decades after researchers at what was then the ITT Rayonier Eastern Research Division Lab in Whippany, New Jersey experimented in the late 1970s with running pulp slurry through a milk homogenizer and created what is regarded to be the first nanocellulose.

UMaine’s entry into the nascent field coincided with the establishment of FBRI in 2007, but the university’s long history of pulp and paper research and industrial collaboration provided a foundation that would help UMaine distinguish itself — first through process innovations, and then through the creation of an unrivaled production and distribution network that is driving nanocellulose research and development across the globe.

PDC has collaborated closely with the industry for decades. The facility was established to support the needs of the pulp and paper industry, and is funded almost exclusively through contract work. Uniquely positioned at the intersection of research and real-world needs, the center has developed a reputation for innovation and problem-solving, leading to discoveries that have become standard practice.

For example, UMaine researchers helped develop nonelemental chlorine bleaching, a process that significantly reduced dioxin generation and discharges. The process became the industry standard. Together with industrial collaborators, the center developed new processes for nonsulfur and oxygen delignification, optimized use of recycled materials, designed equipment and process changes to reduce emissions, and developed and implemented significant strategies for reducing water, raw material, and energy consumption.

These developments benefited Maine’s numerous paper companies

through economic and environmental improvements while also advancing basic scientific understanding. When nanocellulose entered the picture, it was no surprise that pulp and paper companies turned to UMaine.

“We had requests from longtime clients to make this type of material because it wasn’t available commercially,” says Bilodeau, who, as PDC director, led UMaine into large-scale nanocellulose production. “They wanted to evaluate it and keep track of when and how it could be deployed in their products, or how they could use it to make new products.”

The problem was producing it at scale relevant to industrial paper producers, and the homogenizer method was not going to cut it.

“A homogenizer can make a little bit of high-quality stuff, but it’s very expensive,” says Bilodeau. “There was already research published (about nanocellulose) and we started to get clients coming to us asking about making a cheaper version, a coarser version, a less expensive version to put in commodity papers.”

In some ways, nanocellulose research at UMaine evolved along parallel tracks. As the Forest Bioproducts Research Institute was taking shape, UMaine researchers were exploring the properties and potential applications of nanocellulose with small quantities of the high-quality substance they could produce using a homogenizer or purchase from other research institutions. At the same time, PDC’s industrial pulp and paper partners, inspired by research discoveries involving nanocellulose, were clamoring for access to the material to use in their own experiments.

Responding to the needs of their industrial clients, Bilodeau and his PDC team also began making highly refined cellulose, jury-rigging a process involving the center’s existing refining equipment used to prepare stock for making paper.

“A client would say ‘We’re going to do a study and we’re going to use nanocellulose, and could you make some for us?’” Bilodeau remembers. “And then we’d spend days making the stuff. It was extremely energy intensive and slow, and eventually the staff started saying ‘Let’s see if we can’t do it faster, because I don’t want to stay all night making this.’”

Once again, PDC’s long-term industrial relationships were key.



“It wasn’t just paper companies we had as clients, we also had equipment manufacturers, including companies who made refining and stock prep equipment,” says Bilodeau. “And so we worked with them and came up with ways of making it better and better and more efficient, and finally we ended up with a process that we thought was significantly better than what was available, and so we patented the process of making cellulose nanofibrils at a much lower energy consumption.”

A major patent for the high-efficiency production of nanocellulose was filed in 2014 and granted three years later. By that time, UMaine nanocellulose research and development was humming along at a rapid clip, thanks in large part to PDC’s ability to produce the substance in large quantities and make it available to UMaine researchers interested in exploring its uses and properties.

“It wasn’t like we invented the material or we invented its use,” says Bilodeau. “Our claim to fame is really that we could make a lot of it — cheap.”

While pulp and paper expertise, infrastructure and industrial connections gave UMaine a leg up in early nanocellulose research, the university’s ascendance since has been the result of deliberate decision-making and calculated investment. A critical partnership with the U.S. Forest Products Laboratory



Nanocellulose slurry is prepared for distribution in 55-gallon drums, shipped largely across the United States.

Editor's note: Photos without face coverings were taken prior to the pandemic masking requirement.

(FPL) funded construction of UMaine's nanocellulose pilot plant through a joint venture agreement with the USDA Forest Service in 2012.

UMaine's facility, opened in April 2013, was constructed in parallel with the FPL's Nanocellulose Pilot Plant in Madison, Wisconsin, which opened about eight months earlier. The U.S. Forest Products Lab also sited research scientist Jinwu Wang at UMaine as part of the ongoing research collaboration. Jinwu contributes to cellulose nanocomposite research and participates in graduate student education.

UMaine was a key member of a research consortium led by FPL and including six other universities — Georgia Institute of Technology, North Carolina State University, Oregon State University, Pennsylvania State University, Purdue University and University of Tennessee — all working to develop scalable methods to convert wood components into novel, high-performance nanomaterials. Members of the consortium were central to a lobbying effort to inform federal granting agencies of the opportunity to use nanocellulose in a wide range of commercial products, differentiating it from the National Nanotechnology Initiative that was focused on highly specialized applications for different types of nanoscale matter.

"At the time, the National Nanotechnology Institute was getting a lot of funding for nanotechnology, but they were working on very small-scale,

high-tech technology that wasn't easily commercialized," says Bilodeau. "We were trying to make a pitch for a nanomaterial that was biobased, that we could make up in ton quantities, and that you could actually commercialize really quickly."

Tom Vilsack, when he first served as secretary of agriculture under President Barack Obama, was central to securing funding for the expansion of nanocellulose research in the United States. Recognizing an opportunity to support rural communities, Vilsack made support for broader nanocellulose R&D a USDA priority. As a result, UMaine's nanocellulose pilot plant was established not only as a distribution point for product made at UMaine, but also for cellulose nanocrystals produced by the FPL.

"It's difficult for companies to do business with the federal government," says Bilodeau. "There's a lot of paperwork and a high cost involved. The Forest Products Lab decided to send the material to UMaine to distribute and that was great, because then everybody came to us."

"At first, we thought we might sell about \$50,000 worth of samples. We ended up selling several hundred thousand dollars worth," Bilodeau says. "Then, we started selling truckloads of the stuff because those are the volumes that are required to be able to do the type of prototyping at scale in the paper industry to decide whether it was worth it."

Scaling up in-house production and becoming a distributor for research and demonstration material jump-started not only UMaine’s nanocellulose research capacity, but also put the university squarely into the business of nanocellulose. With its in-house pulp and paper expertise and the addition of this new material, PDC could not only push the material out into the world, but also show companies how to use it.

“When UMaine started making and distributing cellulose nanomaterials, it caused a massive shift,” says Sean Ireland, who was deeply involved in efforts to ramp up U.S. nanocellulose R&D and is now vice president of business development at FiberLean Technologies, the leading global producer of microfibrillated cellulose.

“Up to that point, if any researcher wanted to work with nanocellulose, it usually took a couple of Ph.D.s a week or more to make a few grams. So that meant you had to really plan your project and you couldn’t take any risks. Instead of pushing the boundaries of R&D and really understanding the basic principles of what you were developing, you had to go after what you needed, and only that. Then, all of a sudden, you could get a 55-gallon drum.

“When this material became available in large quantities, there was an explosion of publications and patents because people were finally able to really start doing development and unlocking the secrets of cellulosic nanomaterials. It probably changed globally the amount of work being done on nanocellulose, but there’s no question that it accelerated the United States,” Ireland says.

Initially, pulp and paper industry companies were PDC’s primary nanocellulose customers — both to buy material and use the pilot facility for contract work that often led to new research discoveries and patents. At the same time, UMaine researchers now had ready access to the material and began exploring applications, some far from the realm of pulp and paper.

“Now the researchers at UMaine were able to apply for federal grant money to research applications,” says Bilodeau. “Biomedical applications, building products, paper products, a whole bunch of different areas that expanded the use of the material.”



## UMAINE NANOCELLULOSE SAMPLE DISTRIBUTION

Since 2013:

- 50 countries
- Over 600 organizations
- 305 companies
- 276 universities
- 49 government and other entities

Blue indicates countries where PDC has shipped samples. UMaine has shipped almost **4 tons** of 1 pound samples of CNF **worldwide**.

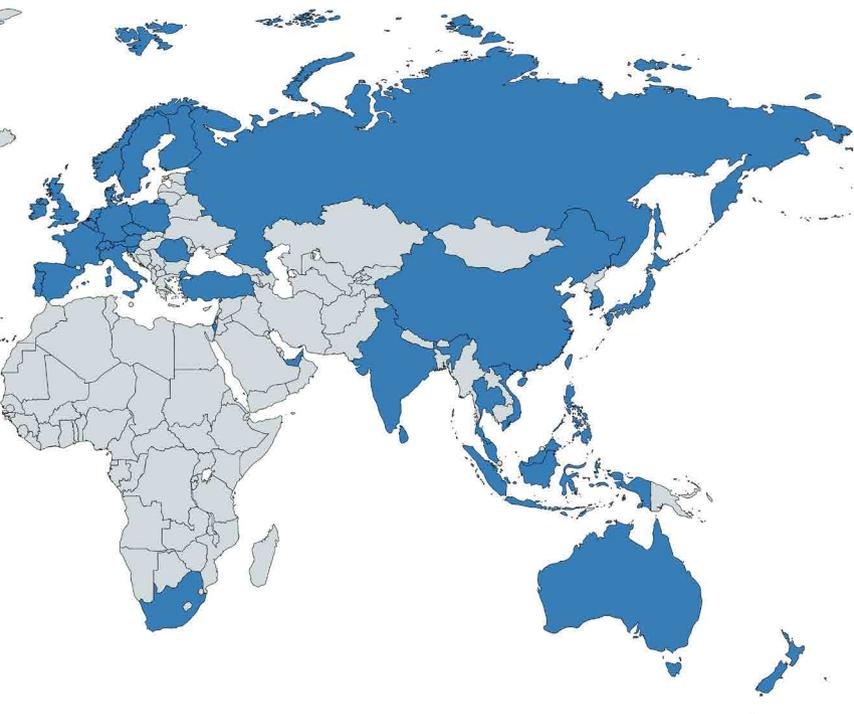
Created with mapchart.net ©

The volume picked up so quickly and the possibilities being discovered — both at UMaine and elsewhere — were so numerous, that Bilodeau, in cooperation with colleagues at FPL, National Institute of Standards and Technology (NIST) and the Technical Association of the Pulp and Paper Industry (TAPPI), put together a book on the topic.

*Production and Applications of Cellulose Nanomaterials* was published in 2013. Its foreword promises “short research summaries, targeted for a level where they can be understood by non-specialists in the research fields, and with a lot of figures and pictures to help convey the science.” It covered applications, including coating, films, medical, composites, liquid gels and aerogels, and even incorporated cellulose nanocrystals into the overcoat varnish of a vibrant pink, purple and yellow cover that showed a magnified image of cellulose nanofibrils.

For a technical volume, it was a hit.

“All we did was take a look at all the research that was being done and compile it into one book,” says Bilodeau. “It was marketing — we did it as another way to make it known that there were materials available and to show all the different applications. It was published through TAPPI and at the time, it was the most popular technical publication they had done. They actually had a second printing.”



Bilodeau was seeing that interest firsthand through the nanocellulose-related contract work coming through PDC.

“If we were working with a client that was utilizing cellulose nanofiber and something commercially interesting came out of the research, they would generally want to file a patent,” Bilodeau says. “Sometimes, we’d get funding to do work ourselves and file patents on those discoveries, and a lot of that was in order to generate more revenue and more traffic through PDC.

“We’d use the patent as a calling card, and it differentiated us from other contract labs because we had something that clients wanted us to demonstrate for them. It kept our books full.”

Established in 2013, the Laboratory of Renewable Nanomaterials led by associate professor of renewable nanomaterials Mehdi Tajvidi is devoted exclusively to applications of cellulose nanomaterials with a special focus on large-volume production and end uses. Tajvidi’s position was created as part of the formation of FBRI and in parallel to UMaine’s increasing profile in nanocellulose production and research.

Tajvidi’s research takes advantage of the tendency that nanofibrils, particularly the type that UMaine produces, have to agglomerate together.

“They bond to each other and bond to things with similar chemical interactions,” says Tajvidi. “That gave us the idea some years ago. What if

nanocellulose could actually be used as a binder to replace all these formaldehyde-based binders and other synthetic binders or adhesives? That’s basically my core research, and there are a lot of other things around this, especially dewatering, but these binder properties are present in almost everything that we look at and we use them as an enabling platform to make a lot of different things.”

Among those things are particleboards, fiberboards and laminates of paper (UMaine holds patents for several of these applications) that could be used in everything from construction to interior automotive components to a variety of household items. The lab also is working on a variety of foam products, everything from nanocellulose-wood fiber composites formed in a microwave to a substance that pairs nanocellulose with mushroom-based organic materials. The resulting materials have some intriguing properties, showing strength, water resistance and the ability to withstand extreme temperatures. Assistant research professor Islam Hafez is leading a project that employs a nanocellulose-based foam purification system to remove arsenic from water.

Tajvidi’s lab often collaborates with professor of chemical and biomedical engineering Doug Bousfield, whose research includes exploring the barrier properties that nanocellulose can bring to packaging applications.

“One property that we found, almost 10 years ago, is that a layer of this cellulose nanofiber is a very good oxygen barrier that, under the right conditions, does better than most plastics,” says Bousfield. “And that leads to something more recently that it’s also a good grease and oil barrier.”

Bousfield points to the increasingly controversial use of a group of manufactured chemicals, per- and polyfluoroalkyl substances (PFAS), that have long been widely used for the grease-resistant properties. According to the U.S. Environmental Protection Agency, PFAS can accumulate in the environment and the human body over time, and there is evidence that exposure to the chemicals can lead to adverse human health effects.

“One kind of easy, low-hanging fruit would be to coat cellulose nanofibers onto paper to create that grease barrier so you avoid using those chemicals,” says Bousfield. “That’s one area that I’m really trying to push along and it’s



The latest research and development investment in PDC includes new refiners that will advance and increase nanocellulose capacity at UMaine.

very simple. Another of my big projects was trying to replace the potato chip bag. A lot of those bags have a metal layer in them, and that's to get the oxygen barrier that plastics can't get. We'd like to go to a fully cellulose-based package for chips or granola or all those dry goods that are in plastic, especially metalized plastic, which you can't recycle if you wanted to."

Bousfield also is exploring combining nanocellulose with calcium carbonate (a chemical compound found in limestone and other rocks) to create a biodegradable material with properties similar to plastic that could be used to make single-use items such as drink lids and disposable cutlery.

"When you combine cellulose nanofibers with calcium carbonate or some other low-cost pigment and dry it, you get a plastic-like object that, if I handed it to you, you couldn't tell was made from cellulose," says Bousfield. "And at the end of use, if you wanted to recycle it, it could go right into a paper recycling system. If someone litters it onto the side of the road, it's going to break down. If someone throws it in the ocean, it will quickly break down into calcium carbonate and cellulose, which are harmless materials."

Bousfield is quick to acknowledge technical challenges associated with the applications he's pursuing, and there are still regulatory questions related

to the use of nanocellulose in applications related to food, but says the capability is there, particularly for the grease and oxygen barrier applications.

"The pilot plant can do this already — add a layer at the wet end of the paper machine or through various coating methods," says Bousfield. "The challenge with coffee cup lids and utensils is getting the right size and shape when you dry them, but I think these problems can be overcome with resources and time to figure it out."

Doug Gardner is part of a team collaborating with Oak Ridge National Laboratory to launch the first large-scale biobased additive manufacturing program in the U.S. The \$20 million initiative involves scores of researchers at UMaine and Oak Ridge, all working to develop next-generation recyclable material systems. Gardner's background is in surface chemistry, adhesion and wood-based composite materials. Since the earliest days of nanocellulose research at UMaine, he has been concerned with the problem of drying nanocellulose.

"One of the first things I worked on with some of my grad students back in 2006–07 was a literature review around applications of nanocellulose," says Gardner. "One of the things that kept coming up was that when you



## IMPORTANCE OF NATIONAL, INTERNATIONAL RESEARCH PARTNERSHIPS

COLLABORATION WITH industry has always been a central part of the Process Development Center's mission and operations, and as the University of Maine has forged ahead with nanocellulose R&D, these relationships are as important as ever. From an exclusive licensing agreement with pulp and paper technologies supplier Valmet that has seen UMaine cellulose nanomaterial production technology installed in commercial facilities around the world to an expansive and groundbreaking multimillion-dollar research collaboration with Oak Ridge National Laboratory, to ongoing research explorations with Sappi, one of the world's largest manufacturers of paper products and itself a nanocellulose innovator, UMaine is working closely with a range of partners that are all seeking to advance commercialization.

make nanocellulose, it's in water, and if you're going to use it in situations where you don't want water, you've got to get rid of the water. But when you do that, you lose the nanoscale aspects of the material and it's a real problem."

With the help of then-graduate student Yucheng Peng, they landed on spray drying as a fairly successful method and hold a patent on that process. Gardner has more recently pursued ultrasonic spray drying and electro spraying technology, though still confronts the challenge of maintaining the nanoscale properties in drying.

An interest in 3D printing developed separately from nanocellulose, and around 2015, long before UMaine was home to the world's largest 3D printer, Gardner started thinking about how to replace thermoplastic feedstocks.

"I saw that one pound of thermoplastic filament was selling for \$50 or \$60, and you could buy those polymers for \$1 to \$1.50 a pound," remembers Gardner. "I thought, 'Well, what if you could make composites?' That's what got me into the area — thinking we could put wood and we could put cellulose into these things and make a better filament than just pure plastic."

For Gardner, the promise of such wood-plastic composites is thrilling.

"Putting a very small amount of this material — 1%, 5% — into a plastic polymer. If you do it right, you can increase the properties by 40, 50, 100%, depending on what the problem is," says Gardner. "At the millimeter- or micron-length scale, you might get small bumps, a 5 or 10% increase.

"When you get to the nanoscale and you get things

"Our work with UMaine is a productive collaboration that centers around advancing cellulose materials, including nanomaterials, into new markets. We're doing work in a lot of the same areas. When you're looking at new engineered materials and you're trying to get traction in the market, often you might be replacing an incumbent material. And sometimes you're trying to create a whole new market, which is even more difficult. So, if you're asking someone who used to use plastic to change to a cellulose material, it takes a lot of work to show them why they should, and UMaine is doing that work. R&D at UMaine is helping to advance the market and advance the industry because the more people are talking about and learning about all the things that cellulose can do, the more comfortable our eventual new customers will be that this material can work. That is really, really valuable."

**Beth Cormier, vice president research, development and sustainability, Sappi North America**

"I rely on the University of Maine for having a North American pilot plant where I can bring customers to do out-of-the-box R&D on refining and processing fiber. Valmet has invested significantly in the facilities at the Process Development Center because they provide us the flexibility to work with our customers. At UMaine, we can test new concepts and experiment with different approaches in ways that we can't anywhere else, and we can do it economically. UMaine's facilities were built and have been developed specifically for research and application, and the people at UMaine are very open and supportive of our customers and our work. If a customer has a crazy idea they want to try, I know that the team at UMaine will do their best to accomplish it."

**David Cowles, global market development manager, nanotechnologies, Valmet**

"The core of our work with Oak Ridge National Laboratory is how to take these cellulose materials — including, but not exclusively nanocellulose — and utilize them within large-area additive manufacturing to create new markets for value-added products from wood. We already know that nanocellulose can be incorporated into the plastic feedstock for printed material to improve its strength. We're trying to get to a similar performance enhancement, but using less energy intensive and more scalable methods. Our goal is to overcome some of the major roadblocks around affordability and processability of nanocellulose and use it to improve the performance of some of these bio-derived materials. It's a huge project that is run through the Advanced Structures and Composites Center, but spans across the university. There are probably more than 50 UMaine researchers involved — not to mention graduate students, undergraduates and post-docs — and equal participation at Oak Ridge."

**Susan MacKay, senior R&D program manager, University of Maine Advanced Structures and Composites Center**



## THE FUTURE OF FOOD?

YOU ALREADY consume cellulose. In fact, there's a good chance that you should be eating more of it.

Cellulose is merely fiber — complex carbohydrates that your body can't entirely digest — and most Americans don't get enough fiber. Occurring naturally in all plants (e.g. any vegetable you eat), cellulose also is a common food and pharmaceutical additive, offering benefits as an anti-caking agent, emulsifier and texturizer, among other uses. It's found in everything from Parmesan cheese to pills, and its many applications are sanctioned by the U.S. Food and Drug Administration. Cellulose is on the FDA's list of substances that are "generally recognized as safe" (often abbreviated as GRAS), a distinction that means the regulator recognizes no hazards related to its use under certain circumstances.

But what about nanocellulose? Researchers have found that it shares many of the same useful properties as cellulose when it comes to food additives, and many of the packaging and other applications being explored could bring nanocellulose materials into direct contact with food and other consumable substances. While nanocellulose is just cellulose reduced to the nanoscale, U.S. regulators have not yet formalized rules on its safety for food and other applications. Successful commercialization for this range of uses will depend on demonstrating the safety of cellulose nanomaterials, paving the way for the substance to achieve GRAS status, like cellulose.

It's an issue that Jo Anne Shatkin, president of Boston-based research and consulting firm Vireo Advisors, focuses on daily. Shatkin is an environmental health scientist with expertise in nanoscale technologies, and her firm counsels clients on market and regulatory requirements for new technologies with the goal of advancing a safer and more sustainable economy.

For more than a decade, Vireo has been working on an environmental health and safety road map for cellulose nanomaterials and has assessed different forms of the material in nearly 60 different scenarios to date, studying everything from material handling and inhalation to food safety. While not yet complete, a wide-ranging and collaborative food safety study offers promising initial results.

Researchers working with both public and private funding have completed both animal and cell-based studies using different cellulose nanomaterials, including UMaine CNF. Their results suggest that both cellulose nanocrystals and cellulose nanofibers behave similarly to conventional cellulose and raise no safety concerns, supporting evidence for use in food.

Backed by this research, Vireo is preparing to seek GRAS designation for cellulose nanomaterials and is exploring the pathway for regulatory authorization in non-U.S. markets.

"We still have a couple of endpoints that are outstanding, a bit more work to do for specific applications, but I feel quite confident that we have demonstrated the safety of cellulose nanomaterials," Shatkin told the audience at UMaine's Cellulose Nanomaterials Forum in August 2021. "We have the data, now we need the regulatory authorities to agree with us and to put that in writing." ♦

well done, all of a sudden the increases in material properties are just beyond what you think they might be, all because of the nanoscale interactions with plastic."

Will Gramlich, associate professor of chemistry, oversees a lab that gets to the heart of this type of interaction, and many others.

"We essentially do chemistry to the nanocellulose to try and change its behavior," says Gramlich. "So, you have your foundational, renewably sourced biobased material, and then we do chemistry to make it have different properties, serve different functions, where they aim to improve it so that it can have different types of applications."

As such, Gramlich's team collaborates with many of the others on campus who work with nanocellulose, from huge initiatives such as the Oak Ridge collaboration at the Advanced Structures and Composites Center to individual researchers exploring narrower questions. The lab's primary focus is on sustainable materials, including hydrogels, derived from nanocellulose.

"One of the unique things about the chemistry that we do in my lab is that we try to do everything in water," says Gramlich. "My group is focused on sustainable materials. Nanocellulose is sustainable, it has a lot of potential applications, but it also has a lot of challenges. By doing some of the challenging chemistry to the surface of the material, we can help characterize it, answer some of those fundamental questions and challenges, and potentially make something that's commercially relevant."

While Gramlich's lab uses water as a solvent, one of the questions they're trying to help answer is how to make it easier to remove the water from nanocellulose and to make nanocellulose compatible in applications where



UMaine nanocellulose production in the Process Development Center begins with rehydrating sheets made from wood pulp.

it might need to repel water, something it's not naturally inclined to do.

“For chemists, the fact that it's in water can be challenging, for applications, that's challenging, and removing water can be challenging, mostly from a cost standpoint,” says Gramlich. “It's not compatible for some of the things you want to use it for, and some of the stuff that we do is trying to improve that compatibility — putting it into a plastic, for example.”

The hydrogels that Gramlich's lab works with have potential for use in biomedical applications, yet another area where nanocellulose shows great promise and one in which UMaine researchers are making new discoveries. Not only is nanocellulose biocompatible — not harmful to living tissue — it also shows intriguing biostatic properties.

Caitlin Howell, assistant professor of biomedical engineering, is deeply interested in these biostatic aspects, whereby nanocellulose doesn't kill microbes, but also doesn't let them grow.

“There were all these anecdotes about how you can leave a bucket of this stuff in the pilot plant and it won't grow anything,” says Howell. “And I thought, ‘No way. This is water and food in a place that's warm. That's the recipe for growing stuff. Microbes love that. There's no way that this doesn't grow anything.’”

Howell, working with a group of undergraduate students through the

FBRI Research Experiences for Undergraduates (REU) program, set out to test this.

“Test after test after test after test proved it,” says Howell. “It actually does not grow anything. This should not be possible. So, one of the research focuses in my group is to figure out what exactly is happening. Why does this material not grow stuff, and how can we make use of that property?”

“That biostatic property, for medical applications, could be really big and really important to solving one of the major crises that is bearing down on us right now, antibiotic resistance. The more we can develop technologies that can help mitigate this without making it worse, and at the same time still be using a natural renewable material, would be a huge win.”

David Neivandt, professor of chemical and biomedical engineering, in close collaboration with recently graduated Ph.D. student Nicklaus Carter, has been studying the use of nanocellulose to make nerve conduits — tube-like structures that can be implanted over a peripheral nerve injury site to facilitate natural recovery. Through funding associated with this work, Carter designed and built a clean room at UMaine's Technology Research Center in Old Town to process nanocellulose under controlled conditions that would make it suitable for use in a medical setting.



Evaluating a freshly produced sample of nanocellulose slurry at the Process Development Center.

“To our knowledge, there isn’t currently a supplier of medical grade cellulose nanofiber,” says Neivandt. “What we set out to create with the clean room was a manner of processing that was entirely reproducible, trackable and consistent.”

This topic also is relevant to the work that professor of biomedical engineering Michael Mason is doing with nanocellulose. Mason’s lab has developed and is in the process of commercializing a nanocellulose composite material for use in orthopedics that promotes the growth of strong natural bone while safely dissolving over time, eliminating the need for metal devices that can be expensive, dense, stiff, prone to infection, and often require costly follow-up surgeries for removal.

This patented technology developed at UMaine is a cost-effective, customizable, resorbable, porous platform biomaterial with the potential to help optimize the healing process for patients. It could be used as a synthetic bone, surgical bone scaffold or bone grafting implement, designed for dissolution and gradual replacement with native bone cells.

And the medical applications for nanocellulose don’t stop with humans. Deborah Bouchard, director of the Aquaculture Research Institute, is studying the use of nanocellulose as a component in injectable fish vaccines. Bouchard and a team of aquaculture and engineering experts, including Mason, are investigating how nanocellulose performs as a vaccine adjuvant,

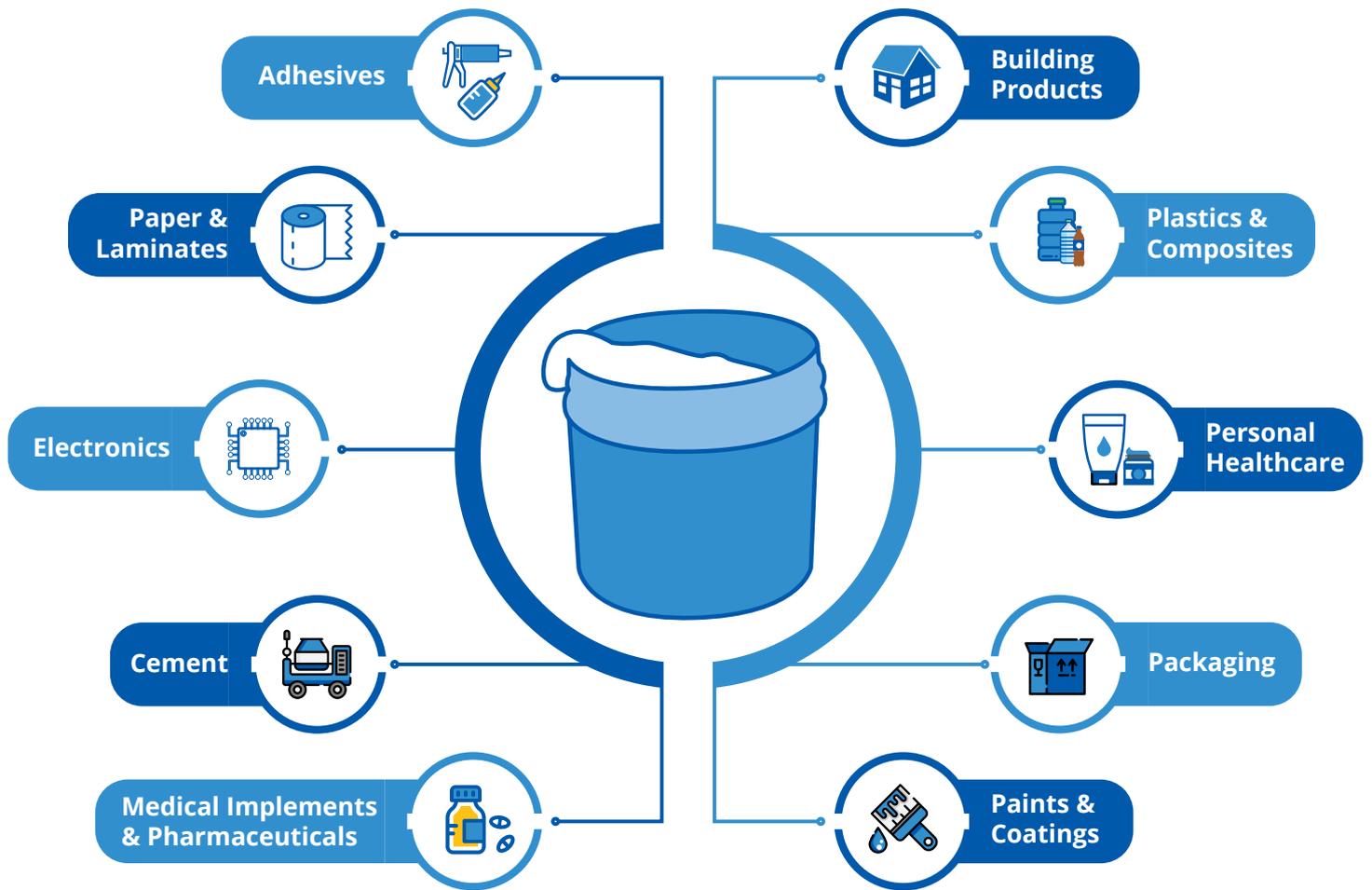
a substance that helps boost an immune response and/or a vaccine depot that keeps the antigen of the vaccine in place, and also helps stimulate the intended immune response.

Typically, adjuvants are water- and oil-based and those currently used in fish vaccines are expensive to produce and also can cause some undesirable side effects, including lower growth rates and adhesions and pigmentation around the injection site. These side effects can be particularly problematic in farmed fish production systems.

“Disease is the number one impediment for all aquaculture and vaccines are just as important for controlling disease in fish as they are in humans,” says Bouchard.

“The adhesions and the discoloration can degrade fillet quality, but the growth penalty really adds to costs because it adds to the time spent raising and feeding the fish. Vaccines made with nanocellulose would be cheaper to produce, and if we could eliminate those side effects, it would make operations more efficient and increase production capabilities.”

Bouchard and her team are experimenting with different types of nanocellulose and, so far, it shows promise not only as a reliable adjuvant substance that can help keep the vaccine antigen in place, but also appears not to cause negative side effects. The potential nanocellulose has shown for aquatic animal vaccines has Bouchard mulling a variety of other prospective uses,



including as a binder for feed, another area she and her team have begun investigating.

All the newest research initiatives at UMaine and beyond make Colleen Walker smile. Knowingly.

This, she confirms, is what Nanocellulose Valley is all about.

Walker is confident that nanocellulose from UMaine could be the catalyst for discoveries and products that will soon impact lives around the globe.

“In 2019, we had a booth at the TAPPI Nano conference in Japan,” says Walker. “It was nonstop. Everybody came to the booth — all these researchers, companies, everyone knew who the University of Maine was and what we were doing.

“I came back from that trip thinking ‘The world knows who we are,’” she says.

The trick, though, is translating that international research reputation into commercialization in the United States, but Walker has a vision for that, too.

“I would love to see an existing paper mill in Maine build a nanocellulose fiber plant,” says Walker. “If you’re making pulp and paper already, this technology is very easy to use. You add a little slip stream to your existing production and you can use just a little bit of nanocellulose to offset fiber and add strength to your paper.

“They do this a lot in Brazil, and they’re using UMaine’s technology licensed through Valmet. And then, as a joint venture, you could build up around the mill a little innovation park filled with satellite businesses who would get the material directly from the plant and use it for whatever they’re producing.”

Walker is particularly bullish on Maine not just because UMaine’s research expertise could support the development of these innovation businesses, but because the physical mill infrastructure and skilled workforce needed for large-scale nanocellulose production is already in place.

“You have people here who have worked on paper machines, people who know how to handle and process fiber,” says Walker. “All of that is transferable. Even if it’s going into new applications, they know this material, they know fiber. There’s all this knowledge that sits here in the state, and nobody else has that.”

Beyond the job skills, Walker sees something else in Maine — a mindset.

“Papermaking is in people’s souls here,” says Walker. “I came from Georgia, which is another really heavy-duty paper producer, but they treat trees like a crop. Here, it’s a respected resource. People want to take advantage of the resource, but with respect.

“Everything goes back to that respect for the forest, which is just part of the culture.” ♦

# Hooked on Aquaponics

## 4-H youths statewide learn life skills in nationally recognized UMaine Extension program

By Joan Perkins

What do guppies and hatchet fish have to do with lettuce and swiss chard? Wyatt Beauchamp, who is 10 years old, can tell you. In detail.

He may be the most passionate of the youths participating in the nationally recognized University of Maine Cooperative Extension's 4-H virtual aquaponics program.

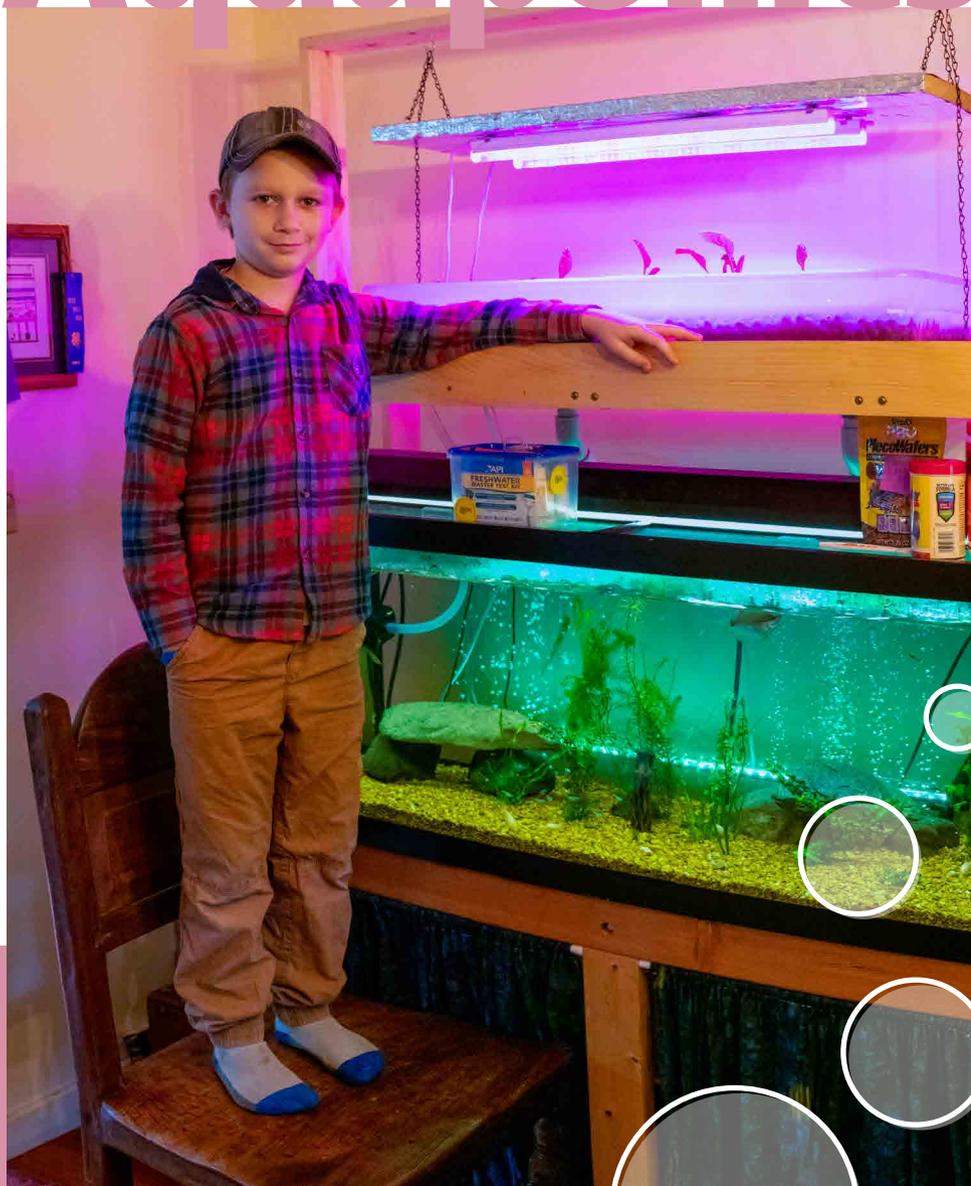
"I love fish," he says. "Any way to work them into my life is amazing. This program is amazing."

Connecting fish and food seemed like an obvious step for Wyatt and his family, who own and operate Lone Spruce Farm in Dedham.

Beauchamp currently maintains five home aquariums, including a 75-gallon aquaponics system he uses to grow greens like lettuce and swiss chard with a little help from his ornamental freshwater fish. And it seems like he is already charting his career path — one that includes designing aquaponics systems for others.

His aquaponics system uses the flood and drain method to produce vegetables in a grow bed filled with clay media and hydrated with water drawn from his largest aquarium. His aquatic community, including guppies, hatchet fish, gouramis, tetras, swordtails and catfish, produce ammonia-rich waste which is converted to nitrate by beneficial bacteria that thrive on the media in the grow bed. The nitrates produced fertilize the crops rooted in the grow bed. The effluent, stripped of nitrates by the vegetables and biologically and mechanically filtered by the clay media, requires no additional filtration before it cycles back into the fish tank.

"We have year-round food happening in the



Wyatt Beauchamp of Dedham maintains a 75-gallon aquaponics system he uses to grow greens and fish. The 10-year-old is active in the 4-H aquaponics program in Maine. Photographs by Adam Kuykendall

dining room — that’s cool,” says his mom, Kristin.

That’s in a dining room the family renovated to accommodate the oversized tank.

The level of commitment doesn’t surprise Carla Scocchi, the 4-H youth development professional who initiated the aquaponics program in summer 2017 with a colleague from the UMaine Center for Cooperative Aquaculture Research (CCAR) in Franklin.

“We give the youth the tools and the resources that they need, and they just blow us out of the water,” Scocchi says.

She and Melissa Malmstedt, the education and outreach coordinator at CCAR, introduced aquaponics as an EPSCoR-funded aquaculture education project serving youth with disabilities. Aquaponics tanks were established at CCAR, and the participants would come to care for the fish about twice a week.

According to Scocchi, the aquaponics program, like all 4-H offerings, presents an opportunity for youth ages 9–18 to explore their STEM interests while learning about themselves.

“It really is a model of experiential learning, inquiry-based learning, youth-led learning,” says Scocchi. “At 4-H, our programs have always been hands-on to facilitate learning by doing and to develop important life skills, like resilience.

“Aquaponics is a challenging project, and we ask a lot of these kids. But that’s part of what makes it so great,” says Scocchi, the recipient of the 2021 Denise Miller National 4-H Innovator Award, presented annually by the National Association of Extension 4-H Youth Development Professionals.

The program has evolved since 2017, and now has a new focus on aquaculture education that aligns with the growth of the industry in Maine. Participants develop technical skills in the aquaponics program, too — skills that employers value.

“The youth learn a little bit about plumbing, a little bit about electricity, and different lamps and pumps,” Scocchi says. “Having a home-based aquarium is having a mini-recirculating aquaculture system in the home. We could be turning their love of fish into a job in Maine someday.”

When the coronavirus pandemic hit in early 2020, Scocchi and Malmstedt had already mapped out the summer aquaponics program.

In the end, the 2020 program was nothing at all like what they had planned. Sustaining connections and building resilience for youth became the focus of this and many other 4-H programs.

The pair immediately went back to aquaponics, knowing that anybody who has a fish tank at home could easily turn it into an aquaponics system. In some ways, the pandemic facilitated the growth of the aquaponics program, as well as the discovery of some unexpected silver linings.



Carla Scocchi, a 4-H youth development professional with University of Maine Cooperative Extension, started the aquaponics program in 2017 with Melissa Malmstedt, the education and outreach coordinator at the UMaine Center for Cooperative Aquaculture Research. In November, Scocchi received the 2021 Denise Miller National 4-H Innovator Award, presented annually by the National Association of Extension 4-H Youth Development Professionals.

Scocchi and Malmstedt welcomed Scarlett Tudor, the education and outreach coordinator at UMaine’s Aquaculture Research Institute, to the leadership team in 2020. Her plans also had been disrupted by COVID-19 when ARI programs were put on hold, events were canceled and students were learning remotely. Tudor, who participated in 4-H as a child, saw this as an opportunity to connect with kids who love fish, but might be unaware of very real career opportunities.

“My interactions with Cooperative Extension actually started when I was 8,” says Tudor. “I took aquaria in 4-H in rural Ohio. I took my aquarium to the state fair, so I would love to give a little bit of that back.”

Tudor believes that her early exposure to aquaria and ornamental fish played an important role in her

career development, and she wants the youth in the aquaponics program to visualize a future working with fish.

“I realized that you can actually get jobs working with fish,” she says. “4-H gave me the environment to explore my passion and I feel like I am helping kids find a career path involving aquatic species. I wish I had more mentors like me, telling me, ‘You can totally get a job doing this.’”

Adding Tudor to the aquaponics leadership team has strengthened the workforce development aspect of the program, particularly by connecting youth with another accessible role model who works with fish.

The shift to virtual programming connected students from all across Maine, including those who would have been unable to travel to in-person meetings.

“They see these other kids who are really obsessed with fish and they think that’s cool,” Scocchi says. “It’s very neat to see. And I was with kids virtually that I would have never seen in person.”

In addition, it seems that aquaponics builds family camaraderie through engagement with the fish at the heart of the system.

Wyatt’s mother couldn’t agree more.

“We have all taken a little part of Wyatt’s passion. If the tank could be a family member, it is one now,” she says.

Tudor recalls the comments received at the conclusion of last year’s program, where participants’ families identified the project as one that engaged the entire household. Parent testimonials described the tanks as a focal point for their family while they were isolated at home.

According to Scocchi and Tudor, the connection established in this program goes beyond a teacher-student relationship; they get to know each other very well and they consider each a friend.

Wyatt concurs.

“They aren’t just my teachers, they are helpful friends,” he says. ♦



# *Call of the wild*

**UMaine has a long tradition of outdoor leadership and adventure learning**

By Casey Kelly | Photographs by Holland Haverkamp, Adam Küykendall and Patrick Wine



Maine Bound trips and clinics include rock climbing in Acadia National Park and cross-country skiing on UMaine trails. Outdoor leadership is a pathway in the Early College program.

**G**rowing up in western Connecticut, Mo Pate loved nothing more than walking in the woods. New Fairfield, her hometown, sits on Candlewood Lake, the state’s largest, surrounded by nature preserves, conservation areas and state forestlands. When it was time to apply to colleges, Pate looked for one that offered plenty of outdoor opportunities, which led her to the University of Maine.

Big attractions were UMaine’s nationally known School of Forest Resources and the Maine Bound Adventure Center, which she describes as “insanely cool,” with its variety of programs, rental gear and a climbing gym right on campus.

“I just fell in love with the interconnectedness of forests when I was a kid, and UMaine is one of the best schools for forestry. Everyone likes going outside here, hiking and adventuring,” says Pate, a senior in ecology

and environmental sciences with a concentration in forest ecosystems.

By the time she graduates in May 2022, Pate also will have completed a minor in outdoor leadership.

A relatively new program started in 2019, outdoor leadership is part of the School of Kinesiology, Physical Education and Athletic Training in the College of Education and Human Development. Students can complete the 19-credit minor or a four-year concentration as part of the kinesiology and physical education (exercise science) major. Taking advantage of Maine’s magnificent wilderness as both classroom and teacher, the curriculum is designed to help students gain the confidence and knowledge needed to safely lead outdoor activities for groups of all ages and in different environments.

“It’s very challenging, but at the same time, supportive,” says Pate.

“There’s a focus on peer-to-peer leadership, holding each other accountable and finding out your strengths as individuals and as a group. It has definitely pushed me to be the best version of myself.”

As she looks forward to life after college, Pate thinks she’d like to work at a nature-based, outdoor-education organization, perhaps with an emphasis on preservation and sustainability.

The summer before her senior year, she completed an internship with the Outdoor Sport Institute, a Millinocket-based nonprofit that aims to help people in the Katahdin region make outdoor activities like skiing, paddling and hiking a greater part of their lives and communities. She and other interns worked on several community-building initiatives. Pate was the lead on a project to create a strategic plan for the Katahdin Gear Library, a resource through Millinocket Memorial Library where residents can borrow outdoor gear and equipment such as skis, snowshoes, paddleboards, kayaks, canoes, bikes and backpacks.

“The community aspect is really important to me,” Pate says. “People in the Katahdin area have all these amazing outdoor resources right in their backyard, but access is still an issue because of financial and social barriers. With the gear library, we’re building a foundation, a culture of recreation and well-being where they can go explore the outdoors.”

There’s a good chance Pate will end up sticking around Maine after graduation. When she came for college, her parents moved with her, settling in Milbridge in rural Washington County.

If she does stay and achieves her goal of working in the outdoors, Pate will join a growing and dynamic sector of Maine’s economy. According to the federal Bureau of Economic Analysis, the outdoor industry added \$2.9 billion to the state’s GDP in 2019, the most recent year for which data are available. That accounted for 4.2% of the state economy, twice the national average and tied for fifth nationally with Wyoming, behind only Hawaii, Vermont, Montana and Florida. The data include the economic impact of activities such as camping, hiking, boating and hunting, as well as gardening, outdoor festivals, construction, tourism and more.



UMaine has long held an important role in the state’s outdoor economy, preparing generations of students for careers in parks, recreation and tourism management, forestry, environmental sciences and more. The outdoor leadership program is the newest addition to that academic tradition, but even it is by no means new.

“There have been components over the years, different iterations that have come and gone,” says Lauren Jacobs, a lecturer in outdoor leadership in the College of Education and Human Development who coordinates the concentration and minor. “It goes way back to when (former professor of education) Walt Abbott was teaching, and he taught these amazing outdoor courses that people across Maine still talk about.”

Jacobs was hired in 2017 in part to figure out a way to make a more lasting and sustainable program that would appeal to students and meet



## Outdoor Leadership

The School of Kinesiology, Physical Education and Athletic Training in the College of Education and Human Development offers an outdoor leadership program with a 21-credit concentration within the kinesiology and physical education major, or a 19-credit minor for students in other areas. Maine’s outdoor resources serve as both classroom and teacher, preparing students for a variety of careers in outdoor industries. All students earn industry-standard certifications, including Wilderness First Responder and Swift Water Rescue. In addition, students in the four-year concentration can dive into their passions in two ways: first, through 12 credits of self-directed study in intensive outdoor coursework, which can be completed at another University of Maine System campus, or in another part of the country or abroad; second, in an individually designed capstone internship in a business, nonprofit, educational or other field setting.



Mountain bike enthusiasts and UMaine outdoor leadership community members, left to right, Lauren Jacobs, Patrick Downing and Trevor England. The KPE Outdoor and Adventure Activities class includes winter shelter construction.

the state's workforce development needs. One of the goals was to create something that filled the gap between management of outdoor resources (forestry and tourism resources, for example) and facilitating experiences. Education seemed to be a natural bridge.

"Our students might literally be outdoor educators working in schools, or for a nonprofit, or a commercial business leading groups into the wilderness and sharing their knowledge and experience," says Jacobs. "That might also be just part of their career, where maybe they are more focused on the resource management side, but they also have the skills to facilitate trips and things like that."

Interest in the program has been building since it was introduced. The four-year concentration and minor have more than 50 students each. Core courses include an introduction to outdoor leadership and facilitation class

that covers the history of outdoor education and helps students identify their personal leadership style, as well as wilderness first responder and paddling safety courses that can lead to industry-standard certifications for students who want to guide trips.

Field experience is an important component of the program, with students challenged in a variety of conditions. Jacobs says instructors don't expect students to become experts in all areas of outdoor leadership, but they should have at least some knowledge of different environments.

Service learning and community engagement are encouraged across the curriculum as well, including a class on ethics and social justice in the outdoors. Jacobs says that class feels really relevant as issues of diversity, equity and inclusion have attracted more attention in recent years.

"We want our students to be able to have conversations about what's happening on a national level," she says. "Historically, outdoor spaces have been segregated by race. Swimming pools are probably the most famous example. But also parks, including national parks. We think it's important for our students to understand that history, as well as how issues like race and class impact people's access to and experiences in the outdoors today."

Students in the concentration supplement the core curriculum with an interdisciplinary program that includes courses in areas such as education, exercise science, leadership studies and natural resources. The four-year program also includes 12 credits of self-directed study in skill- or experience-intensive outdoor coursework and a capstone internship.

For the self-directed study portion, Jacobs says the program leans heavily on connections throughout the state and beyond. For example, students interested in building their sea-based skills could take courses through the outdoor recreation and leadership program at the University of Maine at Machias. Another option is to pursue a semester of outdoor studies in another state or country.

"The self-directed study and internship are really an opportunity for our students to explore their passions," says Jacobs. "It could be business, photography, design, creative writing. It's really up to the individual and their interests."

## Parks, Recreation and Tourism

Based in the School of Forest Resources in the College of Natural Sciences, Forestry, and Agriculture, the PRT major features concentrations in conservation law enforcement, nature-based tourism, and parks and recreation management. The curriculum is designed to provide students with training that will qualify them to work in a variety of settings, such as parks and protected natural areas, the public and private business sectors, nonprofit environmental organizations, as well as state and federal natural resource agencies. The PRT program emphasis on the integration of natural, social and management sciences reflects the interdisciplinary context in which recreation, tourism, natural resource planning and environmental concerns are addressed. The program takes advantage of Maine's coasts, mountains, national and state parks, the Appalachian Trail and other outdoor resources.



The minor in outdoor leadership has attracted students from a variety of majors, including parks, recreation and tourism, business, the liberal arts, natural sciences and beyond.

Seth Campbell is an assistant professor with the School of Earth and Climate Sciences and the University of Maine's Climate Change Institute. Since 2019, he has been director of academics and research for the Juneau Icefield Research Program (JIRP), a 75-year-old project that brings college students from around the country to the glaciers north of Juneau, Alaska each summer for scientific research and other fieldwork.

This past summer, nine UMaine students — a mix of undergraduate and graduate students — were among the more than 50 participants in the program (students in the JIRP field course earn six credits through UMaine). They were able to work on about a dozen ongoing research projects, exploring climate change, glaciology, hydrology and more.

"It's kind of equivalent to a mini-U.S. Antarctic program," Campbell says. "I often tell people that if you can experience the Juneau Icefield for two months, Antarctica or Greenland should be a cakewalk."

A couple of students in the program in 2021 were from outdoor leadership. Campbell, who worked at the Maine Bound Adventure Center and taught kinesiology and physical education courses while working on his MBA at UMaine, says he hopes to attract more in the future.

"It's a challenging environment to work in. You need skiing skills, mountaineering skills. There's also a lot of cross-collaboration that happens, a lot of resource sharing. So having students who are already knowledgeable

about what it takes to work in the outdoors is really important," he says.

Jake Burgess graduated from UMaine in 2020 with a bachelor's in parks, recreation and tourism and a minor in outdoor leadership. Originally from North Berwick, Maine, Burgess grew up on skis, bikes and trails, but says in high school he didn't know that his enthusiasm for the outdoors could also lead to a career. As a lifelong Mainer, he knew he wanted to stay in state for college and that eventually he wanted to live and work in Maine as well.

"I came in undeclared and found parks, recreation and tourism, which I really enjoyed because it's all about working with people," says Burgess. "Outdoor leadership launched the first semester of my junior year, and that was great because it's all about educating people."

Today Burgess is the trail steward for Inland Woods and Trails, a nonprofit that encourages the development, maintenance and use of recreational trails in and around Bethel in western Maine. His primary job is ensuring that the trails managed by the organization, covering a five-town area, meet modern design standards. He also helps design and construct new trails and promotes their use through education and outreach, including leading

hikes and other activities. He says the knowledge, experience and relationships he gained at UMaine prepared him for the work.

"In parks, recreation and tourism, we'd have class with forestry students, ecology students, wildlife students," he says. "Getting those different perspectives and having that mix was fascinating and has helped me become better at building trails. Then with outdoor leadership, the classes almost felt like a guiding trip. We'd be out in the field, practicing leading different

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In parks, recreation and tourism, we'd have class with forestry students, ecology students, wildlife students. Getting those different perspectives and having that mix was fascinating and has **helped me become better at building trails.**"

Jake Burgess



## Outdoor Recreation and Leadership

The outdoor recreation and leadership major at the University of Maine at Machias provides for integrated study of recreation and tourism services to prepare students for careers ranging from game wardens to park interpreters, professional guides, recreation resource managers, camp directors, municipal recreation directors, nature-based tourism providers, fitness center directors, experiential educators and more. Students get hands-on experience in their nature-based coursework and fieldwork. Students gain a broad understanding of leisure and recreation in society while developing managerial skills. The program's Down East location among coves, rivers, lakes and forests lends itself to the enjoyment of outdoor recreational experiences and to unique experiential learning opportunities, particularly for future recreation professionals.



A Maine Bound snowshoeing trip on UMaine trails.

groups or figuring out which leadership styles worked best for us and why. It was great.”

Beyond academics, Burgess says one of his formative UMaine experiences was working at Maine Bound. Chris Bartram, Maine Bound’s assistant director and an instructor in the outdoor leadership program, initially hired him to coordinate the university’s participation in the Outdoor National Campus Challenge, a bid to be named the “most outdoorsy” school in the country. That led to a position as Maine Bound’s marketing and events manager.

“Having classes with Chris and working for him were extremely helpful,” says Burgess. “He’s not that much older than me, but he has that experience of being a leader in an outdoor setting.”

“A big part of the philosophy here is building community,” says Bartram, a passionate advocate for outdoor adventuring in Maine and the university’s leadership role in it.

Although located on the UMaine campus and utilized largely by students, Maine Bound is — importantly — open to anyone of any skill level, even those who are not part of the campus community. Elements of the academic program were actually developed and offered through Maine

Bound for years before the concentration and minor were created. In fact, Maine Bound still offers an outdoor leadership program, consisting of six 1.5-hour educational clinics and participation in two trips, which mirrors the introduction to outdoor leadership course that students take through the College of Education and Human Development.

“If facilitated well, one opportunity in the outdoors has the ability to impact someone’s life,” Bartram says.

For a sense of Maine Bound’s impact, it’s useful to take a quick look at some numbers from a recent year of its operation. In 2019, the program hosted more than 12,000 individual visits to its climbing wall, about 900 people attended one of a dozen or so events it sponsored, it put on more than 150 trips and clinics, and rented approximately \$11,000 worth of gear. Those numbers were down in 2020 due to the COVID-19 pandemic, but largely rebounded in 2021, according to Bartram.

The program was started in 1984 by Kevin Slater, then an Outward Bound instructor and graduate student, who now operates Mahoosuc Guide Service, offering guided dogsledding and canoe trips in Maine, New England and Canada. For a master’s thesis project, Slater began offering one- or two-week backpacking or paddling trips for UMaine freshmen, similar to the Black Bear Bound orientation program that continues to this day.

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## Early College Outdoor Leadership Pathway

A gateway for high school students to explore outdoor career paths while earning up to 15 college credits, the outdoor leadership pathway includes a wilderness first responder course (3 credits), an outdoor and adventure activities course (3 credits), and a foundations of leadership course (3 credits), as well as two electives in areas the student wishes to explore, such as creative writing, business or Native American studies. The Early College pathway is designed for students interested in a career in fields such as outdoor education, guiding and natural resource management, or who want to major in areas such as forestry, kinesiology and physical education, or parks, recreation and tourism in college.



Jon Tierney, who would go on to start Acadia Mountain Guides Climbing School, was involved from the beginning, serving as director of Maine Bound until 2001. Bartram says he's the one who built the program into what it is today with year-round courses offered to the UMaine community and public, equipment rentals and sponsored events.

Today, Maine Bound has two professional staff and 25 student workers, who receive 100 hours of training a year, earning certifications in rock climbing, wilderness medicine and more.

"They are taking those skills and going straight into the industry," Bartram says. "We have Maine Bound alumni working across the state at guiding companies, camps, at schools as outdoor educators."

Patrick Downing, a senior from Natick, Massachusetts, is a student employee at Maine Bound. He works the front desk, does equipment rentals and runs the climbing wall when it's open for top roping, where the climber is attached to a rope anchored to the top of the wall that runs down to a belayer at the base. He and other student workers have to be certified as belayers in order to perform the job. He also helps run the challenge course — including both high and low rope elements, a zip line and a giant swing — located behind UMaine's New Balance Student Recreation Center, as well as hiking and paddling programs.

Downing, a student in the four-year outdoor leadership concentration, hopes to work as a wilderness guide when he graduates.

"Getting my Maine guiding license would be ideal," says Downing. "I've already got some connections from the outdoor leadership program and Maine Bound. I just took the paddling safety course and got swift water rescue certified. So, working for a whitewater company is one option. I also know a lot of former Maine Bound students work at Acadia Mountain Guides, which would be a really great opportunity."

After spending his freshman year at Western Colorado University, Downing transferred to UMaine as a sophomore to be closer to home. Although he's keeping his options open about where he ends up post-graduation, he says Maine is someplace he holds dear.

"I've been coming to Maine my whole life and just love the area," he says.

Despite the COVID-19 pandemic that caused Maine Bound's numbers to dip, plenty of evidence suggests that people were more motivated to participate in outdoor activities as a result of the pandemic. For example, bike sales went through the roof and bookings for campsites in Maine and elsewhere were full. Bartram thinks interest will continue even as the pandemic subsides, and that bodes well for the future of outdoor job opportunities.

"I do think because of the growth in revenue, there's going to be sustainable careers," he says, noting that Maine already had a strong outdoor economy with companies such as L.L. Bean headquartered in the state.

"Maine is probably better positioned than other states, because anyone can get their certifications, apply for a license to become a Registered Maine Guide, then hang a shingle and start their own business," Bartram says.

Still, Maine Bound's mission is not to train people for the workforce. That's the purpose of the academic program. The center is still focused to a large degree on the original vision of its founders to educate anyone and everyone about how to responsibly enjoy the outdoors. Bartram is particularly proud of the impact Maine Bound has on student retention.

"We see 9% higher retention in students who do the Black Bear Bound orientation program. For first-generation college students, it's 16% higher," he says.

UMaine's leadership in the outdoors is key to attracting students who may not view themselves as college material, says Ryder Scott, executive director of the University of Maine Cooperative Extension 4-H Centers, located at Blueberry Cove, Bryant Pond, Greenland Point and Tanglewood.

"A lot of kids in rural areas who we work with, they're not necessarily aspiring to go to college," says Scott. "At the same time, they have a lot of outdoor interests — they love to hunt and fish, to ski and ride snowmobiles — and they are very smart. We feel like if we can get them to do a campus visit, meet some faculty members, they can see opportunities to do something hands-on and outdoor oriented in college. It's a great recruiting tool."



## Maine Bound Adventure Center

A division of Campus Recreation, Maine Bound offers comprehensive outdoor experiences for students and community members of all skill levels. The Maine Bound building is home to a 32-foot-high indoor climbing wall and a 12-foot bouldering wall, and gear rentals to students and community members. It hosts various events, educational clinics and adventure trips during the academic year and the summer. Maine Bound also offers Challenge Course facilitation for both university and nonuniversity groups at a high- and low-ropes course, located behind the New Balance Student Recreation Center. By combining recreation and education, Maine Bound programs offer diverse adventure opportunities while instilling skills that are used in everyday life. The professional staff and devoted student instructors are passionate about educating everyone about all the responsible fun and adventure that the outdoors has to offer.

Scott also coordinates a 15-credit University of Maine Early College pathway in outdoor leadership for high school students. The program, which allows juniors and seniors in high school to take classes tuition-free or at a reduced rate, features some of the same courses taken by students in the outdoor leadership minor and concentration. That includes a wilderness first responder course and an outdoor and adventure activities course, as well as a foundations of leadership class.

The Early College pathway launched in 2019, and Scott says they are working with high schools and Career and Technical Education Centers in Maine to enroll 100 new students in the program by summer 2022.

“One of the things we say is we want to give kids the technical skills to do outdoor industry jobs, but also the entrepreneurial skills to hire 10 more people,” Scott says. “One of the great things about outdoor careers is they can be place-based, so we can train kids for jobs where they go back into the rural communities where they are from.”

The UMaine 4-H Center at Bryant Pond, where Scott is based, is part of an Aspirations Incubator program through the Emanuel and Pauline A. Lerner Foundation that aims to increase the hopes of rural youth in Maine. To do that, the Lerner Foundation provided the Bryant Pond 4-H Center and other groups around the state with funding to offer mentoring, as well as experiential learning, travel and outdoor adventure opportunities to local youth from middle school through 12th grade.

In the first three years of the six-year program, 93% of students involved reported that it helped them feel connected to their community. Participants were half as likely to be chronically absent than their peers, and 70% reported positive growth on measures related to learning and school engagement. Meanwhile, 99% of the eighth graders in the incubator said they would finish high school, and 88% believed they would pursue a college degree.

“Even if a kid doesn’t go on to pursue an outdoors career, there’s a lot of ways our leadership in the outdoors can impact their life,” says Scott of the Lerner Foundation’s findings.

Scott, Bartram and Jacobs, along with Karen Beeftink, an associate professor and coordinator of the UMaine Machias outdoor recreation and leadership program, meet regularly to align curriculum, build professional skills, and share resources and ideas for how to better coordinate programming across UMaine and UMaine Machias. One outcome of their working together: all Black Bear Bound orientation programs this past summer had components take place at one of Cooperative Extension’s 4-H camps.

As the outdoor industry continues to expand, and as more students are attracted to the opportunities afforded by Maine’s wilderness, the group sees the roles of UMaine and UMaine Machias as an outdoor leader continuing to grow. Jacobs notes that every February for the past three years, the outdoor leadership program has hosted an outdoor careers event with the UMaine Career Center.

“It’s been really great to foster connections with businesses and nonprofits who are working in the outdoors,” Jacobs says. “We’re helping build this core group of students who live here, go to school here, and then hopefully want to stay here and be part of the outdoor community.”

“In Maine, we have mountains, rivers, the coast, and everything from biking to kayaking to snowshoeing to camping,” she adds. “We’re so lucky to have all that in our backyard.” ♦



Maine Bound’s Challenge Course in the University Forest is a popular destination, offering team-building programs led by trained facilitators.



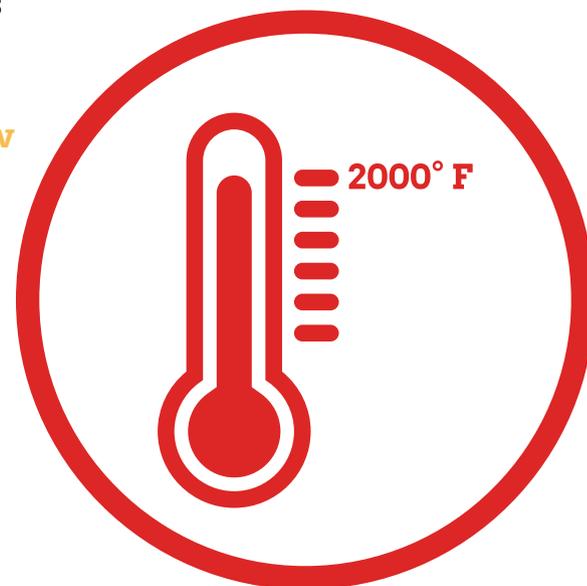
## NEXT GEN SENSORS FOR HARSH ENVIRONMENTS

The next generation of harsh environment materials and wireless sensor techniques are the focus of a \$2.34 million Department of Energy (DOE) EPSCoR award for research led by University of Maine researchers Mauricio Pereira da Cunha and Robert Lad.

The DOE award was one of nine initiatives funded nationwide for a total of \$22 million. The UMaine research received a DOE EPSCoR implementation grant in 2019.

Pereira da Cunha, professor of electrical and computer engineering, and Lad, professor of physics, will lead an interdisciplinary, multi-institution team of researchers. They include eight UMaine faculty members and other researchers from the University of New Hampshire, Bates College and the University of Southern Maine. The research will employ the Frontier Institute for Research in Sensor Technologies (FIRST) facilities and equipment, the university's premier research center for conducting nanotechnology and advanced sensor research.

Their primary goal is to address the pressing need for a new generation of sensor materials, devices and systems that can operate under extreme temperatures (up to 2000° F) and harsh environments that may consist of erosive particles and oxidizing, reducing or corrosive gases. These types of conditions are often found in the rapidly expanding energy sector, such as power plants, gas turbine generators, renewable power generation and advanced manufacturing. ♦



## Pandemic lessons

A new report from the University of Maine Beyond Crisis Schooling project examines the unprecedented challenge of “re-designing schools” undertaken by educators for the 2020–21 school year. Led by associate professor of educational leadership Catharine Biddle and lecturer in educational leadership Maria Frankland, the report, “Re-opening Schools in the Midst of the COVID-19 Pandemic: Lessons for Leaders from the 2020-2021 School Year,” aims to inform the practices of school leaders for the current school year.

Part of the challenge, the report points out, is that fear of COVID-19 transmission undermined staff, parent and school board confidence in schools’ ability to educate children and keep both students and staff safe, and there were no one-size-fits-all solutions.

“What inspired confidence in one district undermined it in another, depending on a variety of contextual factors,” the report states. “Additionally, districts were working with vastly different arrays of local resources, including community organizations, public health infrastructure, community internet access, and political beliefs.”

Since April 2020, the Beyond Crisis Schooling project has examined the COVID-19 response by schools in Maine and Pennsylvania, two states with very different infection rates and local infrastructure. The research team’s first report, released in August 2020, examined district practices that supported remote student learning from March to June 2020. For the new report, the researchers collected approximately 7,000 documents from 674 school districts. According to the superintendents interviewed by the researchers, three factors were most critical in determining stakeholder confidence in schools reopening: size and urbanicity; regional decision-making; and partisanship. ♦

The report offers several recommended leadership strategies for superintendents to build public confidence in schools’ COVID-19 response, including **transparency in how equitable student learning is being defined.**

## Oldest adobe architecture in Americas



Photo courtesy of Ana Cecilia Mauricio

On the north coast of Peru, researchers have discovered the oldest adobe architecture in the Americas, constructed with ancient mud bricks carved from natural clay deposits created by floods caused by El Niño.

The pre-Hispanic bricks — carved from sedimentary layers versus created by mixing clay, temper and water — date the invention of adobe architecture to more than 5,100 years ago, according to the international research team led by archaeologist Ana Cecilia Mauricio.

In the Andes, early adobe monumental structures are associated with communal ceremonies and the rise of social complexity, the team notes.

The research began when Mauricio was an Interdisciplinary Ph.D. student in the University of Maine Climate Change Institute. Her 2015 dissertation advisers were UMaine professor of anthropology Dan Sandweiss and associate research professor Alice Kelley in the Climate Change Institute. Mauricio also received a master's degree at UMaine.

Mauricio, now a professor of archaeology at the Pontifical Catholic University of Peru, has been conducting archaeological and georachaeological studies at the site of Los Morteros and the Archaeological Complex of Pampa de las Salinas in the lower Chao Valley since 2012. Los Morteros had been considered a burial mound until a UMaine research team composed of Sandweiss, Kelley and Joseph Kelley and Daniel Belknap, both of the School of Earth and Climate Sciences and the Climate Change Institute, used georadar in 2006 and 2010 to investigate the mound's interior.

Mauricio's research showed that the mound once thought to be a natural phenomenon is the site of monumental architecture. Evidence of human occupation included stone hearths containing small fish bones, charcoal and scallop shells, and rooms made of adobe bricks, with plastered walls and clay floors. ♦

## BUILDING AG LITERACY

A new University of Maine initiative to build agricultural literacy through an immersive culinary experience for career and technical education (CTE) culinary arts instructors is one of 21 projects funded nationwide by the U.S. Department of Agriculture's National Institute of Food and Agriculture.

NIFA has invested \$6.2 million in the Professional Development and Secondary School Teacher grants to increase the number of K–14 teachers and educational professionals trained in the food and agricultural sciences. The grants to prepare more educators in food and ag science, and support best teaching practices that enhance student learning outcomes, are part of NIFA's Agriculture and Food Research Initiative.

UMaine's Building Agriculture Literacy Through an Immersive Culinary Experience project, which received a \$300,000, four-year grant, is led by Kathy Savoie, University of Maine Cooperative Extension educator and professor; Willie Grenier, executive director of Maine Agriculture in the Classroom; and Rob Dumas, UMaine food science innovation coordinator and pilot plant manager. CTE culinary arts instructors will receive professional development experiences to increase their agricultural literacy, and enhance the connectedness between agriculture and food service in their culinary arts curricula.

A goal of the project is to help create a skilled, educated workforce that will increase the use of Maine grown, processed and produced foods in their programs and careers by changing the way students — tomorrow's food professionals — think about the importance and value of local food, according to the researchers.

"Providing professional development experiences for CTE instructors will help to shift culinary arts programs toward local food system education with the end goal to create a workforce that is proficient in Maine agriculture, and that will be poised to meet today's consumer needs and ultimately boost our state agriculture" says Savoie. ♦

The project provides a **holistic approach to uniting community partners** to identify the best practices for agriculture literacy education at CTE culinary arts programs in Maine.





## FOOD RESCUE

The Senator George J. Mitchell Center for Sustainability Solutions at the University of Maine has partnered with a coalition of Maine communities, including Waterville, to advance the Food Rescue MAINE campaign for ending food loss and waste. The towns are part of a growing statewide movement to reduce municipal waste disposal costs and improve soil, air and water quality by recycling discarded food into compost or biogas.

Other municipalities working with the Mitchell Center to promote food recycling initiatives include Winslow and Portland; both opened community food waste drop-off sites on Earth Day 2021.

Food Rescue MAINE is a statewide food waste education and action campaign funded in part by the Maine Department of Environmental Protection's (DEP) food waste diversion program and spearheaded by a Mitchell Center team comprised of faculty advisers and student interns from several Maine colleges and universities. The project slogan, "Maine Food-Too Good to Waste," is a call to action.

As part of the campaign, the Mitchell Center team has developed materials available to participating towns and the public to build awareness of and support for community food rescue and recycling programs. Resources include a new web portal, a social media platform, and a library of recycling information, signage, flyers and videos. A school outreach program is also being piloted.

According to Susanne Lee, UMaine project lead and faculty fellow at the Mitchell Center, the Maine food waste education and action campaign can help Maine businesses, municipalities and organizations implement sustainable solutions that offer economic, community and natural resource benefits. ♦

## Drug data hub

A new online drug data hub for Maine with the potential to improve care, inform policy and ultimately save lives is the latest impactful tool in response to the state's opioid epidemic.

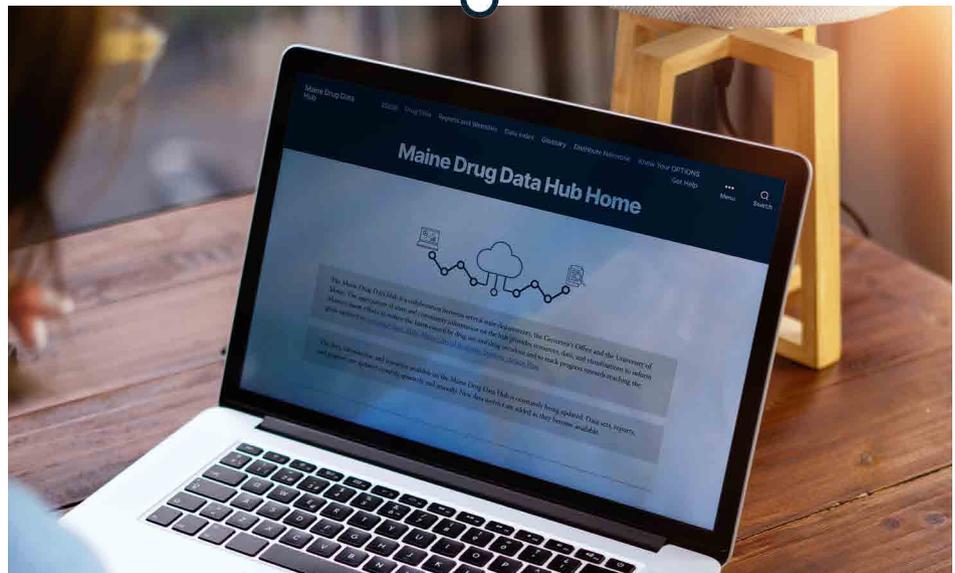
Maine Drug Data Hub, designed to maximize the collection of actionable data and evaluate the impact of interventions, was established through a partnership among the Governor's Office of Policy Innovation and the Future, the Office of the Attorney General, the University of Maine, and several state agencies.

"Our Opioid Response Strategic Plan highlights data collection, analysis and timely communication as one of five crosscutting values that are foundational to each of our areas of focus: Prevention, Treatment, Harm Reduction and Recovery Support," says Gordon Smith, the state's director of opioid response, who led the creation of Maine Drug Data Hub in partnership with UMaine's Margaret Chase Smith Policy Center's Drug and Alcohol Research Program, led by Marcella Sorg, and the Maine Department of Health and Human Services, Office of Behavioral Health. The website project manager is Daniel Soucier, a research associate at the Margaret Chase Smith Policy Center.

Maine Drug Data Hub ([mainedruginformation.org](http://mainedruginformation.org)) links to data, reports and other dashboards related to drug problems and related Maine policies. It integrates data from public health, public safety, corrections and the judicial system using the 2021 Maine Opioid Response Strategic Plan as a framework. It also provides special "use-case" portals for ease of use by policymakers, media and clinicians.

The site is a dynamic, interactive hub for monthly data updates, policy analyses and public communication. It includes a GIS story-maps approach, with narratives geared to substance use problems, and policy solutions and evaluation. In addition, interactive and static policy briefs will provide temporal and spatial analysis of the data provided by the various state agencies involved in the opioid response, and foster greater transparency and understanding of the meaning of the data and how the state is addressing drug-related issues.

Since 2003, UMaine's nationally recognized Drug and Alcohol Research Program has issued monthly, quarterly and annual drug overdose reports. It also manages the State Unintentional Drug Overdose Reporting System and has relationships with many of the data gatekeepers that reside across the public safety and public health sectors of the state government. ♦





## Oldest ice exploration

University of Maine Climate Change Institute researchers will return to the Allan Hills blue ice area in Antarctica as part of a new Center for Oldest Ice Exploration, or COLDEX, led by Oregon State University and made possible by a five-year, \$25 million National Science Foundation grant.

COLDEX is one of six new NSF science and technology centers “to advance ambitious, complex research in fields ranging from mechanobiology to particle physics to climate change.” The NSF Center for Oldest Ice Exploration, led by Oregon State paleoclimatologist Ed Brook, aims to transform the current understanding of Earth’s climate system by discovering and recovering some of the oldest ice on Earth.

The multidisciplinary team will drive this new science and discovery while building climate literacy and action in classrooms and communities across the United States, according to the NSF news release. The center’s researchers are from Oregon State University; American Meteorological Society; Dartmouth College; University of California, Berkeley; University of California, Irvine; University of California San Diego; University of Kansas; University of Maine; University of Texas at Austin; University of Washington; University of Minnesota Duluth; University of Minnesota Twin Cities; Princeton University; Amherst College; and Brown University.

Internationally recognized UMaine climate scientists Paul Mayewski, who directs the Climate Change Institute, and Andrei Kurbatov, an associate professor in the Climate Change Institute and School of Earth and Climate Sciences, and several graduate students will participate in COLDEX project using the state-of-the-art UMaine Keck laser ablation system. ♦



## ON THE SURFACE

A novel liquid surface coating on human catheters could help reduce protein deposition that leads to urinary tract and bloodstream infections, according to researchers at the University of Maine and University of Notre Dame who are leading a study funded by the National Institutes of Health.

The research, funded by a five-year, upward of \$2 million NIH grant, seeks to understand how protein adhesion influences bacterial colonization on commercial catheters, and will explore the development of liquid-infused catheter surfaces for controlling protein deposition. The research will contribute to understanding how reduction of protein deposition on catheters affects urinary tract infections (UTI). The goal is to reduce infection.

The study is led by principal investigators Ana Lidia Flores-Mireles, Hawk Family Assistant Professor of the Department of Biological Sciences at Notre Dame, and Caitlin Howell, UMaine associate professor of biomedical engineering.

“Most research on reducing catheter-associated infections has focused on killing the bacteria using antibiotics, which can lead to antibiotic resistance,” says Howell. “We are using a completely different approach: stopping the adhesion of the proteins

that the body releases in response to the catheter, which stick to the catheter surface and make it much easier for the bacteria to adhere and start growing.”

Among UTIs acquired in the hospital, approximately 75% are associated with a urinary catheter, according to the Centers for Disease Control and Prevention. And the rising incidence of antibiotic-resistant pathogens can turn these infections into life-threatening conditions.

Howell and Flores-Mireles are researching how disrupting this process can lead to new ways of preventing infections without antibiotics. Key to this work is the use of ultra-thin liquid surface coatings that prevent proteins and bacteria from sticking. The innovation takes its inspiration from nature — the pitcher plant, with its liquid coating that traps insects. ♦

Key to this work is the use of ultra-thin liquid surface coatings that prevent proteins and bacteria from sticking.

**The innovation takes its inspiration from nature — the pitcher plant.**



## Science and face coverings

Individuals' perceptions of science as a source of superior knowledge can predict the likelihood of mask wearing during the COVID-19 pandemic, according to a study led by University of Maine psychology researchers.

Doctoral students Morgan Stosic and Shelby Helwig, and assistant professor Mollie Ruben examined whether belief in science (BIS), a construct that measures the value individuals assign to scientific information, regardless of political affiliation, can predict mask wearing behavior and, if so, whether the relationship is mediated by belief in the effectiveness of face masks in reducing transmission of COVID-19.

Study participants self-reported mask wearing behaviors, beliefs in the effectiveness of face masks in preventing the spread of coronavirus, the degree to which they valued science as a source of superior knowledge, and sociodemographic data.

Results show that greater BIS predicted stronger belief in the effectiveness of face masks in reducing the transmission of COVID-19 and greater reported face mask wearing in public. In addition, the study confirmed the mediating role of belief in the effectiveness of face masks in reducing the transmission of COVID-19 in this relationship. Greater BIS predicted greater belief in the effectiveness of face masks in reducing the transmission of COVID-19, which, in turn, predicted greater reported face mask wearing behavior in public. ♦



## CLIMATE EDUCATION

A University of Maine Climate Change Institute collaboration is strengthening climate education for youth in grades 5–12 in Maine. CCI faculty and staff have created the Climate Education Resources webpage to provide educators with a variety of informative materials in one place. The resources are grouped within five themes — Climate Synthesis & Overview, Climate Data Tools, Simple Climate Models, Video and Virtual Library and What's Happening in Maine?

The numerous resources include: videos of research excursions on Everest and in Antarctica and Greenland; an Ice Age Trail Map and Guide; a list of 10 reasons why climate change matters; descriptions of how and why ice cores are collected; the Climate Reanalyzer, which details weather conditions worldwide as well as changes in climate through time; a talk by CCI director Paul Mayewski titled "Climate Change: Scientific Evidence or Alternative Facts"; a link to the Maine Climate and Agriculture Network website that examines projected changes in growing seasons and storm intensity; and the Maine's Climate Future 2020 Update, which contains information about the state's changing climate, impacts on natural resources, adaptation measures, and possible future implications

Mayewski and colleagues began working on the project in response to a Maine Department of Education (DOE) request. Those colleagues are Sean Birkel, research assistant professor and Maine State Climatologist; Daniel Dixon, research assistant professor; Ivan Fernandez, professor; Katie Glover, research associate; Bjorn Grigholm, research assistant professor; Cynthia Isenhour, associate professor; Karl Kreutz, professor; Betty Lee, CCI assistant director; Kirk Maasch, professor; and Molly Schauffler, assistant research professor.

The DOE's outreach includes a request for input about increased climate and career education in response to the state's adoption of Next Generation Science Standards (NGSS) and the Maine Climate Council's Four-Year Plan for Climate Action. NGSS identifies scientific and engineering practices, crosscutting concepts, and core ideas in science that K–12 students should master to prepare for success in college and 21st-century careers.

The Maine Climate Council's four-year plan for climate action calls for increasing public education about climate change, and enhancing educational opportunities for climate science and clean energy careers. ♦

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We hope our effort makes it easier for students to explore why and how climate is changing, **and what the changing climate means in their lives and in Maine communities.**”

Molly Schauffler

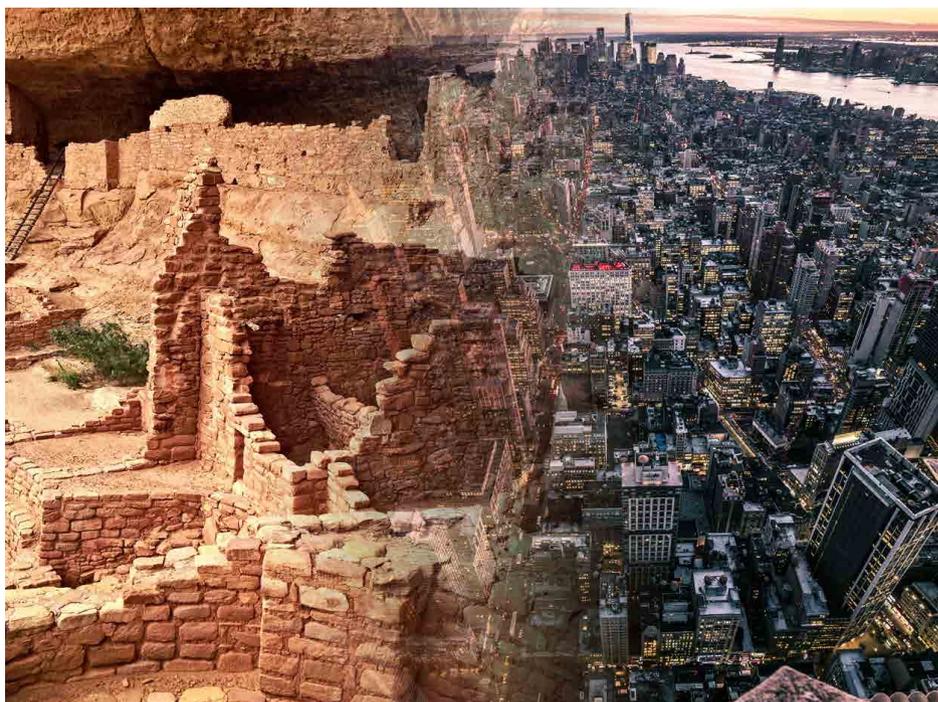
## WABANAKI RESOURCES

The National Endowment for the Humanities has awarded a grant of more than \$59,000 to the University of Maine's McGillicuddy Humanities Center to support development of a centralized digital portal that will improve access to Wabanaki historical and cultural resources and archival collections currently distributed across UMaine and, in the future, to incorporate collections curated by several external institutions.

UMaine professor of English Margo Lukens, a faculty adviser to the McGillicuddy Humanities Center, will lead the interdisciplinary Wabanaki Resources Portal project, which seeks to enhance utilization of existing resources to promote the study of Wabanaki history and culture at the elementary, high school and post-secondary levels in Maine, and to facilitate interdisciplinary academic and arts scholarship.

UMaine's archival holdings related to Wabanaki history and culture are extensive, and include the collection of Fannie Hardy Eckstorm, an early 20<sup>th</sup>-century independent scholar of Wabanaki history and culture; the Molly Spotted Elk Collection, which provides a Penobscot view of the United States and Europe; the Linda Gilbert Collection of Penobscot Indian Music featuring original audio recordings about traditional song and dance; and the Maine Indian Collection, one of the largest institutional collections of Wabanaki baskets and basketmaking materials and tools, which is curated by the Hudson Museum. The museum also maintains a collection of significant primary resources, particularly historic images and documentary film footage portraying traditional Wabanaki activities such as basketmaking and harvesting.

Other Wabanaki artifacts stewarded by UMaine include photographs of Passamaquoddy and Penobscot people, characteristic objects from the 1880s through today, and the Senator William S. Cohen papers related to the Maine Indian Land Claims Settlement Act of 1980. Fogler Library also maintains copies of recordings of Wabanaki speech and stories now in the Library of Congress collection. ♦



## Culture vs. genetics

In a new study, University of Maine researchers found that culture helps humans adapt to their environment and overcome challenges better and faster than genetics.

After conducting an extensive review of the literature and evidence of long-term human evolution, scientists Tim Waring, an associate professor of social-ecological systems modeling, and Zach Wood, a postdoctoral research associate with the School of Biology and Ecology, concluded that humans are experiencing a “special evolutionary transition” in which the importance of culture, such as learned knowledge, practices and skills, is surpassing the value of genes as the primary driver of human evolution.

Culture is an under-appreciated factor in human evolution, Waring says. Like genes, culture helps people adjust to their environment and meet the challenges of survival and reproduction. Culture, however, does so more effectively than genes because the transfer of knowledge is faster and more flexible than the inheritance of genes, according to Waring and Wood.

Culture is a stronger mechanism of adaptation for a couple of reasons, Waring says. It's faster: gene transfer occurs only once a generation, while cultural practices can be rapidly learned and frequently updated. Culture is also more flexible than genes: gene transfer is rigid and limited to the genetic information of two parents, while cultural transmission is based on flexible human learning and effectively unlimited with the ability to make use of information from peers and experts far beyond parents. As a result, cultural evolution provides a stronger type of adaptation than old genetics.

Culture has influenced how humans survive and evolve for millennia. According to Waring and Wood, the combination of both culture and genes has fueled several key adaptations in humans such as reduced aggression, cooperative inclinations, collaborative abilities and the capacity for social learning. Increasingly, the researchers suggest, human adaptations are steered by culture, and require genes to accommodate. Factors that have no genetic equivalent such as conformity, social identity and shared norms and institutions make cultural evolution very group-oriented. Therefore, competition between culturally organized groups propels adaptations such as new cooperative norms and social systems that help groups survive better together. ♦

Culturally organized groups appear to solve adaptive problems more readily than individuals.



## IMPORTANCE OF INDIGENOUS STEWARDSHIP

Darren Ranco says Indigenous peoples should be part of land use decisions, including whether to expand the quarantine zone for the emerald ash borer in northern Maine.

“When Indigenous people are on the land and making decisions about land management, biodiversity increases,” says the University of Maine associate professor of anthropology, chair of Native American Programs, and citizen of the Penobscot Nation.

An international study led by Erle Ellis, a professor at the University of Maryland, Baltimore County, agrees. It found that Indigenous peoples have shaped most of the Earth’s ecology for thousands of years. The main cause of the current biodiversity crisis is not human destruction of uninhabited wildlands, but rather the appropriation, colonization and use of lands previously sustainably managed.

Ranco and Jacquelyn Gill, a UMaine associate professor of paleoecology and plant ecology, and 15 other scientists worldwide joined Ellis to co-author the study, “People have shaped most of terrestrial nature for at least 12,000 years.” They examined the early and sustained global significance of cultural landscapes with a goal to better understand and conserve land, and the animals and plants that live on it.

In addition to its findings, the project demonstrates the power of big data, says Gill.

“The biodiversity crisis is global and tools like this are powerful, because they will help us meet the challenge at the scale of the problem,” she says. “We have an incredible opportunity to take this information and apply it to how we relate to land at the local scale going forward. Indigenous knowledge and stewardship should be central to conservation efforts. We can coexist with nature and wildlife.” ♦



## Predicting iceberg melting speeds

Research led by University of Maine glaciologist Kristin Schild to quantify and predict iceberg melting rates has been awarded NASA New (Early Career) Investigator Program (NIP) funding. Schild received one of 38 NASA NIP awards and is the first Maine-based researcher to receive the triennial recognition since 2003.

The assistant professor with the School of Earth and Climate Sciences and the Climate Change Institute will use her more than \$378,000 award to develop universal measuring strategies and a model for predicting how fast any iceberg would melt and discharge freshwater into the ocean. These tools support remote sensing and iceberg melt studies, and enhance how global-scale models forecast sea level rise and climate change as a result of glacial ice activity.

Freshwater flux, when freshwater enters the ocean, can accelerate sea level rise, and Greenland tidewater glacier contribution to sea level rise has more than doubled since the early 2000s. According to Schild, icebergs constitute about 50% of this glacier contribution. Icebergs also have been connected with prior abrupt climate events across the globe.

Freshwater flux from melting icebergs also has increased in recent years, affecting local climates, ecosystems and local-scale fjord circulation, and posing challenges to shipping and offshore installations, Schild says.

Currently, iceberg freshwater flux is not considered in coupled atmosphere-ocean global climate models (GCMs), which are crucial for establishing climate thresholds, or points at which increasing temperatures would alter climate systems. Schild’s project aims to fill this gap by designing global metrics and a predictive model to anticipate the rate at which freshwater enters the ocean from any melting iceberg. This information will provide scientists with a more comprehensive look at the effects of glacial ice and global warming by allowing GCMs to factor in the contributions of icebergs. ♦

“

This is such an exciting project that tackles one of the fundamental questions concerning the changing cryosphere: **where is this meltwater going and what is the impact?**”

Kristin Schild



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Betty Brown Calkins '50, '57G

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## SCORE!

For the first time in the history of the program, the 2021 University of Maine field hockey team captured the America East championship. The victory, a thrilling 2-1 overtime shootout win over the University of Albany, earned the Black Bears their first-ever trip to the NCAA Tournament. Photo by Seth Poplaski