

FY 2020 Annual Report of Accomplishments and Results

Maine

University of Maine

Cooperative Extension & Maine Agricultural and Forest Experiment Station (MAFES)

I. Report Overview

The NIFA reviewer will refer to the executive summary submitted in your FY 2020 Plan of Work located in the Institutional Profile. Use this space to provide updates if needed.

1. Executive Summary (Optional)

The University of Maine Cooperative Extension and the Maine Agricultural and Forest Experiment Station (MAFES) have served the people of Maine for more than 100 years. Over 190 faculty and professionals contribute to the outreach, research, and development programming benefiting the people of Maine. We ensure our research and extension outreach programs meet local needs by grounding them with input from a variety of advisory groups, regular meetings with constituency groups at field days and other events, county extension advisory committees, and through direct faculty and administrator interaction with cooperators and constituents.

UMaine Extension is a partnership of county, state and federal funding. By conducting Extension programs in every Maine county, we support UMaine's public education and service role as a land grant and sea grant institution. Extension helps support, sustain, and grow the food-based economy, and conducts the most successful out-of-school youth educational program in Maine through 4-H.

MAFES is the College of Natural Sciences, Forestry, and Agriculture's center for applied and basic research. MAFES faculty and scientists use cutting-edge tools to address new challenges for Maine's natural resource-based industries and develop the new knowledge that fuels innovation.

In 2020, UMaine Extension and MAFES programs continued to focus on **five critical issues**:

Maine Food System through research and outreach related to agriculture, aquaculture, food processing and distribution, business education, food safety, and human nutrition to create a safer, healthier, more accessible and increasingly productive food system.

Positive Youth Development through 4-H programs with a focus on the STEM disciplines to boost youth educational, career and life success.

Sustainable Community and Economic Development through programs related to small & home-based businesses, household resources, community assets, farm business management, natural resource-based industries, and commercial fisheries to increase the profitability and sustainability of Maine's natural resource-based industries and provide research support to rural communities to understand and adapt to economic and demographic challenges.

Climate Change by delivering new knowledge and technologies to help mitigate and adapt to the effects of climate variability and change.

Sustainable Natural Resources in agriculture and food sciences, forestry and wood products, fisheries and aquaculture, wildlife, outdoor recreation, and rural economic development to increase our understanding of and knowledge about Maine's natural resources to help the state manage these resources sustainably.

EXECUTIVE SUMMARY - UMAINE COOPERATIVE EXTENSION

Pandemic Response

As it has throughout the country and world, the pandemic presented hardships and challenges to Maine people and communities. Although much of our programming looked different in 2020, Extension continued to reach traditional clients, and we also gained many new clients, developed new tools, and increased accessibility as a result of our pandemic-related innovations. These innovations will strengthen our programs going forward.

In 2020, the pandemic prompted Extension to adapt many of its educational programs and delivery modes, and we did so with innovation, dedicated staff and volunteers, and new ways to deliver programming and engage with our clients. Examples of our program innovations are included in *Section V: Activities and Accomplishments*. In the wake of COVID-19, Extension quickly moved our workshops, classes, and events online. Between March 1 and December 31, 2020, unique pageviews on the Extension website increased nearly 30% over the same period of time the previous year.

- New resources were created and added to the website and social media, including COVID-19 support for Maine farmers, livestock producers, U-pick operations, cut flower and seedlings industries, and consumers.
- Weekly Zoom meetings allowed producers to share what was happening on their farms.
- New “Learn at Home” resources provided educational opportunities for parents, teachers, and youth during school closures.
- Horticulture and food preservation videos, webinars, interactive forms, and virtual office hours provided answers to an increased number of questions from home gardeners.

2020 Annual Report of Accomplishments and Results (AREERA)

- A new interactive locations map allowed clients to find Maine farm and seafood products; the map has been viewed 190,000+ times since it became available to the public on March 20, 2020.
- With the closing of state and county fairs, the first-ever Maine State Virtual Fair was created to recognize 4-H'ers for their efforts on projects they completed and skills they gained over the past year.
- Over 180 online events were promoted through Facebook, which had a reach of 470,000 views and 11,700 responses.
- Our popular Ask the Expert online form received 346 questions from Maine home gardeners between March 1 and December 31, 2020, nearly twice the number during the same period in 2019.
- 42 new publications were published specifically in response to the COVID 19 pandemic. These included: *Finding New Markets for Maine Farmers*, *Managing Garden Centers and On-Farm Seedlings Sales Safely in Maine*, *Best Practices for Washing Produce and Use of Sanitizers on Commercial Farms*, *Tips for Starting a Healthy Garden*, and *Maine Maple Tours: Guidance During COVID-19*. Extension typically publishes 22 new publications in a 12-month period.

Supporting Maine's Traditional and Changing Agricultural Economy

In 2020, Cooperative Extension delivered programming priorities to address the expressed needs of Maine people. Chief among our current priorities was broad work within the Maine food system, including a strong focus on agricultural sustainability and interrelated work in policy, research, production, processing, commerce, nutrition, food security, and food safety. Maine agriculture is diverse with important sectors that include potatoes, wild blueberries, maple, dairy, grains, livestock, poultry, fruits, vegetables, and ornamental horticulture. Even though Maine is 90 percent forested, the state has 7,600 farms, the largest number of any New England state. UMaine Extension continued to play a pivotal role in supporting a majority of these farms. Many of the recommendations to Maine's agricultural community come directly from research conducted at Maine Agricultural and Forest Experiment Station farms.

The Maine potato industry encompasses over 500 businesses employing over 6,100 people and providing over \$112 million in income to Maine citizens. The economic impact from our pest monitoring and educational programs for the 2020 season is estimated to be more than \$10 million.

Maine's wild blueberry industry, with 480 growers on 44,000 acres, annually produces as many as 100 million pounds of blueberries and has a direct and indirect economic impact of over \$250 million to the state's economy. Extension specialists and researchers provide research-based knowledge to blueberry growers through field and lab work directly with growers, graduate students, other researchers in the U.S. and Canada, and the Wild Blueberry Commission of Maine.

UMaine Extension outreach and research efforts improved crop productivity and efficiency by addressing pollinator population enhancement, weeds, pest insects, and diseases. The research-based knowledge provided to growers has enabled growers in Maine to remain competitive in the world marketplace and maintain a significant contribution to the state's economy.

Pest and weather damage are primary causes of significant damage to tree fruit crops, and tree fruit growers rely on UMaine Extension monitoring and management guidance to avoid or reduce pest and weather damage to crop quantity and quality. The Extension Tree Fruit IPM Program provides growers with regular newsletters, statewide field reports, and research updates, plus weekly on-farm scouting visits, situational analysis, weather data resources, individual consultations, meetings, and webinars. In 2020, the sum of crop value of crop losses prevented by the IPM program services was more than \$5.1 million, and across the 2,688 acres of orchard in Maine, estimated pesticide savings in purchase costs was over \$1.17 million.

Maine has the third largest maple production in the United States, behind Vermont and New York. Our maple industry has an annual statewide economic contribution of \$48 million in output, 805 full and part time jobs, and over \$25 million in labor income. Extension leadership in an annual International Maple Syrup Institute (IMSI) Maple Grading School supports this important internationally recognized industry.

Maine's dairy industry generates more than \$570 million a year for the state's economy and contributes more than \$25 million in state and municipal taxes. Dairy farms employ more than 1,300 people statewide, and the industry provides more than 4,000 jobs for Maine people. For public safety and quality control reasons, all dairy producers must keep pathogenic bacteria out of their dairy animals and their dairy products. At the UMaine Veterinary Diagnostic Laboratory (VDL), Extension staff screen both large and small dairies for mycoplasma, one of the most problematic pathogens for producers of milk or beef. Farmers avoid antibiotic use by culling animals with incurable infections, such as *Staphylococcus aureus* or *Mycoplasma bovis*. This protects public health, jobs, and this sector of the state's economy.

The expanding interest in locally grown grains among consumers and food businesses represents a new economic opportunity for grain growers looking for higher value and diversified markets. However, these new grain markets are dispersed and often seeking specific types and varieties of grain unfamiliar to Maine growers. UMaine Extension connects growers with buyers in high value markets and provides the production information needed to help growers succeed, creating increased revenue for Maine growers.

Coordinating and Investing in Agricultural Research and Extension Outreach

The Maine Food and Agriculture Center is a partnership of Cooperative Extension and MAFES and is located on the University of Maine campus in Orono. The center utilizes the 16-county reach of Extension, and many of Extension's recommendations to the state's agricultural community come directly from research conducted at Experiment Station farms. This research-extension partnership has been working for over 100 years and is as vital today as it was early in the 20th century. With \$5 billion in overall economic impact, agriculture, commercial fishing, and food processing include Maine's largest, fastest growing, and most promising industries. The Maine Food and Agriculture Center is growing to encompass all sectors of the burgeoning food economy, establish first-contact access to the programs and expertise available at all seven of Maine's

public universities and create opportunities for cross-campus and cross-discipline coordination and program development based on emerging needs in Maine's food economy.

The University of Maine Cooperative Extension Diagnostic and Research Laboratory houses our Veterinary Diagnostic Lab, Aquatic Animal Health Lab, Arthropod Lab, and Plant Disease Diagnostic Laboratory. This 28,000-square-foot facility is the most bio-secure location within the UMaine System and under one roof brings together scientists researching animals, agriculture, insects, and plants. The unique combination of researchers provides many teaching opportunities for students, as well as premier research and outreach facilities. By allowing for research contributions to agriculture, public health, communities, and wildlife, the lab benefits Maine in a variety of ways, including protecting the natural resource- and food-based economies, adding to food safety and human health, and providing unique diagnostic and testing services to farmers, homeowners and the public.

Offering Assurances of Healthy Animals and Products

The University of Maine Veterinary Diagnostic Lab (VDL) provides services to the veterinarians, livestock producers, and animal owners of the state. The lab performs a variety of diagnostic services, including necropsy, microbiology, virology, pathology, and special research support. It offers diagnostic support to veterinary clinicians and assists in finding solutions for agricultural producers using UMaine Extension resources. Our lab hires a small number of student workers of diverse backgrounds, who help us adapt our methods to develop better teaching and outreach materials for farmers, at the same time as they develop skills and knowledge that will help them in their veterinary careers. Our lab combines service, research, and education to improve agriculture, the food system, and the quality of life in Maine.

In 2020, UMaine VDL staff processed more than 3,500 samples and helped inform in excess of 160 clients about their animals' health. We allowed egg producers in Maine to keep marketing their product by providing FDA-required screening for *Salmonella enteritidis* (SE) on midsize to large egg farms. We helped dairies find out whether their cows were affected by mastitis, and if so, what "bugs" were responsible. We helped horse, sheep, goat, and cattle owners check to see if their animals need worming, and if so, with what kind of product; we also helped them find out if their chosen product actually worked in their animals. We helped the state animal welfare vets discover whether animals had died due to neglect or cruelty by providing fact-based forensic information gathered via necropsies.

Supporting Veterans Through Farming

In 2020, Extension created Boots-2-Bushels (B2B), a 9-month market gardening education and training program for military veterans and their family members. B2B strives to overcome some of the barriers military veterans face when transitioning to farming, such as lack of agricultural knowledge and business experience. Sponsored by Extension's Maine AgrAbility program and in partnership with the Maine Organic Farmers &

Gardeners Association (MOFGA), B2B takes participants from seed-to-salary in a hands-on and realistic project. Once trained, participants put their new knowledge into an intensive 6-month growing season to provide food for their families, other veterans, and community members. Said one B2B participant, “Farming is a form of security to support myself and my community. No matter what happens, farming is a cornerstone for any community to grow around.”

Helping Farmers Resolve Disputes

Extension is home to the Maine Agricultural Mediation Program (MAMP), part of the USDA Agricultural Mediation Program. The MAMP provides alternative dispute resolution through mediation to farmers, their lenders, and others directly affected by the actions of certain USDA agencies; in neighbor disputes; and in workplace and family disagreements that affect the farm. Mediation is voluntary and confidential, and involves a trained, impartial mediator helping participants to resolve disagreements. The Farm Service Agency estimates the typical cost savings for a simple adverse decision case is \$10,000, and as much as \$40,000 can be spent on cases that extend over years. In addition to savings in staff time, savings to producers and/or participants includes preservation of assets, properties, and relationships. In 2020, the MAMP estimates that as much as \$300,000 was saved through agricultural mediation in Maine.

Mobilizing Support for Food Insecure Citizens

Since 2000, UMaine Extension’s Maine Harvest for Hunger (MHH) program has mobilized gardeners, farmers, businesses, schools, and civic groups to grow, glean, and donate high-quality fresh produce to food pantries, shelters, and community meal sites throughout Maine. By the end of the 2020 growing season, 545 Master Gardener Volunteers, farmers, and members of the public grew, gleaned, and distributed 92,482 pounds of fresh produce, valued at \$156,294, to 219 food pantries, soup kitchens, and meal sites throughout the state. Since 2000, MHH participants have distributed more than 3.1 million pounds of food to citizens grappling with hunger.

Master Gardener Volunteers and Home Horticulture

UMaine Extension's Master Gardener Volunteer (MGV) program provides participants with research-based horticulture training and connects them with meaningful service projects in their community. Maine has 932 active MGV participants, 113 of whom were trained in 2020. In total, they donated over 7,600 hours to a variety of educational and food security projects throughout the state. In addition to the MGV program, Extension provides home horticulture support to Maine citizens. In 2020, our home horticulture programs reached more than 10,900 adults and 50 youth through in-person and virtual education programs, and over 19,100 people through videos, newsletters, television segments, and publications.

Promoting Positive Youth Development

An equally strong and traditional focus for Cooperative Extension is 4-H Positive Youth Development. In 2020, our program provided experiential educational and leadership programs for Maine youth, emphasizing the building of life skills necessary to be successful adults. Youth ages 5-18 participated in 4-H through clubs, camps, schools, and afterschool programs. Within the wide variety of 4-H programs we have a special focus on science, technology, engineering, and math (STEM) to help foster interest in these areas as avenues to successful careers. In all programs, youth were actively involved with their own learning, choosing which project areas they would like to learn about and working with volunteers and educators to further their own learning. Our four 4-H Camp and Learning Centers provided pandemic-modified outdoor, experiential learning for clubs, schools, and community, and we continued to expand Extension's youth programming through these venues. As always, volunteers were key to the success of Maine 4-H. Our volunteers worked in partnership with youth to focus on citizenship, leadership, and life skills development through "hands-on" learning experiences. In addition to making a difference in the lives of young people, volunteers also gained skills for their own personal and professional development.

Helping Youth Make Good Nutritional Choices

In 2020, 2,563 youth participated in the Maine Expanded Food and Nutrition Education Program (EFNEP). As a result of participating in EFNEP:

- 76% of youth improved their abilities to choose foods according to current Dietary Guidelines or improved nutrition knowledge.
- 32% of youth improved their daily physical activity practices.
- 57% of youth used safe food handling practices more often.
- 44% of youth improved their ability to prepare simple, nutritious, affordable food.

Building STEM Literacy in Youth

An equally strong and traditional focus for Cooperative Extension is 4-H Positive Youth Development. In 2020, Extension provided experiential educational and leadership programs for Maine youth through 4-H through clubs, camps, schools, and afterschool programs, and continued our focus on science, technology, engineering, and math (STEM) in order to prepare our youth for the estimated millions of STEM-related jobs projected between now and 2022. Given the remote and diverse communities to which Maine youth belong, informal education through 4-H can help minimize inequities in rural youth STEM education and career pipelines.

The 4-H STEM Ambassador program shifted to virtual to allow for multicampus student teams and increased access for more distant community partners regardless of local program model (remote, in-person, hybrid). In 2020, the 4-H Stem Ambassadors program reached more than 200

students, grades 3-8, across 11 sites with the help of 34 volunteer Ambassadors and 4-H staff facilitators. Through this program, youth ages 8-14 come to view these Ambassadors as mentors and leaders in their community while also developing skills in STEM through hands-on activities. The program occurs through all 7 campuses of the University of Maine System.

QuaranTEEN Science Cafés introduced youth to faculty research by providing opportunities for youth to explore and develop college and career aspirations that is paramount to supporting the state's businesses and economy. In 2020, these 4-H Science Cafés were developed as a way for youth to engage with UMaine scientists and engineers in an informal setting. More than 140 youth from Maine and 10 other states participated over an 11-week session.

Follow a Researcher® was created by UMaine Extension and collaborators to increase youth understanding of the research process by engaging them directly with UMaine researchers in the field. FAR® is a UMaine 4-H program using technology and social media to facilitate real-time conversations between youth and graduate student researchers working in remote locations around the world. The program is now a proven model that utilizes technology to engage new audiences with authentic scientific research, humanize the researcher, and make the research process personally relevant. Since 2019, over 5,000 youth ages 7 to 18, and over 170 educators have engaged with researchers during expeditions to Peru, the Falkland Islands, Antarctica, and along the coast of Maine.

UMaine Extension 4-H Camp and Learning Centers provide programs and opportunities for youth, many from underserved populations, with transformational experiences designed to develop a sense of place and belonging, and confidence in the outdoors. Our learning centers typically attract over 2,500 youth each summer and provide school programming for over 6,000 students from more than 60 Maine school groups. In 2020, given the pandemic, our staff pivoted to find alternative programming both for youth and schools. Our initial focus was on 1) designing and offering virtual environmental programming, 2) serving as a location for local K-12 schools to provide outdoor classrooms to help them meet social-distancing needs, and 3) providing essential community services related to pandemic response. Later in the year we increased our in-person programs, incorporating new safeguards and delivery models.

Supporting Career Awareness in Youth, and an Aquaculture Industry Workforce

As a global leader in the aquaculture industry, Maine is uniquely positioned to engage youth in aquaculture education programs that will help grow and strengthen the local business sector and economy. Maine aquaculture generates over \$137 million in sales output, 1,078 full and part-time jobs, and \$56 million in labor income, and there is an increasing need to grow the local workforce to support the growing industry. Hancock County in particular has a thriving aquaculture industry due to its coastal location and access to the UMaine Center for Cooperative Aquaculture Research (CCAR). For the past two years, Extension has partnered with the CCAR in Hancock County to deliver successful aquaculture workforce development programs to teenage youth based on the 4-H model of experiential learning. Through paid internships, youth learn about the role

of sustainable aquaculture in the global food system, gain marketable skills relevant to the aquaculture industry, and practice project management skills with the help of adult mentors and experts. Through participation in the 4-H/CCAR Internship Program, Maine youth are provided an opportunity to lead the way in the growing aquaculture industry.

Sustainable Community and Economic Development

Our work also continued to include a focus on sustainable community and economic development. Much of our sustainable community development work was integrated within our programming in the Maine Food System, and 4-H Positive Youth Development. It also included community leadership, facilitation, and volunteer management. Our economic development work included community economics and education through small business and community development programs where participants learned how to effectively manage and sustain small and home-based businesses, household resources, and community assets. This work contributed to viable businesses, households, and communities by contributing to gainful employment, quality of place, and more effective use of limited public resources.

Helping Farmers and Families Bring Their Recipes to Market

In response to growing demand, UMaine Extension developed the Recipe to Market program in 2007 and has been offering it to statewide audiences annually ever since. The goal of the program is to help potential and existing food entrepreneurs acquire food science and business knowledge and skills to successfully bring a value-added food product to market. We estimate that 60 new value-added food businesses, generating \$2.1 million in direct sales and employing 102 workers, were started in Maine by the 221 people attending our Recipe to Market multisession programs since 2007.

Supporting Maine Families

UMaine Extension Parent Educators work from two offices covering five counties and are part of a statewide network of Maine Families Home Visiting Programs. In 2020, 10 certified parent educators provided 1,686 home visits to 192 parents with 187 children living in four counties. Using the Parents as Teachers model, parent educators met with families in their homes and then virtually due to the pandemic.

EXECUTIVE SUMMARY - MAINE AGRICULTURAL AND FOREST EXPERIMENT STATION

The Maine Agricultural and Forest Experiment Station has been conducting research and providing outreach to Maine and its people for over 135 years. Experiment Station research and development focuses on the natural resources that have been key elements of Maine's economy, including

agriculture and food, forestry and wood products, in-shore marine fisheries and aquaculture, wildlife and the environment and natural area conservation that makes Maine a unique destination.

In order to accomplish its mission, the Maine Agricultural and Forest Experiment Station regularly seeks input from a variety of advisory groups, regular meetings with constituency groups, at field days and other research-associated events, and through direct interaction of faculty with cooperators and constituents. Below is a summary of activities and accomplishments in major areas; documentation of work in related areas is included in the body of the annual report.

Research and Outreach Support for Maine's Crop-Based Agriculture

Maine's 44,000 acres of wild blueberries grow naturally in fields and barrens that stretch along the Downeast coast to the state's southwest corner. The berries are grown on a [two-year cycle](#) — each year, half of a grower's land is managed to encourage vegetative growth and the other half is prepared for a wild blueberry harvest in August. Maine is the leading producer of lowbush, or “wild” blueberries in the world. Experiment Station scientists support the industry through research on blueberry pests and diseases, enhanced production methods, integrated pest management, pollinator conservation, food processing and product development, and analyzing the health benefits of blueberries.

Large- and small-scale potato growers face significant production challenges due to climate change, plant diseases, other pests and high input costs. Potatoes are the leading agricultural commodity in Maine with total sales of >\$540 million dollars and employing over 6,100 people. Station researchers are developing improved potato varieties as part of a regional multi-state effort that will produce high yields, enhance stress tolerance of northern Maine climate conditions, and have improved resistance to diseases. Several new varieties have been released in recent years in an industry partnership with the Maine Potato Board. Other researchers continue to expand our fundamental understanding of common and emerging potato pests and diseases (Colorado potato beetle, PVY virus, pink rot, black rot) and work to develop improved monitoring and control methods.

Maine reported 7,600 farms in 2017 more than any other New England state. Station researchers support development of the rapidly growing small-scale conventional and organic agriculture sector in Maine with research on weed ecology and management, new cover cropping systems for northern vegetables, such as broccoli, and cropping systems for new grain varieties for bread and brewing industries, and in other research areas.

2020 highlights

An Experiment Station researcher compared weed management approaches used by small-scale farmers with a novel analytical frame by characterizing the multiple performance criteria of seed-, seedling- and mulch-focused weed management strategies. The work demonstrated that comprehensive seedbank management, generally considered a costly and long-term strategy, can have short-term benefits of improved yield and

net returns, unexpected results that may encourage farmers to more carefully consider this approach to weed management. Research on "stacking" physical weeding tools showed synergistic effects of two or more tools on weed control efficacy. This novel and unexpected result has prompted an extensive new research initiative focused on improving mean efficacy and reducing variability of physical weed control tools.

Twenty-twenty marked the end of a five-year, NIFA-funded, multistate project to help farmers in New England improve their skills and capacities to grow and handle grains for high-value specialty markets, and to build their network with other farmers and buyers. Collaborators included colleagues at UMaine and the University of Vermont. The project produced actionable information for organic grain farmers in the Northeast including strategies to better manage weeds, diseases, and legume green manures. A whole farm rotation budget tool created by the project gives farmers an easy way to evaluate the likely economic performance of different organic grain crops and rotations. An end of project survey conducted showed that farmers, processors, and commercial end-users in New England have made significant changes and improved the viability of their organic grain businesses as a result of participating in the project. As a result of those changes, farmers reported improved weed management (92%), grain yields (60%) and quality (93%), and increased sales (80%) and profitability (80%). Of the 11 grain processors and commercial end-users who responded to the survey, 80% reported having increased purchases of local organic grains and 86% reported having increased sales and profitability. Among all respondents, 86% reported having shared what they learned with others, and 100% said they had grown and strengthened their organic grain network as a result of participating in the project.

Several potato varieties developed through the collective efforts of Hatch Multistate project NE1731 Collaborative Potato Breeding and Variety Development Activities to Enhance Farm Sustainability in the Eastern US coordinated by a UMaine agronomist currently rank in the top 100 U.S. varieties planted including (acres, rank): Lamoka (3376, 7), Waneta (1114, 17), Caribou Russet (783, 24), Lehigh (399, 35), Lady Liberty (178, 48), Reba (149, 57), Pike (112, 70), Keuka Gold (96, 75), Andover (87,79), Eva (85, 80), NY115 (74, 86), Genesee (67, 90) and Harley Blackwell (55, 96). Caribou Russet continues to increase rapidly in cultivation ascending 8 places in overall production rankings in one year. It was tested under the research identification number (AF3362-1) and resulted from a cross between Silverton Russet and Reeves Kingpin. Desirable features of Caribou Russet include its dual-purpose, russet-skinned characteristic with high yields, mid-season maturity and moderate common scab resistance. A certificate of Plant Protection Variety status acknowledging the University of Maine's development of Caribou Russet was issued on July 6, 2016.

Not only does the Experiment Station provide critical assistance to potato growers by developing new varieties but it also conducts essential research concerning potato diseases and pests. *Dickeya blackleg*, also referred to as *Dickeya*, recently emerged in the USA. It is caused by the bacterium, *Dickeya dianthicola*. The newly released UMaine variety Caribou Russet has been approved to be resistant to blackleg.

Experiment Station research advanced knowledge of bacterial soft rot and blackleg of potato. Some of the more significant work involved sequencing the whole genome of 23 strains of *Dickeya dianthicola* causing blackleg thereby providing informative data for research. Researchers from around the world will benefit from this discovery. The data identified three genetic types of bacteria that cause blackleg. This discovery will

help potato researchers understand how the outbreak of blackleg occurred and find corresponding management strategies. In addition, Experiment Station scientists found *Dickeya aquatica* and other bacteria species in water. This provides new evidence of pathogen survival and potential plant infection.

An Experiment Station project director collaborated with colleagues in New York and Michigan to clarify the level of dominance or recessiveness of Spinosad resistance in the Colorado potato beetle in different parts of the United States and how resistance differs in separate beetle populations. Spinosad is a very popular insecticide among both conventional and organic growers, and its efficacy is declining due to resistance development in many areas, including Maine. Spinosad resistance was found to be incompletely dominant in Maine and Michigan but incompletely recessive on a large, conventional farm on Long Island. Resistance on a smaller, organic farm on Long Island was found to be almost completely recessive. Recessive resistance can be managed using spatial or temporal refuges to allow susceptible individuals to migrate into the population and fitness costs to take effect. Dominant resistance, like that found in the more northern fields, is more difficult to manage and may require the denial of refuges.

Research continued on the acaricidal properties of a relatively new insecticide spirotetramat using its commercial formulation, MoventoEnergy, which is commonly used to control aphid vectors of plant viruses in potato on the two-spotted spider mite, *Tetranychus urticae* Koch (Tetranychidae: Acariformes). This mite is one of the most important agricultural pests in the world with a strong tendency of rapidly developing resistance to acaricides. Spirotetramat applied at concentrations equivalent to the field rates had a strong negative effect on the survival of the treated mites and appeared to interfere with female reproductive system. Furthermore, untreated females that mated with treated males did not produce female offspring and displayed the symptoms of spirotetramat poisoning. None of the treated immature stages survived to adulthood. Based on these results, spirotetramat may be a good option for integrated pest management against both aphids and spider mites, and in pesticide rotation sequences that are a part of integrated resistance management programs.

Research and Outreach Support for Maine Aquaculture

Station researchers fulfill critical roles in discovery, outreach, and assisting with pilot programs for the growing aquaculture industries in Maine including support of finfish, shellfish, and sea vegetables sectors. Aquaculture is the fastest growing food production industry in the world. A recent economic study found that the aquaculture industry in Maine had >\$130 million impact (Maine Aquaculture Economic Impact Report 2017). Most of this revenue is generated from Atlantic salmon farming, and while this industry is profitable, siting and therefore industry expansion is potentially limited because of endangered species interactions, sea lice and superchill. However, eastern oyster and sea vegetable aquaculture has grown considerably in recent years. With 3,500 miles of shoreline, Maine has enormous potential for growth. Station scientists are extensively involved in all aspects of the industry including studies to understand salmon chilling, sea lice ecology, endangered Atlantic salmon ecology, development of disease resistant oysters, sea vegetable ecology and variety development.

2020 highlights

An Experiment Station scientist previously reported the development of a novel behavioral bioassay for sea lice that could more effectively be used to assess behavioral patterns. This methodology was further refined (e.g., light intensity optimization, the refined production of salmon conditioned water), and this method has been successfully used for a number of trials over the reporting period. The working hypothesis was that infective copepodids in the water column are receiving cues from lice that have already colonized the salmon. The results showed that copepodids exposed to water that had previously held pre-adult female or adult male sea lice demonstrated behaviors characteristic of localized search. This is the first finding of the perception of conspecific sex cues by a larval parasite and could highlight a novel mechanism for infestation. Understanding these dynamics will help researchers identify more promising candidate compounds for alternative therapies.

Last year an Experiment Station scientist reported that sub-adult lobsters exposed to predicted end-century ocean acidification were more vulnerable to heat stress and showed a reduced number of immune cells. During this reporting period, Experiment Station scientists conducted studies evaluating the combined effects of elevated ocean temperatures and acidification, similar to what researchers anticipate lobsters to experience along the coast of Maine both currently and in the future. They found temperature and acidification to have a synergistic effect, which increased their susceptibility to disease following exposure to a pathogen commonly encountered in impounded lobsters. It also reduced their heart performance and overall vulnerability to stress.

These assessments required sophisticated techniques to evaluate heart rate under a thermal temperature ramp, so in addition to publishing the research findings, they also published the innovative methods. The methods publication included a video which was produced in collaboration with staff in Marketing and Communications at the University of Maine. Contributing to this story, the researchers completed a study examining the transcriptome (mRNA gene expression) of larval lobsters exposed to expected warming conditions. They found that lobsters under the warmest conditions reduced the expression of genes associated with immunity and shell formation and increased the expression of genes related to metabolism. This suggests that there has been a tradeoff between maintaining immune defenses with maintaining the increased metabolic demands of a warming environment. Taken together, these studies indicate there may be implications for both larval and sub-adult lobsters regarding disease susceptibility and the ability to handle subsequent stress events as waters warm and become more acidic off the coast of Maine. Further, these challenges could be exacerbated for impounded lobsters.

Mitochondria are components of cells that play critical roles in energy production and metabolism. They are sensitive targets of environmental toxins; however, little is known regarding the impact contaminants have on mitochondrial function during embryonic development in fishes. Over the reporting period, an Experiment Station research team developed a high throughput screening assay to test for mitochondrial toxicity in embryonic zebrafish. Researchers tested 24 environmental contaminants and found that some chemicals had stronger effects at lower versus higher concentrations, others had increasing effects with increasing concentration of the chemical, and still others had even more complicated effects. Collectively, the research showed that mitochondrial responses to chemical exposure is highly dynamic and highlights the need to increase the

scientific community's understanding of how contaminants may impact aquatic animals. Further, the scientists developed a high throughput screening assay that can be used to investigate multiple contaminants and could possibly be used to determine if water contains contaminants that may have mitochondrial toxicity.

The seaweed industry in Maine is currently experiencing substantial growth, particularly in the farm-raised seaweed sector. However, a lack of processing infrastructure and knowledge about how to process and transform seaweeds into value-added products pose a significant roadblock to the sustainable growth of the industry. Two studies evaluated the effects of minimal processing (blanching, freezing, and blanch-freezing) and fermentation on the quality attributes of farm-raised sugar kelp. The objective of the first study was to evaluate the effects of blanching time (0, 1, 3 min) on microbial and physicochemical properties of sugar kelp and to compare consumer acceptance of seaweed salad made from raw and blanched kelps. In consumer sensory evaluation, the seaweed salads produced from blanched kelp scored significantly higher for flavor and overall acceptability compared to the raw kelp salads, and the color of the 1-min blanched kelp salad was rated significantly higher than other samples. In the second study, researchers evaluated the effects of pre-blanching and freezing of sugar kelp on the quality attributes of a fermented sauerkraut-style product. None of the processing parameters tested affected the consumer acceptability of the kelp sauerkraut. These are the first studies to investigate the impact of blanching and freezing on sugar kelp intended for subsequent valorization. Given the extremely limited shelf life of fresh sugar kelp and the short harvest window for this crop, optimized methods to preserve quality are necessary to promote the development of value-added food products for consumers.

Sous-vide cooked foods represent a growing trend in the U.S. because of their excellent texture, flavor, and nutrition, resulting from a low temperature, oxygen-free, cooking environment. Currently, pre-packaged, sous-vide ready products are not commercially available due to their short shelf-life. High pressure processing (HPP) offers the potential to increase refrigerated shelf-life and safety of sous-vide ready products. Two studies were conducted.

In the first study, thermoanalytical and biochemical methods were used to evaluate the physical changes in scallop muscle in response to moderate HPP application, with the aim to better understand the observed physicochemical effects on scallops noted in the previous studies. The observed alterations in proteins in response to HPP help explain some of the textural changes previously observed in sous-vide cooked HPP scallops and in raw HPP scallops during iced storage, including increased toughening and weight loss.

Researchers then investigated the effects of sous-vide processing on the physicochemical quality attributes of lobster tails in comparison to conventionally cooked lobsters. Results showed that all sous-vide cooked lobster tails were more tender than those conventionally cooked in boiling water, irrespective of sous-vide parameters applied. Subsequent sensory evaluation confirmed that there were no significant differences in consumer acceptability in response to the sous-vide cooking parameters. Clarifying the effects of this novel cooking method on thermal stability of lobster muscle proteins will help promote the development of optimal sous vide conditions for production of high-quality lobster products.

Research and Outreach for the Nutritional Well-Being of Maine's People

Station scientists have a long track record of research on promoting healthy eating, the health benefits of nutraceuticals in fruits, food safety monitoring, and environmental chemistry in relation to foods and drinking water. Notable new progress has been made in understanding approaches to increasing fruit and vegetable intake in children and young adults, understanding the impacts of blueberries on vascular health, and the nature of potential nutraceuticals in fruits of greater interest in the marketplace today.

2020 highlights

A project director studied beet kvass, a little-known product that has seen a recent surge in popularity among home fermentation enthusiasts. As beetroot is exposed to a number of soil-born microorganisms (fermentation and pathogenic), the researcher thought this product would present a good model for both fermentation quality and microbiological safety parameters. In the microbial safety challenge study of beet kvass, neither salt concentration (0.5%, 1.5%, and 2.5% NaCl) nor presence or concentration of garlic (0.0%, 0.5%, and 1.0%) significantly affected the survival of STEC, Salmonella, or L. monocytogenes during the fermentation of spontaneously fermented beet kvass. These results indicate a potential risk of foodborne illness, irrespective of salt level, primarily because of the low infectious dose of STEC. Overall, these results indicate that although fermented foods are typically considered safe, it is crucial to weigh the health benefits against the risks of foodborne illness as a result of their consumption.

Healthy diet and exercise help people manage their weight and prevent chronic diseases, but individuals can only implement healthy behaviors if they have confidence in their ability and have the motivation to make healthy choices. To pinpoint changes that will provide and encourage healthier habits, a group of 20 college students were gathered to discuss what factors impact their eating decisions and how they use nutrition information in their daily lives. The information that was shared by the college students was used to develop survey questions to measure young adults' nutrition literacy (i.e., how they interpret and use nutrition information for making every day eating decisions). Seven-hundred college students completed the nutrition literacy survey. This data will be used to validate the nutrition literacy survey tool. By developing a nutrition literacy survey, programs that promote healthy eating on college campuses can make sure they are using resources efficiently and instituting the changes that will have the biggest impact on the health of community members. These changes make healthy habits an easier choice for more people. Good health plays a major role in improving individuals' quality of life and ensuring an able workforce and economic stability.

Advancing Maine's Forest-based Economy

The forest and wood products industries of Maine are in the midst of significant change with important economic ramifications for the state. A federally sponsored Economic Development Assistance Team issued a plan to revitalize and direct the forest-based industry of Maine and the University of Maine and Experiment Station have significant roles in conjunction with private, federal and state efforts. Station scientists are

studying the design of silviculture systems for optimizing yield and alignment with future product streams, monitoring spruce budworm risk and assisting with management options, developing new technologies and modeling approaches (Lidar, unmanned aerial vehicles) to increase management efficiency, creating new composite and structural building materials, analyzing the social aspects and management of family forests, investigating workforce issues of rural communities in northern Maine and many other aspects of forest ecology and management to advance forest management, sustainability and economic growth.

2020 highlights

An Experiment Station scientist examined the effectiveness of riparian management as a tool for maximizing the economic productivity of timberlands while safeguarding freshwater and riparian ecosystems and their resources. A specific goal included providing region-specific information on which buffer approaches optimize long-term investment-to-outcome ratios for forgone harvest vs. freshwater ecosystem health. An interdisciplinary team studied three replicates of each of four alternative riparian management approaches: clear cut harvest with i) no buffer, ii) 11 m, or iii) 24 m buffers, and iv) a partial harvest without a buffer. They also included two replicate streams that were unharvested control blocks. Researchers found a legacy of riparian harvest in the relative abundance of different insect species: communities in unharvested control treatments were significantly different from treatments in which harvest occurred in the immediate riparian zone (i.e., blocks with clear cuts and partial harvest). They also observed differences in the feeding guilds of insects among different riparian treatments with collector-gatherers dominating streams in harvested blocks, whereas streams in unharvested control blocks had a higher proportion of scrapers and a more even distribution of functional guilds. The breakdown rate of forest litter in streams did not differ among harvest treatments. This suggests differences in ecological communities did not translate to impaired stream ecosystem function in terms of litter breakdown. These outcomes and underlying data have been made available to natural resource managers, land owners, and scientists via public reports, databases, and a MS thesis. Manuscripts for peer-reviewed publication are in progress.

Advancing Aquatic Ecosystem Conservation and Improving Fisheries Management in Maine

Maine is rich in aquatic resources that encompass the breadth of the state from estuarine areas on the coast to fishless ponds in the western and northern mountains with a myriad of rivers, streams, and lakes in between. The state's extensive and varied waters provide a natural laboratory for understanding the ecology of these ecosystems and their vertebrate and invertebrate organisms and for the conservation of these systems and species. Station scientists are conducting studies on all aspects of river restoration after dam removal in large river systems in the Kennebec and Penobscot Rivers. These include anadromous and catadromous fish species of special concern, riverine bird populations, marine nutrient transfers to freshwater systems, and fish passage and movements around dams. Other examples of important station research include studies of fish movements around experimental tidal power devices, human impacts on stream vertebrate assemblages, water dynamics in watersheds and between ground and surface waters, and long-term impacts of atmospheric nitrogen and climate change on watersheds. These studies are done in close collaboration with natural resources agencies or businesses and have great utility in policy development and permitting processes.

2020 highlights

The desire to understand and anticipate the effects of climate change on ecological communities is a regional, national, and global research priority. The regional effects of climate change have the potential to strongly degrade freshwater ecosystems and the cultural, economic, and social services (e.g., fisheries) they provide the people of Maine. An Experiment Station project director conducted a pond mesocosms experiment in which communities of different ages were subject to a drying disturbance designed to simulate a late season drought. The experiment revealed that younger communities contained a higher proportion of mobile organisms such as winged predators, and these were more impacted by drought than less mobile organisms. These results suggesting more frequent drought disturbances may change the trophic structure of pond ecosystems in ways that may influence mobility and trophic level on community vulnerability to disturbance in pond mesocosms.

Additional work linked to this area of inquiry has included assessing the drivers of community structure and diversity in river-side rock pools along the Penobscot River, one of Maine's largest rivers. The surveys, which comprise the first systematic study of rock pools in Maine, have found that these pools support >60 taxa including several invasive mosquitos, a suite of taxa typically associated with flowing water, and a diverse assemblage of 18 genera of Chironomidae. Pool size, hydrology, resource availability and proximity to the river all influence community structure in these systems.

An Experiment Station project director investigated how the underlying variability in thermal and hydrological regimes alters the effects of climate change stressors on freshwater foodwebs. Broad scale vulnerability of organisms to climate change was tested in the context of species range shifts across elevations in the Elk Mountains of Colorado. The project studied the vulnerability of species and their core ecosystem processes (detritus breakdown and associated nutrient release) to new species' moving upslope as the climate warms. Field experiments conducted by the principal investigator and a research team have amassed a suite of results that indicate that the replacement of resident subalpine species with lower elevation migrants is likely to alter rates of detritus breakdown, secondary production, and the release of detritus-sourced nutrients to the water column. The directional outcome, in terms of increase vs decrease in detritus processing, depends on the functional traits of both the resident and range-shifting species and the elevation at which the range expansion is occurring. Ongoing work is testing how effects observed in microcosms and in-situ cages scale to complex natural ecosystems. The overall outcome of this objective indicates that species range shifts and resulting changes in the identity and relative abundance of organisms in communities will likely have consequences for ecosystem processes that underlie important services such as nutrient and carbon cycling and the quality of surface waters.

Research and Outreach Support for Maine's Terrestrial and Semi-Aquatic Wildlife

Forestry, agriculture, aquaculture and coastal activities all result in significant interaction with terrestrial and semi-terrestrial wildlife populations in Maine as do other recreational, human development, and industrial activities. Station scientists have active research in these realms with outputs of great value to policy makers, regulators, and natural resource managers. Examples include 1) research on predators (Canada lynx, American

marten), grouse species, and bats in northern forests and in relation to forest management, 2) research on coastal and other water birds of special concern that inhabit inland, coastal, and island habitats, 3) the ecology and management of vernal pool habitats and associated amphibian populations, and 4) the human dimensions and policy aspects of wildlife management problems.

2020 highlights

An Experiment Station project jointly led by two scientists addresses an overarching goal of trying to understand how society can maintain biological diversity in the context of human modification of landscapes. The research team investigates the social, economic, and policy ramifications of integrating biodiversity conservation with human use of ecosystems. Vernal pools have been a focus of the research team. These discrete ecological features comprise temporary to semi-permanent hydrology pools in forested landscapes. Many amphibian species rely on vernal pools as primary breeding habitat. Researchers continued to provide support for implementation of the Vernal Pool Special Area Management Plan mitigation tool in two Maine towns. The investigators developed the mitigation pool which was adopted in federal wetland rules for Maine by the US Army Corps of Engineers and the Maine Department of Environmental Protection. The investigators received an NSF NRT grant to support this work. One of five research foci of the award examines how transdisciplinary research approaches can lead to conservation success for these wetlands. A PhD graduate student has been hired to work with these towns investigating how best to communicate with and engage landowners in conservation activities on their lands, in general, and as related to the Vernal Pool Special Area Management Plan.

II. Merit and Scientific Peer Review Processes

The NIFA reviewer will refer to your 2020 Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA’s attention.

Process	Updates ONLY
<p>1. The <u>Merit Review Process</u></p>	<p>(No updates)</p> <p>UMaine Extension faculty and professionals engage in an ongoing process to plan and adjust programs in ways that meet the needs of Maine citizens. To maintain relevant programming, faculty and staff engage in formal and informal review by discipline-specific review panels and advisory groups. This results in defined programming intentions for the near- and long-term, while ensuring it is dynamic allowing us to address emerging issues. The process involves independent review within local advisory structures, and collaborative review within statewide programmatic teams. Programming merit and success for faculty members is also reviewed by faculty peers through reappointment, promotion, and post-tenure processes established by the faculty and administration and codified in employment contracts. A unique process exists for non-faculty programming professionals who undergo annual reviews by supervisors, and peer reviews every 4 years.</p> <p>We partner with regional Extension programs in the Northeast Region whose active vision is to coordinate translational research, education, outreach, and diversity programming to address problems, opportunities, and workforce development. Our primary mission is to enhance institutional cooperation and improve coordination of regional Extension program initiatives for the Northeast. Partners include the following universities: Connecticut, Cornell, Delaware, Delaware State, District of Columbia, New Hampshire, Maine, Maryland, Maryland Eastern Shore, Massachusetts, Penn State, Rhode Island, Vermont, Rutgers, West Virginia, and West Virginia State.</p> <p>The Experiment Station uses its standard external scientific review process for continuing faculty proposing new five-year projects and a fast-track project approval process for new faculty. The fast-track process is intended for new faculty, where an accelerated approval process and a shorter two-year project period better meets the needs of the faculty member and station.</p> <p>For the standard process, Experiment Station faculty prepare a pre-proposal reviewed by the MAFES Research Council, which is comprised of senior faculty. Following Research Council review to ensure that the proposed work falls within the purview of MAFES, addresses an important need identified by</p>

	<p>stakeholders, and that the project director possesses the expertise to conduct the research, full proposals are developed. The full research proposals are sent out for external, expert peer review. Upon completion of the external reviews, proposals are returned to the researchers, who make changes based on the comments of the reviewers. Finally, the proposals are reviewed and approved by the Research Council before being submitted to USDA for final approval.</p> <p>The fast-track process goal is to complete project development and obtain USDA approval in four months. The shorter timeline for fast-track projects is achieved by using an abbreviated and internal proposal review, reducing proposal requirements, and expediting processing. Proposals are reviewed by a member of the Research Council and a faculty member to ensure that the proposed work meets all the expectations inherent in the standard process.</p>
<p>2. <u>The Scientific Peer Review Process</u></p>	<p>The station uses its standard external scientific review process for continuing faculty proposing new five-year projects and a fast-track project approval process for new faculty. The fast-track process is intended for new faculty, where an accelerated approval process and a shorter two-year project period better meets the needs of the faculty member and station. A total of 17 projects went through the process in FY2020.</p> <p>For the standard process, Experiment Station faculty prepare a pre-proposal reviewed by the MAFES Research Council, which is comprised of senior faculty. Following Research Council review to ensure that the proposed work falls within the purview of MAFES, addresses an important need identified by stakeholders, and that the project director possesses the expertise to conduct the research, full proposals are developed. The full research proposals are sent out for external, expert peer review. Upon completion of the external reviews, proposals are returned to the researchers, who make changes based on the comments of the reviewers. Finally, the proposals are reviewed and approved by the Research Council before being submitted to USDA for final approval.</p> <p>The fast-track process goal is to complete project development and obtain USDA approval in four months. The shorter timeline for fast-track projects is achieved by using an abbreviated and internal proposal review, reducing proposal requirements, and expediting processing. Proposals are reviewed by a member of the Research Council and a faculty member to ensure that the proposed work meets all the expectations inherent in the standard process.</p>

III. Stakeholder Input

The NIFA reviewer will refer to your 2020 Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA’s attention.

Stakeholder Input Aspects	Updates ONLY
<p>1. Actions taken to seek stakeholder input that encouraged their participation with a brief explanation</p>	<p>(No updates)</p> <p>The Extension and MAFES Plan of Work is based on updated needs assessment that includes multiple components to encourage direct participation through targeted solicitation of stakeholders, evaluation of current first-source data, and public input. Extension and MAFES have learned from our constituents that high-quality engagement is best when the issue is current, and we engage stakeholders as needs and issues arise. Our matrix of programs involves citizen and volunteer group input, and our work is guided by the community, and commodity stakeholders with whom we have close working relationships. Selected examples:</p> <p>Partnerships with 16 county executive committees that provide direction and advice to extension programs and help to prioritize regional efforts.</p> <p>Interactions with the UMaine Board of Agriculture, formed by state statute, that advise us on agricultural research and extension priorities.</p> <p>Participation at monthly meetings of the Agricultural Council of Maine (AGCOM) as a way to maintain effective communication with the wide array of agricultural organizations in the state.</p> <p>The Maine Wild Blueberry Commission that represents growers and processors. The Maine Potato Board that is composed principally of Maine potato farmers who offer advice and support for research.</p> <p>The Maine 4-H Foundation Board that is a partner with Extension’s 4-H Program.</p> <p>Advisory boards that guide the work of our most important programs. Examples: Maine Sea Grant Policy Advisory Board, Tanglewood 4-H Camp Board, Bryant Pond Learning Center Board, the Maine Board of Pesticides Control, Forest Resources Advisory Committee, and the Coordinating Committee of the Maine Fish and Wildlife Research Unit.</p>

	<p>We partner with discipline-specific groups such as the Maine Organic Farmers and Gardeners Association; Maine Science, Technology, Engineering and Math Collaborative; and the Sportsman's Alliance of Maine.</p> <p>We have an ongoing dialogue with Maine Legislators and County Commissioners to communicate our extension and research focus areas and to respond to the needs that have been identified through their constituents.</p> <p>Our research facilities host field days for apples, small fruits, vegetables, potatoes, grains, wild blueberries, and other growers, that allow researchers and administrators to learn more about stakeholders needs.</p>
<p>2. Methods to identify individuals and groups and brief explanation.</p>	<p>(No updates)</p> <p>UMaine has deep historical connections to the fabric of life in Maine communities. Extension and MAFES stakeholders are primarily identified through:</p> <p>Historical and ongoing connections with traditional stakeholders, and ever-evolving interactions within our communities.</p> <p>Informal and formal interactions with coordinating and advisory committees, and traditional stakeholder groups, including using them as sources of referral for new stakeholder groups and individuals with an interest in research and extension programs.</p> <p>The budget appropriations process with funders such as county commissioners and the Maine state legislature.</p> <p>Active recruitment and retention of people who are traditionally underserved and underrepresented in our programs and employee groups.</p> <p>New groups and individuals will be identified through focus groups internal to Extension and the university, as well as external focus groups comprised of federal and state officials and traditional and nontraditional stakeholders.</p>

	<p>MAFES maintains a list of all known stakeholder groups, and these groups are contacted on a regular basis.</p>
<p>3. Methods for collecting stakeholder input and brief explanation.</p>	<p>(No updates)</p> <p>Extension staff work within program teams to maintain a connection to stakeholder and citizen issues and continuously reassess needs. Our staff review their programming intentions for upcoming years and maintain a five-year vision. As part of the process, they review information from ongoing merit review processes and the needs assessment, and update programming priorities as needed.</p> <p>MAFES collects input through formal organization processes (Board of Agriculture, Forest Resources Advisory Committee, and Maine Cooperative Fish and Wildlife Research Unit Coordinating Committee), and feedback on research programs of faculty via stakeholder grant review programs (Wild Blueberry Commission of Maine Advisory Committee, Maine Potato Board, Cooperative Forestry Research Unit). Extension and MAFES staff meet with and collect input from both traditional and non-traditional stakeholders at the group and individual level.</p>
<p>4. A Statement of how the input will be considered and brief explanation of what you learned from your stakeholders.</p>	<p>(No updates)</p> <p>Extension and Experiment Station administrators will use needs assessment data, that includes stakeholder input, to help prioritize our programs relative to our budgetary capacity, and to inform extension and research teams and individuals about emerging issues that will help them prioritize and focus research and extension programs appropriately and effectively.</p>

IV. Critical Issues Table of Contents

No.	Critical Issues in order of appearance in Table V. Activities and Accomplishments
1.	Positive Youth Development
2.	The Maine Food System
3.	Sustainable Community and Economic Development
4.	Sustainable Natural Resources
5.	Climate Change

V. Activities and Accomplishments

Please provide information for activities that represent the best work of your institution(s). In your outcome or impact statement, please include the following elements (in any order): 1) the issue and its significance (e.g. who cares and why); 2) a brief description of key activities undertaken to achieve the goals and objectives; 3) changes in knowledge, behavior, or condition resulting from the project or program’s activities; 4) who benefited and how. Please weave supporting data into the narrative.

No.	Project or Program Title	Outcome/Impact Statement	Critical Issue Name or No.
1.	4-H Ambassadors Spark Student Interest in STEM Careers	<p>Developing Maine youth’s STEM literacy is vital to ensuring that our state continues to thrive economically and socially. Given the remote and diverse communities where Maine youth live, informal education can help minimize inequities in rural youth STEM education and career pipelines. Future career opportunities in Maine will depend heavily on STEM skills, whether in the growing fields of healthcare and engineering, or in positions requiring technical skills, such as construction, and maintenance of transportation and energy systems.</p> <p>Since 2014, Extension’s 4-H STEM Ambassadors program has reached more than 5,600 Maine youth in classrooms, libraries, and afterschool clubs across the state. More than 500 college students of the University of Maine system have been trained and facilitated in-person, hands-on learning experiences fostering youth STEM enjoyment, literacy, and identity. In 2020, in response to the pandemic, we shifted to an entirely virtual program, including training, facilitation, and support for the health</p>	Positive Youth Development

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		<p>and well-being of all participants. Maine 4-H Foundation support allowed materials to be purchased for every youth participant.</p> <p>The shift to a virtual program allowed for multicampus student teams and increased access for more distant community partners regardless of local program model (remote, in-person, hybrid). In 2020, the 4-H Stem Ambassadors program reached more than 200 students, grades 3-8, across 11 sites with the help of 34 volunteer Ambassadors and 4-H staff facilitators. Through this program, youth ages 8-14 come to view these Ambassadors as mentors and leaders in their community while also developing skills in STEM through hands-on activities. The Ambassadors gained self-esteem and experience presenting publicly.</p>	
2.	<p>QuaranTEEN Science Cafés Introduce Youth to Faculty Research</p>	<p>As the number of jobs in Maine requiring post-secondary education or training continues to increase, providing opportunities for youth to explore and develop college and career aspirations is paramount to supporting the state’s businesses and economy. Unfortunately, the number of Maine high school graduates enrolled in higher education lags at 40th in the nation. Although research recommends beginning to address college and career aspirations in elementary and middle grades, coordinating access to a college campus presents barriers for rural Maine communities.</p> <p>Maine 4-H staff connect youth to the STEM (Science, Technology, Engineering, and Math) resources of the University of Maine. We make these connections by bringing youth to campus, or engaging youth with students, faculty, and staff at their school/afterschool/club sites. In 2020, 4-H Virtual “QuaranTEEN” Science Cafés were developed as a way for youth to engage with UMaine scientists and engineers in an informal setting. The format included time for the guest scientist to introduce themselves, show some of their work, and also share a bit about their pathway to UMaine. There was also time for informal questions from teen participants.</p>	Positive Youth Development

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		<p>More than 140 youth from Maine and 10 other states participated over the initial 11-week session. While the pandemic prohibited us from bringing youth to campus, this virtual program proved to be an accessible way for many youth to be introduced to UMaine and its programs, and resulted in a high level of student engagement. The program’s success prompted Extension to host a second Science Café in the fall.</p>	
<p>3.</p>	<p>4-H Volunteers Go Virtual to Help Youth Thrive in the Pandemic</p>	<p>As the pandemic progressed there was widespread concern for youth who were experiencing isolation and loss of daily routine and social outlets. 4-H is well-positioned to help families reduce isolation and increase social interaction, and while it could not be done in person, it could be done with virtual platforms programming. “4-H can build intentional programs for youths as we move from reaction to recovery and rebuilding...ensure that young people not only survive but thrive in this time like no other” (Arnold and Rennekemp, 2020). To help youth to thrive, UMaine Extension staff recognized it would be crucial to have confident and capable volunteers on board. However, many 4-H club volunteers were not confident in adapting from in-person to virtual programming.</p> <p>Extension created a collection of six tip sheets:4-H Volunteers Can Go Virtual! The tip sheets and embedded videos provided tangible ideas to help volunteers navigate how to run virtual meetings. Topics included:</p> <ol style="list-style-type: none"> 1. Tips for Hosting a Virtual 4-H Club Meeting 2. Components of a Virtual 4-H Club Meeting 3. Ice Breaker Ideas for Virtual 4-H Club Meetings 4. 4-Hing at a Distance Activity Ideas 5. Virtual Judging Workshop 6. Virtual Skill-a-thon <p>These resources were widely shared through a variety of means, including a website that has received more than 5,206 views from individuals located across 44 states and 16 countries.</p>	<p>Positive Youth Development</p>

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<p>4.</p>	<p>Web-based Resources for Families, Caregivers, and Educators</p>	<p>The pandemic caused Maine schools to close and left families and children with huge gaps in daily structure and educational experiences.</p> <p>UMaine Extension responded by creating a web-based resources center for families, caregivers, and educators. We assembled a collection of activity books, guides, and resources with topics ranging from science to financial literacy to help children remain engaged in educational experiences throughout the time period of school closures. The resources were arranged by age range and subject area for easy searchability. We also created and organized a daily schedule of video clips to engage youth and families in additional learning:</p> <ul style="list-style-type: none"> • Mondays: Stir Together (nutrition) • Tuesdays: Teen Science Cafe (science) • Wednesdays: Wednesday in the Woods (environmental and arts) • Thursdays: Growing Maine Gardeners (gardening) • Fridays: 4-H Fridays Fun (fun and creativity) <p>In just over 6 months our website “Learn at Home: Educational Resources to Use During School Closures” had more than 11,100 page views, and our educational video clips had over 8,100 views.</p>	<p>Positive Youth Development</p>
<p>5.</p>	<p>4-H Camp and Learnings Connect Youth to the Outdoors and Build Community</p>	<p>Research has shown that positive social and emotional learning experiences can significantly impact youth development and that connecting youth to a positive adult role model decreases the risk for making unhealthy choices or engaging in risky behaviors. With youth spending more time connected to social media and other digital platforms, resulting in isolation and sedentary indoor time, many youth suffer from obesity and/or ADHD, and some lack opportunities to develop positive interpersonal communication skills.</p>	<p>Positive Youth Development</p>

		<p>UMaine Extension 4-H Camp and Learning Centers provide programs for youth ages 4-17, many from underserved populations, to have transformational experiences designed to develop a sense of place and belonging, and confidence in the outdoors. Our programs include both day and residential summer camps, onsite open-air classrooms for schools, and school-based programs, as well as adult programming and workshops. We have a well-developed virtual component to our programs that gives them added depth and maximizes accessibility. Our learning centers typically attract over 2,500 youth each summer and provide school programming for over 6,000 students from more than 60 Maine school groups.</p> <p>In 2020, given the pandemic, our staff pivoted to find alternative programming both for youth and schools. Our initial focus was on 1) designing and offering virtual environmental programming, 2) serving as a location for local K-12 schools to provide outdoor classrooms to help them meet social-distancing needs, and 3) providing essential community services related to pandemic response. Later in the year we increased our in-person programs, incorporating new safeguards and delivery models.</p> <p>In 2020, our 4-H camp and learning staff innovated by:</p> <ul style="list-style-type: none"> • Providing 75 middle school youth from St. George with daily education programs at Blueberry Cove during a time when students would be learning virtually at home. • Providing 125 primary school youth and teachers from Belfast with weekly educational programs at Tanglewood, where they learned about ecology and seasonal changes while exploring the woods each week. 4-H staff created successive lesson plans and videos for teachers. • Developing family-oriented programming to provide parents and teachers with hands-on, home-based learning experiences. Extension created an online “Learn at Home” resource page and a weekly live-streamed and recorded “Wednesdays in the Woods” series of 44 virtual lessons connected to ecology, observation 	
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		<p>skills, nature crafts, and personal reflection. This series had over 10,800 views.</p> <ul style="list-style-type: none"> • Continuing to support Telstar Freshman Academy at Bryant Pond, offering daily, yearlong, experiential learning designed to engage students in an outdoor setting. • Continuing at Bryant Pond to deliver the NorthStar Youth Mentoring program that connects young people with caring adults through community engagement, cultural exchange, and adventure challenge and leadership. The program is grounded in in-person contact, and also uses virtual contact for family and other activities. • Building a fall program at Bryant Pond that allowed the county’s two largest local school districts to expand on their open-air classroom spaces. This involved retrofitting buildings, designing two independent health center units with quarantine rooms, and delineating footprints and plans to provide a safe and clean space for students. <p>Supporting community pandemic relief efforts. Extension staff at Bryant Pond and Blueberry Cove identified food insecurity as a pandemic-related need. The camps became staging areas for receiving, repackaging, and delivering essential food to food pantries and food banks. Staff were able to move large quantities of food quickly to areas identified as high demand/need for food. These efforts reduced exposure risks to an aging population by door-to-door delivery, relieved the stress on regional food banks, and supported food-insecure families.</p>	
6.	<p>Reducing Obesity in Youth</p>	<p>In 2020, the U.S. youth obesity rate was 14.9%. It is estimated that more than half of today’s children will be obese by the age of 35 if current trends continue. Nearly 20% of Maine children are food insecure, and Maine ranks 17th in the nation for child food insecurity. Rising childhood obesity rates coupled with poor dietary intake will strain current health promotion programs, continue to raise health care costs for the nation, and shorten the lifespan of today’s youth.</p>	<p>Positive Youth Development</p>

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		<p>To help lower childhood obesity rates, UMaine Extension Expanded Food and Nutrition Education Program (EFNEP) provides direct education to Maine’s low-income children to build their knowledge, behaviors, and attitudes related to improving diet quality, increasing daily physical activity, and using food resources management practices to learn how to plan and shop for healthy meals and snacks. Program outcomes are measured for all youth ages 5-18 using validated pre/post program surveys.</p> <p>In 2020, 2,563 youth participated in Maine EFNEP. Youth participated in an average of 5 classes over a time frame of 3 months. Sixty-four percent of youth participants completed a pre- and post-survey. As a result of participating in EFNEP:</p> <ul style="list-style-type: none"> • 76% of youth improved their abilities to choose foods according to current dietary guidelines or improved nutrition knowledge. • 32% of youth improved their daily physical activity practices. • 57% of youth used safe food handling practices more often. <p>44% of youth improved their ability to prepare simple, nutritious, affordable food.</p>	
7.	<p>Maine Potato IPM Return on Investment over 100 to 1</p>	<p>The \$500 million potato industry is the largest agricultural sector in Maine, encompassing more than 500 businesses generating more than \$300 million in annual sales, employing over 6,100 people, and providing over \$112 million in income to Maine citizens. The management of insects, diseases, weeds, and other pests is integral in sustaining a healthy Maine potato crop. Potato growers are increasingly relying on a multidisciplinary Integrated Pest Management (IPM) approach to ensure that Maine’s potato crop is pest- and damage-free while attempting to minimize the quantity of pesticides applied.</p> <p>Extension’s Potato IPM Program impacts Maine’s 300 commercial potato growers and 48,000 acres of potatoes and has become an integral part of</p>	<p>Maine Food System</p>

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		<p>the Maine potato industry. The program also broadly impacts national and international growers who rely on the state’s seed crop. The project maintains nearly 100 specialized insect traps, coordinates a statewide network of electronic weather stations, and surveys 75 potato fields on a weekly basis for weeds, insects, and diseases. IPM scientists with the help of trained field scouts track potential pest outbreaks to provide growers with current information on treatments to minimize the number of pesticide applications and maximize potato yield. In 2020, we conducted a potato IPM program using six student potato field monitors.</p> <p>By monitoring the potato sites for insect pests (aphids, Colorado potato beetle, potato leafhopper, European corn borer, etc.) and reporting weekly to all growers, we estimated an approximate savings of \$10 million in losses avoided, yield increases, and reduced pesticide use. For an expenditure of \$95,000, the return was 110 to 1.</p>	
<p>8.</p>	<p>Enhancing Sustainability of Maine & Eastern US Potato Production</p>	<p>Several potato varieties developed through the collective efforts of Hatch Multistate project NE1731 Collaborative Potato Breeding and Variety Development Activities to Enhance Farm Sustainability in the Eastern US include the most commercially important varieties grown in the country. This project is a highly collaborative effort involving seven states and four breeding programs in the East coordinated by a UMaine agronomist. The project promotes collaboration and communication among researchers and stakeholders - all with the aim of enhancing farmers’ ability to provide a safe and nutritious supply of potatoes to consumers in an environmentally sustainable manner that enhances profits and rural America. It addresses the needs of the small-, medium-, and large-scale growers, marketers, and processors of the Eastern potato industry through a collaborative process of potato breeding, selection, evaluation, and variety release. Varieties bred by this project that currently rank in the top 100 U.S. varieties planted include (acres, rank): Lamoka (3376, 7), Waneta (1114, 17), Caribou Russet (783, 24), Lehigh (399, 35), Lady Liberty (178, 48), Reba (149, 57), Pike (112, 70), Keuka Gold (96, 75), Andover (87,79), Eva (85, 80), NY115 (74, 86), Genesee (67, 90) and Harley Blackwell (55, 96). Caribou Russet continues to increase rapidly in cultivation ascending 8 places in</p>	<p>Maine Food System</p>

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		<p>overall production rankings in one year. It was tested under the research identification number (AF3362-1) and resulted from a cross between Silverton Russet and Reeves Kingpin. Desirable features of Caribou Russet include its dual-purpose, russet-skinned characteristic with high yields, mid-season maturity and moderate common scab resistance. A certificate of Plant Protection Variety status acknowledging the University of Maine’s development of Caribou Russet was issued on July 6, 2016.</p>	
<p>9.</p>	<p>Disease and Pest Research to Boost Potato Production</p>	<p>Not only does the Experiment Station provide critical assistance to potato growers by developing new varieties but it also conducts essential research concerning potato diseases and pests. Multiple investigations continue to advance understanding of the epidemiology and management of major potato diseases. The diseases include late blight, pink rot, ring rot, black scurf, powdery scab, and common scab. Research also continues to develop environmentally friendly and economically viable management approaches for insect pests of potato.</p> <p>Dickeya blackleg, also referred to as Dickeya, recently emerged in the USA. It is caused by the bacterium, <i>Dickeya dianthicola</i>. The newly released UMaine variety Caribou Russet has been approved to be resistant to blackleg.</p> <p>Experiment Station research advanced knowledge of bacterial soft rot and blackleg of potato. Some of the more significant work involved sequencing the whole genome of 23 strains of <i>Dickeya dianthicola</i> causing blackleg thereby providing informative data for research. Researchers from around the world will benefit from this discovery. The data identified three genetic types of bacteria that cause blackleg. This discovery will help potato researchers understand how the outbreak of blackleg occurred and find corresponding management strategies. In addition, Experiment Station scientists found <i>Dickeya aquatica</i> and other bacteria species in water. This provides new evidence of pathogen survival and potential plant infection.</p> <p>An Experiment Station project director collaborated with colleagues in New York and Michigan to clarify the level of dominance or recessiveness</p>	<p>Maine Food System</p>

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		<p>of Spinosad resistance in the Colorado potato beetle in different parts of the United States and how resistance differs in separate beetle populations. Spinosad is a very popular insecticide among both conventional and organic growers, and its efficacy is declining due to resistance development in many areas, including Maine. Spinosad resistance was found to be incompletely dominant in Maine and Michigan but incompletely recessive on a large, conventional farm on Long Island. Resistance on a smaller, organic farm on Long Island was found to be almost completely recessive. Recessive resistance can be managed using spatial or temporal refuges to allow susceptible individuals to migrate into the population and fitness costs to take effect. Dominant resistance, like that found in the more northern fields, is more difficult to manage and may require the denial of refuges.</p> <p>Research continued on the acaricidal properties of a relatively new insecticide spirotetramat using its commercial formulation, MoventoEnergy, which is commonly used to control aphid vectors of plant viruses in potato on the two-spotted spider mite, Tetranychus urticae Koch (Tetranychidae: Acariformes). This mite is one of the most important agricultural pests in the world with a strong tendency of rapidly developing resistance to acaricides. Spirotetramat applied at concentrations equivalent to the field rates had a strong negative effect on the survival of the treated mites and appeared to interfere with the female reproductive system. Furthermore, untreated females that mated with treated males did not produce female offspring and displayed the symptoms of spirotetramat poisoning. None of the treated immature stages survived to adulthood. Based on these results, spirotetramat may be a good option for integrated pest management against both aphids and spider mites, and in pesticide rotation sequences that are a part of integrated resistance management programs.</p>	
<p>10.</p>	<p>Adding Value to Maine Wild Blueberries</p>	<p>Maine’s wild blueberry industry, with 480 growers on 44,000 acres, annually produces as many as 100 million pounds of blueberries and has a direct and indirect economic impact of more than \$250 million to the state’s economy. UMaine Extension specialists and researchers provide</p>	<p>Maine Food System</p>

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		<p>research-based knowledge to blueberry growers through field and lab work directly with growers, graduate students, other researchers in the U.S. and Canada, and the Wild Blueberry Commission of Maine. Unfortunately, since 2014 the price per pound that farmers receive for their berries has dropped below the cost of production. Farmers now receive an average of \$0.35/pound for their berries to go to the conventional frozen market and it costs \$0.52 cents to produce each pound of berries using the recommended range of pest and crop management tools. Value-added markets are needed to diversify the channels in which wild blueberries are sold.</p> <p>In 2018, Extension began working with Bluet Winery located in Maine, which makes a dry, sparkling wild blueberry wine and was looking for a source of blueberries. Extension introduced Bluet to growers interested in selling their berries to a winery and advocated for the farmers by explaining the costs of production. Since then, Extension has shared our knowledge of the crop with Bluet, facilitated collaborations between Bluet and UMaine food science faculty, and successfully secured funding from the USDA CARE program to study the wild blueberry ripening process and field-to-field flavor variation with Bluet.</p> <p>Growers who sell berries to Bluet make \$0.60-\$1.00 per pound. Bluet’s use of Maine blueberries has grown from producing 50 cases of wine in 2014 for distribution in Maine to 4,000 cases in 2020 for national distribution. They use an average of 176 pounds of wild blueberries per case of wine. In 2020, Bluet purchased 100,000 pounds of Maine wild blueberries from 5 farms and 1 processor. The company connects their product to the farmers who grew the crop and the land that nurtures this native berry.</p>	
<p>11.</p>	<p>Tree Fruit IPM Increases Crop Value and Decreases Pesticide Costs</p>	<p>Pest and weather damage are primary causes of significant damage to tree fruit crops, and tree fruit growers rely on UMaine Extension monitoring and management guidance to avoid or reduce pest and weather damage to crop quantity and quality.</p>	<p>Maine Food System</p>

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		<p>The Extension Tree Fruit IPM Program provides growers with regular newsletters, statewide field reports, and research updates, plus weekly on-farm scouting visits, situational analysis, weather data resources, individual consultations, meetings, and webinars.</p> <p>In 2020, a survey that reached the majority of commercial Maine tree fruit growers and production found:</p> <ul style="list-style-type: none"> • 100% of growers benefited from the weather resources and decision support reports provided by Extension. • 67% of growers benefited from the Extension orchard scouting program, and 96% of those growers reported benefiting from either an IPM presentation, in-person field visit, or telephone or email consultation. • Growers estimate that crop value, either yield or quality, would have been 31% lower without the Extension Tree Fruit IPM Program. Extrapolating from the most recent USDA statistics for apple crop value in Maine, the value of crop losses prevented by the IPM program services is more than \$5.1 million per year. • In addition to higher production value, Maine growers reported pesticide savings of \$436 per acre. Across the 2,688 acres of orchard in Maine, estimated pesticide savings in purchase costs was over \$1.17 million. 	
<p>12.</p>	<p>Protecting Maine’s Layer Poultry Industry</p>	<p>Maine has a poultry industry worth nearly \$39 million in 2020, with over 3.5 million layers. Of Maine’s 7,600 farms, many raise hens to sell eggs on a large scale (in which case, the FDA mandates testing for <i>Salmonella enterica</i> subspecies Enteritidis (SE)), for home consumption, or to neighbors. In any case, testing for SE is a prudent plan.</p> <p>The UMaine Veterinary Diagnostic Laboratory’s (VDL) certified salmonella testing allows poultry farms to meet FDA standards for SE screening. Because the VDL provides FDA-mandated salmonella testing for medium- to large-sized egg producers in Maine, New Hampshire, and</p>	<p>Maine Food System</p>

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		<p>Vermont, these farms can operate within FDA’s Egg Rule. Recently, retailers such as Whole Foods have required smaller farms to meet FDA standards, and VDL testing has enabled these farms to gain access to a valuable market. In 2020, the VDL processed 1,107 environmental swabs for SE (none were positive) and tested more than 1,000 blood samples to confirm salmonella vaccination status.</p> <p>An ongoing cooperation between Extension, the state of Maine, and the layer industry consists of sharing results of SE screening, oversight of rodent control and barn hygiene on the farm (provided by the state and Extension veterinarians), and yearly meetings to discuss poultry health challenges (all entities). This protects public health via prevention of human salmonellosis (SE) that might be acquired through eggs. It is estimated that the cost to the egg industry of an SE outbreak could be greater than 10% of production.</p>	
<p>13.</p>	<p>Maine AgrAbility Boots-2-Bushels</p>	<p>Research indicates that our veterans interested in farming as a career and farmers with disabilities are most challenged by skills related to crop and production knowledge, financial skills, time management, aging, and declining strength.</p> <p>UMaine Extension created Boots-2-Bushels (B2B), a 9-month market gardening education and training program for military veterans and their family members. B2B strives to overcome some of the barriers military veterans face when transitioning to farming, such as lack of agricultural knowledge and business experience. B2B helps veterans use the skills and abilities honed in the military, such as teamwork, perseverance, resilience, initiative, and creativity, in a supportive environment with like-minded peers. B2B uses the “Five Fs” framework (Farming, Family, Finances, Future, Fitness) to address production, marketing, financial, and human sources of agricultural risk, and creates a near-peer cohort that fosters unit cohesion in an empathetic, therapeutic environment.</p>	<p>Maine Food System</p>

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		<p>Sponsored by Extension’s Maine AgrAbility program and in partnership with the Maine Organic Farmer & Gardener Association (MOFGA), B2B takes participants from seed-to-salary in a hands-on and realistic project. Extension and MOFGA educators provide participants with 10 weeks of classroom instruction that includes cultural practices of growing fruits and vegetables for market, and business skills required to sustain a farm business. Once trained, participants put their new knowledge into an intensive 6-month growing season to provide food for their families, other veterans, and community members. Said one B2B participant, “Farming is a form of security to support myself and my community. No matter what happens, farming is a cornerstone for any community to grow around.” At the end of 2020, the program had 23 participants, representing 17 veteran farms, and has an international dimension with one couple from Japan (soon to move to Maine), and a veteran joining from Italy.</p>	
<p>14.</p>	<p>Maine Farm and Seafood Products Directory Helps Consumers Find Vendors</p>	<p>The onset of the COVID-19 pandemic created widespread fear about what would happen to the markets and businesses of Maine-based farmers. The nearly overnight shutting of restaurants and institutional markets (such as colleges and industrial campuses) and temporary closing of farmer’s markets appeared to directly shut off farmers from the majority of their markets. This impacted farms and food-based businesses of all types and scales, including vegetable, meat, dairy, cut flower, seafood, and bakeries.</p> <p>In March 2020, an innovative farmer reached out to UMaine Extension for support in promoting a simple spreadsheet that she’d created for seven neighboring farms including their contact information, products available, immediate needs on the farm, and COVID-19 protocols that they had incorporated into their marketing strategies. Extension used our statewide networks and staff to expand on this idea, developing a process for farmers throughout the state to join the list, creating a website to promote the effort, and creating a public-facing map and spreadsheet for viewing the farm information. The farm community saw the value of this marketing tool for connecting with direct-to-consumer sales and quickly signed up.</p>	<p>Maine Food System</p>

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		<p>Within a month there were 405 farm and seafood vendors listed and more than 100,000 views to the page, and there are now nearly 500. While the community demand for local food and direct-to-consumer sales have significantly increased as a result of the pandemic, farmers have attributed much of their new customer base this year to the popularity of this list. The directory has also assisted farms in finding complementary partner farm business with which to build collaborative marketing systems. This transition of markets also includes farms that were primarily wholesale farms transitioning to marketing through established direct-to-consumer farms.</p>	
<p>15.</p>	<p>Creating the First-Ever Virtual Seafood HACCP Training</p>	<p>The 2011 Food Safety Modernization Act (FSMA) was a significant change to food safety regulations in the U.S., introducing a proactive rather than reactive approach to outbreaks. Two major rules impacted farmers and food businesses in Maine and throughout the U.S. They are the Produce Safety Rule and the Preventive Controls for Human Food Rule. The overall goal of these rules is to make America’s food system safer. For produce farmers, the impact of the changes is great because this industry has not been regulated so thoroughly before. Many farmers remain uncertain of how the regulations affect their work.</p> <p>In 2020, the pandemic created an increased demand for training and need to innovate to offer cutting-edge educational programs. UMaine Extension collaborated with Cornell University/New York Sea Grant to develop national and international guidelines for offering virtual seafood Hazard Analysis Critical Control Points (HACCP) training available through the national Seafood HACCP Alliance and Association of Food and Drug Officials (AFDO).</p> <p>Since being granted approval by these certifying bodies in April 2020, Extension delivered the first-ever virtual Seafood HACCP training in the world and taught in seven additional training sessions, reaching 117 participants. We also facilitated a new FSMA Preventive Controls virtual</p>	<p>Maine Food System</p>

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		training.	
16.	Maine Agricultural Mediation Program (MAMP) Saves Money, Properties, and Relationships	<p>Resolving disputes through administrative appeals or litigation is costly, time-consuming, and stressful for everyone involved. It can take years for a case to filter through the courts, the impact on a farm or family can be devastating, and costs can multiply across local and state agencies. By contrast, mediation generally resolves disputes with only a few meetings, providing a low-cost alternative to appeals or often expensive litigation and bankruptcy. Each case that is resolved through mediation saves time, attorney and court fees, travel, and the family’s mental and physical well-being.</p> <p>Extension is home to the Maine Agricultural Mediation Program (MAMP), part of the USDA Agricultural Mediation Program. The MAMP provides alternative dispute resolution through mediation to farmers, their lenders, and others directly affected by the actions of certain USDA agencies; in neighbor disputes; and in workplace and family disagreements that affect the farm. Mediation is voluntary and confidential, and involves a trained, impartial mediator helping participants to resolve disagreements. In 2020, the MAMP held 19 mediations and provided coaching to 4 farms. All cases were resolved without needing to progress to the courts.</p> <p>The Farm Service Agency estimates the typical cost savings for a simple adverse decision case is \$10,000, and as much as \$40,000 can be spent on cases that extend over years. In addition to savings in staff time, savings to producers and/or participants includes preservation of assets, properties, and relationships. In 2020, the MAMP estimates that as much as \$300,000 was saved through agricultural mediation in Maine.</p>	Maine Food System
17.	Enhancing Grain Production, Processing, and Usage in New England	Recent successes in building New England's local organic wheat economy have inspired new markets for a variety of food grains. The region now boasts scores of businesses (e.g., mills, bakeries, malt houses, and distilleries) with business models centered around locally grown organic grains. Concurrently, the need for local sources of organic and non-GMO feed grains continues to increase. Synergy among these markets and the	Maine Food System

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		<p>related infrastructure creates the opportunity for organic grains to become an important agricultural sector for our region.</p> <p>Twenty-twenty marked the end of a five-year, NIFA-funded, multistate project to help farmers in New England improve their skills and capacities to grow and handle grains for high-value specialty markets, and to build their network with other farmers and buyers. Collaborators included colleagues at UMaine and the University of Vermont. The project produced actionable information for organic grain farmers in the Northeast including strategies to better manage weeds, diseases, and legume green manures. A whole farm rotation budget tool created by the project gives farmers an easy way to evaluate the likely economic performance of different organic grain crops and rotations. An end of project survey conducted showed that farmers, processors, and commercial end-users in New England have made significant changes and improved the viability of their organic grain businesses as a result of participating in the project. As a result of those changes, farmers reported improved weed management (92%), grain yields (60%) and quality (93%), and increased sales (80%) and profitability (80%). Of the 11 grain processors and commercial end-users who responded to the survey, 80% reported having increased purchases of local organic grains and 86% reported having increased sales and profitability. Among all respondents, 86% reported having shared what they learned with others, and 100% said they had grown and strengthened their organic grain network as a result of participating in the project. The project produced 26 research reports, 1 budget tool, 7 videos, 10 abstracts and proceedings, 2 theses, 1 book chapter, and 8 journal articles.</p>	
<p>18.</p>	<p>Advancing Weed-Control Strategies on Organic and Low-External-Input Farms</p>	<p>Weeds continue to pose an important production constraint for most organic and low-external-input farmers, especially the increasing numbers of new farmers. Seedling managers respond to an increasing weed problem with more tools, additional cultivation events, and supplemental hand weeding. "Seedbank Managers," on the other hand, have a longer-term perspective, recognizing that a decreasing weed seedbank results in fewer weed seedlings, and decreasing investments in cultivation and hand</p>	<p>Maine Food System</p>

		<p>weeding to achieve nearly weed-free crops. A third strategy, that employed by "Intensive Mulchers," aims to solve the weed problem with a large, early-season investment of labor and purchased (i.e., black plastic) or on-farm organic residues placed thick enough to provide season-long weed control.</p> <p>An Experiment Station project director compared weed management strategies with a novel analysis by characterizing the multiple performance criteria of seed-, seedling- and mulch-focused weed management strategies. This work demonstrated that comprehensive seedbank management, generally considered a costly and long-term strategy, can have short-term benefits of improved yield and net returns, unexpected results that may encourage farmers to more carefully consider this approach to weed management. Research on "stacking" physical weeding tools showed synergistic effects of two or more tools on weed control efficacy. This novel and unexpected result has prompted an extensive new research initiative focused on improving mean efficacy and reducing variability of physical weed control tools.</p> <p>Tarping and solarization were evaluated as strategies to reduce the germinable weed seedbank. Both were generally effective practices, although effects were variable. Assays of the soil microbial communities showed that solarization effects were transient, with microbial activity rebounding to pre-treatment conditions in the weeks following treatment. Working in organic cereals, researchers found that weed control could be improved by inter-row hoeing, a physical weed control practice that is more aggressive than the standard practice of tine-harrowing. Furthermore, sowing in bands instead of conventional rows, combined with inter-band hoeing and harrowing offered improved weed control, but with variable effects on crop yield.</p>	
<p>19.</p>	<p>Improving Scientific Understanding of Pests Affecting Farm-Raised Salmon</p>	<p>Imports of Atlantic salmon to the US were valued at more than \$3.4 billion dollars in 2018, highlighting a tremendous opportunity, and need, for domestic production growth. The commercial farming of salmonids had its infancy in Norway in the 1960s, and optimal culture techniques for this</p>	<p>Maine Food System</p>

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		<p>relatively young industry have yet to be determined. Most pathogens threatening salmonid production have been successfully addressed through vaccines or other measures, however, sea lice remain the greatest constraint to the viability of the salmon farming industry and account for a nearly \$300 million dollar loss to the industry annually. Sea lice feed on the fish's mucus and skin, and a heavy infestation can cause considerable lesions, which often lead to mortality. A heavy reliance on pesticides to treat for sea lice has resulted in widespread developing resistance to currently available products.</p> <p>An Experiment Station scientist worked to identify alternative compounds that will elicit aversion behavior in sea lice (<i>L. salmonis</i>). The researcher previously reported the development of a novel behavioral bioassay for sea lice that could more effectively be used to assess behavioral patterns. This methodology was further refined over the reporting period (e.g., light intensity optimization, the refined production of salmon conditioned water), and this method has been successfully used for a number of trials over the reporting period. The goal of these studies was to investigate the potential that conspecific sex pheromones influence copepodid behavior, and to determine whether they play a role in the infection dynamics of this system. In net pen culture, it is often the case that there is a disproportionate number of lice on each salmon. Meaning, some salmon may be heavily infested, while others have few or even no lice. The researcher hypothesized that infective copepodids in the water column are receiving cues from lice that have already colonized the salmon. The results showed that copepodids exposed to water that had previously held pre-adult female or adult male sea lice demonstrated behaviors characteristic of localized search. This is the first finding of the perception of conspecific sex cues by a larval parasite and could highlight a novel mechanism for infestation. Understanding these dynamics will help scientists identify more promising candidate compounds for alternative therapies.</p>	
20.	Investigating the Effects of Climate Change and Ocean	Maine's lobster harvesters landed 100,725,013 pounds of the crustacean in 2019 valued at \$485 million. Data published by the National Oceanic and	Maine Food System

	<p>Acidification on American Lobster Health</p>	<p>Atmospheric Administration (NOAA) show lobster as the most valuable harvested species in the US for 2015, 2016, 2017, and 2018, with Maine landings accounting for approximately 80 percent of that value each year. Last year an Experiment Station scientist reported that sub-adult lobsters exposed to predicted end-century ocean acidification were more vulnerable to heat stress and showed a reduced number of immune cells. The research team speculated that this could make them more vulnerable to disease or other environmental stressors. During this reporting period, Experiment Station scientists conducted studies evaluating the combined effects of elevated ocean temperatures and acidification, similar to what researchers anticipate lobsters to experience along the coast of Maine both currently and in the future. They found temperature and acidification to have a synergistic effect, which increased their susceptibility to disease following exposure to a pathogen commonly encountered in impounded lobsters. It also reduced their heart performance and overall vulnerability to stress.</p> <p>These assessments required sophisticated techniques to evaluate heart rate under a thermal temperature ramp, so in addition to publishing the research findings, the researchers also published the innovative methods. The methods publication included a video which was produced in collaboration with staff in Marketing and Communications at the University of Maine. Contributing to this story, the researchers completed a study examining the transcriptome (mRNA gene expression) of larval lobsters exposed to expected warming conditions. They found that lobsters under the warmest conditions reduced the expression of genes associated with immunity and shell formation and increased the expression of genes related to metabolism. This suggests that there has been a tradeoff between maintaining immune defenses with maintaining the increased metabolic demands of a warming environment. Taken together, these studies indicate there may be implications for both larval and sub-adult lobsters regarding disease susceptibility and the ability to handle subsequent stress events as waters warm and become more acidic off the coast of Maine. Further, these challenges could be exacerbated for impounded lobsters.</p>	
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<p>21.</p>	<p>Investigating the Impact of Human-induced Environmental Change on the Reproductive Health of Commercially Important Aquatic Animals</p>	<p>Mitochondria are components of cells that play critical roles in energy production and metabolism. They are sensitive targets of environmental toxins; however, little is known regarding the impact contaminants have on mitochondrial function during embryonic development in fishes. Over the reporting period, investigators developed a high throughput screening assay to test for mitochondrial toxicity in embryonic zebrafish. Researchers tested 24 environmental contaminants and found that some chemicals had stronger effects at lower versus higher concentrations, others had increasing effects with increasing concentration of the chemical, and still others had even more complicated effects. Collectively, the researchers showed that mitochondrial responses to chemical exposure is highly dynamic and highlights the need to increase human understanding of how contaminants may impact aquatic animals. Further, they developed a high throughput screening assay that can be used to investigate multiple contaminants and could possibly be used to determine if water contains contaminants that may have mitochondrial toxicity.</p>	<p>Maine Food System</p>
<p>22.</p>	<p>Strengthening the Expanding Farm-Raised Seaweed Industry</p>	<p>The seaweed industry in Maine is currently experiencing substantial growth, particularly in the farm-raised seaweed sector. However, a lack of processing infrastructure and knowledge about how to process and transform seaweeds into value-added products pose a significant roadblock to the sustainable growth of the industry. An Experiment Station scientist has explored developing preservation processes for refrigeration-stable Maine seaweeds. A PhD student working in the scientist’s research team completed two studies which evaluated the effects of minimal processing (blanching, freezing, and blanch-freezing) and fermentation on the quality attributes of farm-raised sugar kelp.</p> <p>The objective of the first study was to evaluate the effects of blanching time (0, 1, 3 min) on microbial and physicochemical properties of sugar kelp and to compare consumer acceptance of seaweed salad made from raw and blanched kelps. The color, texture, and microbial counts changed significantly in response to blanching, with the kelp blanched for 3 min having lower aerobic plate counts. In consumer sensory evaluation, the</p>	<p>Maine Food System</p>

		<p>seaweed salads produced from blanched kelp scored significantly higher for flavor and overall acceptability compared to the raw kelp salads, and the color of the 1-min blanched kelp salad was rated significantly higher than other samples.</p> <p>In the second study, the researchers evaluated the effects of pre-blanching and freezing of sugar kelp on the quality attributes of a fermented sauerkraut-style product. Pathogens were not detected in the freshly made sauerkraut and all samples had low microbial counts. Blanching significantly affected the color and texture of the sauerkraut, while freezing did not. None of the processing parameters tested affected the consumer acceptability of the kelp sauerkraut.</p> <p>These are the first studies to investigate the impact of blanching and freezing on sugar kelp intended for subsequent valorization. Given the extremely limited shelf life of fresh sugar kelp and the short harvest window for this crop, optimized methods to preserve quality are necessary to promote the development of value-added food products for consumers.</p>	
<p>23.</p>	<p>Investigating High Pressure Processing to Increase Shelf-life of Sous-vide Products</p>	<p>Sous-vide cooked foods represent a growing trend in the U.S. because of their excellent texture, flavor, and nutrition, resulting from a low temperature, oxygen-free, cooking environment. Currently, pre-packaged sous-vide ready products are not commercially available due to their short shelf-life. High pressure processing (HPP) offers the potential to increase refrigerated shelf-life and safety of sous-vide ready products.</p> <p>Two recently graduated PhD students completed the final year of the USDA AFRI supported research to validate the use of HPP in the production of high-value sous-vide scallops and lobsters. In the first study, thermoanalytical and biochemical methods were used to evaluate the physical changes in scallop muscle in response to moderate HPP application, with the aim to better understand the observed physicochemical effects on scallops noted in the previous studies. The HPP parameters (150/350 MPa pressure levels and 5/10 min holding</p>	<p>Maine Food System</p>

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		<p>times) modified the sarcoplasmic and myofibrillar proteins of sea scallops, as measured by protein solubility, differential scanning calorimetry, protein molecular weight, and protease function. The observed alterations in sarcoplasmic and myofibrillar proteins in response to HPP help explain some of the textural changes previously observed in sous-vide cooked HPP scallops and in raw HPP scallops during iced storage, including increased toughening and weight loss.</p> <p>In the second study, the research team investigated the effects of sous-vide processing on the physicochemical quality attributes of lobster tails in comparison to conventionally cooked lobsters. Shucked lobster tails were vacuum-packaged and sous-vide cooked to internal temperatures of 55, 60, and 65 °C against equivalent times values (208, 45, and 10 minutes, respectively) aimed to control the target foodborne pathogen, <i>Listeria monocytogenes</i>. Results showed that all sous-vide cooked lobster tails were more tender than those conventionally cooked in boiling water, irrespective of sous-vide parameters applied. Interestingly, no significant differences were observed in physicochemical qualities among the sous-vide cooked treatments. In support of these results, subsequent sensory evaluation confirmed that there were no significant differences in consumer acceptability in response to the sous-vide cooking parameters. Clarifying the effects of this novel cooking method on thermal stability of lobster muscle proteins will help promote the development of optimal sous vide conditions for production of high-quality lobster products.</p>	
<p>24.</p>	<p>Supporting Healthy Habits in College Youth</p>	<p>Healthy diet and exercise help people manage their weight and prevent chronic diseases, but individuals can only implement healthy behaviors if they have confidence in their ability to discern and have the motivation to make healthy choices. To achieve this objective, focus groups with 20 college students were conducted to inform the development of questions that make up the nutrition literacy survey tool. Using the focus group data, 130 questions about nutrition literacy have been developed. An expert review of the questions has also taken place with 15 experts in the field of dietetics and nutrition. The survey questions were then refined to 120</p>	<p>Maine Food System</p>

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		<p>items and 700 college students were recruited to complete the survey to establish reliability and validity. The development of this survey tool will lead to a change in knowledge</p> <p>Seven-hundred college students completed the nutrition literacy survey. This data will be used to validate the nutrition literacy survey tool. By developing a nutrition literacy survey, programs that promote healthy eating on college campuses can make sure they are using resources efficiently and making the changes that will have the biggest impact on the health of community members. These changes make healthy habits an easier choice for more people. Good health plays a major role in improving individuals' quality of life and ensuring an able workforce and economic stability.</p>	
<p>25.</p>	<p>Improving Food Security and Diet of Parents and Caregivers</p>	<p>According to USDA, 13.6% of the Maine population experienced some form of food insecurity in 2018, which is a higher rate than the national level of food insecurity of 11.7%. With food insecurity comes greater health disparities among populations. Overweight, obesity, sedentary lifestyles, and poor diet quality are predictors of many chronic diseases. In Maine, 30.4% of adults are obese. One of the most common and preventable risk factors for premature death is consuming too few fruits and vegetables. In 2017, 31.4% of Maine adults consumed fruit less than one time per day and 12.4% of Maine adults consumed vegetables less than one time per day. The combination of high rates of food insecurity and obesity of Maine adults will continue to strain current health promotion programs and continue to raise health care costs for the state and the nation.</p> <p>To improve the food security and the diet of Maine’s low-income parents and caregivers, UMaine Extension implements direct education through EFNEP to encourage behaviors related to improving diet quality, increasing daily physical activity, and using food resources management practices to learn how to plan and shop for healthy meals and snacks. Program outcomes are measured for all adults using validated pre/post program surveys. In fiscal year 2020, 518 adults participated in Maine</p>	<p>Sustainable Community and Economic Development</p>

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		<p>EFNEP, and the education reached a total of 2,157 individuals in the program families. Of the 518 adults, 252 completed pre- and post-surveys. As a result of participating in EFNEP:</p> <ul style="list-style-type: none"> • 38% eat fruit more often each day • 38% eat vegetables more often each day • 23% drink soda less often • 38% make small changes each day to be more active • 40% thaw frozen food at room temperature less often • 37% plan meals before shopping more often • 27% make a list before shopping more often. <p>These small steps taken together and modeled for their children help to improve participants' and families' long-term health and reduce their health care expenditures.</p>	
<p>26.</p>	<p>Master Gardener Volunteers</p>	<p>Successful school and community gardens are an important tool for enhancing public health and providing meaningful community engagement opportunities by increasing access to locally grown food, providing a safe space to connect with neighbors, and offering learning opportunities outside the classroom. Extension supports volunteer leaders and provides educational resources, which are key contributors to the success of these projects.</p> <p>In 2020, due to the pandemic, gardening and gardening questions increased as much as 70% from last year in some counties. Now more than ever Maine residents need access to reliable research-based information to become successful gardeners.</p> <p>In 2020, Master Gardener Volunteers (MGV) played a vital role in connecting communities with educational resources through one-on-one mentoring, social media, and virtual programming. The MGV program provides participants with a minimum of 40 hours of in-depth training in horticulture. Trainees receive current, research-based information from our</p>	<p>Sustainable Community and Economic Development</p>

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		<p>educators and industry experts and are connected with service projects that match their interests, skill set, and availability. MGV coordinators facilitate relationships between MGV and community partners, assisting with needs assessment, program planning, risk management, and problem solving.</p> <p>The MGV program provides opportunities for gardeners with all levels of experience to connect with meaningful service projects in their communities. Of the 932 active MGVs, 113 were trained in 2020. In total, they donated 7,600 hours to a variety of food security projects and virtual volunteer opportunities. MGVs reported that they:</p> <ul style="list-style-type: none"> • increased consumption of home-grown food • adopted techniques to improve soil quality • developed new or expanded gardens • implemented practices that improve efficiency and reduce inputs and negative impacts • engaged positively with their communities. <p>Many volunteers enter the MGV program with the goal of improving their gardening skills for their own personal benefit and leave surprised by how deeply involved and passionate they become about community projects.</p>	
27.	<p>Maine Harvest for Hunger: Support for Food-Insecure Citizens</p>	<p>Maine has the highest rate of food insecurity in New England and ranks 12th in the nation. The USDA estimates that 13.6% of Maine households (over 182,000 individuals) are food insecure. Furthermore, nearly 1 in 5 children are food insecure and 23% of Maine seniors are experiencing marginal, low, or very low food security. In 2020 the pandemic drove a 40% increase in the state’s food insecurity rate. Thirty-seven percent of food-insecure people do not qualify for food assistance or other government programs. It is especially challenging for food-insecure people to afford high-quality, fresh, nutritious food, and donations of fresh produce to Maine’s emergency food system have declined significantly in recent years.</p> <p>Since 2000, UMaine Extension’s Maine Harvest for Hunger (MHH) program has mobilized gardeners, farmers, businesses, schools, and civic</p>	<p>Sustainable Community and Economic Development</p>

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		<p>groups to grow, glean, and donate high-quality fresh produce to food pantries, shelters, and community meal sites throughout Maine. In early 2020, with restrictions in place due to the pandemic, over 100 Master Gardener Volunteers grew, harvested, and distributed thousands of pounds of fresh produce from the safety of their own home gardens. Once protocols and a training module were in place, Extension trained MHH volunteers so they could safely resume in-person gleaning in small groups. Said one volunteer, “I was so grateful to Cooperative Extension for keeping us safe during COVID-19, while helping me feel that I was still contributing to my community in meaningful ways.”</p> <p>By the end of the 2020 growing season, 545 Master Gardener Volunteers, farmers, and members of the public grew, gleaned, and distributed 92,482 pounds of fresh produce, valued at \$156,294, to 219 food pantries, soup kitchens, and meal sites throughout the state. Extension staff and volunteers supported the development of collaborating gleaning organizations such as the Maine Gleaning Network, Merry Meeting Gleaners, and Maine Mid Coast Gleaners. Our MHH harvest donations this year combined with the donations of our collaborating partners to allow us to meet the additional need for fresh produce created by the rise in numbers of food-insecure Mainers during the pandemic. Since 2000, MHH participants have distributed more than 3.1 million pounds of food to citizens grappling with hunger.</p>	
<p>28.</p>	<p>Parent Education Program Promotes Early Screening and Intervention for Developmental Delays</p>	<p>The first 3 years of a child’s life are a critical time for growth and development. Early identification of developmental delays and subsequent referrals to appropriate early intervention services are essential to reduce the long-term impacts. Developmental delays, learning disorders, and behavioral and social-emotional problems are estimated to affect 1 in every 6 children. Only 20-30% of these children are identified as needing help before school begins. Intervention before kindergarten has huge academic, social, and economic benefits. Studies have shown that children who receive early treatment for developmental delays are more likely to graduate from high school, hold jobs, live independently, and avoid teen</p>	<p>Sustainable Community and Economic Development</p>

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		<p>pregnancy, delinquency, and violent crime, which results in a savings to society of about \$30,000 to \$100,000 per child.</p> <p>UMaine Extension Parent Educators work from two offices covering five counties and are part of a statewide network of Maine Families Home Visiting Programs. In 2020, 10 certified parent educators provided 1,686 home visits to 192 parents with 187 children living in four counties. Using the Parents as Teachers model, parent educators met with families in their homes and then virtually due to the pandemic. They:</p> <ul style="list-style-type: none"> • provided families with current information on child development and parenting • shared activity ideas and ways to engage and nurture children’s optimal development • provided connections and linkages to community resources. <p>In our two county-based offices, over 90% of children enrolled had a timely screening for developmental delays (91% in Knox-Lincoln County and 98% in Waldo County). In cases where a delay was discovered, 100% of those children were successfully referred and connected with local intervention programs for further developmental evaluation and services. All of the families who completed the annual parent survey reported Maine Families helped them understand their child’s growth and development.</p>	
<p>29.</p>	<p>Recipe to Market Program: Growing Successful Food Entrepreneurs in Maine</p>	<p>There has been a growing interest in value-added food production in Maine—from farmers looking to add value to their raw products, to Maine families interested in turning their favorite recipes into viable food businesses. In response to this growing demand, UMaine Extension developed the Recipe to Market program in 2007 and has been offering it to statewide audiences annually ever since. The goal of the program is to help potential and existing food entrepreneurs acquire food science and</p>	<p>Sustainable Community and Economic Development</p>

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		<p>business knowledge and skills to successfully bring a value-added food product to market.</p> <p>Since its inception, Extension has conducted 28 programs in nine counties reaching 350 participants across the state. The program is offered in both multiple- and single-session formats and is designed to help participants understand licensing/regulations, processing/packaging, and the specialty food industry, and acquire business management knowledge and skills. The program is conducted by a multidisciplinary team of Extension faculty and covers topics such as introduction to specialty foods, developing your product and process, business realities, marketing, and a resource panel discussion.</p> <p>As a result of attending these educational programs, more than 90% of the participants surveyed indicated they improved their knowledge and skills and plan to adopt business and food processing/safety practices they learned during the program. Long-term survey results indicate that participants used the new knowledge they gained from attending Recipe to Market to make more effective business decisions, develop new food products, and write and revise business and marketing plans. The survey results also indicate that 27% of the Recipe to Market multisession participants subsequently started food businesses. We estimate that 60 new value-added food businesses, generating \$2.1 million in direct sales and employing 102 workers, were started in Maine by the 221 people attending our Recipe to Market multisession programs since 2007.</p>	
<p>30.</p>	<p>Maine Ocean and Coastal Acidification Partnership Advises on State and Northeast Strategies</p>	<p>Ocean and coastal acidification (OCA) is highly variable at local scales, as it is influenced by local hydrologic and oceanographic conditions and nutrient pollution. It is therefore essential to conduct coastwide sampling to identify areas of relative vulnerability and resilience to OCA that may inform strategic and sustained efforts over time.</p> <p>Since 2018, through a project supported by the NOAA Ocean Acidification Program, Maine Sea Grant and UMaine Extension have</p>	<p>Sustainable Community and Economic Development</p>

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		<p>worked with NOAA staff, UMaine researchers, and other partners to develop and implement a northeast regional strategy for coordinated ocean and coastal acidification monitoring and related education and training activities. The Maine Ocean and Coastal Acidification (MOCA) partnership is a voluntary network of 220 people led by a 7-member steering committee coordinated by Extension and a 38-member advisory group. MOCA’s membership includes scientists, fishermen, aquaculturists, advocates, legislators, and concerned citizens. We have worked together to understand the impacts of ocean climate change on Maine’s marine waters, economies, and communities and to implement the recommendations of Maine’s Ocean Acidification Study Commission.</p> <p>In 2020, MOCA shared “An Action Plan to Address and Adapt to Ocean Climate Change in Maine” with legislators and the Maine Climate Council and has continued to play a role in advising state strategy.</p>	
<p>31.</p>	<p>Conserving biological diversity in human-modified landscapes</p>	<p>An Experiment Station project jointly led by two scientists addresses an overarching goal of trying to understand how society can maintain biological diversity in the context of human modification of landscapes. The research team investigates the social, economic, and policy ramifications of integrating biodiversity conservation with human use of ecosystems. They continued to implement the Vernal Pool Special Area Management Plan (https://www.vernalpools.me/samp) mitigation tool in two Maine towns. The investigators originally developed the tool which was adopted in federal wetland rules for Maine by the US Army Corps of Engineers and the Maine Department of Environmental Protection. To support this work, the investigators received an NSF NRT grant. One of five research foci of the award examines how transdisciplinary research approaches can lead to conservation success for these wetlands. A PhD graduate student has been hired to work with these towns investigating how best to communicate with and engage landowners in conservation activities on their lands, in general, and as related to the vernal pool Special Area Management Plan.</p>	<p>Sustainable Natural Resources</p>

<p>32.</p>	<p>Effectiveness of Riparian Management for Maximizing the Economic Productivity of Timberlands While Safeguarding Freshwater and Riparian Ecosystems</p>	<p>An Experiment Station project director collaborating with an interdisciplinary team used a combination of experiments, field surveys and paleoecological studies to understand how climate-linked changes in catchment forest composition alter the structure and stability of aquatic food webs. The research team examined the effectiveness of riparian management as a tool for maximizing the economic productivity of timberlands while safeguarding freshwater and riparian ecosystems and their resources. Researchers approached the project with the specific goal to provide region-specific information on which buffer approaches optimize long-term investment-to-outcome ratios for forgone harvest vs. freshwater ecosystem health by 1) conducting a literature review of the current state of knowledge of the investment cost and effectiveness of riparian buffers in the Northeast; and 2) resample a 2001 riparian buffer experiment in 15 western Maine streams to quantify the long-term (17-year) ecological outcomes and economic investment in alternative riparian buffer designs for forested freshwater resources.</p> <p>These study sizes encompassed three replicates of each of four alternative riparian management approaches: clear cut harvest with i) no buffer, ii) 11 m, or iii) 24 m buffers, and iv) a partial harvest without a buffer. They also included two replicate streams that were unharvested control blocks. Over two summers, the research team collected and analyzed data on riparian forest composition and timber value; stream habitat quality; aquatic invertebrate communities; fish abundance and condition; riparian insects; and ecosystem processes (litter decomposition rates). These data enabled scientists to quantify the ecological outcomes of alternative riparian management approaches and model the timber value differences between the riparian buffer treatments using forest growth and yield programs. They did not observe any significant differences in total abundance and diversity of all taxa, and of that of vulnerable organisms (mayflies, stoneflies, and caddisflies), among the alternative riparian management treatments. However, they did detect a legacy of riparian harvest in the relative abundance of different insect species: communities in unharvested control treatments were significantly different from</p>	<p>Sustainable Natural Resources</p>
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		<p>treatments in which harvest occurred in the immediate riparian zone (i.e., blocks with clear cuts and partial harvest).</p> <p>Researchers also observed differences in the feeding guilds of insects among different riparian treatments with collector-gatherers dominating streams in harvested blocks, whereas streams in unharvested control blocks had a higher proportion of scrapers and a more even distribution of functional guilds. The breakdown rate of forest litter in streams did not differ among harvest treatments. This suggests differences in ecological communities did not translate to impaired stream ecosystem function in terms of litter breakdown. These outcomes and underlying data have been made available to natural resource managers, landowners, and scientists via public reports, databases, and a MS thesis. Manuscripts for peer-reviewed publication are in progress.</p>	
<p>33.</p>	<p>How More Frequent Flood and Drying Disturbances Expected with Climate Change Alter the Effects of Warming on Freshwater Food Webs</p>	<p>The desire to understand and anticipate the effects of climate change on ecological communities is a regional, national, and global research priority. The regional effects of climate change have the potential to strongly degrade freshwater ecosystems and the cultural, economic, and social services (e.g., fisheries) they provide the people of Maine. An Experiment Station project director conducted a pond mesocosms experiment in which communities of different ages were subject to a drying disturbance designed to simulate a late season drought. The experiment revealed that younger communities contained a higher proportion of mobile organisms such as winged predators, and these were more impacted by drought than less mobile organisms. These results suggesting more frequent drought disturbances may change the trophic structure of pond ecosystems in ways that may influence mobility and trophic level on community vulnerability to disturbance in pond mesocosms.</p> <p>Additional work linked to this area of inquiry has included assessing the drivers of community structure and diversity in river-side rock pools along the Penobscot River, one of Maine’s largest rivers. The surveys, which comprise the first systematic study of rock pools in Maine, have found that</p>	<p>Climate Change</p>

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		<p>these pools support >60 taxa including several invasive mosquitos, a suite of taxa typically associated with flowing water, and a diverse assemblage of 18 genera of Chironomidae. Pool size, hydrology, resource availability and proximity to the river all influence community structure in these systems.</p>	
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