UMaine Today

CREATIVITY AND ACHIEVEMENT AT THE UNIVERSITY OF MAINE

FALL/WINTER 2015

Vigil in the Pine Tree State

Will the spruce budworm decimate millions of acres again?


1865
THE UNIVERSITY OF
MAINE

OUR YEARLONG celebration of the University of Maine's 150th anniversary is drawing to a close — a statewide affirmation of the legacy and ongoing leadership role of the land and sea grant university. Anniversary events this fall included Open University Day, featuring tours, demonstrations and performances in 29 campus venues, held in conjunction with one of our biggest Homecoming and Family and Friends Weekends in UMaine history. It was a great way to celebrate the state's flagship university and its mission of teaching, research, economic development and public service throughout Maine and beyond.

Earlier this fall, we welcomed an impressive group of new faculty members, including a Guggenheim Fellow and two world-class researchers who are recipients of new named professorships. Our new faculty speak to the caliber of educators and scholars this university attracts. And they told us they came to UMaine because of its outstanding reputation, because it is a place to do great science, and because of our commitment to collaborative research and teaching.

That commitment to teaching, research and hands-on experience is the UMaine difference that also resonates with students, including our incoming class. For the third consecutive year, the number of new first-year students exceeded 2,000. In-state students and an increasing number of out-of-state students come to UMaine because it offers so many opportunities to define tomorrow.

The university's distinctiveness is grounded in its role as Maine's partner. In that model for the future, all members of the University of Maine community actively contribute, including undergraduate and graduate students working in collaboration with faculty, connecting with businesses, schools, communities, nonprofits and local governments. This issue of *UMaine Today* magazine offers profiles of that UMaine difference.

Susan J. Hunter
President

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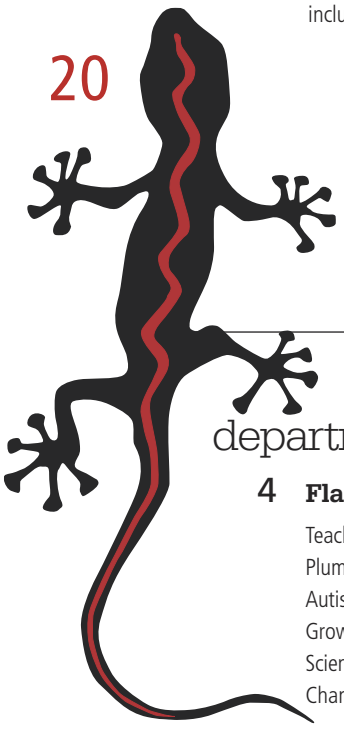

departments

ON THE COVER: The last eastern spruce budworm outbreak in Maine lasted from 1970–85, destroying 21 percent of all the fir trees, costing the state's forest-based economy hundreds of millions of dollars and leaving lasting effects on forest management in the Pine Tree State. With a new spruce budworm outbreak now decimating millions of acres in southern Quebec and expected to reach Maine in the next two years, the Maine Forest Service, Maine Forest Products Council and the University of Maine have developed a disaster preparedness plan. See story on page 10.

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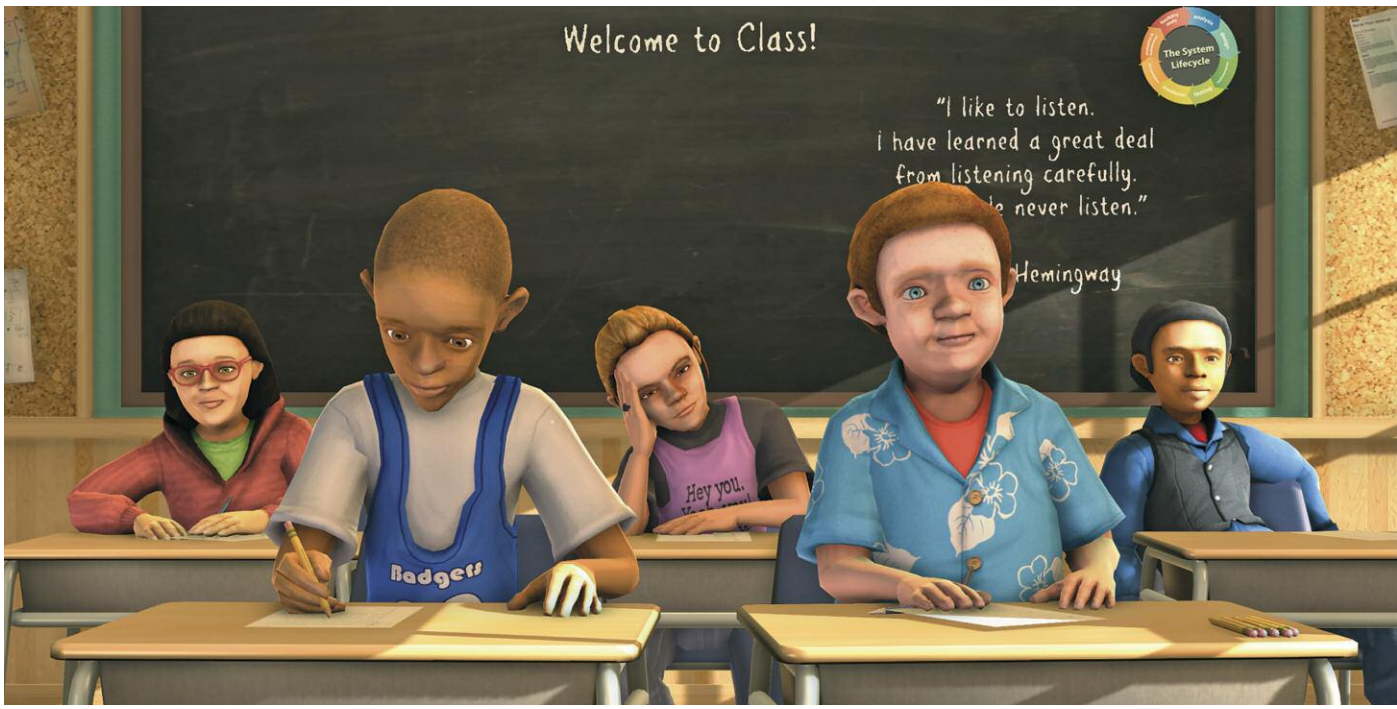


TeachLivE image courtesy of Mursion Inc.

Teaching avatars

THE TeachLivE lab in Shibles Hall consists of a large display with a computer used to interact with the TeachLivE engineers who run the simulations. A camera and microphone connect the educator to the interactor, or actor, who portrays the voices and mannerisms of the avatars who have distinct personalities and behaviors, as well as a range of compliance levels. The program also has an adult avatar for parent-teacher conference simulations. TeachLivE engineers and interactors are given lesson plans and educational objectives before each simulation for a tailored learning experience. The simulations can be "paused" and "rewound" to allow for feedback and a chance to try different techniques. Research with TeachLivE has found that as little as three, 10-minute sessions can change teaching behaviors.

EDUCATION MAJORS at the University of Maine have the opportunity to teach in front of a virtual classroom of avatars in preparation for student teaching in area schools. The new lab enables students in UMaine's College of Education and Human Development to teach five avatars controlled by professional technicians and actors in a classroom simulation, allowing them to better hone their skills and become more confident teachers.

TeachLivE is a mixed-reality environment that supports teacher practice in classroom management, methods and content. It provides preservice and in-service teachers the opportunity to learn new skills without placing students at risk during the learning process. The program, launched in 2011, was developed by education and computer science faculty at the University of Central Florida with funding from the Bill & Melinda Gates Foundation.

UMaine's TeachLivE Lab, opened in September, is being used in two undergraduate and three graduate courses this fall. The college plans to expand the lab's use in the coming semesters, and will hold open houses, visits and meetings for those who want to learn more about the simulation's potential. Susan Gardner, interim dean of the College of Education and Human Development, says the low-risk environment provides a safe space to make errors and learn. UMaine is one of an estimated 75 educational sites nationwide using TeachLivE. ■

Plum assignment

> By the time apple season rolls around, the tourists have left. **Plums are ready during the peak tourist season."**
>
> Angela Myracle

UNIVERSITY OF Maine researchers are working to bring locally grown plums to farm stands around the state. The two-year project — funded by the Maine Department of Agriculture, Conservation and Forestry — is identifying suitable plum varieties for Maine's climate that would help diversify the state's apple farms. The project is a joint collaboration between Angela Myracle, a phytochemist and nutritional biochemist at UMaine, and Renae Moran, a tree fruit specialist with UMaine Cooperative Extension.

Moran is collecting yield measurements, assessing the plum trees and evaluating the economic feasibility of growing plums in Maine. She got involved with plum research after farmers began to show interest in growing another fruit crop in addition to apples.

Plums are the perfect candidate. This summer, the team harvested plum varieties — grown at Highmoor Farm in Monmouth — for sensory testing, to allow the researchers to see how consumers perceive the fruit based on appearance, taste and texture. The last testing had approximately 100 participants. Leading the sensory testing is Zakkary Castonguay, a master's student in food science and human nutrition. Castonguay's research project is focused on the consumer acceptability and phytonutrient assessment of locally grown Maine plums. He is measuring the bioactive constituents found in plums to determine if local, tree-ripened plums have greater health benefits. ■

THE MAJORITY of plums in Maine are harvested unripe and shipped long distances, compromising quality. Growing plums in Maine could bring in extra income for farmers, as well as decrease transportation costs by selling the fruit locally, says Angela Myracle. The project could help farmers diversify their farms with fruit harvested during peak tourist season.

Autism advocacy

Photo courtesy of Felicia Kasprzak

A YEARLONG collaboration between a group of parents and the Maine Autism Institute for Education and Research has culminated in the three-volume *Maine Parent Guide to Autism Spectrum Disorders.* The series is available online and in print this fall. It is designed to help families and others learn more about autism and how to access educational and social services in Maine — from the first question, "Does my child have autism?" and steps for obtaining assessments to the transition from high school to adult services statewide.

THE MAINE Autism Institute for Education and Research (MAIER), recently was awarded more than $150,000 from the Maine Department of Education (DOE) to advance its work as the state's first autism institute. The funds are in addition to the $209,802 the department and UMaine's College of Education and Human Development contributed to open the institute in January 2014.

The collaborative partnership between Maine DOE and the college was formed to create a statewide system of supports for Mainers who serve children with autism and their families. The new funding will further the institute's initial efforts to build statewide capacity to improve outcomes for young Mainers with autism.

The institute serves as the state's primary source of education and training related to evidence-based practices for professionals working with children and families with autism spectrum disorders, and for undergraduate and graduate students aspiring to serve children, families, schools and community service providers. For families seeking assistance, the institute offers services, resources and information; support and guidance; and tools to contribute to awareness.

In its first 16 months, the institute has supported hundreds of professionals who work with children with autism and their families. To date, 28 Maine Autism Leader Teams have been established in the state, and 14 new teams will receive advanced training this academic year. ■

About **9 percent,** or 2,776, of the identified children with disabilities in Maine K–12 public schools have been **diagnosed with autism.** Maine Department of Education

Growing organic

ELLEN MALLORY'S research will focus on optimizing green manure systems for organic grain production by evaluating legume species and legume/grass mixtures for their ability to produce nitrogen to support the growth of grain crops. UMaine collaborators include weed ecologist Eric Gallandt, who will focus on weed management, and economist Aaron Hoshide, who will concentrate on rotation budgeting tools.

RESEARCHERS AT the University of Maine have received a $1 million grant from the U.S. Department of Agriculture to continue their efforts in boosting organic grain production in northern New England. The award recognizes the impact of the work UMaine has done with farmers, millers and bakers with a prior grant to build a local, organic bread wheat economy in the region, says Ellen Mallory, University of Maine Cooperative Extension specialist and associate professor of sustainable agriculture.

The grant — which will be shared with researchers at the University of Vermont — will provide support to expand the local organic grain sector, including oats, barley, rye and spelt. The project is aimed to help farmers combat critical constraints in organic grain production by designing robust weed and disease management strategies, establishing efficient legume green manure systems and expanding social networks in their communities. The researchers will work to develop and evaluate sowing and hoeing equipment, and rotation budgeting tools to help farmers reduce production risks. ■

Science partners

THIS FALL, the Maine Elementary Sciences Partnership (MaineESP) received the 2015 Philip Marcoux Award from the Maine Science Teachers Association. The MaineESP is a partnership among the Maine Center for Research in STEM Education (RiSE Center) and more than 50 school districts. Together, the Maine Physical Sciences Partnership and the MaineESP promote research-guided science instruction, from early childhood through ninth grade, affecting the science learning of more than 20,000 students last year alone.

THE MAINE Physical Sciences Partnership (MainePSP) recently was awarded more than $2 million from the National Science Foundation (NSF) to continue advancing science education in Maine.

The award builds on the $12.3 million granted by NSF in 2010 to establish an infrastructure to strengthen rural science education throughout the state.

The MainePSP is a collaboration among the Maine Center for Research in STEM Education (RiSE Center) at the University of Maine, almost 30 school districts in the state, and nonprofit partners, including the Schoodic Institute and Maine Department of Education.

In the past five years, the MainePSP has established an innovative partnership between university faculty and preK–12 science teachers, creating a diverse learning community of educators discussing and demonstrating best practices in science education — from preschool to graduate school.

Because of the proven effect of the partnership on teaching and learning in science, the MainePSP will focus on strengthening recruitment, preparation and retention of science, technology, engineering and mathematics (STEM) teachers. Experienced classroom teachers will be involved in teacher preparation, bridging the gap between theory and practice. ■

Change champion

HABIB DAGHER, founding director of the University of Maine Advanced Structures and Composites Center, was recognized as a 2015 White House Transportation Champion of Change on Oct. 13.

The White House Champions of Change event in Washington, D.C., focused on "Innovators in Transportation for the Future," and was hosted by the U.S. Department of Transportation and the White House Office of Public Engagement. U.S. Secretary of Transportation Anthony Foxx recognized 11 of the nation's top innovators for their exemplary leadership in advancing and leading change that benefits the nation's transportation system.

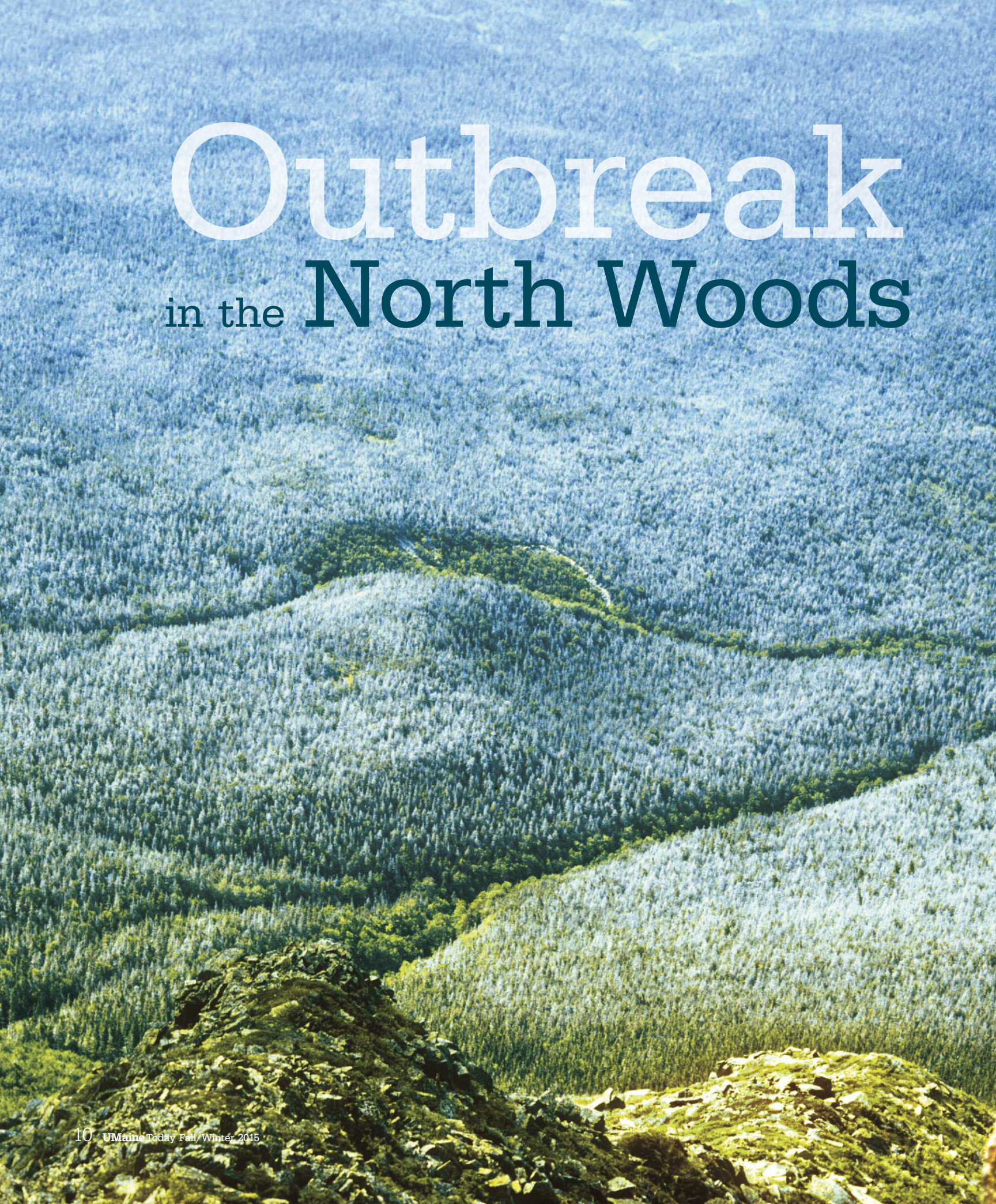
Dagher is the primary inventor of the award-winning Composite Arch Bridge System known as Bridge-in-a-Backpack™. His history of innovation includes being named on 24 patents, with eight more pending.

The American Society of Civil Engineers nominated Dagher as a White House Transportation Champion of Change, noting that the composite arch bridge technology developed at UMaine is "a wonderful example of knowledge transfer to the private sector and a valuable innovation to the transportation industry." ■

THE LIGHTWEIGHT, corrosion-resistant Composite Arch Bridge System is for short- to medium-span bridge construction. It uses FRP composite arch tubes that start out flat, packed in a bag. The tubes are inflated and bent to any curvature over a mold and infused with a resin. The tubes cure in three hours, resulting in a curved hollow arch twice as strong as steel, which is then filled with concrete on site. Prior to placing the concrete, a 60-foot span arch can be lifted into place by two people. The FRP tubes provide exoskeleton reinforcement, formwork and a protective layer for the concrete. The patented bridge technology saves both time and money, reduces the carbon footprint of the bridge by 30 percent compared to current technologies, and provides for up to a 100-year life.

> "The University of Maine continues to prove that it is a **first-class research institution,** and Dr. Dagher and his team at the Composites Center are **exemplary of that excellence."**
>
> Sens. Susan Collins and Angus King

Outbreak in the North Woods



UMaine and its partners undertake disaster preparedness in advance of the next spruce budworm infestation

By Elyse Kahl

MAINE'S MOUNT Katahdin is known for its challenging trails with rewarding, breathtaking views. On a clear summer day at Baxter Peak, the most northern point of the Appalachian Trail, hikers can take in all the natural beauty Maine has to offer — a green canopy dotted with cool, blue bodies of water as far as the eye can see.

In the late 1970s and early '80s, that same view was a sea of gray, decimated by a relentless killer — the spruce budworm.

The eastern spruce budworm is believed to be the most damaging forest insect in Maine and North America. Outbreaks of the insect that kills balsam fir and spruce trees occur every 30 to 60 years.

And another one could be heading for Maine.

During the last outbreak, which lasted from 1970–85, the insect decimated up to 25 million cords of spruce-fir wood — 21 percent of all fir trees in the state, according to the Maine Forest Products Council. The infestation cost the state's forest-based economy hundreds of millions of dollars and had lasting effects on Maine forest management.

Already severely damaging an area the size of Maine in southern Quebec, the spruce budworm is on track to begin defoliating trees in the Pine Tree State in the coming years.

In advance of the outbreak, the University of Maine has partnered with the Maine Forest Service and Maine Forest Products Council to form a Maine Spruce Budworm Task Force to keep forest landowners and government officials informed about the insect and aspects of Maine's forest resources that would be affected by the next outbreak. The team also has created a disaster preparedness plan.

"Coming Spruce Budworm Outbreak: Initial Risk Assessment and Preparation

In 1980, Maine's North Woods was a sea of gray, the result of a spruce budworm infestation that decimated millions of acres. This color photograph taken from the Knife Edge Trail on Mount Katahdin in 1980 shows the large area of trees killed by spruce budworm. Photo courtesy of David Field

& Response Recommendations for Maine's Forestry Community" was released for public review in November 2014. The document was led by Maine Spruce Budworm Task Force leaders Robert Wagner, director of the Cooperative Forestry Research Unit (CFRU) at UMaine; Patrick Strauch, executive director of the Maine Forest Products Council; and Doug Denico, director of the Maine Forest Service.

The report includes an assessment of the last outbreak and how to prepare for the coming flare-up using research and information from experts and landowners.

"Research since the last outbreak has contributed a lot to what we know today," Wagner says. "What the budworm gave us last time is a better ability to respond this time."

THE SPRUCE budworm is the immature stage of a gray-brown moth native to the northeastern United States and Canada. Numbers of the insect are often too low to detect, but every 30–60 years, the population explodes.

The exact mix of factors driving the insect's episodic cycle in this part of its range are not known, Wagner says, but they include climatic conditions, other insects that feed on the budworm and availability of susceptible trees.

In Maine, the spruce budworm feeds primarily on the needles of balsam fir and white spruce, but also attacks black and red spruce, larch and hemlock, according to the Maine Forest Service. Heavily infested stands appear red in July due to dead needles on the branches. After several years of heavy feeding and two or three rounds of defoliation, the trees die.

The current outbreak has caused severe defoliation to about 15 million acres of spruce-fir forest in Quebec, according to the task force report. Northern Maine insect traps have captured increasing numbers of spruce budworm moths in the past several years, and defoliation of spruce-fir stands is approaching Maine's northern border, the report states.

"It's like having a hurricane moving toward us from offshore," says Wagner, the Henry W. Saunders Distinguished Professor in Forestry in UMaine's School of Forest Resources. "We know it is there, how it behaves, and the kind of damage it can do. We can hope that it misses us, but if we don't prepare for the worst — shame on us."

AT LEAST six serious outbreaks have been recorded in 1770, 1806, 1878, 1910, 1949 and 1970–85, according to the Maine Forest Service. The 1910 outbreak devastated forests, but few people were living in the state, and the timber economy was small, Wagner says. Maine largely dodged a smaller outbreak during World War II in the 1940s and '50s, which hit New Brunswick and prompted the use of DDT.

In the 1970–85 outbreak, spruce-fir was king in Maine's forests, Wagner says. It was the primary feedstock for the

Spruce budworm **life cycle**

The spruce budworm is the immature stage of a gray-brown moth. It's at this stage in the life cycle that the insect feeds on tree needles.

In mid- to late-June, the larvae become pupae, and adult moths emerge about 10 to 14 days later.

Source: Trees, insects and diseases of Canada's Forests, Spruce budworm fact sheets. Photo reproduced with the permission of the Minister of Natural Resources Canada, 2015.

state's mills, with up to 70 percent of paper and solid wood products coming from spruce and fir. Concern grew with the loss of timber and the effect it would have on the future wood supply — and mills.

UMaine's forestry department, established in 1903, has been through three spruce budworm cycles. Now a fourth is on the horizon. Many forestry students who graduated during the last outbreak built their careers on the effects of the budworm — from trying to control it to dealing with its aftermath.

John Bryant, regional manager for American Forest Management in Milford, Maine, earned a bachelor's degree in forest utilization from the university in 1977. Early in his career, he learned how to manage a crisis and restore a healthy forest after a devastating insect infestation.

"I was a very young forester fresh out of college," Bryant says. "The spruce budworm was feeding on red spruce, balsam fir and eastern hemlock trees, creating high levels of foliage damage and tree mortality. I vividly recall the brown and gray tops of trees, which were supposed to be green. And, the never-ending insects dropping from the trees, looking for more trees to eat."

UMaine was viewed as a critical partner in helping the forest products industry cope with the last outbreak. In 1975, Fred Knight, former director of UMaine's School of Forest Resources, established an industry-university cooperative to allow companies to pool resources and work together to solve problems through research.

"The budworm gave us the CFRU, which is a model of stakeholder-driven research with the people who own and manage the forest," Wagner says.

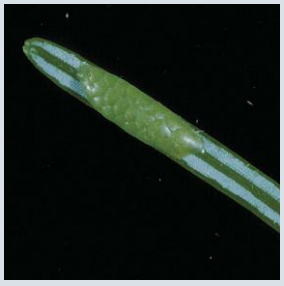
AS PART of the cooperative, landowners — mostly large pulp and paper companies at the time — became part of a committee that strategized about UMaine research that would be most beneficial in the North Woods.

"The spruce budworm defined everything the CFRU did in the '70s, and as we went into the '80s, the budworm defined the forest. The cooperative's research agenda evolved along with the forest," Wagner says, noting that the group's concerns changed from how to control the insect and understand its effects to managing the decimated forest.

CFRU's focus on how to rapidly regenerate forests after the outbreak gave rise to research on vegetation management and seedling quality. Many of CFRU's early studies led to some of the first herbicide research to control competing vegetation in the country, according to Wagner.

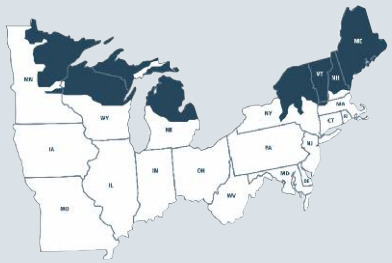
The research led to successful, widespread herbicide use in the 1980s and '90s to regenerate the damaged forests. By the 1980s and '90s, CFRU researchers began studying

- The adult moths have black and white markings.



- In late July, the female moths lay eggs — about 200 — on the underside of fir or spruce needles.
- In the spring, the larvae emerge to feed on opening buds and developing foliage for about five weeks.

- In Maine, the spruce budworm feeds primarily on the needles of balsam fir and white spruce, but also attacks black and red spruce, larch and hemlock.
- Heavily infested stands appear red in July due to dead needles on the branches.



- The insect severely affects Canadian forests from the Yukon to Newfoundland. During major outbreaks, infestations will extend southward into Maine, Vermont, New Hampshire and New York, as well as northern Michigan, Minnesota and Wisconsin.
- Numbers of the insect are often too low to detect, but every 30–60 years, the population explodes.

Information from the Maine Forest Service and CFRU.

Photos reproduced with permission from the Maine Forest Service and the Natural Resources Canada, Canadian Forest Service, 2015.

the budworm's effects on wildlife and biodiversity as environmental concerns gained public attention.

The forest recovered and researchers turned their attention to vegetation management. Stands responded and were soon overstocked with spruce and fir. Research then switched to best practices in precommercial thinning.

There was a great deal of political pressure in the '80s and '90s about clear-cutting that resulted from harvesting trees killed by the spruce budworm, Wagner says, and the public controversy eventually led to the Forest Practices Act in 1989 to regulate clear-cutting. The act has gone on to define how much of the forest looks and is harvested today.

By the late '90s, the precommercial thinning had dissipated and the first stands became merchantable, Wagner says. In the new millenium, CFRU was helping landowners better understand commercial thinning, as well as researching the effects of forest management practices in the post-budworm forest on wildlife, including Canada lynx, moose, deer, songbirds and the northern long-eared bat.

"All those clear-cuts that created the controversy grew back into new forests that the forest products industry relies on today. Many of these stands are being commercially thinned now," he says.

During the last outbreak, which lasted from **1970 until 1985,** the insect decimated up to **25 million cords** of spruce-fir wood — **21 percent** of all fir trees in the state.

Without a forest management response, the annual economic impact of the upcoming outbreak could reach **$794 million.**

CFRU HAS a responsibility to help landowners deal with the coming outbreak and conduct new research, Wagner says.

"What makes me feel good about what we're doing is that we have been having this conversation about the budworm for more than a year and we're still two or more years away from having the first defoliated trees," he says.

The long time span between outbreaks creates new challenges whenever the insect returns in full force.

"Every time the budworm comes back, there's been enough evolution in the way people are using and managing the forest that it becomes a new event. A lot of the things we did last time are not relevant or aren't acceptable based on today's standards," Wagner says, citing the heavy insecticide spraying and government funding used in the 1970s and '80s.

The current outbreak in Quebec started in 2008 and has grown to affect more than 15 million acres in Canada, which is almost the same size as the state of Maine, Wagner says. The epicenter of the outbreak features moth flights so large they can be picked up by doppler radar. Moth flights toward Maine have already been seen on radar — technology that is helping researchers track and better understand these events.

The Maine Forest Service is monitoring pheromone traps to determine the change in moth populations around the state. Officials in New Brunswick also are using traps and comparing data with Maine. In 2010, New Brunswick began to see an increase in moth catches; two years later, Maine saw an increase, Wagner says.

"It's an interesting phenomenon because there are native budworms in our forest, and the big question is: How much of the outbreak happens from the resident budworm populations exploding or from these waves of immigration?" Wagner says, adding that this is the first outbreak where technology exists to help answer that question, and a lot of research, particularly from the Canadian Forest Service, is looking at understanding some of the biological questions.

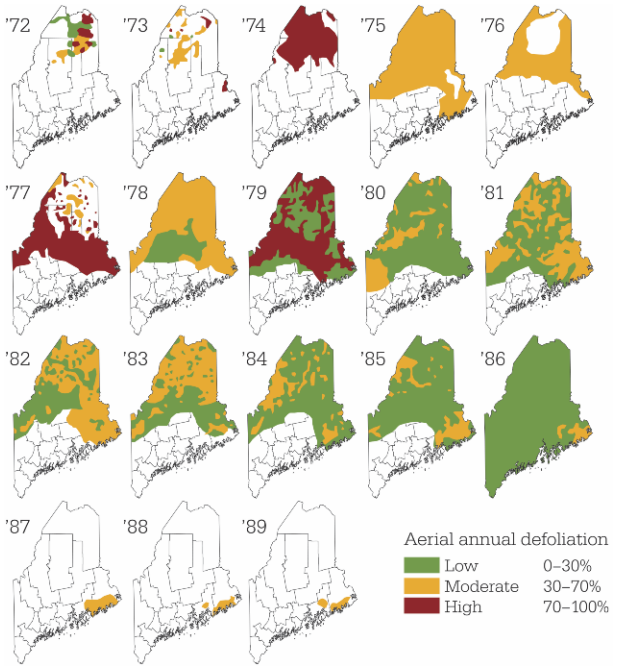
Pheromone trap sampling, which can be done by anyone and tracked using a mobile app, is an important part of the monitoring process. During the last outbreak, the idea of an early intervention strategy, or EIS, was born and monitoring is an essential part of the plan.

In 2014, the Canadian government awarded $18 million

The current outbreak has severely defoliated about **15 million acres** of spruce-fir forest in Quebec. Up to **5.8 million acres** could be affected in Maine.

A severe outbreak could result in **1,196 jobs lost** annually in the forest products sector.

Sources: CFRU, Maine Forest Service and Maine Forest Products Council



to explore an EIS, according to Canada Economic Development. Maine officials are working with their Canadian counterparts on the strategy being led in New Brunswick, Wagner says. In the 1970s, a similar Canadian-U.S. partnership was formed to focus on the budworm and other insects.

As the outbreak moves from Quebec into New Brunswick, Canadians are using traps to identify hot spots where populations are rapidly exploding. As part of the EIS, they are conducting insecticide treatments in small areas in hopes of suppressing the population explosion, according to Wagner.

He says there are several successful examples where intensive monitoring and small-scale insecticide applications were used to suppress the population of insects, such as the gypsy moth, to keep major outbreaks from starting.

"We think what happens is populations build to the point where they explode, and once they hit that threshold, there's nothing you can do to deal with it, and that's what happened in the '70s outbreak," Wagner says, adding that the monitoring efforts and biological understanding of the outbreak were unsophisticated by today's standards.

EVEN WITH technological advances, there is no way to predict how the coming outbreak will compare to the last.

"It could be like the '40s and be a little blip; not a big deal. Or we could see a wave that is almost as serious as the one that happened in the '70s. It's unclear," Wagner says. "The one thing that is clear is that the outbreak in Quebec is quite serious. The center of that outbreak is as bad as it was in the '70s. How badly, severely and broadly that moves out of that epicenter, nobody really knows."

Bryant says he thinks the outbreak will be less intense than the last.

"We will experience tree damage, but not to the extent of the last outbreak," he predicts. "The forest is more diverse, fragmented, younger and healthier. We have more sophisticated tools to monitor, respond and access areas of high spruce budworm populations."

Large landowners in northern Maine are likely to have some of the first properties in the state affected by the insect in 2016 or 2017. To prepare, they are looking into early intervention strategies that allow for treatments using aerial insecticides, according to Wagner.

The biological insecticides used today target the spruce budworm family and are unlike the broad-spectrum chemical insecticides that were used in the last outbreak. The bacterial insecticide *Bacillus thuringiensis* (Bt) is one of the only insecticides registered for organic farms.

New Brunswick, which just completed its second year of targeted insecticide application as part of its EIS, has seen its first defoliated trees this year, Wagner says. That means defoliated trees in Maine are likely in about two years.

"Mainers should understand what's going on in their forest," he says. "Balsam fir forests around them may turn red and gray. It will change the scenery, it will affect the aesthetics of the forest and it could become a fire hazard."

Wagner says residents, not just large landowners, should be concerned about the outbreak's effect on the sustainable wood supply for northern Maine's forest-based economy. Less wood to harvest could affect jobs, as well as have secondary economic effects in the community, including the Christmas tree and wreath industries, he says.

As CFRU director, Wagner often speaks with the directors of the Maine Forest Service and the Maine Forest Products Council, a political advocacy organization for the forest industry. The Maine Forest Service has a legislative responsibility to address forest health, and the Maine Forest Products Council represents the mills and landowners that will be affected by the outbreak.

"We knew we needed to get the parties that are going to have some kind of direct responsibility working together ahead of the outbreak, because we know from the last outbreak that when it starts, it can start very quickly," Wagner says. "It's like planning for a fire. You can't do it while a fire is starting. You have to be ready to go because it happens so fast."

LED BY UMaine, the Spruce Budworm Task Force formed in 2013 to determine what economic and ecological effects an outbreak might have on the state, and what can be done to minimize those effects. The task force was divided into teams to look into specific areas. The teams brought together about 65 experts to contribute to the nearly 90-page assessment and preparation plan that focuses on wood supply and economic impacts; monitoring and protection; forest management; policy, regulatory and funding; wildlife habitat; communications and outreach; and research priorities.

Many of the senior foresters who contributed, including Bryant, were UMaine graduates whose careers were defined by the budworm, Wagner says.

Mainers should understand what's going on in their forest. **Balsam fir forests** around them **may turn red or gray.** It will **change the scenery,** it will **affect the aesthetics** of the forest and it **could become a fire hazard."** Robert Wagner

"It's a useful way for us to bring that historical voice," Wagner says. "Many of our newly graduating forestry students will likely have their early career experiences formed by the next budworm outbreak, too."

Creating the plan got forest landowners, mills, the government and university researchers talking with each other, Wagner says.

The beginning of the report is an assessment that includes original research conducted by CFRU, starting five years ago. Research includes a wood supply impact analysis conducted by CFRU, as well as an economic analysis conducted by UMaine economist Todd Gabe for the Maine Forest Products Council's 2013 Maine's Forest Economy report.

"We learned from the last outbreak that the budworm was a sociopolitical event," Wagner says. "It's not enough to have the government and landowners on the same page. We really need to get to the environmental groups in the state, the municipalities, the policymakers, the people who live in rural communities, the people that have camps in northern Maine."

A draft of the report was released in November 2014. Task team leaders have presented the report to municipalities, environmental groups, the legislature, logging contractors and economic development consortiums. The task force report includes about 70 recommendations, several of which have already been implemented.

Wagner is now assembling the final report.

"We have a preparation plan. We're waiting for this outbreak to unfold in the state. We've got a lot of the pieces

in place and it will evolve," Wagner says. "The report is not meant to be a blueprint for the future. A successful response will rely on good adaptive management."

BRYANT SAYS he thinks Maine is more prepared for this outbreak because the state is already monitoring the insect's movement, the forest is more accessible due to improved road systems, and foresters better understand the need to preempt the damage caused by the budworm.

The report's recommendations on preparing for the outbreak include increasing monitoring efforts, judiciously applying insecticides where needed, changing forest management strategies such as harvesting, and seeking markets for presalvage trees that likely would be lost.

"The key message: Don't wait for the outbreak to properly manage the forest," says Bryant, who led the forest management task team and was charged with developing guidelines for foresters to use in preparation for — and in response to — the coming outbreak.

A major concern for environmentalists is the use of insecticides and the effects on wildlife, which wasn't as big of a worry 40 years ago. The question over who will pay for insecticide spraying — landowners or the government — already has started because of the report, Wagner says. The state and federal governments, which don't have the available funds they did in the '70s, have said if landowners want to treat their forests, it will be their responsibility. That gives landowners time to plan, which would not have happened if the conversation began during the outbreak.

An environmental and economic matter raised in the report is deer wintering, particularly those areas where spruce and fir trees provide a thermal cover for deer to stay warm during the winter months. These areas are likely to be severely damaged by the budworm, Wagner says. It is important to have conversations now about who will be responsible for protecting these areas, he says.

The report also includes research recommendations to increase understanding of budworm biology, monitoring, control and management. Short- and midterm research will be needed early in the outbreak to help forest managers respond. Longer-term research will inform those managing the next outbreak, likely to occur around 2055. ■

How landowners can prepare

THE FOLLOWING is a partial list of recommendations from "Coming Spruce Budworm Outbreak: Initial Risk Assessment and Preparation & Response Recommendations for Maine's Forestry Community."

- Participate in monitoring efforts such as moth trap counting using pheromone.
- Map the location, condition and concentration of high-risk stands on forestlands.
- Stop precommercial and commercial thinning within three years of the outbreak in stands where balsam fir and white spruce make up more than 50 percent of the composition, or where red spruce will be greater than 50 percent of the post-thinned stand.
- Seek and encourage markets for low-value trees from presalvage and salvage operations.
- Adapt harvest activities before or as early as possible into the outbreak to reduce the area available in stands.
- Apply insecticide to protect foliage in high-risk and high-value stands that are not ready for harvest.
- Prepare action plans to salvage trees that would likely be lost through spruce budworm mortality.
- Track annual progress of the infestation by monitoring spruce budworm population levels and distribution.
- Regularly communicate with government agencies and other landowners to understand how the infestation is moving and to develop plans to minimize the effect.

Green insulation

Nadir Yildirim

Young entrepreneurs plan to introduce a new generation of recyclable, reusable foam products

IN 2014, two University of Maine graduates set out to replace petroleum-based thermal insulation products with more environmentally friendly and sustainable options.

Now, with support from several organizations, including the National Science Foundation (NSF) and Maine Technology Institute (MTI), the pair's Orono-based company has created a prototype for the first completely eco-friendly thermal insulation foam board.

Nadir Yildirim, a graduate of UMaine's innovation engineering program and a Ph.D. candidate in forest resources, and Alexander Chasse, a civil engineering alumnus, launched Revolution Research Inc. (RRI) to develop recyclable and reusable products using cellulose nanofibrils (CNFs).

"I believe RRI will open a new page in the insulation industry," says Yildirim, who has been working with advanced nanocomposites for more than seven years, and conducts his Ph.D. research at UMaine's Advanced Structures and Composites Center.

The company's focus is the creation and commercialization of thermal and acoustical insulation foam boards for use in the construction and packaging industries. One of the largest uses of energy is heating and cooling buildings, according to the researchers, which drives companies to search for products that improve insulation performance.

Foam board insulation products now on the market are produced from petroleum-based chemicals. RRI aims to use CNFs and green polymers to produce a thermal insulation board with a lower carbon footprint, as well as the necessary mechanical and thermal properties to meet market needs.

The researchers also hope to offer the board at a comparable price to current insulation products.

CNFs have the ability to reinforce weak materials, permitting new composite products. The raw material — cellulose — is abundant and obtainable from renewable sources, including plants and sea animals. Green polymers, which will be used by RRI, also are a readily available renewable resource, but are weak and brittle without CNF reinforcement.

"RRI's novel foam boards will not only be better for the environment than current petroleum-based products, but will also provide improved energy efficiency," says Yildirim of Mugla, Turkey, where he says it never snows, and heating, cooling and energy efficiency is not a concern.

When he moved to Maine in 2011 — the coldest place he has ever been — he realized the importance of thermal insulation.

"With a better thermal insulation, you can save the environment; you can save lots of money," he says, citing a lack of available eco-friendly thermal insulation alternatives. "We are planning to have the first 100 percent recyclable and reusable foam board on the market."

In June, NSF awarded RRI $224,996 for research and development.

In October, Yildirim received $40,000 from MTI — on top of a previous $5,000 award — to further develop the business. He was awarded a $15,000 Business Accelerator Grant to support commercialization and market research, as well as a $25,000 seed grant to buy equipment to research and develop a commercially viable product.

RRI also won first place in the 2015 UMaine Business Challenge.

NSF's Small Business Technology Transfer Phase I project funding will allow the company to rent space and buy equipment for a laboratory. Successful completion of the NSF project will provide the opportunity for Phase II, which would allow RRI to apply for a grant of up to $750,000.

In the next five years, Yildirim hopes the company will have a Maine-based production facility with about 30 employees. ■

Mysterious islanders

Red-backed salamanders reveal a new pocket of biodiversity in Maine

By Amanda Clark

WHEN EVOLUTIONARY biologist Michael Kinnison saw a photograph of a red-backed salamander taken by an ornithologist working on Maine's Petit Manan island — a 16-acre, rocky island with only one tree — his scientific mind began to question his eyes. Red-backed salamanders, he thought, weren't on Maine islands.

They can't swim.

"Salamanders are not animals you think of as inhabitants of marine islands in Maine," says Kinnison, professor of evolution at the University of Maine. "As a rule, salamanders and seawater just don't mix, and red-backed salamanders are the least aquatic of our Maine species."

Nearly all amphibians are unable to tolerate the concentrations of salt in seawater, but the challenges of open water are even greater for this particular forest-dwelling species.

Red-backed salamanders lack lungs and absorb oxygen through their skin — a physiological trait that makes them, oddly enough for an amphibian, susceptible to suffocating, even in freshwater. And unlike many other salamanders, the red-back doesn't have an aquatic larval stage.

So how did that salamander get there?

Kinnison discussed the peculiarity of the salamander sighting with his UMaine colleague Cynthia Loftin, unit leader for the U.S. Geological Survey Maine Cooperative Fish and Wildlife Research Unit, and an experienced herpetologist.

"I'm not sure if I said it out loud or not, but my response was along the lines of, 'Are you crazy? Salamanders on rocky, treeless, ocean islands?'" says Loftin.

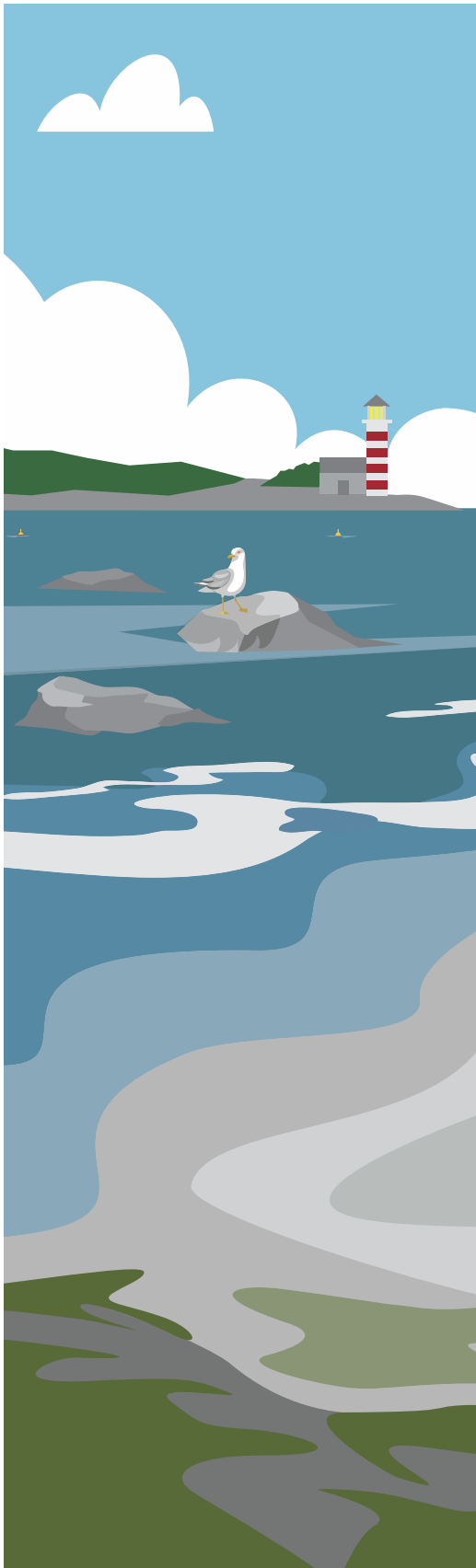


Illustration by Carol Nichols

But she was intrigued.

The researchers wanted to know if the red-backed salamander on Petit Manan had been introduced recently by chance or if it had a more ancient history. They also wanted to know if red-backs inhabited other coastal islands in Maine.

"When we started this project, we were looking at the records of what amphibians were found on Maine islands. Though the Maine Department of Inland Fisheries and Wildlife had a very good reptile and amphibian database, islands were fairly underrepresented," says Loftin.

THE TWO researchers wrote a grant proposal to the Maine Outdoor Heritage Fund, found a graduate student interested in the project and set out to solve the mystery.

For three years, Nikko-Ideen Shaidani, a UMaine graduate student in biology, sampled red-backed salamanders on islands off the coast of Maine to conduct population genetic analyses that could shed light on when and where the salamanders originated.

At the beginning of the project, the researchers considered a flood of explanations. The salamanders could have floated to islands in rotted logs. They could have been stowaways on European ships during early settlement.

One could have been dropped by a seabird. Or two or three or four.

Though many options seemed plausible, one hypothesis was especially intriguing: The salamanders might have walked there, before the islands were islands.

For this hypothesis, the investigators turned back the region's geologic clock 12,000 years when, following glacial retreat and rebound of the land, sea levels were approximately 60 meters lower than they are today, roughly equivalent to a 20-story building.

Then, like the way a rising tide wraps around a sand castle, the sea level began to gradually rise and submerge the coast of Maine, shattering it into the many islands we see today.

"If the island salamanders had been isolated for thousands of years, then those populations may have adapted to their island ecosystems and thus become unique pockets of genetic diversity," says Kinnison. "Identifying such unique components of diversity is especially valuable to resource managers and policymakers that prioritize populations and habitats for conservation."

But before Shaidani could identify potentially noteworthy populations of red-backed salamanders, he had to catch them. Which is easier said than done.

SHAIDANI'S RESEARCH sites were scattered across the coast of Maine — from the Isles of Shoals on the border of New Hampshire to Cross Island on the edge of New Brunswick, Canada.

Splitting the coast and islands into seven geographic domains, Shaidani surveyed as many as three island sites within each region, along with an adjacent mainland site.

His trips were planned on short notice and around nature's schedule, often dictated by the weather or the swing of the tides. Once on an island, he usually had a few hours to collect and measure salamanders before making a hasty retreat.

Shaidani coordinated transportation to his research sites on ferries, research vessels and fishing boats with the help of the U.S. Fish and Wildlife Service National Refuge System, National Park Service, Maine Department of Inland Fisheries and Wildlife, and others.

Due to the rocky coastline of many of the islands, the larger boats could only take him so far. The last legs of his trips were often spent paddling in a raft to the island, where he would climb the slippery shoreline to his research sites. Then his search for salamanders began.

"The feeling of arriving to a scenic island, exploring its unique landscape, and digging through the substrate in search of elusive salamanders is unlike any other," says Shaidani.

RED-BACKED salamanders thrive in forest ecosystems, swiftly moving among

rocks, fallen logs and leaf litter, eluding their many predators — mainly mammals, snakes and birds. They are an integral part of an ecosystem, providing food for their predators and consuming a smorgasbord of invertebrates.

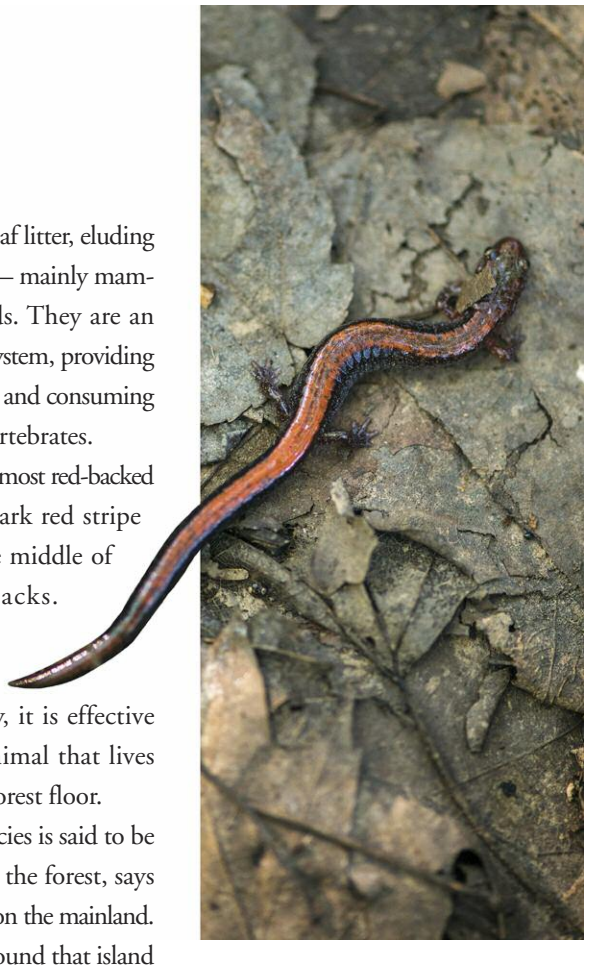
True to their name, most red-backed salamanders have a dark red stripe that streaks down the middle of their tiny black backs. Though the stripe makes them relatively easy to identify, it is effective camouflage for an animal that lives among debris of the forest floor.

This particular species is said to be the most abundant in the forest, says Loftin about red-backs on the mainland. And Shaidani's study found that island red-backs live up to that reputation.

Red-backed salamanders didn't just turn up on one island, or even a few islands. They turned up on almost every island Shaidani surveyed, and often in surprising numbers.

"It's mind-blowing to think that these salamanders could actually be the most abundant vertebrate on many of Maine's islands, and yet they were overlooked for all this time. Not to mention, unlike seabirds and other common inhabitants, red-backs live there year-round," says Kinnison.

ONCE SHAIDANI captured a salamander, he anesthetized it to take measurements, a tissue sample and photographs. For genetic analysis, he removed a few millimeters off the tip of each salamander's tail before releasing the animal back into the environment. This species of salamander can lose and regrow its tails to evade predators, making the location ideal for tissue sampling.



The salamanders could have **floated to the islands** in rotted logs or could have been **stowaways on European ships** during early settlement. One could have been **dropped by a seabird.** Or they might have **walked there.**

Over the three years, Shaidani sampled 604 salamanders and spent hundreds of hours in the field.

He used the tissue samples to conduct microsatellite DNA and trait-based assessments of divergence, comparing island populations to mainland populations and each other, to better understand their possible relationships, isolation, ecology and adaptations to island ecosystems.

His analyses are ongoing, but have yielded interesting initial results. Overall, his findings support general genetic differentiation occurring among island and mainland populations, as well as an interesting pattern among island populations.

"Salamanders from distant islands were found to have the greatest genetic divergence values," Shaidani says. "These island salamanders likely have been isolated for an extended period of time and may even represent glacial relics."

Glacial relics are species estimated to have originated from the time after the last glacial period, approximately 12,000 years ago.

Though further genetic analysis is needed, this pattern of divergence is consistent with distant islands being isolated earlier than near-shore islands when sea levels rose.

Thus, there is the possibility that salamanders might have been there already — or arrived soon thereafter.

"If what this analysis is showing is that there is a uniqueness between the islands, then that is important information for our natural resource managers to have because they can decide whether conserving these unique populations is important for the biodiversity of the state," says Loftin.

AMPHIBIANS FACE some of the greatest rates of local and global extinctions due to habitat loss, disease, pollution and invasive species interactions.

"Locations that support isolated and unique populations of one species have greater odds of supporting isolated and unique populations of other species, and so our work on red-backs might be indicative of broader repositories of biodiversity," says Kinnison.

At the same time, island systems often are more susceptible to species losses due to their isolation, small populations, limited gene pools and common enemies — diseases, predators and competitors.

According to the World Conservation Monitoring Centre, 75 percent of all documented animal extinctions since 1600 A.D. have been of island taxa, making island systems a priority for conservation and resource management. The researchers note that thwarting this trend may require that conservation efforts include more than threatened and rare species.

> It's mind-blowing to think that these salamanders could actually be **the most abundant vertebrate on many of Maine's islands,** and yet they were **overlooked for all this time.** Not to mention, unlike seabirds and other common inhabitants, **red-backs live there year-round."**
>
> Michael Kinnison

"Often people don't keep track of common species, and don't necessarily notice when populations are declining," says Loftin. "For this particular species, because it's so widely distributed, it's a good species to look at to address the particular question of isolation on islands."

Widely distributed and abundant animals like red-backed salamanders are often more effectively studied than sparsely distributed and rare species when it comes to identifying the role of landscapes — or seascapes — in producing pockets of biodiversity or detecting changes in abundance or geographic range.

However, these inferences often depend on having good baseline data on where such species exist today.

The researchers submitted their findings to the Maine Amphibian and Reptile Atlas Project (MARAP) to expand amphibian species records to encompass understudied island systems. MARAP, maintained by Inland Fisheries and Wildlife in cooperation with UMaine and the Maine Audubon Society, is a database of the state's 34 amphibian and reptile species. ■

Milestones

Alumnus on campus for two of UMaine's major anniversary celebrations

ALLAN ARCH, a 1965 University of Maine alumnus, was a student during the university's 100th anniversary. This fall, he returned to campus for his 50th reunion and experienced another UMaine milestone — the 150th anniversary celebration.

Arch, of Fort Lauderdale, Florida, graduated with a bachelor's degree in history. In addition to holding various fraternity offices, he belonged to several singing groups on campus, including Maine Steiners, UMaine's oldest a cappella group. Arch's most memorable UMaine moments were helping run the campus mayoral campaign for his Tau Kappa Epsilon fraternity brother, Sarge Means, and being in constitutional law class when he learned President John F. Kennedy was assassinated about a month after coming to campus and delivering what was to be his last major foreign policy speech.

When he graduated, Arch joined the Navy. He also met Susan, his wife of 47 years. In 1968, he began his career with the family business, Southern Gear & Machine, Inc., an employee-owned company in Miami that manufactures open custom gearing. He continues to work at Southern Gear and has been involved with the College of Engineering ever since his company donated to UMaine's Machine Shop.

"To get benefits from my UMaine education 50 years later simply is remarkable and appreciated," he says. ■

Susan and Allan Arch

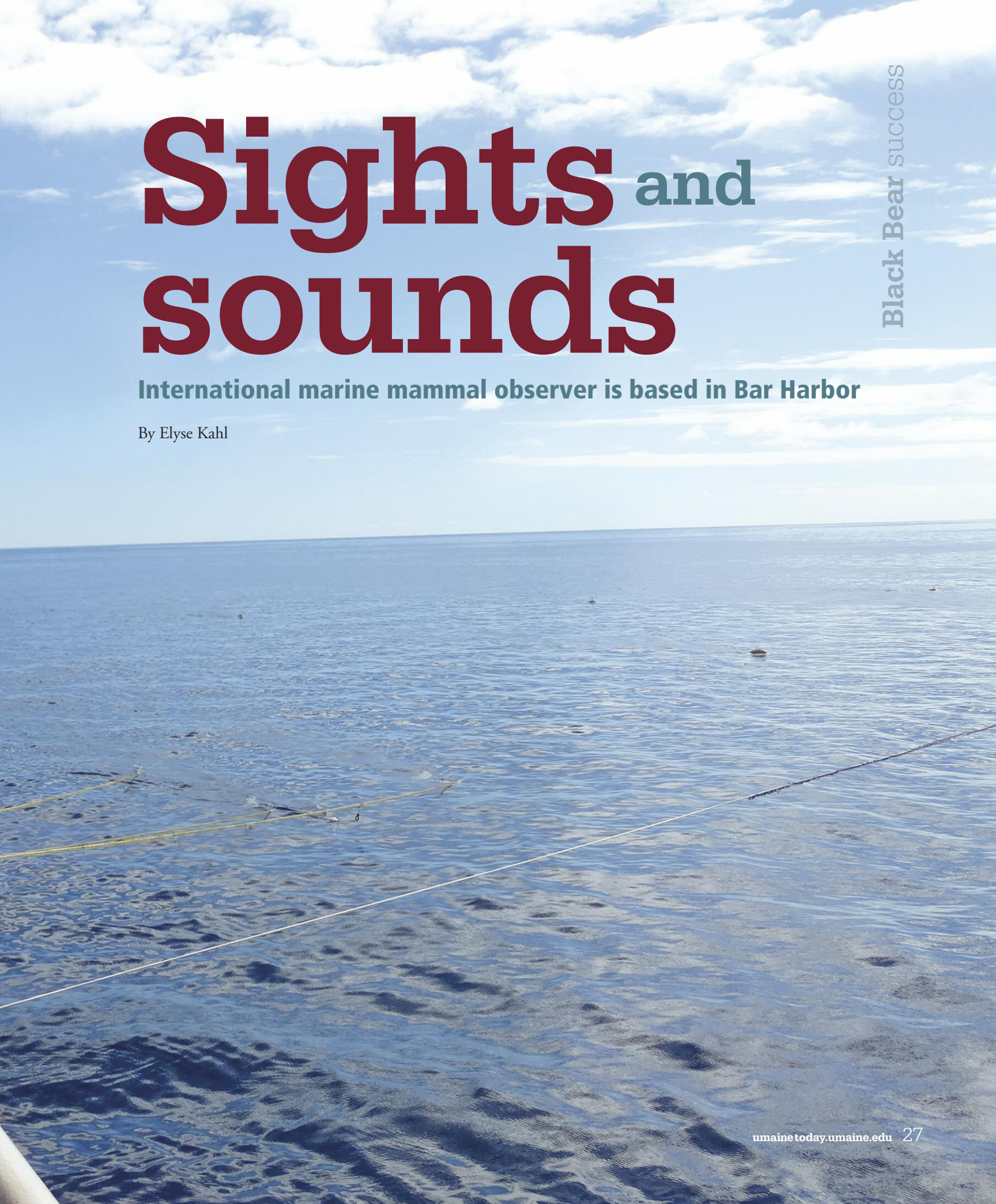
As an international marine mammal mitigation specialist and passive acoustic monitoring operator, UMaine alumna Kaitlyn Mullen travels the world to help reduce human impacts on protected species, including marine mammals and pelagic birds. In the past five years, her consulting destinations included Madagascar, where she searched for animals to protect from the land air guns used in the search for oil.

Photo by Angieszka Adamiak

Sights and sounds

International marine mammal observer is based in Bar Harbor

By Elyse Kahl



Sights and sounds

KAITLYN MULLEN was 3 years old the first time she clearly saw a whale.

"Do you know they 'see' by making and listening to sounds?" her grandmother asked her.

Mullen was captivated. Growing up near the Richmond, Virginia coast in a family rich in fishing heritage, Mullen was already in love with nature. But this new information about whales resonated with the youngster who had just undergone corrective eye surgery.

"Wow, this thing 'sees' the world the way I see the world, by hearing," she thought. "I wonder if I can talk to this — and if it has stories."

In the years to come, whales and their ocean habitat were never far from Mullen's mind, even when, at 17, she moved to Nashville, Tennessee to pursue a music career.

In 2002, she graduated with a bachelor's degree in music business administration and marketing from Belmont University. Through internships and connections she made at Belmont, she achieved success as a recording artist and songwriter. She was signed to a publishing company and made a couple of independent country-folk albums.

"When I went to Nashville, it was kind of an either/or choice to make," says Mullen, a University of Maine alumna based in Bar Harbor who today is one of the world's leading marine mammal observers and passive acoustic monitoring operators. "When I was done with music and that world, I started looking at research and wondering if whale vocalizations have musical components to them."

Mullen worked as a song publisher and real estate advertising manager until she left Nashville to return to school for marine sciences. She chose UMaine because she was looking for an affordable, nationally ranked program that offered more than marine biology. UMaine offered strong oceanography and Earth science programs that would allow Mullen to learn about marine mammals, as well as their environments.

As an undergraduate, Mullen interned with the College of the Atlantic's marine mammal research group Allied Whale, identifying individual whales using photos, and collecting biopsy samples of finback and humpback whales. While tending bar at a local hotel the next semester, Mullen was offered a summer job at the Bar Harbor Whale Watch Co., as a whale watch naturalist, where she continued collecting photos and identifying whales, using the whale watch boats as research platforms.

MULLEN GRADUATED with a bachelor's degree in marine sciences in 2005 and a Ph.D. in ocean engineering in 2013. Her dissertation focused on the acoustics of ships in relation to the growing problem of baleen whales getting hit and killed by the vessels. Mullen used marine mammal biology, ecology, physics and acoustic engineering to record and characterize marine mammal vocalizations, as well as develop and test a prototype solution for whale-ship strike mortality.

"It didn't make sense to me because when you look at big baleen whales, they're the ones that hear at really low frequencies — long wavelength sounds — which is exactly the kind of sound that big boats make," Mullen says. "If they primarily use their ears to survey their world, then they should be able to hear these things coming. Big boats are louder than jet planes in their own environment."

Mullen worked closely on the project with Michael "Mick" Peterson, a UMaine mechanical engineering professor with an innovative ability to combine experts from seemingly unrelated disciplines to solve research issues. In one meeting, Peterson brought in a traffic flow engineer, saying "This is what he does all day. He deals with random objects that interrupt the flow of traffic. Let's talk to him."

Mullen and her team looked at how ships are built,

When not traveling the world, Kaitlyn Mullen is a tour boat captain, naturalist and manager for Acadian Nature Cruises in Bar Harbor, where Egg Rock and other islands are included on lighthouse, puffin and seabird cruises.

where their sound sources are located and how those factors influence the sound that's produced, depending on the environment. She specifically examined Maine's rugged, granite ocean floor that changes depth quickly. She found that when the depth changes abruptly, the boat's quietest part is directly ahead of it at the surface.

"If you're listening to a boat coming toward you underwater, like baleen whales would be doing, they actually think they're jumping out of the way when they're swimming into that space ahead of an oncoming ship, where they're getting killed," she says.

Mullen began developing a sound source that would mimic a boat and be placed in front of the ship, making that area louder than the sides or back. The first prototype was tested as a portion of her thesis and performed successfully, raising the total amount of noise created in the area immediately in front of the boat.

Prototypes will include improvements for reducing sound source drag and increasing volume by focusing the low-frequency components of the source using array geometry, similar to hip-hop concert technology that focuses bass.

MULLEN'S MUSIC background factored into one of the most common challenges researchers face — the affordability of conducting research. In her studies, she used recording equipment made for musicians instead of scientific equipment, which cut the budget almost in half.

"Recording underwater is not that much different than recording live," Mullen says. "All the principles are the same, and many postprocessing techniques are similar."

Mullen credits UMaine with helping her find community partners that were welcomed into the academic setting.

"UMaine has an extremely nurturing academic environment," she says. "It is a research institution, but there's freedom here that you don't have at a lot of research institutions to pursue your own ideas."

Ocean engineering careers in Maine

ACCORDING TO an annual survey by the University of Maine Office of Institutional Research, 86 percent of recent engineering baccalaureates were employed full time, 60 percent of whom were working in Maine. The College of Engineering's highly regarded graduate programs also attract students who earn advanced degrees and choose opportunities in Maine — careers that include research that continues to benefit the state.

DOUGLAS READ

Associate Engineering Professor, Maine Maritime Academy

Read came to UMaine for the interdisciplinary ocean engineering program and earned his Ph.D. in 2009. "The ability to combine mechanical engineering with the courses I wanted in electrical and computer engineering, and marine sciences was a unique opportunity," he says. While earning his Ph.D., Read began teaching as an adjunct at Maine Maritime Academy in Castine, where he landed a full-time job days after defending his dissertation. Read, who has always been interested in fluid flow and how the geometry of a vehicle affects its performance, focuses his research on hydrodynamic optimization and testing of ship hulls, using both experimental and computational fluid dynamics. At MMA, Read has been conducting research on increasing the fuel efficiency of smaller vessels, particularly fishing vessels. He continues his relationship with UMaine through collaborative research projects. "MMA and UMaine engineering faculty have developed a good working relationship over the last few years. I continue to be involved in research projects at UMaine, and also advise graduate students. The two schools have a lot to offer each other, so I hope the trend continues," he says.

ANNA DEMEO

Director of Energy Education and Management, College of the Atlantic

Demeo earned a master's degree in marine bioresources and a Ph.D. in engineering in the natural sciences at UMaine. She began teaching part time at the College of the Atlantic in Bar Harbor while working as an engineering consultant at a private practice. "Over time, I migrated more and more toward teaching and research until finally taking a full-time job at the college in 2014," Demeo says. She teaches project-based renewable energy courses with a strong hands-on component. Her research focuses on community-scale renewable energy and microgrid technology. Demeo's work at COA recently was featured in the *New York Times.* While pursuing her Ph.D., Demeo worked closely with mechanical engineering professor Michael "Mick" Peterson, whom she calls inspirational and encouraging. Demeo also credits UMaine's flexibility and support for allowing her to further her education and work while raising a family. "In addition to being conveniently located, UMaine is small enough to give one a sense of place, but large enough to offer an abundance of opportunities," she says. Demeo has worked on two grants with UMaine faculty in recent years, and sees many areas in which COA and UMaine could continue to collaborate.

While earning her Ph.D., Mullen worked in Bar Harbor as a whale watch naturalist, research associate with Allied Whale, marine mammal observer, education software consultant, and tour boat captain and company manager.

Her time managing Acadian Nature Cruises also prepared her for her research.

"It doesn't matter if you go into research or business on your own, but at the end of the day you still have to manage a project budget, you still have to manage people, and you still have to market yourself," she says, adding that knowing boat maintenance proved to be an invaluable skill for a field-based marine scientist.

Kaitlyn Mullen

UMAINE CONTINUES to be a resource for Mullen, who applauds the university for working with the state's coastal community.

"UMaine does some great research, and it helps foster research in smaller academic institutions, like College of the Atlantic or Maine Maritime Academy, which are both on the coast. And by fostering those partnerships, people like me who are so invested in the community can then reach out and bring the community into a lot of the same projects," she says.

In the past year, Mullen has continued her job as tour boat captain and company manager in Bar Harbor. She also works as an international marine mammal observer and passive acoustic monitoring operator during seismic exploration for oil, a method used to determine how far down oil may be located.

Mullen travels the world to look for whales near the ocean surface as a marine mammal observer. Across seascapes, she determines the animals' locations based on the loudness of their vocalizations by passive acoustic monitoring.

She searches for animals to protect them from the extremely loud air guns — about 260 decibels — used to detect oil.

"(Seismic reflection) is a better way of doing it than drilling and putting pockmarks all over the ocean, but it's certainly not perfect," Mullen says. "Two hundred and sixty decibels of sound would deafen most humans and probably deafen most marine mammals if they were extremely close."

Depending on a country's guidelines, when Mullen spots marine mammals within 500 meters of the air guns, she has the authority to either stop the survey or reduce the power to 90 decibels, preventing hearing damage.

For the past five years, Mullen has worked in the Gulf of Mexico, and off the coasts of Tanzania, Comoros, Mozambique, Madagascar, South Africa, Peru and Saba Island in the Netherlands Antilles. She also has volunteered to help the small community on the Caribbean island of Saba find resources and develop skills to spot and identify humpback whales returning to the area.

For three years, Mullen has worked with the Saba Conservation Foundation's Sea & Learn Program. The data local people collect have aided Allied Whale, which studies the North Atlantic humpback whale.

Information from Saba helped the researchers discover that different feeding populations of whales spotted in the North Atlantic may use separate portions of the Caribbean as breeding grounds.

"We do have a good idea of where they breed and where they feed. But the in between is fairly a blur," Mullen says. "We're not sure what drives them and we're not sure, in the case of some of them, what they eat in different environments. These are really basic questions, and there are very few animals in the world for which those kinds of things are unknown." ■

Jeffrey Rogers

Financial future

Rogers at home at UMaine, State Street, Wall Street

JEFFREY ROGERS of Bangor, Maine has long been linked to the University of Maine. His grandparents, parents and sister are all UMaine grads, and through the years, he had many opportunities to "visit and enjoy the campus, the athletics and the atmosphere," he says. "Even before coming here, I felt as though I had a home waiting for me after high school." The summer before he enrolled, Rogers worked in his father's consulting firm and realized that he was destined for a career in business. **ACADEMICS AND AVOCATIONS**: At UMaine, Rogers is double majoring in finance and financial economics. He serves as president of the Senior Skulls honor society and is a Maine Business School student ambassador. He also is co-president of SPIFFY, the Student Portfolio Investment Fund where students manage a mutual fund. Rogers and other SPIFFY leaders were on the floor of the New York Stock Exchange in November. **WORLDVIEW:** Rogers has spent two summers interning at State Street Bank in Boston, Massachusetts, one of the world's largest financial institutions. He worked with currency traders on a foreign exchange trading desk and analyzed trading patterns of firms. At State Street, Rogers was selected to participate in a leadership development program, where he led a case study exploring the environmental strategies of large financial institutions. **CAREER LAUNCH:** In October, seven months before graduation, he accepted a job offer from The Beacon Group in Portland, Maine. He plans to earn the Chartered Financial Analyst designation and, ultimately, pursue an MBA. ■

“You go through **15 years of research** to select the characteristics you want, but then it’s up to the market to decide if the **timing is right** for this potato.” Gregory Porter

THE COMMUNITY of Presque Isle in the northernmost county in Maine is home to Aroostook Research Farm — the largest of five University of Maine experimental research facilities. In the summer months, the 425-acre farm is covered in rows of lush, leafy green plants adorned with tiny white and purple flowers. Though the expansive fields make for a beautiful scene, researchers and farmers are more interested in the thousands of plump, starchy vegetables just inches below the Earth's surface.

Since 1912, the farm has been ground zero for UMaine's potato research programs, serving as the hub for agriculture research and development for the state's potato industry. The university's potato breeding program introduces new varieties with improved disease resistance and marketability for potato growers in the eastern United States.

"Roasted potato, baked potato, mashed potatoes, potato salad — it's such a versatile crop. What's not to like about the potato?" says Professor of Agronomy Gregory Porter, who has led the breeding program for the last eight years.

Today, the potato — nicknamed spud after the tool used to unearth it — is a leading vegetable crop in the United States, ranking fourth in the world of potato production behind China, Russia and India. It is a key crop around the globe, alongside wheat, rice and sugar, with a total production that exceeds 300 million metric tons, according to the International Potato Center.

From the ground up

The state's potato breeding program cultivates new varieties to grow the industry

By Amanda Clark

It's in the genes:
Steps to creating a new variety of potato

Potato plants are cross-pollinated in the Roger Clapp Greenhouses at UMaine to produce new varieties.

The fruit of the plant is collected and the seeds are extracted and stored until the following spring, when they are germinated and grown into seedlings.

The seedlings are then planted in greenhouses at Aroostook Farm. Tubers from the seedlings are planted on the farm the following year.

According to the United States Department of Agriculture, Maine farmers alone planted 55,000 acres of potatoes in 2014.

This year, UMaine's breeding program produced 50,000 seedlings, each containing a unique set of genetic material that could hold the key to the next decade's successful potato varieties.

IN THE past decade, the program, in partnership with the Maine Potato Board, has released three new varieties. The three — Easton, Sebec and Caribou Russet — had the competitive yield and quality attributes necessary to move from the research conveyer belt to market shelves.

But that isn't always the case.

Creating a new successful potato variety takes a great deal of time, expertise and ample, uninterrupted funding.

"You go through 15 years of research to select the characteristics you want, but then it's up to the market to decide if the timing is right for this potato — are there enough positive results to increase the acreage next year, things like that," says Porter, who grew up on a potato and grain farm in northern Maine, and has been a UMaine researcher for three decades.

Once a variety is released, it can be introduced into different markets, such as the potato chip industry or the seed market, depending on the potato's characteristics.

The program's most recent potato varieties had what it took to make it through a decade of extensive evaluation and testing. Now it's up to growers and markets to decide how successful the new varieties will be. Though each of the varieties has some useful disease-resistance traits, one is not resistant to all of the major plant diseases that affect today's potato industry.

UMaine's potato breeding program is working to change that.

New varieties of potato can take as many as 15 years to hit the market, and even then,

In the fall, the tubers are dug and hand evaluated to select the best looking. Those continue on to the next year of testing. Third-year material is evaluated in the lab, looking for genes associated with disease resistance.

After 10–15 years, a variety will be released into various markets, such as the potato chipping industry, french fry-processing industry, seed market or fresh market.

researchers are gambling to select varieties adapted to the climate, and resistant to current and future virus strains. Which is especially difficult because viruses and pathogens in the environment change from season to season, similar to how the flu virus annually adapts.

Predicting what genes will be important to fight diseases 15 years in the future in a constantly adapting environment is almost as difficult as searching for a needle in a haystack that's being tossed around by a tornado. But as genetic testing capabilities have continued to advance, the breeding process has steadily picked up speed.

Porter's breeding program is aimed at selecting genes that produce resistance to three common potato diseases currently affecting growers in the eastern United States — potato virus Y, common scab and late blight.

THERE ARE an estimated 4,000 edible varieties of potatoes, mostly in the Andes of South America. Though many varieties exist, creating a successful variety adapted to the climate and resistant to common plant diseases is not a simple task. It involves the expertise of breeders, growers, entomologists, food scientists, agronomists and geneticists.

New varieties are created with traditional breeding methods by controlled crossing, which has been done for hundreds of years. Not to be confused with genetic engineering — the molecular approach of inserting genes into an organism. While controlled crossing modifies genetic material, it does so by the natural process of pollination, says Porter.

The cross-pollination process takes place at Aroostook Research Farm and at UMaine's Roger Clapp Greenhouses, horticulture research facilities of the College of Natural Sciences, Forestry, and Agriculture, and the Maine Agricultural and Forest Experiment Station. Here, researchers cross-pollinate the potato plants by

This year, the breeding program produced **50,000 seedlings**, each containing a unique set of genetic material that **could hold the key to the next decade's successful potato varieties.**

transferring pollen grains from the anther of the flower (where the pollen is produced) to the stigma (where the pollen germinates) of another flowering potato plant.

The potato plant's five-lobed flowers contain both male and female plant reproductive organs, but a cross with two different plants is typically required to produce a new variety.

The cross-pollinated flower grows to produce fruit resembling tiny green tomatoes, which encase the seeds and dangle on the above-ground herbaceous perennial plant. The true seeds, which are the size of coarse particles of sand, are extracted and stored until the following spring when they are germinated and grown into seedlings in greenhouses at Aroostook Research Farm.

Potatoes also can be grown by planting a tuber, but since the vegetables are only enlarged underground stems, the result will be a clone of the original parent material.

By using multiple generations of seeds, researchers produce potatoes with different expressions of certain traits. Because potatoes are tetraploids and contain four sets of chromosomes, each cross results in considerable genetic variation and a diverse combination of plant, tuber and disease-resistance traits.

"If you have a pair of parents that have desirable traits, you are going to get everything under the sun, because potatoes are complex. You do a cross with a plan in mind, and see what you get," says Porter.

AS SUMMER turns into fall, the breeding program switches gears and the harvest of the much-anticipated tubers begins. Once dug, the potatoes are evaluated by hand for disease symptoms, shape and overall appearance. Of the 50,000 potatoes planted, 1,000 will survive the initial evaluation and be planted in second-year plots, and of that batch, about 300 will be selected to plant the following year in third-year plots.

Third-year potatoes are tested for genetic markers associated with disease resistance. If the variety has a resistant gene, the likelihood it will undergo another year of testing increases. This process continues until researchers find a potato with desireable characteristics.

In the summer months, growers and researchers are on high alert for symptoms of the three diseases that can decimate their crops in a matter of weeks. One of the most dangerous plant viruses affecting production is potato virus Y (PVY). In some affected plants, the leaves appear yellow, underdeveloped and crinkled.

The virus results in lower potato yields and infected tubers, forcing growers to remove the infected plants by hand before the virus spreads extensively within the seed crop. Symptoms range from production loss to potato tuber necrotic ringspot disease, which renders the infected potato unmarketable. Seed lots cannot be certified for use if the infection level exceeds 5 percent.

A grower must spot the symptoms early to remove disease-infected plants before they spread throughout a field. Though there are field tests, a farmer can't afford to test every variety. In a commercial acre of seed potatoes, there can be nearly 30,000 plants, says Porter.

Another high-priority focus of the breeding program is promoting resistance to the common scab, an external defect that reduces marketability and causes significant economic losses for growers.

And then there is late blight, caused by the oomycete pathogen *Phytophthora infestans,* the culprit behind the Irish potato famine — the most devasting potato disease outbreak in history. When a plant is attacked by late blight, leaves and stems can be destroyed, yields are reduced and tubers can decay in the field or in storage.

Crane Brothers Farm in Exeter, Maine has been a longtime collaborator with the University of Maine potato breeding program. UMaine agronomist Greg Porter, pictured above, uses the site as a testing plot for some of his trial potatoes. Porter has worked in the potato industry for nearly 30 years, including the past eight as the head of UMaine's potato breeding program.

Late blight control and losses due to the disease can be extremely costly for growers. For this reason, researchers at UMaine and across the country are racing the clock to introduce varieties resistant to the three detrimental diseases and common pests, including Verticillium wilt and the Colorado potato beetle, which would also decrease the need for pesticides.

In Maine, those researchers include experts with Cooperative Extension, whose crop monitoring and science-based pest management recommendations routinely save the Maine potato industry more than $10 million annually in crop losses, reduced pesticide applications and labor costs.

AN IMPORTANT collaborator in UMaine's breeding program is Benildo de los Reyes' functional genomics lab. The professor of molecular genetics uses plants as a model system to understand genetic regulatory networks that allow plants to adapt to various environmental conditions.

"It has to be a sustainable industry, and one major thing that affects sustainability is disease pressure. We have to have technology that addresses this constantly," says de los Reyes, who helps Porter identify genes known to promote resistance, as well as identify new genes resistant to late blight. By peering into a potato's genetics and identifying specific genes early in the breeding process, de los Reyes can save growers time, money and labor.

Using leaves from second-year testing trials, de los Reyes extracts DNA from a potato leaf and runs it through PCR — technology that amplifies pieces of DNA — to determine if it contains a genetic marker associated with disease resistance.

The goal, says de los Reyes, is to combine different genes in a single genetic variety so if one disease-resistance mechanism fails, there is another mechanism as backup. This method is

> We are already **fielding questions from growers around the country,** as well as in Maine. This type of result is what makes this **partnership** truly advantageous for **the future of our industry."** Don Flannery

called resistance gene pyramiding or resistance gene stacking.

"Diseases have a profound impact on the profitability of potato and, therefore, having a program centered around the use of state-of-the-art genetic technology to address issues of disease resistance in potatoes is very important," says de los Reyes.

Recognizing and combining genes that make potato varieties more resistant to different strains of the late blight pathogen would help growers prepare, says de los Reyes.

Ph.D. student Kristen Brown works with Porter and de los Reyes to identify strains of late blight to see how they affect varieties of potatoes. In particular, she looks for genetic markers associated with resistance.

She is evaluating varieties from Porter's program and from around the country in hopes of improving resistance, and speeding up the identification and removal processes for growers.

"Greg looks at the varieties in the field, and Benildo looks cellularly and on the tissue level. Combining the two forces saves time and money," says Brown. "I work somewhere in the middle of the two."

Brown runs her experiments in the Clapp Greenhouses at UMaine, where she extracts DNA from leaf samples to look for genes that have been shown to promote resistance to late blight.

With a background in plant ecology, Brown's research is directly applicable to farmers and breeders around the world.

"There is no other school, I think, that I would be able to work in so many different areas and produce something that is useful today and will be useful 10 years from now — and beyond," she says.

THIS FALL, Brown assisted Porter during harvest season at Crane Brothers Farm in Exeter, Maine. Crane Brothers Farm has been a longtime collaborator with Porter's breeding program, allowing him to use the site as a testing plot for some of his trial potatoes.

"Greg is a real professional. I'm always amazed that he has chosen to keep his career in Maine because he could work at any major university in the world. He's that good," says Jim Crane, co-owner of the fourth-generation Crane Brothers Farm.

"The potato industry is really fortunate to have him, especially in Maine."

Four of Porter's potatoes are currently being evaluated at Aroostook Farm in a national trial aimed at selecting a potato that may replace Russet Burbank, the longstanding standard french fry potato. The collaborative research project also is looking to select a potato variety with low levels of sugars in the tubers, which, when heated at high temperatures, combine with amino acids to produce a by-product called acrylamide.

"While it hasn't been proven to be harmful to human health, it wouldn't hurt to decrease it," Porter says.

The potato breeding program solves problems for both commercial and organic growers. One struggle organic growers face is the Colorado potato beetle, which feeds on the foliage of the potato plant.

In Maine's colder climate, the beetle doesn't have enough time to produce multiple generations, which is an issue in warmer climates. But the small striped beetle and its pink larval stage can still cause a tremendous amount of damage in a short amount of time.

UMaine's breeding program collaborates with Cornell University, North Dakota State University and North Carolina State University, which provide genetic material to breed varieties resistant to potato beetles and aphids.

In addition, like conventional growers, organic farmers also struggle to control late blight outbreaks.

"Late blight resistance for an organic grower is extremely valuable. They are more likely to be quick adopters of that sort of disease resistance than large-scale conventional growers because they don't have as many pesticides available for controlling late blight," says Porter.

UMAINE POTATO varieties in their third-year of testing also are planted throughout the country, including in Florida, Pennsylvania and North Carolina, to allow researchers to select varieties that can thrive in a wide range of growing conditions. When Porter thinks he has a successful new variety, he offers samples to farmers willing to plant and evaluate the new spud.

UMaine's breeding program is funded by research grants, federal funding and the Maine Potato Board (MPB), a longtime partner that helps with commercialization. When a variety is released from UMaine's breeding program, MPB has first dibs on licensing in order to control how and where the new spud is marketed.

"The University of Maine has the research and development capability and commitment for developing new potato varieties, from the lab to the field, which takes years," says Don Flannery, executive director of the Maine Potato Board. "They understand what the growers and the industry are looking for and need. We, in turn, as a board, have the capacity to promote the varieties and maintain the quality of seed certification required for the integrity of the variety and the market."

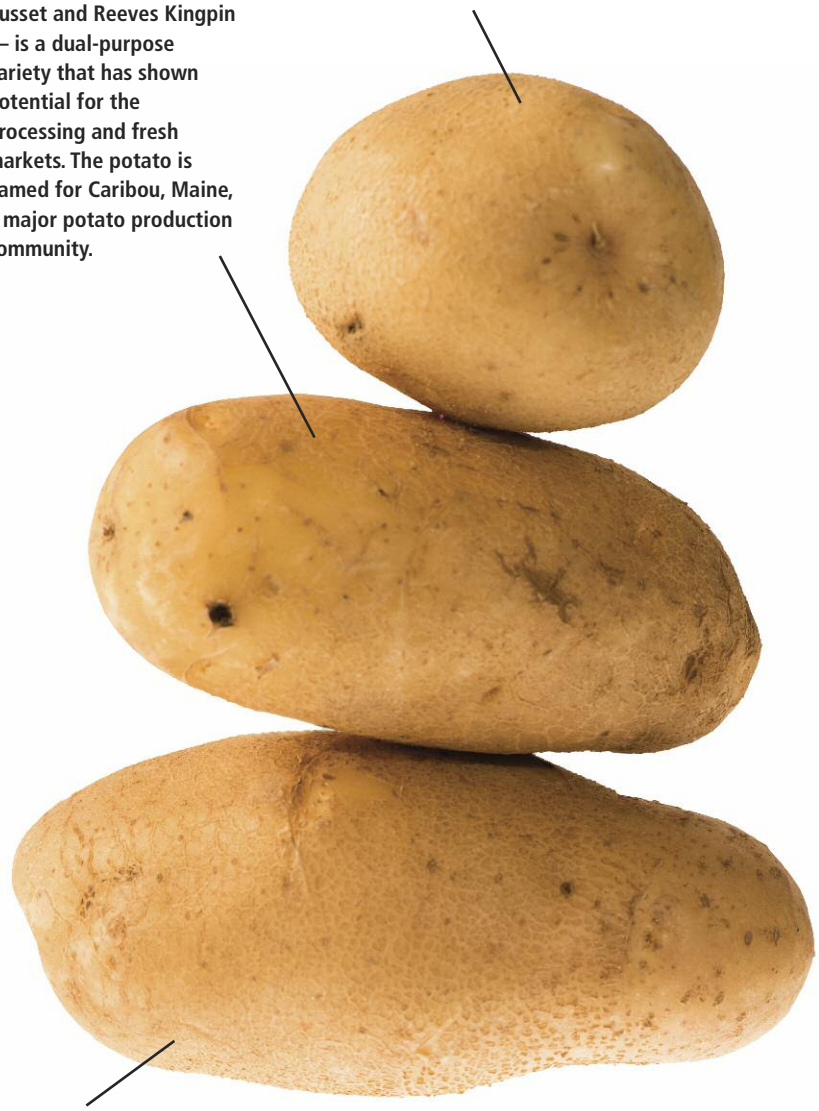
"We are already fielding questions from growers around the country, as well as in Maine. This type of result is what makes this partnership truly advantageous for the future of our industry," Flannery says.

Caribou Russet

Released in March 2015, the Caribou Russet — a cross between Silverton Russet and Reeves Kingpin — is a dual-purpose variety that has shown potential for the processing and fresh markets. The potato is named for Caribou, Maine, a major potato production community.

Sebec

Released in February 2014 to the potato chip industry, Sebec was named for Sebec Lake in Piscataquis County. The variety has round to slightly oblong tubers, and is lightly textured, with buff-colored skin and white flesh.



Easton

Released in February 2014 to the french fry industry, Easton — named for the town in Aroostook County — is praised for its high yields and its high-quality french fries.

Funding is critical to the breeding program for obvious reasons; funding a research project for 15 years carries a hefty price tag.

"You have to be able to sustain funding over many, many years in order to get something from 2015 to be a variety in 2027. It's a long-term commitment and it's a very challenging one," says Porter. That's one of the many reasons he and his team work to ensure research results and reports are available to farmers, breeders and researchers each year at statewide trade shows and meetings.

Now, Porter is particularly excited for a potato variety going through commercial trials. The variety, referred to as AF4648-2, has shown to be immune to potato virus Y, highly resistant to common scab and moderately resistant to late blight. Porter predicts this potato will be useful in the fresh market and the potato chip industry.

Though he is hopeful, it will be years before he'll see if it has what it takes to make it into your favorite potato salad recipe.

"Potato varieties, historically, have a 1-in-10 chance of being a major success — if that," he says. "Even after 10, 12, 15 years of research, it's still a difficult thing for a potato variety to be a really big success.

"It's a gamble. It really takes someone getting behind it, looking at it and giving it a good hard try commercially."

Porter has worked in the potato industry for nearly 30 years and has seen his share of failed potato varieties. But he continually strives to create a more perfect potato, which involves a long list of avid collaborators.

"That's a really fun thing about this job. You get to interact with everyone — from small-scale growers and organic growers to McCain Foods, the largest potato processing company in the world," says Porter. "You meet some really great people along the way." ■

Ginger Kieffer

Potatoes and politics

WHEN GINGER KIEFFER graduates from the University of Maine in May 2017 with a degree in political science, she plans to take her roots with her.

The political science major from Caribou, Maine grew up surrounded by potatoes and learned early on the economic importance of spuds.

Her interest in food systems led her to professor Gregory Porter, director of UMaine's potato breeding program. She began working as a student researcher last spring, collecting pollen from potato plant flowers in the Roger Clapp Greenhouses and cross-pollinating them to create new varieties of spuds.

In summer 2015, Kieffer worked at Aroostook Farm, removing disease-infested plants from the potato fields, extracting and counting stems, and collecting samples.

Kieffer plans to integrate the knowledge she gained working in potato research into her future career in politics.

The potato industry is a "complex animal" of production, and research and development, says Kieffer.

"I'm so thankful I had this opportunity to expand my horizons on the level of care that goes into this economic engine so prevalent in my hometown and state," she says. "Little did I know the research and development that went into the bag of potatoes you see in the store."

At UMaine, Kieffer minors in leadership studies and sustainable food systems, and is a member of the Honors College. She is interning in U.S. Sen. Susan Collins' Bangor office, assisting staffers on casework that varies from veterans affairs to helping constituents receive benefits.

After serving in the Peace Corps, Kieffer plans to enroll in a political science master's/doctoral degree program.

Brain power

Collaborative research in a neurobiology lab epitomizes the student experience

By Amanda Clark

KRISTY TOWNSEND'S scientific roots reach back to her undergraduate years at the University of Maine. "Some of the most important and formative scientific experiences in my life were when I was mentored as a young scientist and was able to work alongside faculty on novel research projects," says Townsend, whose undergraduate research included collaboration with UMaine Professor of Psychology Alan Rosenwasser on studies of circadian rhythms.

Today at UMaine, Townsend teaches introduction to neuroscience and cellular biology, and is dedicated to giving young scientists hands-on experience in the lab. While juggling her own research projects, she mentors 18 undergraduates, including many in the laboratory — mentoring that is typical in the UMaine student experience.

Townsend received her undergraduate degree in biochemistry at UMaine in 2002. A dozen years later, she returned as an assistant professor of neurobiology and a cooperating graduate faculty member in the Graduate School of Biomedical Science and Engineering.

Townsend earned her Ph.D. in neuroscience from Boston University in 2007. She studied energy balance, body weight regulation and obesity using bat and mice models to explore how the brain changed during the process of body weight regulation.

After two years at King's College in London as a postdoctoral researcher, Townsend worked at

Brain power


Cordell Beaton
Third-year biology major, chemistry minor
Caroline Curtis
Third-year biology major, neuroscience minor
Kristy Townsend
Assistant professor of neurobiology
Bethany Miles
Fourth-year biology major
Magdalena Blaszkiewicz
First-year graduate student
Not pictured:
Raymond Vallejo — fourth-year biology major, neuroscience minor and pre-medical studies concentration
Brenna Gerchman — fourth-year biology major
P. Dillon Kress — third-year biology major, pre-medical studies concentration

Harvard Medical School in the Joslin Diabetes Center for five years as a researcher and junior faculty member. Her research explored how brown adipose cells develop and function to burn calories, as well as how growth factor signaling pathways in the brain control activation of brown adipose thermogenesis, a process that expends energy.

Now in the Townsend lab on campus, undergraduate and graduate students collaborate on research to unravel the mysteries of the nervous system and how the brain regulates energy balance. Her team is exploring how the brain communicates with adipose tissue in the body through the action of peripheral nerves, and how this helps to maintain a healthy metabolism.

"The more often students are given the opportunity to be involved in 'real science' and to think critically about a research problem, the better honed their scientific skills will be, and the larger their scientific toolbox will be as they enter the next phase of their careers," says Townsend.

"I strongly believe it is the duty of faculty to pay that experience forward by helping to train and mentor the next generation of scientists and medical professionals in the classroom and the lab." ■

"I strongly believe it is the duty of faculty to **pay that experience forward** by helping to **train and mentor the next generation** of scientists and medical professionals in the classroom and the lab." Kristy Townsend

Waves of the future

New $13.8 million ocean engineering research facility focuses on marine-related economic development

By Margaret Nagle

A NEW WIND-WAVE research facility to strengthen marine-related economic development in Maine, including boatbuilding, opened at the University of Maine with the help of an award from the Harold Alfond Foundation.

The foundation awarded a $3.9 million grant to UMaine to match $9.98 million already raised to establish the Ocean Engineering and Advanced Manufacturing Laboratories at the Advanced Structures and Composites Center on campus. The Alfond Foundation's award will help equip the facility, hire world-class engineers for the startup in 2015–16, and fund graduate and undergraduate students over three years.

The new facility, dedicated in a ceremony Nov. 23, is called the W^2 Alfond Ocean Engineering Laboratory in honor of philanthropist Harold Alfond, a longtime UMaine benefactor.

Through the years, Harold Alfond and the Harold Alfond Foundation have made more than $15 million in gifts and pledges to the University of Maine, including naming gifts for Alfond Sports Arena and Alfond Stadium, and the creation of the annual Alfond Challenge to benefit UMaine football. The philanthropy has benefited hundreds of students, fans and other members of the UMaine community.

The world-class ocean engineering facility will assist businesses in developing products for the ocean economy, including improved boat and ship hulls; ocean energy devices

The wave maker at one end of the basin is capable of creating waves of varying frequency and as high as 0.8 meters (equivalent to 40 meters at full scale).

such as wind, wave and tidal energy; aquaculture facilities; oil and gas structures; waterfront infrastructure, such as bridges, piers, docks and port facilities; and systems to protect coastal cities from the effects of erosion, sea-level rise and extreme storms.

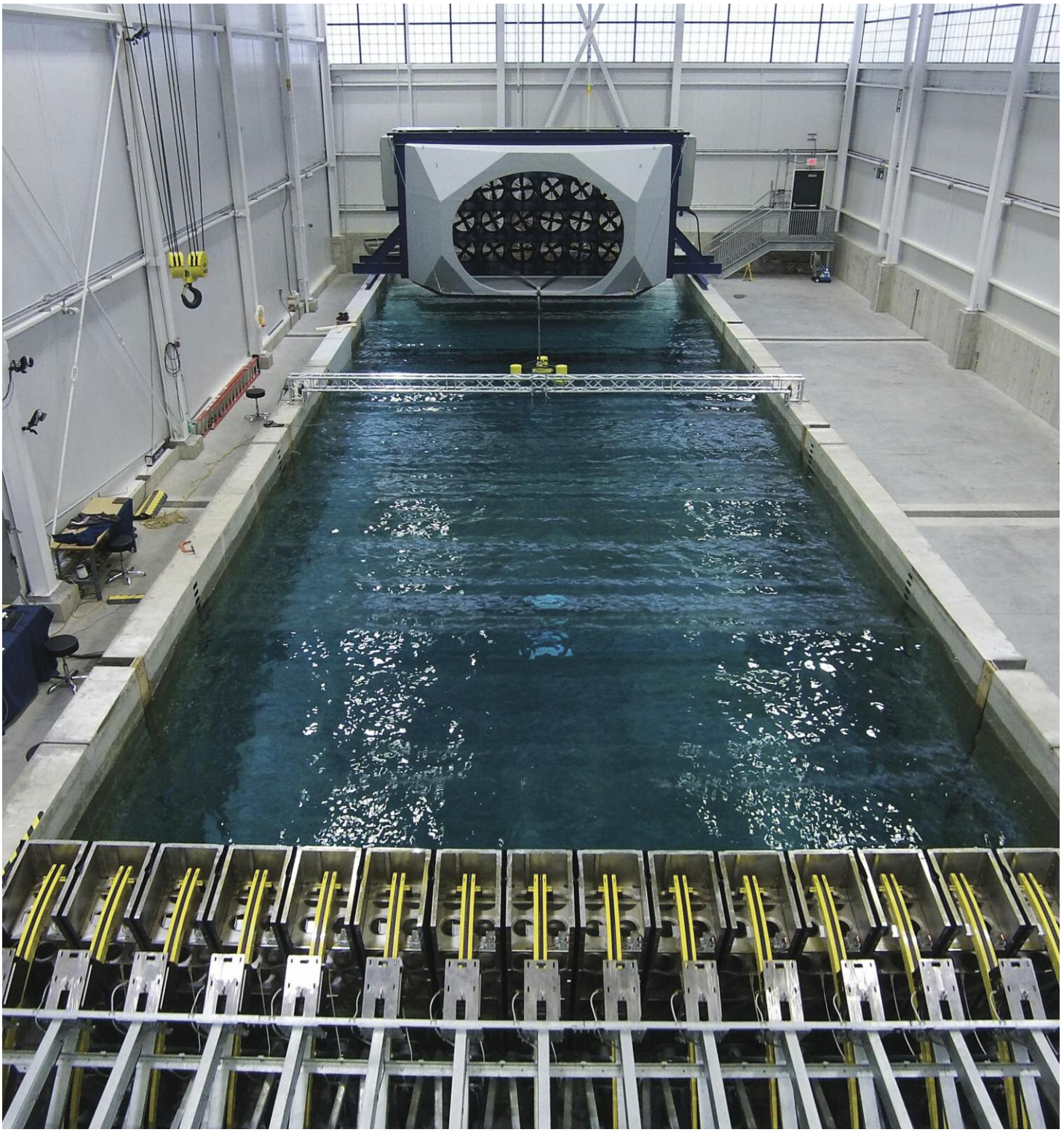
Through it all, undergraduate and graduate students will receive hands-on training in the research and technology, joining more than 1,800 students who have gained real-world experience at the Advanced Structures and Composites Center since its inception in 1996.

"We are investing in people and infrastructure that will support ocean engineering and advanced manufacturing education and research, and grow Maine jobs," says Gregory Powell, chairman of the Harold Alfond Foundation.

THE UNIQUE facility is equipped with a high-performance rotating wind machine over a wave basin, which can simulate some of the largest wind and wave storms seen on Earth. The basin will be an important resource for companies in Maine and throughout the world to develop next-generation ocean devices and structures.

In an ocean state such as Maine, an important part of the economy revolves around our ability to harness the Gulf of Maine's full potential, while protecting its delicate ecosystem, says Habib Dagher, executive director of the UMaine Composites Center and the BIW Professor of Structural Engineering.

"These will be the only labs of their kind in Maine with world-class capabilities to educate students, and conduct



The multipaddle wave basin has a rotatable wind machine, producing velocities up to 7 meters per second, for simultaneous application of scaled wind and wave environments for sophisticated floating body model testing. The concrete floor moves up and down to model ocean depths.

cutting-edge research and development," says Dagher. "The R&D will support the growth of the ocean economies and shipbuilding sectors in Maine and the nation, as well as the growth of digital and additive manufacturing of thermoplastic composite materials."

The Advanced Manufacturing Laboratory for thermoplastic composites will utilize digital, additive and robotics manufacturing to reduce cycle time and cost. Structural thermoplastics are recyclable materials that could transform composite materials used in cars, ships, boats and aerospace applications.

In June, the Composites Center received $497,965 from the National Institute of Standards and Technology to develop a national road map for advanced manufacturing of structural thermoplastics composites materials.

The total construction, equipping, and startup of the new laboratories over the first three years will cost more than $13.8 million. Of that, the center had raised more than $9.98 million through four grant competitions, which included funding through the U.S. Economic Development Administration, National Science Foundation, National Institute of Standards and Technology, Maine Technology Institute and a voter-approved bond.

Commercial testing in the facility is expected to begin in April.

> "We are **investing in people and infrastructure** that will support ocean engineering and advanced manufacturing **education and research, and grow Maine jobs."**
>
> Gregory Powell

THE COMPOSITES Center is the largest science, technology, engineering and mathematics (STEM) research and development program located at a Maine university, and is key to one of the seven University of Maine Signature Areas of Excellence — Advanced Materials for Infrastructure and Energy.

Since it was established with funding from the National Science Foundation, the UMaine Composites Center's researchers and students have led award-winning R&D projects with more than 500 Maine-based, national and international companies. The mission of the Advanced Structures and Composites Center is to apply the comparative advantages offered by Maine industries, labor and natural resources to conduct world-leading research, educate Maine students, and develop Maine's economy while encompassing the material science, manufacturing and engineering of composites and structures.

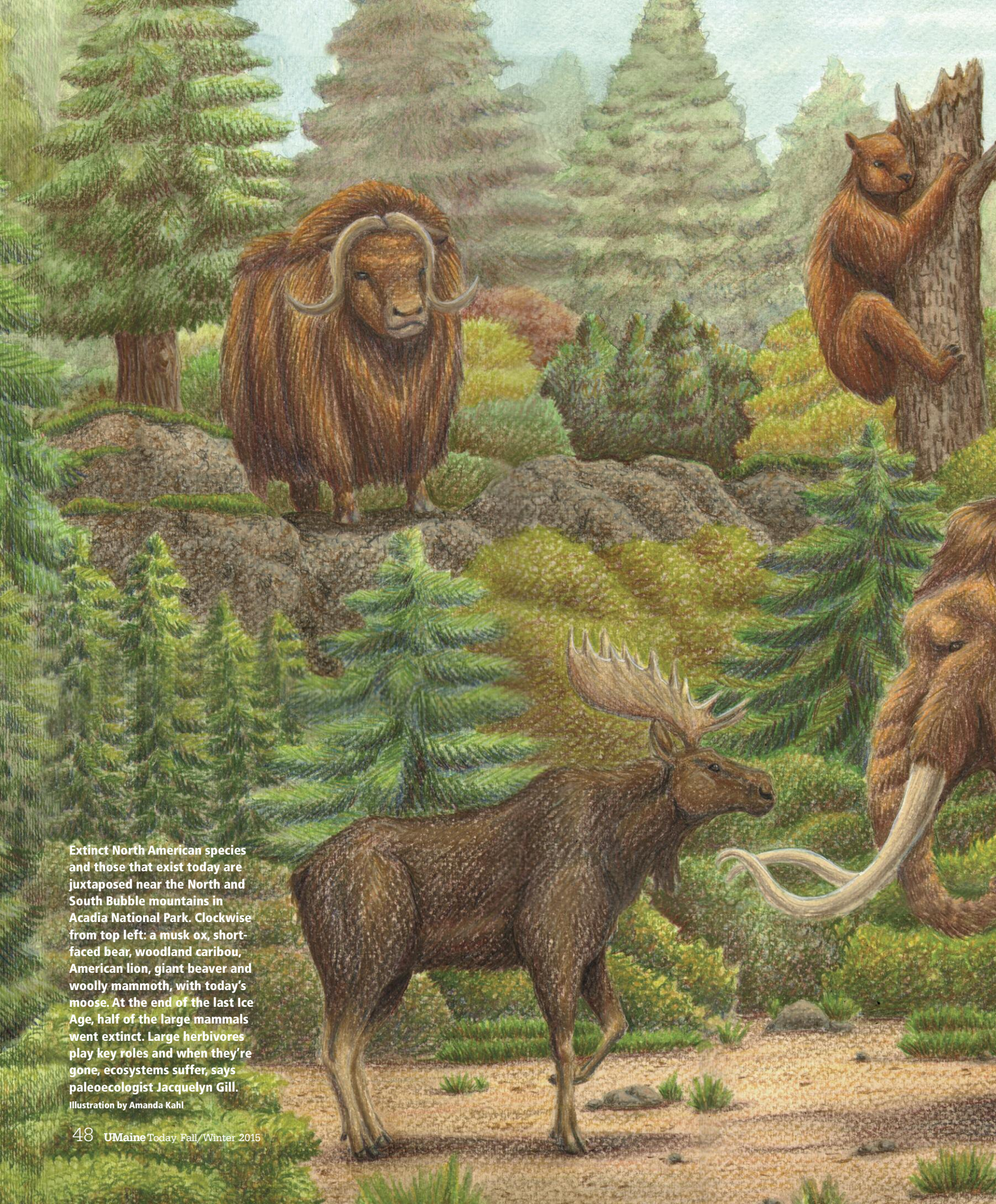
Research at the 100,000-square-foot laboratory facility has resulted in 42 issued and pending patents, more than 500 published technical papers, and the creation of Maine spin-off companies through licensing agreements of its inventions, patents or trade secrets. This earned the UMaine Composites Center the 2008 Maine Development Foundation's Champion of Economic Development Award.

In addition, the center has received 40 national and international awards, including the Charles Pankow Award for Innovation from the American Society of Civil Engineers, the top global innovation award for its Bridge-in-a-Backpack™ technology; and the Engineering Excellence Award of the American Council of Engineering Companies.

With funding from the Department of Energy, the Composites Center has pioneered development of ocean energy technologies, deploying in 2013 the first grid-connected floating offshore wind turbine in the U.S. in partnership with 30 organizations.

Advanced Infrastructure Technologies, a 2008 spin-off, constructed 20 bridges and became the first composite technology bridge system to be approved in the U.S. AASHTO highway code. It is now an international company after installing a bridge in Trinidad.

In addition, Compotech Inc., located in Brewer, spun off the center in 2014 to commercialize blast and ballistic technologies. ■



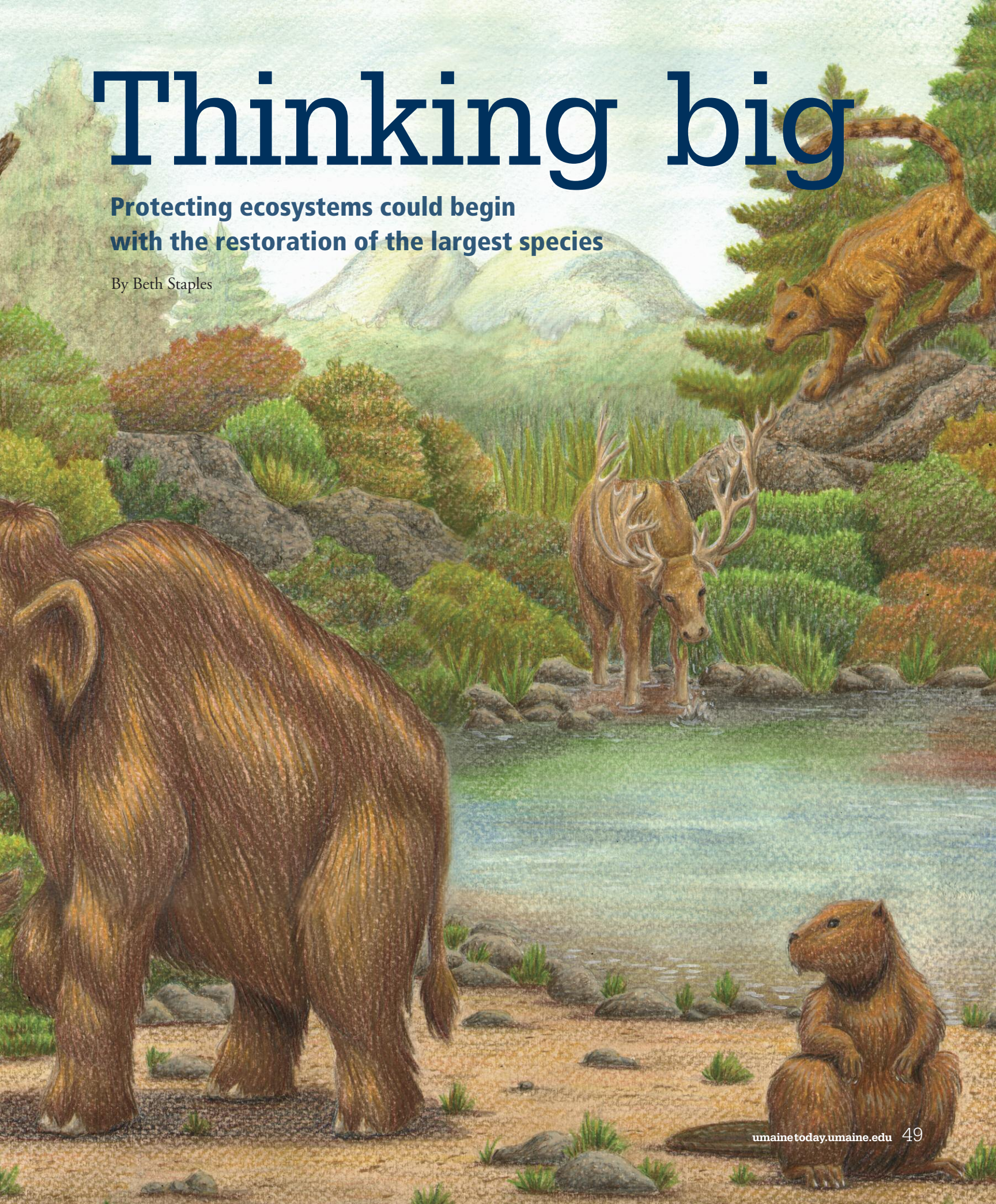
Extinct North American species and those that exist today are juxtaposed near the North and South Bubble mountains in Acadia National Park. Clockwise from top left: a musk ox, short-faced bear, woodland caribou, American lion, giant beaver and woolly mammoth, with today's moose. At the end of the last Ice Age, half of the large mammals went extinct. Large herbivores play key roles and when they're gone, ecosystems suffer, says paleoecologist Jacquelyn Gill.

Illustration by Amanda Kahl

Thinking big

Protecting ecosystems could begin with the restoration of the largest species

By Beth Staples



JACQUELYN GILL puts the dead to work. She pores over fossils, pollen and spores from the Earth's past, extracting clues about ecosystems through deep time and over vast regions of the planet. Clues from the departed can help the living, says the assistant professor with the University of Maine School of Biology and Ecology, and the Climate Change Institute.

The dead are not just a collection of bones and long-dead things in a drawer, she says. Rather, extinct animals and plants are naturally concluded experiments of the past, and teasing apart bits of material from what plants and animals left behind can inform current conservation efforts.

The past matters and is a great resource to teach people about the world today, says Gill.

"If we understand the consequences of extinction better, we might be able to motivate ourselves to manage biodiversity better," she says.

While resilience of fauna and flora throughout the paleorecord gives Gill hope for the future, she says climate change is creating a planet of winners and losers.

Climate change predicted in the next century will push the planet outside anything we've experienced in hundreds of thousands of years, or even longer, Gill says, and in many cases it's predicted to happen faster than the recent past. Saving a million species from extinction can be overwhelming, especially with so much uncertainty, she says.

According to *Nature* news feature editor Richard Monastersky's 2014 article, 41 percent of all amphibians on the planet face extinction, as do 26 percent of mammal species and 13 percent of birds.

What may matter more than losing species in general is the specific species we're losing, Gill says.

For instance, the African elephant population is estimated to be fewer than 500,000. According to National Geographic, in 1930, there were 5 million–10 million of the majestic plant-eaters that can grow to 13 feet and 14,000 pounds.

"If you want to protect an entire ecosystem, start with protecting its largest inhabitants," Gill says. "At the end of the last Ice Age, we lost half of the mammals in North America larger than a German shepherd, and the forests and grasslands they inhabited noticed the difference.

"Large herbivores, from mammoths to elephants, play special keystone roles in ecosystems. When we lose them, we lose all the services they provide — from spreading nutrients to creating patches where many different plants can thrive," Gill says.

In the absence of these large herbivores, there are cascading effects across ecosystems, including an increase in the incidence of wildfires.

FOR SOME conservationists, wildlife biologists and ethicists, de-extinction — resurrection of species that humans drove to extinction — may be a viable (though controversial) way to protect a variety of the planet's animal and plant life.

"Like *Jurassic Park,* but actually possible," says Gill, a paleoecologist, which she compares to being a forensic scientist. Gill studies the ecology of the past, and geographical distribution of living things through space and time.

Due to developments in genetics and stem cell technology, as well as recovery of ancient DNA and reconstruction of lost genomes, Gill says it's possible that shaggy-coated, 15-ton animals with 15-foot tusks — similar to woolly mammoths — could again roam the Earth.

In spring 2015, a team of scientists in Sweden completed the woolly mammoth genome by extracting DNA from the remains of a woolly mammoth that lived more than 40,000 years ago. Another team at Harvard is working to insert the DNA into elephant stem cells to give elephants mammoth-like traits like blood with a kind of antifreeze.

King penguins *(Aptenodytes patagonicus),* like other seabirds, are an important part of the marine-terrestrial nutrient linkage on the Falkland Islands. The penguins transport nutrients from the ocean to the land in their feces, enabling coastal plants to thrive in an otherwise nutrient-poor environment. Falkland Island photos by Kit Hamley

"I think climate change is really going to force us to be creative with conservation solutions," says Gill. "This may be the kind of creative solution we need to think beyond the level of the species and protect biodiversity as a whole."

However, Gill cautions that de-extinction needs to be driven by science and a strong research agenda, and include the public as a stakeholder.

So too, does rewilding — or returning keystone species into areas where they've been absent for some time.

The reintroduction of gray wolves into Yellowstone National Forest in the 1990s is one example of rewilding. By the 1930s, hunters in Yellowstone had wiped out the gray wolf, which then affected other parts of the ecosystem. The elk population exploded. When they feasted on willow, aspen and cottonwood trees, land degradation followed, including erosion and a lack of food for beavers.

Since the reintroduction of wolves in the 1990s, scientists say the elk population has been reduced and willow stands have rebounded, providing songbird habitat. There's been more food for beavers, too, which has resulted in new dams and cold-water ponds for fish.

While there's a spectrum of what is practical and what the public has a will for, Gill says discussions about de-extinction and rewilding are great to highlight why species matter and their roles.

GILL SAYS she's interested in a variety of topics — from the natural world to history — and that growing up in the '80s and '90s, she became acutely aware of the environmental problems facing the planet.

As a young girl, Gill says she loved learning and loved sharing what she knew with other people.

"Probably as a kid I was insufferable, but now I'm proud to do it," she says.

One of her moments of inspiration happened when she was an undergraduate at the College of the Atlantic. Guest lecturer Marcus Vandergoes, then a UMaine Climate Change Institute professor, was demonstrating how to use a coring device in Sunken Heath in Acadia National Park.

Gill describes the process as similar to sticking a straw in a milkshake and capping the top hole with your thumb. Rather than pulling up gooey chocolate ice cream, students pulled up 12,000-year-old light gray clay from the last Ice Age.

Gill says seeing time — reflected in changes in the sediment core — and touching the past were the coolest things that had ever happened to her. Something clicked.

Standing in Sunken Heath, a movie began playing in her mind of what the bog looked like thousands of years ago and how it got to be like it is now.

"I like thinking in big scales — big scales in time and big scales across space," she says.

Imagine time fast-forwarding through a film. In the movie's opening scene, ice 2 kilometers thick envelopes the landscape. Its massive weight compresses the Earth's crust.

As the movie progresses, ice melts and the sea rushes in over land now called Maine. Without the massive weight of the ice, the Earth's crust rebounds, causing the ocean to retreat. Eventually, grasses, mosses and willows grow, along with an occasional spruce tree.

Long-tailed meadowlarks *(Sturnella loyca falklandica),* seen here atop marram grass *(Ammophilia arenaria),* are only found in the Falklands Islands. Long-tailed meadowlarks survive by feeding mainly on insects, like the one caught in this photo.

Time passes and boreal forests grow — an attractive habitat for woolly mammoths, giant beaver the size of black bears, woodland caribou, dire wolves, musk oxen, giant moose and elk, grizzlies and short-faced bears.

After a brief return to Ice Age conditions, the current warming period begins. Humans appear for the first time, and the largest animals disappear.

For decades, scientists have researched why some megafauna — giant charismatic animals like mammoths — went extinct. Gill, though, prefers to study what happened to the land and other animals after the extinction.

"If we want to understand how plants respond to extinction of animals, we need to be able to directly compare those two fossil records," she says.

This is tricky, because fossil bones aren't usually found in sediment cores. So Gill gets creative, looking for the disappearance of spores from a fungus that reproduces on animal dung to time the local extinction of mammoths.

"The idea is we can look to the fossil record to understand how species responded to climate change and will respond going forward to inform conservation," she says.

In her research, Gill found the extinction of mammoths and other large plant-eaters triggered a 1,000-year period of upheaval and ecological surprises that was quite unlike anything seen since.

Today's plants are all Ice Age survivors, but their ecology is different in the absence of those animals. And this has big important conservation relevance, she says.

Sheep farming and the export of wool have been the economic base for 140 years in the Falkland Islands, where acidic and infertile soil make it difficult to grow crops. Roaming sheep interact with native grazing upland geese *(Chloephaga picta leucoptera),* as well as penguins and other seabirds.

GILL HAS traveled the country and world doing research. Her lab concentrates on understanding consequences of climate change and extinction on ecosystems, particularly interactions across the food web.

She shares with land managers how ecosystems are interconnected and what happens when one piece out of the puzzle is removed.

Currently, Gill and UMaine students are studying interactions of penguins, tussock grass and sheep on the Falkland Islands, an archipelago of two main islands and nearly 800 smaller islands.

The UMaine team is striving to find ways for all the islands' inhabitants — residents, sheep, sheep ranchers, sea lions, tussock grass, penguins and other seabirds — to exist in healthy harmony despite competing interests, as well as sea-level rise and erosion.

Part of the research is examining the fossil record to learn how sensitive the ecosystem has been in the past.

The native tussock grass, which can grow over 6 feet high in the windy, cold climate, provides habitat and protection for penguins and seals. In turn, penguin and sea lion feces nourish the grasses. The sheep, brought to the islands in the 1800s, eat the tussock grass, which impacts the habitat for sea lions and penguins.

Rotational sheep grazing may be one resolution, Gill says.

Gill strongly believes in communicating science so it's understandable and relevant to a variety of audiences—from 5-year-olds to senators.

In addition to sharing her expertise with students, Gill writes a blog, "The Contemplative Mammoth: (ecology and climate change from the 4th dimension)." Topics range from the causes of ice ages to public education.

> "I think climate change is really going to force us to be **creative with conservation solutions.** This may be the kind of creative solution we need to **think beyond the level of the species and protect biodiversity as a whole."** Jacquelyn Gill

In her Sept. 16 blog, "In defense of information by, of, and for the people," Gill wrote: "I dedicated my dissertation to the forgotten, unnamed women who wrote the manuscripts, conducted the experiments, and brewed the coffee and cared for the babies so that their husbands and colleagues could win Pulitzers.

"I wouldn't be here without those women. And I wouldn't be here without libraries, Sesame Street, free school breakfasts, the Pell Grant, or the National Science Foundation, either."

She frequently tweets as well (@JacquelynGill) and says social media has been a great way to connect with scientists, the public and journalists.

Gill began blogging in college because she thought she had a voice to contribute.

Others agree.

She has been a source for articles in *National Geographic* and *Rolling Stone,* and appeared in last summer's five-part PBS series "First Peoples" about the spread of the first humans across the globe.

In the *Rolling Stone* article "The Point of No Return: Climate Change Nightmares Are Already Here," Gill said ancient data provide "really compelling evidence that there can be events of abrupt climate change that can happen well within human life spans. We're talking less than a decade."

Gill says there is still time to turn things around, but to do that, greenhouse gas emissions need to be severely curbed on a massive scale.

"In terms of acidification of oceans and sea-level rise, there are points of no return," she says. "The sooner that we act, the more likely it will be that we avoid a catastrophic increase in temperature in the future. It comes down to political will."

Because de-extinction, rewilding and other conservation strategies can't remedy an uninhabitable planet. ■

Shrinking bison

Jeff Martin

JEFF MARTIN'S boyhood interest in fossils was heightened during a family vacation to Wind Cave National Park and The Mammoth Site of Hot Springs in South Dakota. A stop at Yellowstone National Park in Wyoming sparked his lasting bond with bison.

For Christmas a few years later, Martin's parents got him Gummy Bear — a 1,700-pound bison.

The University of Maine Ph.D. student in ecology and environmental sciences still has Gummy Bear. She's the largest female in his 15-head herd and has given birth to 10 offspring.

The vacation affected Martin's parents, too. They now have 30 bison and, during summer months, they host up to 100 more of the magnificent animals with long, shaggy brown coats on the 214-acre family ranch in Wisconsin.

"They're a majestic and purely intimidating animal, and you should have a lot of respect for them," says Martin about bison, who can weigh up to 2,200 pounds, run 40 miles an hour and jump 6 feet high. "They're a massive animal — but right now, today, they are the smallest they've ever been in their evolutionary history."

At UMaine, Martin researches how abrupt climate change has influenced bison size. His goals as a paleoecologist and vertebrate paleontologist dovetail with his goals as a bison rancher — he wants bison and the bison meat industry to flourish.

Martin is in the National Science Foundation's Integrative Graduate Education and Research Traineeship (IGERT) program, focusing on Adaptation to Abrupt Climate Change.

Bison, says Martin, have existed for about 2.5 million years. Understanding their past is the best way to prepare them for adaptation to future climate change, and to inform conservation and economic management of bison.

While many large herbivores — including mammoths, mastodons, giant ground sloths, giant camels and giant moose-elk — went extinct in North America at the end of the last Ice Age, bison survived.

"They've covered England to America, Russia to India, northern Arctic Canada to southern Mexico," he says. "They're one of the more successful genera in terms of land coverage."

This past summer, Martin was back at Wind Cave National Park in South Dakota. This time, he was with professors Jim Mead of East Tennessee State University and Jacquelyn Gill of UMaine to take part in a dig in Persistence Cave. The cave, about 27 feet long and 6 feet deep, with 15 inches of clearance, was discovered after its entrance naturally reopened due to drought followed by extreme rain events.

The unearthed fossils included remains of animals that went extinct and those that survived the last Ice Age about 11,000 years ago.

Mead was Martin's adviser when Martin earned a master's in geosciences. Martin says Mead is "the No. 1 collector of No. 2," adding that Mead's collection includes dung from thousands of species and seasons.

Martin came to UMaine to work with Gill because of her research linking abundance of the dung fungus *Sporormiella* to bison population dynamics through time.

Dung is important because it allows scientists to understand dietary changes over time and geography, says Martin, adding it also helps researchers determine what plants were around at different times in Earth's history.

Pollen samples from trees and plants also provide vital information about the past climate in North America, including what food was available for bison, as well as horses, camels and bats around the time of the last Ice Age.

Hucklebeary is a 2,200-pound, 6.5-foot-tall breeder bull on the Martin family ranch in Wisconsin. Bison, says Jeff Martin, are the smallest they've ever been in evolutionary history, due, in part, to climate change. The giant bison *(Bison latifrons)* that lived between 200,000 and 20,000 years ago stood about 8 feet tall and weighed more than 4,400 pounds.

Photo courtesy of Jeff Martin

Semester in Antarctica

Marine sciences major studies impact of warming ocean temperatures

IN PREPARATION for her final undergraduate year at the University of Maine, Maggie Halfman didn't buy textbooks. She bought long underwear, wool socks and seasickness medicine (just in case). In October, she and several other researchers boarded a cruise ship in Punta Arenas, Chile that headed 837 miles south to Palmer Station — one of three United States research stations on the Western Antarctic Peninsula.

They return at the end of December.

On the expedition, Halfman, from Fond du Lac, Wisconsin, is conducting an independent research project and assisting Jay Lunden, a UMaine School of Marine Sciences postdoctoral researcher. Lunden is exploring the affect warming ocean temperatures have on the development of cold-water coral larvae.

Halfman's project uses oceanographic and biological analysis to examine how water masses are changing around the Western Antarctic Peninsula. By looking at CTD transects — conductivity, temperature and depth — from the past five years, she hopes to determine how temperatures vary in the areas of Antarctica experiencing the greatest rate of basal melting.

"It's important to understand how the oceans are changing, what the potential repercussions of climate change might be, and how we can and should act in order to minimize disturbances, which could involve the economy, natural disasters or ecosystem degradation," says Halfman, a marine sciences major with a concentration in physical science.

Lunden and Halfman are collecting larval samples of *Flabellum impensun* — one of the largest species of solitary coral in the world — from the ocean floor at depths to 1,000 meters using remotely operated underwater vehicles. They are exposing the baby corals to several warming scenarios and observing their physiological stress response to environmental changes.

The researchers hope their observations will shed light on the implications climate change will have on coral organisms and marine ecosystems.

Maggie Halfman

The goal is to bring back 2,500 samples.

Rhian Waller, a UMaine professor of marine sciences, is leading the Antarctic expedition. Waller's research focuses on the reproduction and development of cold-water and deep-sea invertebrates around the globe. She explores how these animals are affected by both natural and anthropogenic environmental change.

In summer 2013, working in Waller's laboratory at UMaine's Darling Marine Center in Walpole, Halfman learned histological techniques used to analyze marine organisms. During that same time, Waller was notified that the National Science Foundation's Polar Program funded her expedition to Antarctica. Within the grant proposal, Waller had requested funding to bring an undergraduate and postdoctoral researcher on the research expedition.

When deciding which undergraduate student to take on her expedition, Waller had a mental list of characteristics that she needed the student to embody: a reliable, independent worker excited for an authentic research experience, able to handle working in Antarctica's harsh conditions.

Halfman was the perfect fit. ■

The project, "Creating a Virtual Infrastructure for Engaging Rural Youth in STEM Disciplines Through Computer Science," is a UMaine collaboration with several Maine middle schools and ThoughtSTEM, a San Diego-based computer science education organization.

THE LEARNING GAME

USING A popular video game to immerse rural Maine students in computer science and math concepts is the focus of a three-year, $2 million research project.

Bruce Segee, the Henry R. and Grace V. Butler Professor of Electrical and Computer Engineering at the University of Maine, is leading the project that aims to advance efforts of the National Science Foundation's Innovative Technology Experiences for Students and Teachers program to better understand and promote practices to increase the likelihood that students will gain important skills and ultimately pursue careers in science, technology, engineering or mathematics (STEM).

The researchers — Segee and co-principal investigators Craig Mason, a UMaine professor of education, and Stephen Foster, CEO and co-founder of ThoughtSTEM — will develop and use a curriculum for rural middle school children to engage them in programming, spatial reasoning and problem-solving skills using Minecraft. The popular open-world game enables players to construct buildings and environments using cubes.

The project will look at using the game in classrooms and after-school programs, including those offered by University of Maine Cooperative Extension 4-H.

> "Use of computer games as a mechanism for teaching **computer science concepts** while also improving the effectiveness of the **core curriculum** is incredibly exciting." Bruce Segee

Not all plastics are equal

EVER BUY a fish at a pet store that died within days of being put in the home aquarium? The plastic bag used in the transport may be the culprit, according to research by University of Maine marine scientist Heather Hamlin. She and colleagues discovered that certain plastic bags with FDA food-grade approval leach nonylphenol (NP) in concentrations that are highly toxic to fish. The chemical NP — also found in food packaging, cosmetics and laundry and dish detergents — binds to estrogen receptors. Even at low concentrations, it mimics estrogen, which feminizes and alters fertility in fish, thus threatening their existence. NP also has been found to alter fish immune function and damage DNA. Hamlin's findings, published in the journal *Chemosphere,* demonstrate that NP may pose a greater health risk to people, the ocean and to aquatic wildlife than can be predicted from examining properties of plastic from one manufacturer, which is the method the FDA uses to test for toxicity. The study contributes to the growing body of research highlighting concerns with plastic contaminants, says Hamlin, an assistant professor of aquaculture and marine biology.

BUOYING AQUACULTURE

UNIVERSITY OF Maine scientists have deployed an ocean-observing buoy at the mouth of the Damariscotta River to better understand how different types and scales of aquaculture can fit into Maine's working waterfront. The buoy is part of a National Science Foundation Sustainable Ecological Aquaculture Network (SEANET) project, geared to help the aquaculture sector maintain an environmentally and economically sustainable production path.

Professor Neal Pettigrew's Physical Oceanography Group in the School of Marine Sciences will use data gathered by Mooring E0501 to map water circulation at the mouth of the river. The detailed circulation patterns will be integrated into ecosystem models under the supervision of Damian Brady, assistant research professor at the Darling Marine Center. The models will include results of environmental monitoring, field investigations and lab analysis, much of which will be conducted at the Darling Center.

The Ocean Data Acquisition System, designed and constructed by Ocean Science and Technology LLC, includes technology developed for the network of deepwater buoys in the Gulf of Maine that are part of the Northeastern Regional Association of Coastal and Ocean Observing Systems.

Center of Academic Excellence in Geospatial Sciences

THE UNIVERSITY of Maine has been named a national Center of Academic Excellence in Geospatial Sciences in a joint application and designation process sponsored by the National Geospatial-Intelligence Agency and the U.S. Geological Survey. UMaine is among 17 universities nationwide selected to receive the award in the first year of the program. While centered in the School of Computing and Information Science in the College of Liberal Arts and Sciences, faculty from across several colleges detailed their course offerings and research in the bid to receive the campuswide designation. The recognition reflects UMaine's dedication to teaching the breadth and depth of theory and real-world applications of geospatial sciences that prepare students for success in the public, private and academic sectors. Reapplication for the designation is required every three years.

IT TAKES GUTS

RACHEL LASLEY-RASHER wanted to learn more about highly mobile shrimp that are important food for baleen whales and commercial fish along the continental shelf from Cape Hatteras to Nova Scotia. Because of their significance in the marine food web, a better understanding of shrimp migration patterns could fill knowledge gaps and help predict effects of global stressors on their locations and abundance. The problem, says Lasley-Rasher, is that shrimp often are underestimated when sampled at large spatial scales, since they're too small to be caught in trawl nets and they easily escape from capture by plankton nets. To solve the dilemma, the postdoctoral researcher at the University of Maine Darling Marine Center followed her gut. Or, more precisely, followed fish guts. Since fish are adept at catching shrimp, Lasley-Rasher and colleagues analyzed the National Oceanic and Atmospheric Administration's database that has information about gut contents of fish collected at nearly 400 stations along the northeastern U.S. shelf for the last 40-plus years. The four shrimp families — euphausiids, pandalids, mysids and crangonids — are vital food sources for groundfish. The database confirmed late winter onshore migration by mysids and crangonids, and revealed an unanticipated northward March migration by euphausiids and pandalids. These migrations over tens to hundreds of kilometers occurred across multiple decades and were well tracked by fish.

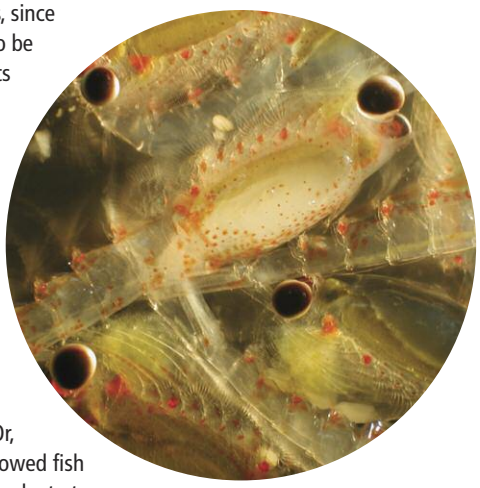


Photo by Matt Wilson/ Jay Clark, NOAA NMFS AFSC

IMPROVED SENSOR DATA

TWO UNIVERSITY of Maine researchers have received a $500,000 National Science Foundation award to advance scientists' ability to analyze massive data samples collected by real-time sensors.

The technology could be used to model a broad range of environmental phenomena, such as air pollution, smog levels, pollen distribution, toxic chemical plumes and humidity.

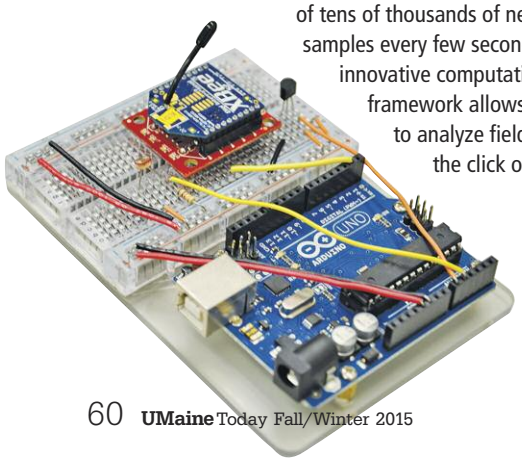
Today, sensors are capable of taking samples at discrete points in space, such as taking hundreds of individual photographs. Oftentimes, the data has to be physically retrieved on a memory card or SD card from the research site, which can be time consuming and inconvenient.

Though mathematically complicated, the new information system will **make data analysis and collection much more convenient** for the user.

Ideally, sensor data would be collected in real-time, continuously updating in the blink of an eye. Real-time sensors can bring in 20,000 new samples every few seconds, dramatically enhancing the scope of data available to scientists.

The project involves the use of fields — commonly used in physics and mathematics — to integrate with data streams mathematically to make mapping between the two easier and more accurate.

UMaine School of Computing and Information Science professors Silvia Nittel and Max Egenhofer and their team created software to help a computer keep up with the updating of tens of thousands of new data samples every few seconds. The innovative computational framework allows researchers to analyze fields with just the click of a button.



RISING WATERS

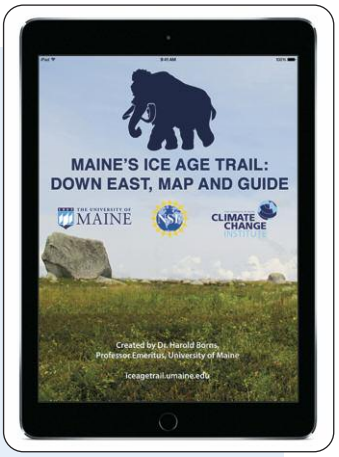
NEW RESEARCH finds increasing potential of compound floods along the U.S. coastline. The confluence of storm surges and heavy precipitation can bring dangerous flooding to low-lying coastal regions, including major metropolitan areas. The study of the United States coastline by a U.S.-German team of researchers found the risk of such flooding is higher on the Atlantic coast than the Pacific, and the number of these compound events has increased significantly in many major cities in the past century.

The research team was led by Thomas Wahl, a postdoctoral researcher at the University of South Florida and University of Siegen, Germany, and involved four other researchers, including Shaleen Jain, a University of Maine associate professor of civil engineering. Their findings were published in the journal *Nature Climate Change*.

With nearly 40 percent of the U.S. population residing in coastal counties, accurate estimates of compound flooding can help assess the adequacy of flood-protection infrastructure and improve engineering design. The 2013 Infrastructure Report Card issued by the American Society of Civil Engineers assigned the following grades: levees (D-), ports (C), wastewater (D), roads (D). With this daunting perspective in mind, the researchers sought to quantify the frequency of occurrence of compound flood events, as gleaned from the historical record. The goal was to develop a new approach to assess spatial patterns of the risk of compound flooding, as well as its variability over the past century, says Jain.

ICE AGE APP

MAINE'S ICE age is now part of the digital age with a free iPad app, developed by University of Maine alumnus Joshua Plourde and glacial geologist and professor emeritus Hal Borns, author of the *Maine's Ice Age Trail: Down East, Map and Guide*. The app (available at iceagetrail.umaine.edu) highlights 46 unique landscape features, including the Bubbles in Acadia National Park and boreal forest between Cutler and Lubec, created between 13,000 and 16,000 years ago when the Laurentide Ice Sheet withdrew northward.



FUNGUS JOINS THE FIGHT

UNIVERSITY OF MAINE researchers are one step closer to controlling the ever-growing invasive fire ant populations, *Myrmica rubra,* spreading through Maine for the last 15 years.

Due to the highly competitive and aggressive behavior of these fire ants, eradication has proven to be almost impossible. UMaine researchers are turning their attention to a different kind of control to combat these tiny stinging insects. Their weapon — pathogenic fungi.

The newly discovered fungus is the first species of the *Orphiocordyceps* (previously *Hirsutella*) genus to be isolated from the North American European fire ant in New England, though there are two other pathogens within the genus that infect fire ants in the United Kingdom.

> **We are attempting to try and grow this newly discovered fungi in the lab** in order to look at its utility for management of the ants."
>
> Eleanor Groden, UMaine professor of biological sciences

SO WORTH IT

AS THE cost of a higher education rises, some students, parents and policymakers are finding themselves asking, "Is it worth it?" According to a new Lumina Foundation report by University of Maine Margaret Chase Smith Policy Center professor Philip Trostel, the answer is a resounding, "Yes."

In the 73-page report "It's Not Just the Money: The Benefits of College Education to Individuals and to Society," Trostel found that the benefits of a higher education extend far beyond earnings.

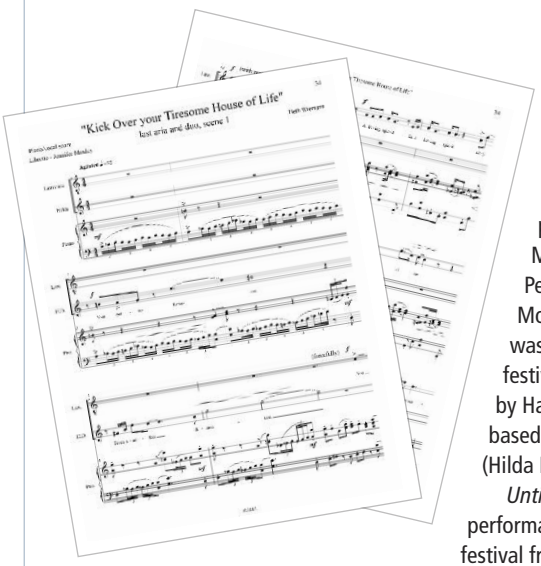
Americans with college degrees are more healthy and live longer. They have higher job security and a greater chance of having health insurance. They enjoy safer work environments and, in the event of a disability, are more likely to have to financial solvency to endure it. In addition to personal benefits Americans with college degrees have a greater positive effect on their communities.

"In some contexts, an issue basically boils down to the monetary bottom line. In other contexts, though, focusing just on the dollars is like throwing the baby out with the bathwater. The value of a college education is one such example," says Trostel, a UMaine professor of economics and public policy.

Americans with bachelor's degrees in 2012 were:

- **44 percent more likely to report being in very good or excellent health** over high school graduates never attending college.

3.2 times more likely to be leaders in school, community service, and civil and religious organizations.



NEW OPERA FEATURED

AN EXCERPT from *Until the War Is Over,* a chamber opera by composer Beth Wiemann, University of Maine professor of music and chair of the Music Division of the School of Performing Arts, and poet Jennifer Moxley, UMaine professor of English, was performed at the New in November festival in Hartford, Connecticut, sponsored by Hartford Opera Theater. The opera is based on a novel by American poet H.D. (Hilda Doolittle).

Until the War Is Over was selected for performance in this year's New in November festival from more than 40 submissions. Hartford Opera Theater established the festival in 2010 to "seek out and encourage contemporary opera composers and to create an opportunity for the community to experience performances of these new works," according to the company's website. Each year, the festival features six 10-minute scenes from new operas.

This is the first collaboration between Wiemann and Moxley. Wiemann's compositions have won awards from the Orvis Foundation, Colorado New Music Festival and others. This past spring, Moxley received the 2015 William Carlos Williams Award from the Poetry Society of America for her book, *The Open Secret.*

Wiemann and Moxley are collaborating with the Division of Theatre/Dance for a performance of an excerpt, expected in 2016.

FUNDING FOR FLORA

CENTURIES OF discoveries that document the diversity of life on Earth will be more accessible than ever with the help of National Science Foundation (NSF) grants awarded to institutions across the country, including the University of Maine.

The initiative will allow scientists and the public to view online collections of plant and fungal specimens that once could only be seen by visiting a herbarium, a facility where dried collections reside.

With this treasure trove of historical and current data on the diversity of organisms, scientists can study factors such as past changes in climate and land use on biodiversity, says Seanna Annis, a UMaine associate professor of mycology and principal investigator for one of the awards.

It also allows us to plan for future disturbances and what their effects may be, she says.

Maine received a total of $106,000 for two of the seven projects funded in the fifth round of NSF's Advancing Digitization of Biodiversity Collections (ADBC) program. To date, ADBC has made a total of more than $5.8 million in awards to scientists from nearly 50 U.S. institutions.

Photo courtesy of O'Brien Medical

ON THE MARKET

A NEW device on the market, developed by O'Brien Medical in Orono in collaboration with the University of Maine, has the potential to improve detection of diabetic peripheral neuropathy that can lead to limb loss. ETF128, an electronic tuning fork, named one of the Top 10 innovations in podiatry by *Podiatry Today* magazine, was patented last year and is now manufactured by Saunders Electronics in South Portland, Maine. The 128-Hz device offers a significant improvement over current methods used by doctors to detect diabetic peripheral neuropathy, a nervous system disorder with symptoms of pain, sensation loss and weakness in limbs. To develop ETF, Dr. Todd O'Brien, president and founder of O'Brien Medical, worked with Advanced Manufacturing Center, an engineering support and service center dedicated to promoting manufacturing economic development in the state.

Electronic tuning fork named one of the

TOP 10

innovations in podiatry by *Podiatry Today* magazine

UMaine's Herbarium contains comprehensive, organized collections of **plants, fungi, lichens and mosses** collected in the **past 170 years.**

OUT OF THIS WORLD

CIVIL ENGINEERING doctoral student Andrew Young has been named a 2015 NASA Space Technology Research Fellow for his work on the Hypersonic Inflatable Aerodynamic Decelerator (HIAD) project at the University of Maine's Advanced Structures and Composites Center.

HIAD is a nose-mounted device on a spacecraft that slows the vehicle as it enters a planet's atmosphere. The NASA technology is intended to make it possible for a spaceship large enough to carry astronauts and heavy loads of scientific equipment to explore Mars — 34,092,627 miles from Earth — and beyond.

UMaine is assisting NASA by testing its structures in the laboratory, and analyzing stresses and deformations in the HIAD.

NASA annually selects a group of graduate and doctoral students to become NASA Space Technology Research Fellows. The goal is to sponsor U.S. citizen and permanent resident graduate students who show significant potential to contribute to NASA's goal of creating innovative new space technologies for the nation's science, exploration and economic future.

The yearlong fellowship includes a 10-week visiting technologist experience.

ALDA CENTER AFFILIATE

MEMBERS OF the University of Maine Faculty Fellows Program are participating in intensive communication training offered through a collaboration between UMaine's Margaret Chase Smith Policy Center and Stony Brook University's Alan Alda Center for Communicating Science.

The nationally recognized Alda Center program combines theater improvisation techniques with communication training to create an experience that will help participants speak about UMaine and their own work with passion and confidence to students, policymakers and the public.

As an official Alan Alda Center affiliate, UMaine offers the training on campus.

Alda, an actor best known for his role on the television series "M*A*S*H," hosts PBS's "Scientific American Frontiers." The Alan Alda Center, founded in 2009 by Alda and a team of researchers and educators, believes researchers have a responsibility to share their knowledge with the public. The center is primarily concerned with "the curse of knowledge," or the idea that a person can know something so well that he or she forgets what it's like to be new to the information and, therefore, have a difficult time explaining the work to others.

UMaine is one of several institutions nationwide in the Alan Alda Center's network.

THE MAINE
Hunger Dialogue

TAKING ACTION was an emphasis of the second Maine Hunger Dialogue at the University of Maine in November.

About 150 students and staff from 17 universities and colleges throughout the state packed 10,000 nutritious, nonperishable meals for food pantries.

In addition, participants from five college campuses and Mt. Ararat High School reported on hunger-alleviation projects they implemented after last year's inaugural Maine Hunger Dialogue.

The goal of the Maine Hunger Dialogue is to inspire students from the state's public and private universities and colleges, including community colleges, to learn, share ideas, network and work together to fight hunger across Maine.

> By focusing on campuses and surrounding communities across the state, **students can make a real difference in people's lives,** as well as gain career skills, raise awareness of and work toward ending food insecurity in Maine."
>
> Frank Wertheim, University of Maine Cooperative Extension

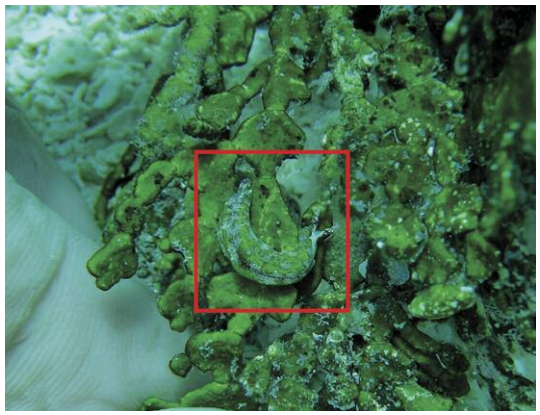


Photo by Doug Rasher

STALKING SLUGS

AN UNDERWATER sea slug has evolved chemical foraging and defense abilities that are functionally identical to those of terrestrial insects, despite being unrelated to their land-based counterparts and living in vastly different habitats for 400 million years.

"Specialized herbivores on land and sea appear to make a living in similar ways," says University of Maine postdoctoral research associate Doug Rasher, whose team's findings have been published in the *Proceedings of the National Academy of Sciences.*

In sea grass beds off the Florida Keys, the sea slug *Elysia tuca* hunts its prey, the seaweed *Halimeda incrassata,* by honing in on chemical cues the seaweed emits. After locating the toxic seaweed, the slug punctures it with its saw-like radula and sucks out chloroplasts. Since chloroplasts continue photosynthesizing inside the slug, the slug becomes solar-powered and uses the light as an energy source.

The discovery is believed to be the first time an herbivore's foraging cues have been identified in a marine ecosystem.

> "Who says there's no free lunch? The sea slug's lunch is **not only free — it generates metabolic power"** through photosynthesis.
>
> Robert Steneck, School of Marine Sciences

The future of dams

A NEW $6 million grant from the National Science Foundation's EPSCoR program will fund a four-year study examining the future of dams in New England.

The new tri-state collaboration, led in Maine by the Senator George J. Mitchell Center for Sustainability Solutions at the University of Maine, will strengthen connections between scientists and decision-makers about potential dam options, including maintaining existing hydropower dams, expanding hydropower capacity, and removing aging dams to restore fisheries or reduce safety risks. By examining economic, environmental and social trade-offs, the project will help individuals and communities make better decisions about dams. The project is highly relevant, given that hydropower is a major source of renewable energy in New England. More than 50 hydropower dams are scheduled for relicensing in the next decade.

The project marks an expansion in partners and scope for the New England Sustainability Consortium (NEST), adding Rhode Island to the existing partnership between Maine and New Hampshire. NEST was launched in 2013, when Maine and New Hampshire began an innovative collaboration focused on increasing the safety of coastal beaches and shellfish beds threatened by bacterial pollution and other microbial pathogens. NEST is designed to respond to societal challenges where economic and community development goals need to be balanced with environmental protection. Such sustainability objectives are of central importance in New England, and represent national and global imperatives.

$6M grant

will fund a four-year study of the future of dams in New England

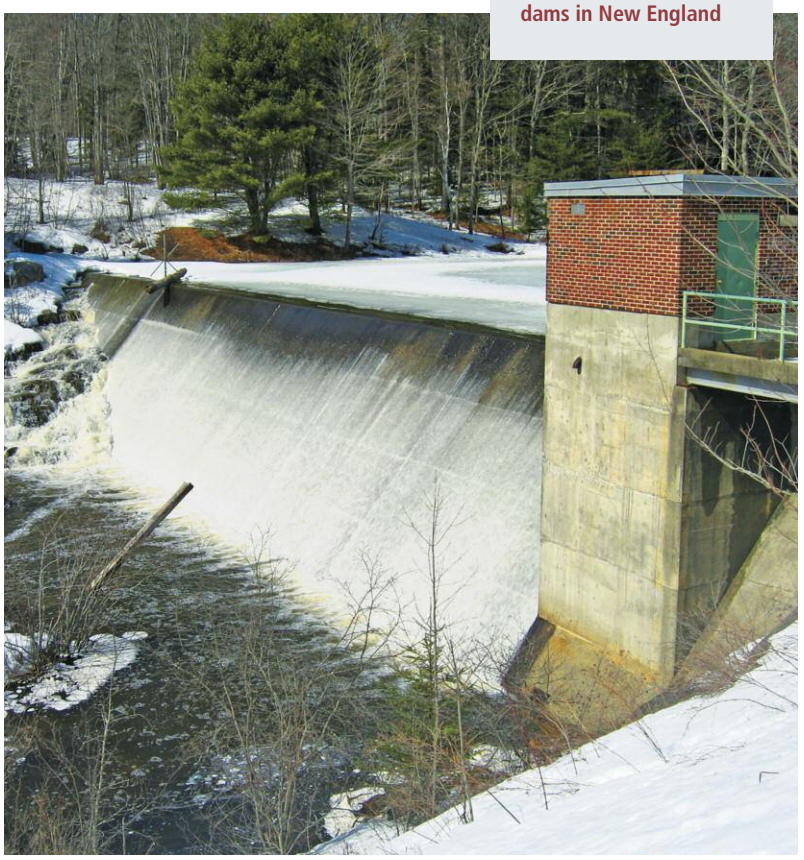


Photo by Laura Wildman, PrincetonHydro

"There is no getting around it. Dental school has become extremely expensive over the years. The low-interest Gilbert Loans I received through the **UMaine Foundation enabled me** to finance dental school, and helped give me the freedom to stay in Maine and practice dentistry. I am very grateful that I can **stay in the state I love** and further my career." Ben Lawlor

THE CHARLES E. GILBERT LOAN PROGRAM FUND provides low-interest loans for University of Maine graduates seeking medical, dental or veterinary school. The fund has supported more than 327 Maine students in pursuit of their medical degrees. Charles E. Gilbert graduated from the UMaine in 1894 with a degree in mechanical engineering.

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