Spring 2022

THRIVE

NEWS FROM THE COLLEGE OF LIFE SCIENCES AND AGRICULTURE

IN THIS ISSUE

Preserving New Hampshire's Natural Resources in the Face of Climate Change

University of New Hampshire

Through the scientific leadership in our college, we address critical questions with data-driven experimentation and discovery, community engagement and teaching that prepare future leaders.

ON THE COVER

Mauro Brum, *postdoctoral researcher, and* ***Heidi Asbjornsen,*** *professor of natural resources and the environment, extract core samples from a red oak at UNH's Thompson Farm Earth Systems Observatory.*

THE BOUNTY AND BEAUTY OF NEW HAMPSHIRE

As part of New Hampshire's flagship public research university, the College of Life Sciences and Agriculture (COLSA) is responsible for delivering research, teaching, service and outreach that address contemporary issues across the broad reach that comes with being a land, sea and space grant institution.

Two of the questions at the core of what we do in COLSA are: "How do we sustain or expand rural economies in the Granite State?" and "How do we conserve the integrity of New Hampshire's ecosystems?" — particularly in the shadow of climate change. Through the scientific leadership in our college, we address both of those critical questions with data-driven experimentation and discovery, community engagement and teaching that prepare future leaders.

This work reflects both our responsibility to New Hampshire's citizens and communities, which rely on the state's clean water, healthy forest ecosystems, vibrant farms and stable wildlife populations for economic stability and well-being, and our broader mandate to contribute to the knowledge and research that could alleviate the potentially devastating global impacts brought by extreme weather, rising seas, warming temperatures and novel diseases.

In this issue of THRIVE, we are excited to bring you stories that provide a glimpse into the depth and breadth of COLSA's work to protect and preserve our natural resources and how we contribute in meaningful ways to address and mitigate the impacts of climate change across the state of New Hampshire and around the world.

An engaged community beyond the borders of our campus is a crucial part of our ability to advance the work we do. Thank you for reading and for your continued support!

Sincerely,

ANTHONY S. DAVIS
Dean, College of Life Sciences and Agriculture

THRIVE CONTENTS

University of New Hampshire
College of Life Sciences and Agriculture

THE (603) CHALLENGE

Join us this year in supporting the College of Life Sciences and Agriculture (COLSA). Last year, our **400+ donors** helped raise **over $100,000** for the college. Examples of what these funds helped support during the 2021-22 academic year include:

- **New ÄKTA chromatography systems for the biochemistry teaching labs,** a vital upgrade to some of the most challenging courses taught at UNH
- **New camera equipment and digital media support** to enhance the quality and quantity of online and print materials shared with our alumni and donors
- **Flea and tick preventative medication** for the patients at our on-campus PAWS Veterinary Clinic
- **Dean's office engagement activities**, including a book share program and socially distanced activities for students, staff and faculty

As usual, you'll be able to make your gift go even further by taking advantage of bonus and matching funds during the event.

Please rise to the challenge and support COLSA!

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A FOCUS ON FORESTS AND OCEANS

As the climate changes, so too do our forests and oceans. Here are two projects looking at these important ecosystems.

The Role of Tiny Woodland Animals in Forest Health

Rebecca Rowe, associate professor of natural resources and the environment, is studying the role of small mammals in forest ecosystems. New research by **Ryan Stephens,** a postdoctoral fellow in Rowe's lab, found that mice, voles, chipmunks and shrews are critical to ensuring both the health of forests and the economic sustainability of New Hampshire's timber industry.

These tiniest of woodland animals eat and then disperse certain types of symbiotic fungi that help trees absorb water and nutrients and regenerate after timber harvests. The fungi, says Rowe, also help make the trees more resilient to disturbances like drought and insect infestation, two threats that are increasing because of climate change.

Benjamin Borgmann-Winter '22G is also assisting in Rowe's research. His preliminary data suggest that the fungi dispersed by small mammals differ from those dispersed by the wind, confirming the unique ecological role played by small mammals in the forest.

The work has important implications for forest management practices. "By using management strategies that retain downed woody material and existing patches of vegetation, which are important habitat for small mammals, forest managers can help maintain the populations," says Stephens. "Ultimately, such practices may help maintain healthy regenerating forests."

Rowe is also a co-principal investigator — along with **Mark Ducey,** professor and chair of the department of natural resources and the environment, and **John Gunn,** research assistant professor of natural resources and the environment — on a project addressing the restoration of degraded areas of the Northern Forest. This project includes research about the ecosystem services provided by small mammals and songbirds. The researchers' goal is to provide new management approaches that will increase ecosystem health and resilience while enhancing long-term productivity of high-value timber and greenhouse gas sequestration. Master's student **Mike Thompson '23G** is also involved in the project.

The Future of Marine Ecosystems in the Northwest Atlantic Ocean

As the oceans warm, fish are on the move in search of cooler waters. This phenomenon, which is happening at different rates and patterns among various fish species, is raising questions about what these changes mean for marine ecosystems — and the fishing industry — over the long term.

Nathan Furey, assistant professor of biological sciences, and Kathy Mills, research scientist at the Gulf of Maine Research Institute, are studying how warming waters and migrating fish populations will affect the diets of fish and the growth of fish species in the northwest Atlantic Ocean, whose waters are among the fastest warming on the planet. They are also using climate change models to predict what the food web will look like in 2055. **Nathan Hermann '25G,** a doctoral student in the biological sciences program, is assisting Furey and Mills with their research.

"This project is going to help us understand what types of characteristics, like how fish feed and how they move, might actually allow certain species to withstand their rapidly changing ecosystem," says Furey, "and ultimately what types of fish species are going to be winners or losers in climate change."

Along with identifying potential issues, Furey hopes the work will identify potential opportunities for the fishing industry and help communities adapt based on where fish will migrate in the future.

Since 1977, students, staff and faculty in the department of natural resources and the environment have made a game of guessing the day when the leaves on the ginkgo tree outside James Hall will fall. But it's more than a fun competition. According to **Serita Frey,** professor of natural resources and the environment and the current ginkgo record-keeper, the collected data has become a record of climate change at work. The tree now drops its leaves an average of 10 days later than when record-keeping began more than four decades ago. Last fall, the tree finally dropped its leaves on Nov. 6.

For the second year in a row, UNH broke its record for competitive research funding, closing fiscal year 2021 with more than $260 million in new grants and contracts, double its FY20 record. The funding — from federal agencies, state collaborators, business and industry and private foundations — supports a range of projects that improve life in New Hampshire and beyond. The Institute for the Study of Earth, Oceans, and Space, which is UNH's largest research center and shares several scientists with COLSA, received $175.7 million, the largest share of external funding. COLSA received $20.5 million.

With the launch of COLSA's molecular and cellular biotechnology (MCBT) professional master's program, five UNH-affiliated industry representatives were invited to meet with MCBT students as part of the college's plans to forge new internship programs and enhance career opportunities in the biotechnology sector. There are more than 200 biotechnology/biomedical companies in New Hampshire.

Thanks to a wetter-than-normal summer and fall, 2021 was a banner year for mushrooms. Students in the New England Mushrooms course — taught by **Christopher Neefus,** professor of biological sciences and director of the Albion R. Hodgdon Herbarium — collected 168 species, mostly from College Woods. Mushrooms are the fruiting bodies of an extensive fungal network called mycelium that is hidden underground or within decaying material on the forest floor. Neefus says that in recent years scientists have begun to understand that mycelium forms a vast network of branching threads that trees use to exchange signals and nutrients with one another. The network, nicknamed the "wood-wide web," is key to the health of the forest.

SAVING THE SHEA

Genome sequencing supports breeding, conservation efforts

An international team of researchers led by **Iago Hale,** associate professor of agriculture, nutrition and food systems, has sequenced the shea tree's genome, providing an important tool for the strategic development of the species and contributing to its preservation.

The shea tree is a vital social and economic crop in several African countries. It is best known for producing shea butter, a multimillion-dollar ingredient extracted from the nut of the tree and used in cosmetics, personal care products, pharmaceuticals and chocolate. For hundreds of thousands of African families living in the "shea belt," the shea tree is also a crucial source of nutrition and income. But despite increasing demand for shea butter, the shea tree is at risk. The slow-growing tree is threatened by other cash crops, and its preservation most likely lies in its genetic improvement.

"A shea tree can take 25 years or more to come into production, so it can be very costly for a farmer to wait that long and wonder if a tree is worth keeping," says Hale. "With such a long growing period, traditional breeding strategies simply aren't viable. Through genome-enabled tree selection, we can start moving the needle on this difficult species."

RETHINKING ENVIRONMENTAL POLICIES

There are many federal, regional, state and municipal environmental policies in New Hampshire that are intended to protect natural areas and improve life in the state. This includes building and land conservation policies designed to mitigate the effects of climate change, such as sea level rise, coastal erosion and flooding, and policies that aim to improve access to "green assets," such as healthy river systems, public transportation and bike trails. But do these policies work for everyone? That is the question that drives much of the research of **Catherine Ashcraft,** assistant professor of natural resources and the environment.

Ashcraft's flood mitigation research focuses on the policies in place in New Hampshire that manage flood risks through nature-based approaches, like living shorelines and buffers. "I'm trying to understand what priorities are reflected in those policies," she says. "Who participates in figuring out where these projects go, what the objectives are, and how outcomes are evaluated."

Her current work includes a Collaborative Research Excellence (CoRE) interdisciplinary project with **Shannon Rogers,** associate extension professor of nature-based economic development, and **Jayson Seaman,** associate professor of recreation management and policy. The team is studying how access to natural environments and green spaces impacts the economic, social and ecological resilience of communities.

Also engaged in the research with Ashcraft are **Michal Zahorik,** a doctoral student in the natural resources and Earth systems science Ph.D. program, and **Cody Crytzer '22G** and **Claire McGlinchey '22G,** both of whom are pursuing a master's degree in natural resources.

Ashcraft's focus is on how diversity, equity and inclusion fit within this "nature economy" and whether access to these resources fosters equity and social justice, particularly against the backdrop of a changing climate.

"Ultimately, we aim to develop tools and create spaces that amplify the priorities and needs expressed by underserved and overburdened communities so they're reflected in policy decisions," says Ashcraft. "It's about recognizing needs and priorities and supporting the capabilities of organizations and individuals to impact the decisions that affect them."

ON THE FOREFRONT

Campus veterinary diagnostic lab at work safeguarding animal and public health in New Hampshire

When researchers at the New Hampshire Veterinary Diagnostic Laboratory (NHVDL) at UNH found *Listeria monocytogenes* bacteria in two gray foxes about 18 months ago, they knew the discovery had potentially serious implications for both animal and human health. Not only were these cases part of a significant uptick in listeriosis cases over the past few years, but one of the two cases of the bacteria, which can also sicken humans and farm animals, was highly virulent with resistance to multiple antibiotics.

The researchers immediately reported their discovery to New Hampshire's state veterinarian and COLSA affiliate faculty member **Stephen K. Crawford,** who then alerted key stakeholders in the state.

"Antimicrobial resistance is a real and evolving concern for human health, animal health and environmental health," says Crawford. "Findings like this in wildlife clearly demonstrate the direct links among these three worlds. Passing antimicrobial resistance is not a one-way street from animals to humans. There is still much to learn, and discoveries like this one at the NHVDL provide those opportunities."

The NHVDL has been on the forefront of animal disease detection in and around the state for more than 50 years. Lab veterinary pathologists and staff, with help from UNH student technicians, process thousands of samples each month — from blood and tissue isolates to necropsies of dead animals — for wildlife, domestic pets, livestock, zoo animals and marine life. They then relay results back to regional veterinarians, farmers, wildlife nonprofits and state and federal agencies.

"The majority of infectious and emerging diseases in humans are zoonotic, which means they can be transferred from animals to humans," says **Robert Gibson,** manager of the lab. "Our ability to accurately and rapidly identify infectious agents is critical in safeguarding public health."

Climate change, which he says can influence disease threats, has created new challenges.

"There are diseases we've seen that parallel larger trends and correlate with diseases that are more certainly attributable to climate change," says **David Needle,** clinical associate professor of molecular, cellular and biomedical sciences and pathology section chief at the NHVDL.

One example is an emerging fatal fungal disease in wild North American porcupines that the lab began tracking in 2012. The disease, which is caused by a fungus that also causes ringworm in dogs, cats and people, has a possible link to the changing climate.

"Fungal pathogens are devastating wildlife worldwide," Needle says. "So this may be part of the climate change and globalization associated with the emergence of fungal diseases."

Following the discovery of the disease in porcupines, Needle and others from the lab collaborated with colleagues at Cornell University to pioneer a novel process to identify fungi in archived tissue samples, which advanced the ability to detect, track and understand the evolution of fungal diseases.

Another disease that may have a climate change link is avian malaria, a globally common and potentially deadly mosquito-borne parasite not found in New England loons until a few years ago.

"In 2015, a loon from Lake Umbagog [in Coös County, N.H.] submitted by a wildlife biologist was found to have classic signs of avian malaria," says **Inga Sidor,** a clinical associate professor in the department of molecular, cellular and biomedical sciences and senior pathologist at the NHVDL. "I have been studying loon mortality in the Northeast since the late 1990s and had never seen this before."

After the initial case, Sidor and Ellen Martisen, a molecular parasitologist from the Smithsonian Institute, began tracking emerging cases of loon mortality from the disease. "In the case of the loons, we believe that climate change may be leading to northerly expansion of a mosquito species carrying a particularly pathogenic disease strain," Sidor says. "But until we prove the parasite is in the mosquito, it's correlation not causation."

In the years since the first case, they have seen several more cases of mortality in loons from New Hampshire and Maine, which Sidor describes as an emerging significant cause of death in this population. She and Martisen are working to define the geographic range of the parasite and to better understand whether infections are always deadly and what host or parasite factors may contribute to mortality in the infected birds.

"Loons are an iconic species of the north and act as a sentinel species in a number of ways. They reflect the health of the lakes they live in, the abundance and quality of fish, and the robustness of their ecosystems, all of which we share with them," says Sidor. "We live around those lakes, eat those fish and benefit in many ways, personal and economic, from the health of our lakes and loons. This story is, we think, another warning of the effects of climate change and environmental degradation."

In addition to diagnostic services, the NHVDL serves as a critical research and educational resource for UNH students who will be part of the next generations of pathologists, diagnostic technicians and veterinary personnel. The lab and faculty provide extensive hands-on research experience and relevant animal courses for prospective veterinary school applicants, which gives them an admissions advantage over graduates from other pre-veterinary programs.

SPOTLIGHT: EMILY INNIS '22

"I thought that I wanted to work in the veterinary field but was unsure of exactly what I wanted to do," says **Emily Innis '22,** a biomedical science major with a focus on medical and veterinary sciences, who joined the New Hampshire Veterinary Diagnostic Lab (NHVDL) in September 2020 as an undergraduate laboratory technician. "Working at the lab has solidified that I am passionate about microbiology," she says, "and I have decided to pursue a master's degree after I graduate in May."

In the lab, Innis handles a variety of tasks, including processing microbial samples, prepping antibiotic sensitivity tests and performing a highly specialized form of mass spectroscopy to identify pathogens — experiences that are highly valuable for her future career in the field of microbiology. She credits an improvement in her classwork to the hands-on experience she has gained while working in the lab.

A BATTLE FOR BEECH

Understanding the disease that's been attacking the American beech tree for more than a century — and could spread faster with climate change

Over half of New Hampshire's deciduous and mixed forests are dominated by maple, birch and beech trees, which define the state's landscape, contribute to the economic resiliency of local communities and help sustain wildlife species. But like billions of trees in eastern North American forests that have been killed by diseases and insects, the iconic American beech has been ravaged by beech bark disease for more than a century, and large, stately beech have been replaced by shrub-like thickets and small, pockmarked trees.

"This shift from larger to smaller beech trees results in major reductions in carbon storage capacity, nut crop production, and the availability of cavity nesting habitat, and generally alters the look and feel of the forest," says **Jeff Garnas,** associate professor of forest ecosystem health. In New Hampshire, that means less food for wildlife like deer, lower quality bird habitat and numerous beech sprouts that out-compete more economically valuable timber species, such as sugar maple.

What makes beech bark disease particularly difficult to study is its manifestation through a "disease complex," so termed because the disease emerges via the interaction of an insect — in this case, the felted beech scale — and at least two species of pathogenic fungi that cause localized wounds, called cankers, on the trunks. These disease agents interact with host trees, the environment and one another in distinct ways, making the disease itself extremely hard to predict and understand.

Using genetic sequencing and statistical modeling, COLSA researchers led by **Eric Morrison,** a New Hampshire Agricultural Experiment Station (NHAES)-funded postdoctoral scientist in Garnas's lab, are investigating the key interactions that determine the disease's severity. Researchers want to know which fungi are present in beech bark in infected and uninfected trees and how these communities vary both geographically and across stages of tree decline, symptom severity and duration of infection. Morrison recently began researching how the fungi have spread and whether they have locally adapted to climate and host conditions.

"It's an open question what genes will be involved in helping the fungi adapt to warmer temperatures," says Morrison. "Based on population genomic data, we are already finding signals of climate adaptation."

Kenneth Windstein, a NHAES-funded doctoral student in Garnas's lab, studies trees that persist in infected zones, also known as aftermath zones. According to Windstein, a changing climate creates greater urgency to understand beech bark disease. Mild winters with low precipitation lead to drought stress in American beech and could create conditions for larger populations of scale insects to survive the winter, particularly on already infected trees. In turn, infected trees may experience disease in a more severe form or even exhibit increased mortality.

Garnas says his lab's research is contributing to scientific understanding of how beech bark disease behaves in forests under a changing climate and is providing a significant step forward in the management of this complex and nuanced challenge to forest health.

THE FUTURE OF THE FOREST

Research explores the impact of climate change on two keystone tree species

The New Hampshire seacoast experienced severe summer droughts in 2016 and 2020, but a small plot at UNH's Thompson Farm Earth Systems Observatory has seen droughts of the artificial variety for each of the past six years. To simulate once-in-a-century drought conditions and learn more about the impact of drought on New England's forests, **Heidi Asbjornsen,** professor of natural resources and the environment, and her colleagues built two 10,000-square-foot structures supporting gutters that channel half the rainfall away from a stand of red oak and white pine.

Forests play a critical role in protecting and regulating water resources, and red oak and white pine in particular have significant economic and ecological value across much of the Northeast.

"Climate change is already causing an increase in the frequency and intensity of extreme rainfall events, including both intense storms and droughts," says Asbjornsen. "This trend is expected to continue in the future and will likely have important consequences for plant growth and mortality, pest outbreaks, and the capacity of forests to provide numerous benefits to society."

White pine and red oak respond differently to the moisture stress that occurs during a drought. White pines tend to be relatively conservative in their water use, reducing water uptake and photosynthesis as moisture becomes more limited. Although this allows the trees to protect their tissues against damage from prolonged drought, it comes at the expense of growth.

In contrast, red oak has been considered a more drought-tolerant species due to its deep roots, ring-porous wood, and a less conservative water-use strategy that allows it to continue photosynthesizing even as moisture decreases. However, the data show that once soil moisture levels fall below a certain threshold, red oak also shuts down its water use and photosynthesis, suggesting that it may experience physiological stress during extreme droughts.

Figuring out how white pine and red oak respond to drought and what

81 percent

PROPORTION OF LAND IN NEW HAMPSHIRE THAT'S FORESTED

4.8 million

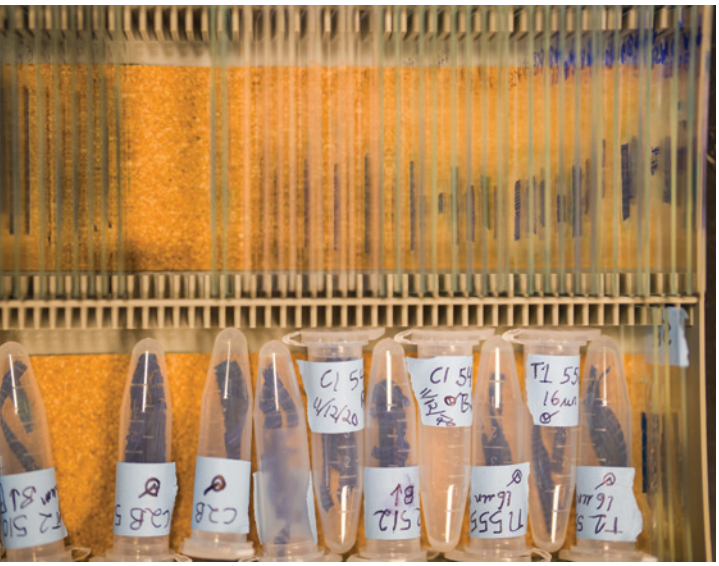
NUMBER OF ACRES OF FORESTS IN NEW HAMPSHIRE

#2

NEW HAMPSHIRE'S RANKING IN THE LIST OF MOST FORESTED U.S. STATES

$2.26 billion

DIRECT ANNUAL IMPACT OF FORESTS ON NEW HAMPSHIRE'S ECONOMY, APPROXIMATELY HALF OF WHICH IS RELATED TO FOREST-BASED MANUFACTURING AND THE OTHER HALF TO RECREATION AND TOURISM



ecological traits allow them to adapt to changing conditions is one part of the research. Asbjornsen is also interested in how the trees recover when the drought ends. To address this question, she and her team — which includes **Sam Zuckerman '24G,** postdoctoral researcher **Mauro Brum** and research scientist **Matthew Vadeboncoeur** — have started looking at specific anatomical and physiological traits that may provide clues about each species' drought resilience. Once the drought structures are removed in late 2022, the team will be able to measure more precisely the ability of the trees to recover from drought.

"Our hypothesis is that with extreme drought, red oak may actually be the more vulnerable species," says Asbjornsen. "That's really important to know because our typical understanding of red oak is that it's more drought tolerant and can withstand extended periods of moisture stress."

Under future climates, Asbjornsen says, droughts may be too severe for red oak to fully recover due to catastrophic damage to its tissues. Even if the trees don't die, Asbjornsen says, the data so far suggest that they can still become extremely stressed. In contrast, white pine's health is more likely to suffer during prolonged periods of more moderate drought, which over time may also affect its ability to recover. The nature of the drought and how the trees respond will determine the long-term survival outcomes for these species.

One possible management solution would be to strategically plant trees in places where future climate conditions are likely to be most favorable for their survival — something that's not currently done in the Northeast but is common in other regions.

"We rely mostly on natural regeneration," says Asbjornsen. "But the climate is changing too rapidly for species to keep up by migrating. As variability increases and droughts become more common, sites further north in the state are going to be more suitable for species that today are found further south."

As a part of another project, Asbjornsen is studying the feasibility of assisted migration, which involves moving tree species into areas where they normally do not grow but where scientists anticipate the future climate will be favorable for the particular species. The work has the potential to facilitate the establishment of future forests in the Northern Forest region extending from eastern Maine to the Adirondacks of New York that will be better adapted to warmer, drier climates and support the sustainability of both forest ecosystems and the local communities that rely on them.

Forests provide goods and services such as timber, fuel and other wood products; reliable supplies of clean water; a diversity of non-timber forest products such as tree syrups, mushrooms and forage production; habitat for plant and wildlife species; and recreational opportunities.

"The results of this research will improve understanding about the impacts of climate change," Asbjornsen says, "and provide policymakers, forest managers and landowners with practical tools for improving the health and sustainability of forests into the future."

A FEW OF OUR FAVORITE PLACES

Stonehouse Pond in Barrington is a special place. There is a spectacular view after a fairly short hike. In the summer, the pond is great for swimming. People rock climb there as well. It is special to me because I used to take my dog Melvin there. He knew the trail better than anyone and loved to go for a dip in the pond to cool off.

-Kelly Giraud, *associate professor*

Franconia Notch in the White Mountains.

-Sarah Proctor '96, *clinical associate professor and veterinary technology program coordinator*

Zealand Trail to Zeacliff. Zeacliff has some of the best views in the Whites. The best part is the trail also has a beautiful pond, waterfall and one of the AMC [Appalachian Mountain Club] huts.

-Wendy Rose, *program manager*

Great Bay National Estuarine Research Reserve.

-Elizabeth Harvey, *assistant professor*

One of my favorite places is Foss Farm. It is a great place to walk my dog and to bird. We are fortunate to have the forested lands we do so accessible to campus.

-Kim Babbitt '84, *associate dean of academic affairs*

Burley-Demeritt Farm in Lee, New Hampshire.

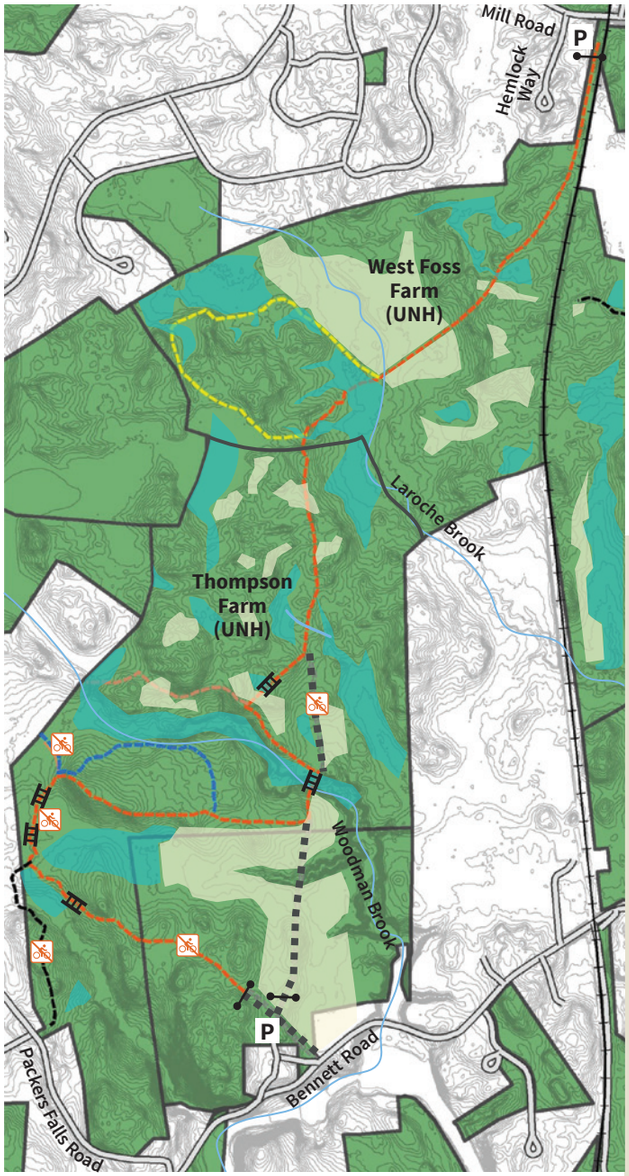
-Ryan Courtright, *farm manager*

The Oyster River Trail features the glorious Spruce Hole Bog and the little waterfalls along the Oyster River. The Orange Trail that passes through West Foss Farm and Thompson Farm is delightfully diverse, with marshlands, woodlands and meadows, and offers access to several other trails. What surprises me is how few people I encounter on these trails, given their proximity to the campus. Check them out!

-Rick Cote, *professor and director of the Center of Integrated Biomedical and Bioengineering Research*

EXPLORE:

UNH'S THOMPSON FARM AND WEST FOSS FARM



LEGEND

- P — Parking
- Gate
- Town or State Road
- Trail
- Access Road
- Bridge, Footbridge
- UNH, Town or Fish and Game Land
- Field or Young Forest
- Wetland
- River or Stream
- Not Bike Friendly

The university's woodlands and natural areas — 22 managed properties in the state totaling roughly 3,600 acres — are managed by **Steve Eisenhauer** and his team at the UNH Office of Woodlands and Natural Areas, which is part of COLSA. The properties provide educational resources, research opportunities and recreational assets for the students and citizens of New Hampshire and beyond.

Thompson Farm is a 204.7-acre property located in Durham, New Hampshire, that includes agricultural fields, woodlands and streams. There is a small working farm and an extensive trail system that connects with the trail system at West Foss Farm. There is also an active beaver swamp on the property.

Mountain biking, cross-country skiing, hunting and running are the main recreational uses of the Thompson Farm woodlands, as well as sugar maple tapping and timber harvesting.

West Foss Farm is an approximately 91.8-acre property located off Mill Road in Durham. The property is used for mountain biking, walking, running and cross-country skiing. Proximity to campus and unique vegetation types make this a popular choice for UNH class lab trips.

To learn more, please visit colsa.unh.edu/woodlands.

Please Remember:

- Leash your dog and take your waste bags with you.
- Use only marked trails or access roads. Trail construction or modification is prohibited.
- These properties are multi-use. All hunters must register with UNH Police.
- No camping or fires allowed.
- Do not disturb vegetation. Research plots are often unmarked.
- Register recreational groups of 10 or more and all research and education use with the Office of Woodlands and Natural Areas.

Questions? Contact woodlands@unh.edu or call (603) 862-3951.

Directions

To Thompson Farm:

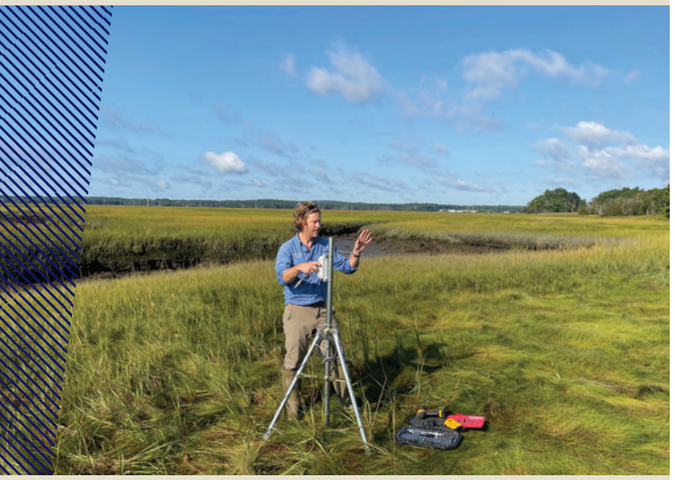
To West Foss Farm:

The properties abut one another and can be accessed from each other.

$3.1M GRANT SUPPORTS COASTAL RESEARCH
IN NEW HAMPSHIRE AND MASSACHUSETTS

UNH researchers have received $3.1 million from the National Fish and Wildlife Foundation for an innovative project that will protect the Great Marsh — 20,000 acres of salt marsh along the coasts of northeastern Massachusetts and southeastern New Hampshire — and the wildlife and people who share it.

The project, led by **Gregg Moore,** associate professor of biological sciences, is pairing marsh restoration and resilience efforts in the Hampton-Seabrook Estuary with dune stabilization measures from northern Massachusetts to southern New Hampshire. Researchers will use a variety of restoration techniques coupled with the latest technology, such as drone-based modeling, and will invite stakeholders, community volunteers and K-12 students to participate in creating solutions to stabilize and manage these fragile ecosystems.



"The Great Marsh is a dynamic watershed system that serves as the primary coastal resilience landform protecting homes, businesses, infrastructure and the invaluable resources of the estuary," says Moore, principal investigator on the grant. "The marsh exists because of the fragile dunes, and now these coastal habitats are in peril from threats like sea level rise, coastal storms and other pressures."

David Burdick, research associate professor of coastal ecology and restoration, and **Alyson Eberhardt '04G, '19G,** extension specialist at UNH Cooperative Extension and New Hampshire Sea Grant, are co-principal investigators. The researchers and their partners have been developing approaches to bolster the resilience of the broader Great Marsh for more than 15 years. This project will build on that experience.

WATER'S WAYS

UNH research is focusing on inland streams and rivers that play an outsize role in water quality and ecosystem health

Nearly 60 years after Luna Leopold wrote that "rivers are the gutters down which flow the ruins of continents," researchers at COLSA are collecting data to parse the details. The hydrologist, son of famed environmentalist Aldo Leopold, understood that the dynamic ecosystems in small rivers and streams make big contributions to the environment.

News about water quality problems usually focuses on large-scale crises — rarely, if ever, does it concentrate on the contribution of upstream rivers and streams in maintaining water quality. These inland flowing waters, once considered only conduits, are key factors in mitigating pollution that comes from roadways, lawns, sewage treatment plants, agriculture and more.

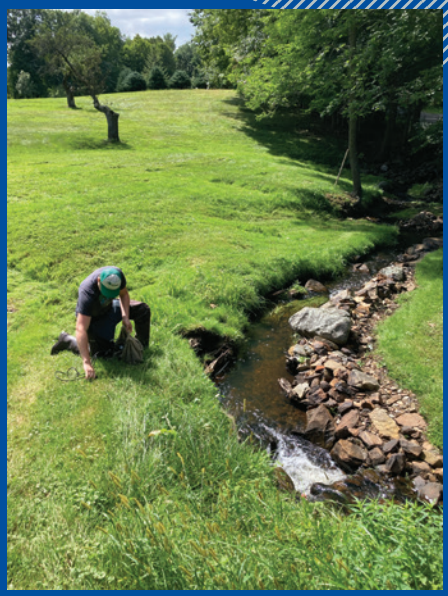
"These flowing waters are dynamic systems that transform the ecosystem," says **Adam Wymore,** research assistant professor of natural resources and the environment.

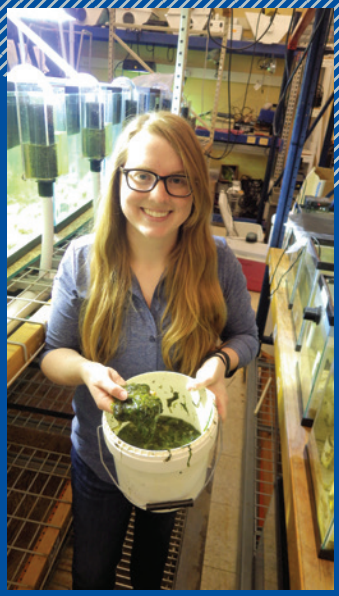
But their influence is largely determined by climate. Wymore explains that rivers are a double-edged sword: They can help protect the environment, but they can also add to its pollution. Rivers can transform pollutants, such as nitrogen-based fertilizers, into less harmful forms through microbial reactions. But during periods of heavy rainfall, rivers can send nitrogen and other solutes barreling downstream, where they collect in estuaries and harm aquatic plants. The sensitivity of these ecosystems to changes in weather is becoming ever more important as climate change causes erratic and sometimes extreme weather.

Over the past decade, researchers in the department of natural resources and the environment have been tracking New Hampshire's 800 lakes and ponds and approximately 19,000 miles of rivers and streams. They and their colleagues have deployed roughly 250 sensors around the state, taking measurements every 15 minutes and gathering data on salt concentration, organic matter, nitrate, turbidity, pH and more. As climate change accelerates and New Hampshire's population continues to tick up, these researchers hope to better understand how these ecosystems are responding.

Wymore is particularly concerned about weather anomalies like the one in summer 2021, when the longest drought in New Hampshire's history was punctuated by one of the wettest summers on record. He recently published research showing that during these periods of heavy rainfall, watersheds act as conveyor belts, sending solutes and potential pollutants downstream.

Wymore says this flip-flopping between wet and dry conditions could lead to increased pollution, and he is partnering with watershed managers to learn when it might be beneficial to adjust flow conditions — releasing dammed





water from reservoirs, for instance — to mitigate pollution, including the potential emission of greenhouse gases. In summer 2020, for example, water was released from Dolloff Dam at Pawtuckaway Lake to restore the Lamprey River, which was at historically low flow rates.

"Rivers are unique ecosystems, in that they are very dynamic because of flow," says **Wilfred Wollheim,** associate professor of natural resources and the environment and a freshwater ecosystem ecologist. Wollheim is studying plastic accumulation in New England's rivers and streams, trying to determine how much pollutes the rushing waterways and how much gets washed out to sea. He says it's important to understand that these ecosystems are all connected: What happens upstream, in terms of land use, plastic pollution and fertilizer application, may be stored in rivers (in the case of plastic), removed by ecosystems (in the case of nitrogen) or travel and have important implications for places downstream. One of those places is Great Bay.

Great Bay is a large tidal estuary fed by three rivers — the Lamprey, Squamscott and Winnicut — and it has experienced declining water quality for decades. Beginning in the 1990s, scientists started noticing that eelgrass in the bay was disappearing at an unprecedented rate. The plant, a cornerstone species important for providing food, habitat and better water quality, was likely falling victim to excessive nitrogen inputs from a variety of sources.

Bill McDowell, professor of natural resources and the environment and director of UNH's New Hampshire Water Resources Research Center, recently received a grant from the National Oceanic and Atmospheric Administration to study how eelgrass is responding to the recent declines in nitrogen inputs to Great Bay that have occurred due to upgrades in sewage treatment facilities by multiple local communities. He hopes the reestablishment of the eelgrass will be a "self-healing process," with the growth of more eelgrass improving the water quality and the water quality in turn leading to more abundant eelgrass. "The towns would be excited about this," he says, "since it means that investments in reducing nitrogen inputs to the bay would be magnified by improved growth of eelgrass."

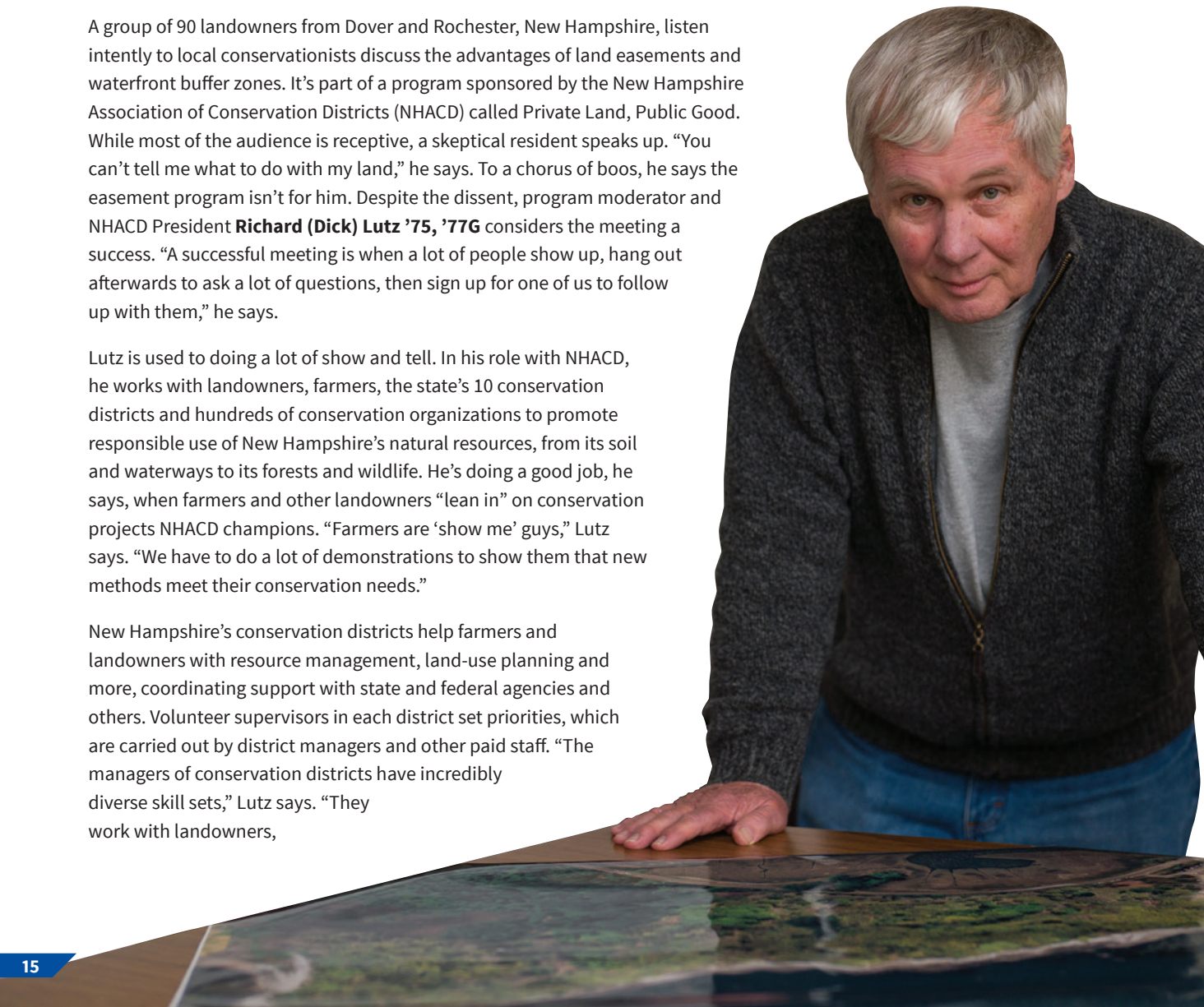
McDowell is also interested in questions around land use and development. New Hampshire's population has been increasing steadily over the past four decades, and changes in land use are predicted to continue. McDowell has been building simple predictive models using sensor data and other long-term data from research sites around the region, including the Lamprey River Hydrologic Observatory in Rockingham County, to understand how this growth will affect the watershed. His team is analyzing how agriculture, suburban development and even sewage treatment plants affect water quality, as well as making models to inform zoning decision making. McDowell is hoping to capitalize on the long-term data being collected by UNH to gain new insights into the effects of climate change and development in the region. "It's exciting times for understanding water quality right here in New Hampshire," he says.

In the years to come, the conclusions reached by Wymore, Wollheim, McDowell and their colleagues will inform decisions about a myriad of issues such as dam removal, zoning and land use at the local level. As New Hampshire's population continues to grow and erratic weather becomes commonplace, it will be more important than ever to understand how best to manage watersheds. Knowing where to place housing developments and sewage treatment plants, when to release water from dams, or even when to repair crumbling dams or dismantle them altogether could mean the difference between New Hampshire's waterways becoming polluted or staying healthy and clean. The small decisions made upstream will no doubt ripple throughout the ecosystem to Great Bay, the Gulf of Maine and beyond.

COMMON GROUND

Richard Lutz ’75, ’77G helps New Hampshire landowners “lean in” on conservation

A group of 90 landowners from Dover and Rochester, New Hampshire, listen intently to local conservationists discuss the advantages of land easements and waterfront buffer zones. It’s part of a program sponsored by the New Hampshire Association of Conservation Districts (NHACD) called Private Land, Public Good. While most of the audience is receptive, a skeptical resident speaks up. “You can’t tell me what to do with my land,” he says. To a chorus of boos, he says the easement program isn’t for him. Despite the dissent, program moderator and NHACD President **Richard (Dick) Lutz ’75, ’77G** considers the meeting a success. “A successful meeting is when a lot of people show up, hang out afterwards to ask a lot of questions, then sign up for one of us to follow up with them,” he says.



Lutz is used to doing a lot of show and tell. In his role with NHACD, he works with landowners, farmers, the state’s 10 conservation districts and hundreds of conservation organizations to promote responsible use of New Hampshire’s natural resources, from its soil and waterways to its forests and wildlife. He’s doing a good job, he says, when farmers and other landowners “lean in” on conservation projects NHACD champions. “Farmers are ‘show me’ guys,” Lutz says. “We have to do a lot of demonstrations to show them that new methods meet their conservation needs.”

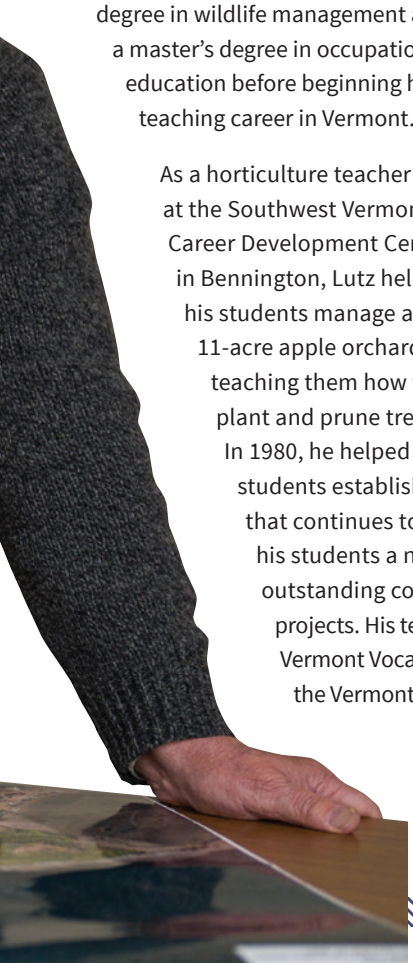
New Hampshire’s conservation districts help farmers and landowners with resource management, land-use planning and more, coordinating support with state and federal agencies and others. Volunteer supervisors in each district set priorities, which are carried out by district managers and other paid staff. “The managers of conservation districts have incredibly diverse skill sets,” Lutz says. “They work with landowners,

easements, fish, water, farm management, erosion control. Their wheelhouse of knowledge is huge."

Lutz, who is also a volunteer supervisor with the Rockingham County Conservation District, rarely has a dull day. He develops policies and secures funding to provide farmers with equipment like no-till planters to improve soil quality. He helps restore New England cottontail rabbit habitat by planting native plants and bushes in places like Dover's Bellamy River Wildlife Management Area. He moderates public programs, explaining how responsible land management benefits New Hampshire waterways, and conducts tours in the field for state legislators and congressional representatives to show where state and federal tax dollars are spent. "Our group touches more than 700 conservation organizations in New Hampshire," says Lutz. "We team up with everyone to make things happen."

Teacher and Advocate

Lutz has spent much of his life in the outdoors or advocating for its protection. Growing up in Hollis, New Hampshire, he was an avid outdoorsman. At UNH, he considered becoming a biology teacher until his adviser, **Bill Mautz,** now a professor emeritus, recommended teaching forestry. "That changed the course of my career," Lutz says. He went on to receive a bachelor's degree in wildlife management and a master's degree in occupational education before beginning his teaching career in Vermont.



As a horticulture teacher at the Southwest Vermont Career Development Center in Bennington, Lutz helped his students manage an 11-acre apple orchard, teaching them how to plant and prune trees. In 1980, he helped his students establish a local farmers market that continues to this day and that earned his students a national award for outstanding community development projects. His teaching accolades include Vermont Vocational Teacher of the Year and the Vermont AgriScience Teacher Award.

In 2006, Lutz became career and technical education director of the Wilbur H. Palmer Career and Technical Education Center, a vocational school on the campus of Alvirne High School in Hudson, New Hampshire. He grew enrollment in the agriculture program to 550 students, the fourth-largest agricultural school enrollment east of the Mississippi. The school's farm earned a Farm of Distinction Award from the New Hampshire Department of Agriculture in 2010. After retiring from teaching, Lutz became executive director of NHACD for a year and also a consultant, helping wild blueberry growers and lobstermen in northern New England write business plans. He was named NHACD president in 2020.

"Loud and Proud"

Lutz intends to keep promoting NHACD's efforts. He's anticipating an increase in federal funding for soil-based carbon sequestration, a method of removing carbon from the air by storing more of it in soils. Budget increases would expand opportunities for farmers and landowners interested in following land management practices that encourage soil carbon storage. "If some of the proposed funding comes through, we'll sponsor demonstrations for farmers and landowners on how to measure the level of carbon in their soil and sequestering it," Lutz says.

He also hopes to raise visibility for NH Envirothon, an annual academic competition for high-school-age students that's sponsored by NHACD. The event provides students with problem-solving, team-building and leadership experience while testing their knowledge of environmental subjects like soils, aquatics, wildlife and forestry. Plans are in the works for a conservation-themed night at a New Hampshire Fisher Cats game, an opportunity "for kids to meet professionals, then watch a baseball game and have fun," Lutz says.

"Conservation districts like to be quiet and unseen," he says. "I'm of the opinion if you're loud and proud, people will talk back. We've got a lot of great things to show why funding our initiatives is important." As always, Lutz is eager to show and tell.

Transforming Students Into Climate Leaders

The next generation of climate science researchers is getting its start at UNH, thanks to three new initiatives that will engage students with international research experiences at global flashpoints of our changing climate. The projects, all funded by the National Science Foundation (NSF), will send undergraduates, graduate students and faculty mentors from UNH, minority-serving institutions (MSIs) and international research centers to Sweden, Finland and Ecuador.

International Collaborative Experiences to Track Arctic Lake Systems (ICE-TALKS) will provide research opportunities in Sweden and Finland for nine UNH graduate students and nine undergraduate students from partnering MSIs. While the overarching goal of the project is to develop consistent observations of how Arctic lake systems are changing under thawing conditions, ICE-TALKS will also build students' research skills — and enthusiasm — for understanding the effects of climate change on the planet. **Ruth Varner,** professor of Earth sciences and director of the Leitzel Center, and **Jessica Ernakovich,** assistant professor of natural resources and the environment, are UNH collaborators.

A second project will take 18 UNH undergraduate and graduate students to the mountains and rainforests of Ecuador to explore that region's water-related challenges from both science and policy perspectives. **Heidi Asbjornsen,** professor of natural resources and the environment, leads the project, called the Andean-Amazonian Watershed Experience: Exploring Sustainability of Mountain Ecosystems in Ecuador, or AWESOME. **Bill McDowell,** professor of natural resources and the environment, **Tom Safford,** associate professor of sociology, and **Catherine Ashcraft,** assistant professor of natural resources and the environment, are co-investigators, along with Shadi Atallah of the University of Illinois.

EMergent Ecosystem Response to ChanGE, or EMERGE, which launched at UNH last year with a $3.6 million NSF grant, is currently recruiting 30 undergraduate and post-baccalaureate students for paid summer research experiences. Students will develop projects that investigate how a rapidly warming Arctic is transforming permafrost peatlands into wetlands and will travel to Arctic Sweden to conduct their research.

UNH faculty involved in the research include Varner and Ernakovich, as well as **Steve Frolking,** research professor in Earth sciences; **Michael Palace,** associate professor in Earth sciences; **Florencia Fahnestock,** research scientist in Earth sciences; **Melissa Aikens,** assistant professor in biological sciences; **Kate Siler,** program coordinator of UNH ADVANCE; and **Erik Froburg,** education and outreach specialist at UNH's Leitzel Center.

"Hands-on research experiences and cultural exchanges help students to see the world and themselves in new ways," says Ernakovich. "These new student-centered research programs help our collective efforts to transform students into leaders in the study of our changing Earth system."

DEVELOPING A BETTER WAY TO MONITOR MARINE HABITATS

Grant Milne '24G, a doctoral student in the marine biology program, is developing a minimally invasive method to identify the environments that exist in various coastal habitats, using passive acoustic monitoring and genetic seawater sampling.

COLSA: Why is your research important?

Grant: As waters in the Gulf of Maine warm at unprecedented rates, the ecosystems present undergo rapid change. The geographic ranges of warm-water species are expected to expand and native species will experience new biological and geophysical pressures, making techniques for monitoring change in Gulf of Maine habitats essential for assessing the impact of these environmental shifts.

One of the major obstacles for research in marine habitats is reduced accessibility when compared to terrestrial research. Reduced light transmission in water means that visual observation is difficult. Hands-on research requires special training in scuba and is time and depth limited, and many methods for surveying marine biota are disruptive or destructive, such as trawl surveys, hooks or long lines, trapping and other methods that involve disturbance or removal of organisms in their natural habitat.

COLSA: What drives you?

Grant: My passion for conducting research on aquatic ecosystems comes primarily from spending countless hours of my life in lakes, streams and rivers, which cultivated a deep internal appreciation for the water and the organisms that call the water their home. Nearly all my hobbies from childhood into adulthood have revolved around water, and I have a strong desire to give back to the aquatic ecosystems to which I attribute so many positive experiences in life.

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CANDID CAMERA

UNH researchers are developing a unique wildlife monitoring system for the Granite State

With New Hampshire's vast forested lands home to more than 500 vertebrate animals, the Granite State's wildlife populations are important to the ecological, recreational and economic sustainability of the state. Managing and conserving New Hampshire's wildlife species requires robust data on where they are located and the size of their populations. However, this information is often challenging to obtain, as many wildlife species are difficult to monitor and populations fluctuate from year to year.

Expanding threats like climate change make it even more important to monitor wildlife communities so we can understand how species adapt and survive in the ever-changing landscapes they share with humans.

Remington Moll, assistant professor of natural resources and the environment, along with doctoral student **Andrew Butler** and researchers from the New Hampshire Fish and Game Department, are harnessing the increased quality of trail cameras and improved models for analyzing the images to develop an efficient program to monitor secretive furbearer species like fox, bobcat, coyote and fisher and help inform management and conservation decisions.

Residents and visitors to New Hampshire spend more than $280 million annually on viewing wildlife in the state, according to the U.S. Fish and Wildlife Service. Even if Granite Staters do not see many wildlife species regularly, they often strongly value them, says Moll.

The researchers are analyzing more than 250,000 wildlife images recorded by trail cameras at more than 145 research sites throughout southeastern and central New Hampshire. They plan to expand the study across the entire state.