

2019 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 Plan of Work. Use this space to provide updates to your state or institutions as 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 over 100 years. Over 160 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 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. In 2019, we welcomed Hannah Carter as the new dean of Cooperative Extension.

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 2019, UMaine Extension and MAFES programs continued to focus on 5 planned program areas:

Maine Food System through research and outreach related to agriculture, aquaculture, food processing and distribution, business education, food safety, and human nutrition.

Positive Youth Development through 4-H programs with a focus on the STEM disciplines.

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.

Climate Change by conducting research to understand changing global and regional climate patterns, and how these changes impact the state's agricultural and natural resources.

Natural Resources in agriculture and food sciences, forestry and wood products, fisheries and aquaculture, wildlife, outdoor recreation, and rural economic development.

EXECUTIVE SUMMARY UMAINE COOPERATIVE EXTENSION

Supporting Maine's Traditional and Changing Agricultural Economy

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 over 8,200 farms, the largest number of any New England state. UMaine Extension played pivotal roles in supporting a majority of these farms over the past year.

The Maine potato industry encompasses over 500 businesses employing over 2,600 people and providing over \$112 million in income to Maine citizens. The economic impact from our pest monitoring and educational programs for the 2018 season is estimated to be more than \$8 million.

Maine's wild blueberry industry, with 500 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.

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.

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. UMaine 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.

Interest in agriculture and starting new farms in Maine has increased dramatically over the past fifteen years. Since 2011, UMaine Extension has provided educational outreach through its "So You Want to Farm in Maine" series to enhance the skills, business management knowledge, confidence of new and established farmers. The SYWTFIM series has reached over 500 participants from all Maine counties and out-of-state. A survey sample of participating farmers (n=158) revealed 88 new jobs, with estimated wages of \$612,000 annually, and an estimated total market value of agricultural products sold by these farms of over \$2.2 million annually. Since 2017, when the training qualified as FSA borrower training, farmers with FSA loans have completed their loan requirements and received nearly \$2.4 million in farm loans.

In 2012, UMaine Extension used a SARE professional development grant to focus on increasing the ability of individual agricultural service providers (ASPs) to meet the needs of new and beginning farmers. This sparked the formation of the Beginning Farmer Resource Network of Maine (BFRN), a coalition of Maine agriculture agencies and organizations working together to connect aspiring and beginning farmers to resources for farm business success. In 2018, an impact survey of BFRN members showed that as a result of BFRN, over 800 farmers made changes (e.g. business planning and accessing technical assistance), affecting about 40,750 acres and 47,265 animals, and resulting in a total value over 5 years of more than \$8 million.

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.

A large investment in infrastructure and programming was realized in June 2018 with the opening of the University of Maine Cooperative Extension Diagnostic and Research Laboratory. Funded by an \$8 million bond referendum, the lab occupies a 28,000-square-foot commercial laboratory building located a few miles from campus, and houses our Veterinary Diagnostic Lab, Aquatic Animal Health Lab, Arthropod Lab, and Plant Disease Diagnostic Laboratory. This facility is the most bio-secure location within the UMaine System. The new lab brings together scientists researching animals, agriculture, insects, and plants under one roof. 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 will benefit 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. In 2019, the University of Maine Animal Health Lab (UMAHL), tested over 6,000 samples, the great majority of which were from farm animals. Our salmonella and mastitis labs test poultry farm environmental swabs and milk, allowing farms of all sizes to operate with more assurance of healthy animals and healthy products. The new Diagnostic and Research Laboratory has expanded Extension's services, outreach, and positive impact on Maine's farms.

Helping Farms to be Safe and Accessible

Maine AgrAbility helps farmers, loggers and fishermen facing physical or cognitive challenges, to enhance their ability to farm and live independently. AgrAbility specialists assess issues and offer adaptive recommendations. They provide education about safe work methods and connect people with other resources. Since the project began in 2010, Maine AgrAbility has provided technical information to 754 farmers and conducted on-site assessments for 92 agricultural workers. The diverse agricultural operations include dairy and livestock operations, Christmas tree farms, fruit orchards, agritourism, vegetable and maple syrup production, hay sales, managing woodlots and lobstering. Clients reported increased knowledge of their conditions and enhanced accessibility for their daily work.

UMaine Extension provided farm safety training to 372 youth and farmers, including 143 in tractor safety. To support this programming, Extension collaborated with Maine Farm Bureau, the New York Center for Agricultural Health and Medicine, tractor dealerships, and local farms. In 2019, 61 individuals completed the 5-week, 20-hour, National Safe Tractor and Machinery Operation Program curriculum. Eighty-two people participated in abridged Tractor Safety Short Courses. As a result of this programming, 14 farms installed safety components (Slow moving vehicles signs and PTO Shields) to their tractors.

Mobilizing Support for Food Insecure Citizens

Maine has the highest rate of food insecurity in New England, and ranks 12th in the U.S. The USDA estimates over 13.6 percent of Maine households, over 182,000 individuals, are food insecure. Twenty percent, or 1 in 5 children are food insecure. Twenty-three percent of seniors have marginal, low, or very low food security. Since 2000, UMaine Cooperative Extension's statewide Maine Harvest for Hunger (MHH) program has mobilized gardeners, farmers, businesses, schools, and civic groups to grow, glean, and donate high quality produce to distribution sites (pantries, shelters, low income senior centers, etc.) and directly to neighbors in need, to mitigate hunger, improve nutrition and health, and help recipients develop lifelong positive nutritional habits.

In 2018, MHH also focused on educational programs that engage food pantry recipients, seniors and community gardeners in growing more of their own produce and learning practical methods of cooking and utilization of fresh produce. Since 2000, MHH participants have distributed over 3 million lbs. of food to citizens grappling with hunger. In 2018, donations of over 193,000 lbs. of fresh produce from over 120 Maine farms went to 207 hunger alleviation distribution sites. A corps of 365 volunteers and 8 corporate partners logged 2664 hours, and the value of the produce is estimated at over \$327,000.

Training Master Gardener Volunteers

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 937 active MGV participants, 144 of whom were trained in 2019. In total, they donated over 33,500 hours to a variety of educational and food security projects throughout the state including supporting 53 community gardens, 50 school gardens, 57 demonstration gardens, and 66 youth programs involving 4,129 youth in horticulture. Many volunteers enter the MGV program with the goal of improving their gardening skills for personal benefit and then become deeply involved in community projects.

Reducing the Risk of Foodborne Illness in Vulnerable Populations

Since 2013, 1,400 volunteer quantity cooks from across Maine have attended UMaine Extension Cooking for Crowds: Food Safety Training for Volunteers workshops. On average, these volunteers feed 500 people a week. Cooking for Crowds is an innovative program that blends food safety education with food security efforts to reduce risk of foodborne illness within vulnerable populations. Program participants have increased their knowledge base to reduce food borne illness in the 5 million meals they serve annually to Maine's food insecure population. Assuming that foodborne illness patterns mirror population patterns and that Cooking for Crowds reduces foodborne illness in Maine by even just 1 percent, the program is estimated to prevent more than \$640,000 in economic losses and 1,977 cases of foodborne illness each year.

Helping Youth Make Good Nutritional Choices

In 2019, over 2,000 youth participated in the Maine Expanded Food and Nutrition Education Program (EFNEP). Youth participated in an average of 6 classes over a time frame of two months. Ninety-seven percent of participating youth completed a pre and post survey. As a result of participating in EFNEP:

- 77% of youth improved their abilities to choose foods according to current Dietary Guidelines or improved nutrition knowledge.
- 38% of youth improved their daily physical activity practices.
- 53% of youth used safe food handling practices more often.
- 46% of youth improved their ability to prepare simple, nutritious, affordable food.

Teaching Broad Life Skills to Youth

Last year over 23,400 youth participated in the Maine 4-H program by attending 4-H camps and learning centers, 4-H community clubs, school, after school, and special interest programs. We reached more under-served and underrepresented youth than ever before. With many youth participating in multiple ways, UMaine Extension faculty and staff, and more than 1,500 volunteers, provided positive learning experiences for:

- 8,450 youth through our 4-H Camp and Learning Centers
- 1,880 youth through our 4-H clubs
- 2,500 youth through our Eat Well program
- 4,900 youth through our Special Interest/Short Term programs
- 5,700 youth through our School Enrichment Programs

Building STEM Literacy in Youth

Relevant, meaningful, and authentic experiences in science, technology, engineering and math (STEM) are important to developing positive attitudes, increasing knowledge, and preparing Maine youth for the estimated millions of STEM-related occupations projected between now and 2022. 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 to which Maine youth belong, informal education can help minimize inequities in rural youth STEM education and career pipelines.

The 4-H STEM Ambassador program trained 116 college students in the development and delivery of informal STEM-based educational experiences. Combined, these volunteers worked with over 850 youth at schools and community sites, and committed 1,740 hours of time including training, preparation and program delivery. 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.

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. In development is the Follow a Researcher® network, that will enable us to manage expeditions from multiple sites from our new website (followaresearcher.org) and engage 4-H programs and researchers from other universities to share expeditions with youth and educators from around the world.

Tech Wizards is a youth mentoring program that uses STEM education and service learning to help youth learn life and workforce skills, improve academic performance, and aspire to post-secondary education, productive careers, and community engagement. Extension coordinates the program in Maine, with funding from the U.S. Department of Juvenile Justice. In 2019, Maine's Tech Wizards program matched 120 youth along with 10 adult mentors. Youth learned invaluable STEM skills, participated in ongoing fieldwork, citizen science initiatives, service learning, and were empowered to engage with their communities and contribute their time and skills to address important scientific questions, and to recognize that environmental stewardship is both the platform for their learning and an overarching life ethic.

4-H Summer of Science is an effort to increase science proficiencies in local communities and prevent summer learning loss. Extension staff use summer of science experiential learning activities to address summer learning loss and work toward youth engagement and interest in science. The program focuses on programming where youth already are, and uses positive 4-H youth development programs to reduce barriers to involvement in STEM. In 2019 Maine 4-H Summer of Science, 700 adult volunteers and 41 teens and 12 Extension staff facilitated activities with over 3,600 youth at 50 unique sites in 10 counties.

4-H Community Central addresses the increased vulnerability that children in public housing experience due to their environment. The program places Extension staff in public housing sites in the state's two largest cities, Portland and Lewiston, where they engage youth with their parents, elders, school, and community through hands-on 4-H projects in science, leadership, and citizenship. In five years, the program has involved over 8,000 school-age participants. In their local communities, youth in grades 3-8 received over 780 hours of 4-H STEM programming taught by teen mentors and community leaders. Ninety-six teens (82% of color), in grades 9-12 dedicated over 440 hours of mentoring and leadership to young people in their communities. Participating youth have demonstrated knowledge, skills, attitudes, and behaviors necessary for fulfilling, contributing lives.

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. In 2019, the 4-H summer camps served 2,454 youth from all 16 counties in Maine, 22 states, and 6 countries. Through living and working together, campers and staff became part of an interconnected community committed to a sustainable future. Youth and program alumni report that the 4-H Camp and Learning Center experience has helped them develop greater self-confidence, civic engagement, and personal and academic success. The

Camps' Open Air Classroom programs provide residential, nature and school-based programs that help schools to meet learning standards, and engage students in active learning. In 2019, the 4-H Camp and Learning Centers provided programming for over 6,000 students from over 60 Maine school groups.

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.

Helping Rural Entrepreneurs Increase Profitability

Research shows that helping rural entrepreneurs improve their business skills will improve their chances for success. One of the most important business management skills is pricing, yet many small business owners lack the knowledge and skills necessary to develop a profitable pricing strategy. In 2019, UMaine Extension conducted pricing workshops across the state, presented a pricing webinar in collaboration with the Maine Food Strategy, and taught a pricing seminar at a statewide conference for entrepreneurs. More than 70 rural entrepreneurs from across Maine participated in this highly successful training. They included specialty food producers, farmers, craft artists, food retailers, environmental consultants, bookkeepers and other small rural businesses.

Promoting Community Based Adult Education through Extension Homemakers

In many Maine counties Extension Homemakers remain a traditional and vital part of the community fabric. They also provide direct and indirect benefits in terms of volunteer hours, fundraising, and material donations. In 2019, over 460 Extension Homemakers from over 40 Local Extension Homemaker Groups met and delivered or engaged in Extension programming involving over 1,800 participants and 200 programs including food,

personal and community; nutrition and health; gardening and environmental, financial planning and consumer; personal growth; and cultural and creative arts. The total estimated monetary value of the Extension Homemaker program to their communities was nearly \$700,000.

Recipe to Market Program: Growing Successful Food Entrepreneurs

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, Extension developed the Recipe to Market program in 2007 and has been offering it to statewide audiences ever since. Since then, Extension has conducted 28 programs reaching 350 participants across the state. 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. Twenty-seven percent of the Recipe to Market multi-session 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 multi-session programs since 2007.

Supporting Coastal Communities

As a designated Sea Grant College, the University of Maine hosts the Maine Sea Grant College Program, a federal-state partnership funded by the National Oceanic and Atmospheric Administration and the state of Maine. The Marine Extension Team (MET) is a collaboration between Sea Grant and Extension and includes professionals located in coastal communities statewide. MET members work with communities to provide research and outreach addressing problems and responding to opportunities in four major areas: ecosystem health; sustainable coastal communities; fisheries and aquaculture, and coastal community resilience. The MET provides coastal communities and other stakeholders with scientific information and assistance, and ensures that researchers are aware of the most pressing issues facing the state. Information is transferred to and from citizens by Marine Extension Associates who design and deliver local outreach programs. Through this process, communities gain the capacity to make informed decisions on the management of coastal and marine resources that promote ecological and economic sustainability.

Expanding Outreach through Online Presence

In 2019, UMaine Extension's website at extension.umaine.edu - a composite of 68+ interconnected websites - received over 2.4 million pageviews, 79 percent of which came from the United States and nearly 38 percent of which from Maine. UMaine Extension instructional videos have been viewed more than 4 million times. Nearly 37,000 followers followed or were subscribed to UMaine Extension's 53 county and

program-specific social media accounts on Facebook, Twitter, YouTube, Pinterest, and Instagram. More than 230 educational videos were available to visitors on our YouTube and Kaltura channels; many were also embedded in our web pages. More than 2,700 clients used our online registration system to register for classes, workshops, events, and more.

Enhancing Program Impacts with Extension Volunteers

Volunteers are the heart of UMaine Extension, giving their valuable time, effort, and expertise to greatly magnify the value of our work to the people of Maine. All of our volunteers commit time to appropriate training prior to their service. In 2019, over 4,100 Maine people volunteered more than 82,000 hours with us in a myriad of ways from 4-H clubs to fundraising, from growing food to managing county Extension office budgets. This remarkable effort equates to over 40 full-time staff members.

Continuing to Bring Research-based Knowledge to Maine People

We are proud to report that the faculty and staff of the Experiment Station and UMaine Extension continue to perform excellent work as we bring research-based knowledge and practical solutions to the people of Maine. We are committed to working successfully with a broad range of partners to meet the needs of Maine people, and we understand that community-based collaboration is key to achieving measurable results. We believe that the need for University research and outreach through committed, enthusiastic, and energized Experiment Station and Cooperative Extension programs has never been greater.

EXECUTIVE SUMMARY--MAINE AGRICULTURAL & FOREST EXPERIMENT STATION

The Maine Agricultural and Forest Experiment Station has been conducting research and providing outreach to Maine and its people for over 125 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.

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, producing and utilizing 101.6 million pounds in 2016. That same year fresh blueberries accounted for 380,000 pounds, and 101.2 million pounds were processed. In total, fresh and processed wild blueberries were valued at \$27.7 million (NASS 2017).

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 a total economic value of >\$500 million dollars and employing over 6000 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.

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.

2019 highlights:

Wild blueberries rely on bees and other pollinators to produce fruit. Bee health and population declines threaten wild blueberry production. An Experiment Station faculty member working with an undergraduate student and two electrical engineers at the University of Maine developed a portable Doppler radar unit which provides estimates of colony strength. A commercial version has been tested and will be marketed in 2020.

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 including (acres, rank): Lamoka (3458, 7), Waneta (1125, 18), Caribou Russet (448, 32), Lehigh (334, 40), Pike (233, 46), Keuka Gold (162, 57), Reba (132, 64), Andover (107, 70), Niagara (101, 71), Brodie (87, 77), Eva (80, 78), NY115 (75, 84), and Harley Blackwell (66, 89).

The NE1731 project web site and interactive searchable database, which is updated regularly (see: <http://potatoes.ncsu.edu/NE.html>), continues to grow in importance and popularity. Evidence of its importance includes its use as a model for other regional and national projects (e.g. the USDA-NIFA SCRI potato acrylamide mitigation project and the USBP national chip trials). The web site provides current contact information for project cooperators and recent research reports, as well as access to a regional variety database and a dynamic summary generator for all released varieties. The interactive database has become popular as a tool used by researchers and stakeholders, and it can be viewed at <http://potatoes.ncsu.edu/nesrch.php>. The summary generator allows users to build a cultivar summary that contains the most up-to-date performance data in a concise one-page format <<http://potatoes.ncsu.edu/nesummary.php>>.

Annual surveys of winter grain conference participants indicate that farmers and processors continue to make changes to their organic grain businesses based on what they have learned from a Maine Agricultural and Forest Experiment Station project. In ME, 73% of farmer respondents reported having changed at least 1 practice, and on average 6.5 practices, as a result of what they learned over the last 4 years from the project's organic grain events and resources. These included changing a weed or fertility management system, calibrating their grain drill to achieve a target plant density, purchasing a new piece of equipment, and expanding markets and networks. Processors reported developing new sources and markets for local grains (71%) and increasing local grain purchases (43%). As a result of these changes, 77% of respondents reported at least one, and on average 5 improvements in their grain-based business, including improved grain yields and quality, expanded networks and access to markets, and enhanced profitability.

Spring annual weeds remain organic growers' number one production problem for spring grains, limiting the viability of organic grain systems in the Northeast. In both on-farm and research station trials, researchers demonstrated that combining selective cutting with automated camera-guided cultivation reduces both current and future weed pressure by reducing the seed production of weeds that escape cultivation.

The rapid expansion of the craft brewing and distilling industries in the Northeast has created demand for locally grown and malted barley, and the need for research-based information on which malting barley varieties are best adapted to Maine growing conditions and the craft malting process. Working with Maine's two malthouses, a researcher has identified varieties that have better sprout tolerance and malting qualities than the current standard variety. In 2019, Maine Malt House of Mapleton grew replicated 3-acre blocks of the standard variety, Newdale, and two new varieties, KWS Tinka and LCS Genie, which yielded 15% and 9% more than Newdale. During this past winter, Maine Malt House malted and analyzed 4500-lb lots of each variety, which were then brewed and taste-tested by Allagash Brewing Company. All three varieties malted and brewed well.

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.

2019 highlights:

An Experiment Station scientist conducted a survey of oyster growers in the Northeast about their experience with and concern about blister worm. Analysis of this survey indicates that while few farmers have experienced economic losses from blister worm infestations, concern over the loss of sales, product value, and farm reputation remains high. Following the survey workshops were conducted with oyster growers in the fall and winter of 2018/2019 that covered the results of the survey, the findings from the field treatments, the development of blister worm management plans, and discussing future research needs. During this research three separate species were identified that infest oyster and scallops in the region. In addition to *P. websteri* which has been observed in the Northeast for decades, *P. onagawawensis* and *P. neoceaca* were found to occur with some regularity on northeastern shellfish farms. These species occur worldwide. Experiment Station scientists are working with international colleagues to investigate how shellfish culture has affected the spread of these three species and may be involved in the infestation dynamics.

Major findings and impacts stemming from oyster research work include: 1) With proper attention to weather conditions, farmers using the "Oyster-Gro" type cages can reduce the load of blister worm in their oysters by 90 to 95%, or more. 2) In workshops on blister worm with shellfish farmers, research informs the need for shellfish producers to adopt and follow biosecurity plans that include inspection of any seed for the presence of blister worm before it is introduced to a farm. 3) The integrated research and education project on blister worm has assisted Maine oyster growers in the development of best management plans for reducing the impact of blister worm on their farms.

Research was also conducted to determine the impact of oyster aquaculture on benthic community structure. The research revealed that the organic loading in sediments under three oyster farms in Maine was only marginally higher than in areas adjacent to but outside of the influence of farms. Similarly, there were only minor changes in species composition and abundance of macrofauna in the sediments under farms. The

researchers conclude that, at the densities currently deployed at Maine farms, oyster aquaculture has a minor impact on benthic community structure.

Mussel research focused on the development of hatchery and settling protocols for blue mussel production explored a variety of nutritional sources for the cost-effective conditioning of blue mussel broods and different rope types for efficient setting of blue mussel seed. The major impacts and conclusions drawn from this work include: 1) The use of live algal feeds is preferable to dried algal diets during the conditioning of blue mussel brood stock, and 2) Despite a reduced surface area for settlement, a natural-fiber, Portuguese-type rope is optimal for promoting high-density mussel settlement without excessive fouling.

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

Station scientist 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, such as elderberries.

2019 highlights:

To pinpoint changes that will provide and encourage healthier habits in college students, 75 communities are using a new tool developed by a team of land-grant university researchers. Over 2,000 college students were surveyed from the following institutions: University of Rhode Island, West Virginia University, University of Tennessee, University of Maine, Rutgers University, South Dakota State University, University of Nebraska-Lincoln, and University of Florida. Results indicated that college students would like better support for mental health and healthy eating options on campus, and are more satisfied with physical activity resources on their campuses. Using the audit and survey tool, college campuses and others can make sure they are using resources efficiently and making the changes that will have the biggest impact on the health of community members.

Researchers also put together the Healthy Community Index, so that each community can see how its audit score compares to others. So far, 75 communities have used these new tools and can work towards making changes to their policies and improvements to their health environments. These changes make healthy habits an easier, more sustainable choice for more people.

A Behavioral Environment Survey was further developed and refined. More than 2,000 participants from eight campuses took the survey and data was collected on perceived environmental healthfulness, along with health behaviors such as dietary intake, physical activity, health related quality of life, and body mass index. The analyses showed that a strong psychometrically sound survey was developed and that students

reported poorer mental health and dietary resources on campus, but reported higher physical activity resources. Based on these findings, college campuses can now collect information on students' perceptions about the healthfulness of their campus. This information can be used to inform policy changes and/or promotional activities to attract potential students.

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.

2019 highlights:

A prototype of the Maine Integrated Forest Ecosystem Service (MIFES) model has been developed and periodically updated. MIFES is a dynamic optimization model of forests and land use that maximizes the net present value of economic surplus for the forestry industry. The model optimizes the timing of harvesting, the area of forests, and investment in managing forests through replanting, competition suppression, thinning, and other practices at multiple scales (including stand/local) and is linked to a global timber supply model to account for market and policy influences beyond Maine. The model is currently functioning and capable of estimating trends in growing forest stocks, the provision of harvested biomass and industrial roundwood, and forest carbon sequestration in both standing forests and harvested wood products for 8 forest types in the state of Maine.

The Bear Brook Watershed in Maine is one of the longest running whole forested watershed manipulation experiments in the world. For over 25 years the experiment has studied the effects of air pollution on forested watershed chemistry, hydrology and ecology. The particular focus has been on atmospheric deposition of nitrogen and sulfur interacting with our changing climate.

The Bear Brook Watershed in Maine was chosen as one of the key case studies to highlight by the U.S. Environmental Protection Agency in its review of the secondary effects of atmospheric sulfur and nitrogen pollution. The experimentally treated watershed has demonstrated the impacts we would have experienced without the federal policy, and has documented the effects of long-term nitrogen enrichment on forest function. The Bear Brook Watershed in Maine also was featured in a paper that was the first to document recovery from acid rain in forest soils,

a finding that has been widely documented, including by this project, in streams and lakes. The project also contributed to the scientific interest in the interaction of phosphorus with nitrogen in forest ecosystems using a unique double manipulation design at both the whole watershed and plot scales. The project provides one of the most robust data sets in Maine on forest soil carbon, an increasingly important management and policy interest in Maine.

The Howland Forest of central Maine, with its long-running CO₂ flux tower, provides an ideal location in which to explore the relationship between local atmospheric CO₂ flux and annual variation in above ground tree growth (i.e., carbon sequestration). Results from this work have identified an important link (including a shifted lag period) between annual CO₂ flux and annual tree growth at the Howland Research Forest (Maine), which has generated investigations of this relationship at six additional research sites across the US.

University of Maine leadership of the Hatch Multistate NE1601 Eastern White Pine Health and Responses to Environmental Changes helped to produce a highly useful field guide to white pine health. *Field Manual for Managing White Pine Health in New England* was published by the Maine Agricultural and Forest Experiment Station in June 2019. It provides essential information about pests, pathogens, site conditions, and climate associated with white pine health issues in the eastern US. The manual makes management recommendations for improving white pine health and reducing economic losses. A pdf version is available at: <https://umaine.edu/mafes/publications/miscellaneous-publications/>

UMaine faculty collaboration with the Wisconsin Young Forest Partnership (WYFP) yielded new management insights. Woodcock surveys indicated a positive impact of harvesting aspen forest on displaying male woodcock abundance. Researchers confirmed that forest habitat best management practices for woodcock were effective and should continue to be implemented. The study emphasized the need for thorough evaluation of new citizen science programs so that resources are used effectively, quality data are generated, and project outcomes are achieved. Due to the study's results, a regional wildlife partnership greatly altered the purpose and structure of its monitoring program.

Public outreach to key target audiences is important in applied research given that transfer of information and ideas for implementation is critical to promote change in knowledge, attitudes, and behaviors. A UMaine faculty member presented programs on wildscaping or birdscaping to four Audubon chapters and garden clubs in Maine. Participants eagerly sought ideas to improve wildlife habitat on private lands including "the backyard." By working with organizations like Maine Woodland Owners (formerly, Small Woodland Owners Association of Maine), project researchers were able to reach a large number of family forest owners with each event.

Not all outreach efforts require in-person programming. Two new websites were constructed to promote the woodcock migration study but also to promote new research initiatives of the Midwest Migration Network (see Eastern Woodcock Migration Research Cooperative (<https://www.woodcockmigration.org>) and Midwest Migration Network (<https://midwestmigrationnetwork.org>)). These websites have reached thousands of individuals and organizations which helps researchers to share information and create opportunities for collaboration.

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. Stations 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, 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.

2019 highlights:

The first publication of the multistate NC1189 Understanding the Ecological and Social Constraints to Achieving Sustainable Fisheries Resource Policy and Management including the active participation of two UMaine scientists was published in early 2019 (Carlson et al. 2019; <https://doi.org/10.1002/fsh.10238>). The work revealed that, based on the perspectives of state fisheries administrators, that the greatest perceived threats to fisheries were water quality/quantity impairment, land-use change, and invasive species. An interesting insight from the study was that state agency-experiment station relationships could be used to better leverage resources to study fisheries at longer-term and large-scales than are generally invested in by state agencies. An in-person, full-team meeting was held in May 2019 where the group discussed its future direction and decided to focus on the 10 Steps to Responsible Inland Fisheries as presented at the Global Conference on Inland Fisheries held in Rome in 2015.

In the spring of 2019, five faculty, two research associates, and one marine extension agent, representing the diverse fields of marine biology, coastal engineering, human dimensions of natural resources, and geospatial sciences established the Western Passage Student Research Collaborative (WPSRC). The WPSRC included six students, representing all of these disciplines. Beyond the focus on research to inform ecosystem monitoring protocols for tidal power development in Downeast Maine, the WPSRC was formed to have these students experience how integrated interdisciplinary research is organized and offered a research and training framework applicable to other marine systems and management contexts. The team met weekly from May through August and biweekly in the fall of 2019. The students presented their proposed research at the beginning of the summer at a regional conference (the Eastern Maine Current Coastal Collaborative meeting) and presented their

results at the end of the summer (at the SEA Fellows Symposium). The team is currently drafting a manuscript for publication, targeting *Oceanography: Breaking Waves*.

Research continued on two major population genetics projects. One involved summarizing the population structure of 72 wild brook trout populations in three major drainages in Maine, including the St. John (mostly Fish River Drainage), Androscoggin (mostly Dead River) and Penobscot Rivers (mostly West Branch). These drainages support populations with and without histories of historical stocking (aquaculture inputs). Researcher data suggest substantial genetic structure by drainage and that historical stocking of hatchery sources did not leave a lasting mark on many populations. In another project, analysis began of the population genetics of Maine's 12 relict landlock Arctic charr populations.

These populations are the only remaining indigenous Arctic charr populations in the USA outside of Alaska, and under review by the USFWS due to challenges they face from invasive species and climate change. As part of this reanalysis of old and new samples, Experiment Station research documented that one population that was previously thought to be a non-native introduction is actually a native population.

Several noteworthy accomplishments were achieved in the area of Environmental DNA (eDNA). Probably the biggest development this year was securing a \$20 million EPSCoR RII Track 1 grant funded by NSF and that will support extensive new eDNA research, student training, and outreach for the next 5 years. In addition to project elements related to ecosystem-based fish restorations, this project also brings eDNA to understand shellfish recruitment and aquaculture, harmful algal blooms, and climate-related range shifts of coastal species.

Work continues with NOAA/NMFS on new assays for Maine's diadromous fish assemblage and on testing the detection and quantification capabilities of such assays. For Rainbow Smelt, research was completed on a Maine Outdoor Heritage Funded project with Wells National Estuarine Reserve to test detection of Rainbow Smelt in four streams that vary in smelt abundance. Work started with MDIFW to conduct eDNA surveys for invasive mudpuppy (salamanders), a cryptic species that appears to be spreading in multiple Maine lakes and associated waterways following historical introduction to one stream. A new collaboration began with the Gulf of Maine Research Institute to combine eDNA with sonar data to quantify Atlantic herring abundances.

Work on model fish systems took advantage of the discovery of an introduced population of mosquitofish living on Cape Cod, where winter temperatures would normally limit persistence. A lab experiment showed that female mosquitofish from this source have extreme cold-temperature tolerance, whereas male tolerances would often be exceeded by winter temperatures. This suggests the peculiar life history of this species may allow the population to persist through hard winters by females storing sperm and establishing sex ratios in the spring. If so, these fish may be more of an invasive threat to northern habitats than suggested by prior tolerance testing.

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.

II. Merit and Scientific Peer Review Processes

The NIFA reviewer will refer to your 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
<p>1. <u>The Merit Review Process</u></p>	<p>In an ongoing effort to maintain valuable and relevant programming, faculty and staff engaged in formal and informal review by discipline-specific review panels and advisory groups that help to provide focus. While this results in defined programming intentions for the near- and long-term, the process is dynamic and ongoing throughout the year, and can result in new work to address emerging issues at any time.</p> <p>Programming merit and success for faculty members is also reviewed by faculty peers and supervisors 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</p>

	<p>problems, opportunities, and workforce development. Our primary mission is to enhance regional cooperation and improve coordination of regional Extension program initiatives for our region. 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>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 24 projects went through the process in FY2018.</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 time line 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 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
<ul style="list-style-type: none"> • Actions taken to seek stakeholder input that encouraged their participation with a brief explanation 	<ul style="list-style-type: none"> • Targeted invitation to traditional stakeholder groups • Targeted invitation to non-traditional stakeholder groups • Targeted invitation to traditional stakeholder individuals • Targeted invitation to non-traditional stakeholder individuals • Targeted invitation to selected individuals from general public • Survey of traditional stakeholder groups • Survey of traditional stakeholder individuals • Other (research using relevant current and first-source data) <p><u>Cooperative Extension</u> engages stakeholders on an ongoing basis, and also as needs and issues arise. Our programs seek and involve citizen and volunteer group input, and our staff work closely with community and commodity stakeholders to guide their work. Selected examples:</p> <ul style="list-style-type: none"> • Our partnership with 16 local county executive committees that meet regularly and provide direction and advice to our programs. These committees also hold countywide meetings inviting public input into programming. • The UMaine Board of Agriculture, as formed by state statute, advises us on agricultural research and Extension priorities. • The Maine Wild Blueberry Commission that represents growers and processors, and administers a state tax fund of over \$1 million. • The Maine Potato Board composed principally of Maine potato farmers that offers advice and support for research. The Board also administers a state tax fund to support Maine's most valuable agricultural commodity. • The Maine 4-H Foundation Board that works as a close partner to enrich youth experiences through our 4-H Youth Development Program.

- A variety of advisory boards formed with targeted intent to 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, and county-based 4-H Leaders Associations.
- We also partner with discipline-specific groups whose mission is to achieve success in a given area. Examples: Maine Organic Farmers and Gardeners Association, Maine Science, Technology, Engineering and Math Collaborative, and the Sportsman's Alliance of Maine.
- We maintain an ongoing open dialogue with Maine Legislators and County Commissioners to communicate our program focus areas and to respond to the needs that have been identified through their constituents.

The Experiment Station encouraged stakeholder input by hosting (along with the college leadership) formal meetings with advisory groups including the Board of Agriculture (two times), the Forest Resources Advisory Committee, and the Coordinating Committee of the Maine Cooperative Fish and Wildlife Research Unit. This year again, as a way to encourage more participation by state legislators, one Board of Agriculture meeting was held in the state capitol building and included a session which featured a majority of the Agriculture, Conservation, and Forestry Committee interacting with the Board.

Experiment Station leaders and staff regularly attend 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. MAFES faculty, through their interaction with stakeholder groups and individuals in both formal and informal settings, also continued to encourage stakeholder participation. Our research facilities hosted field days for apples, small fruits, and vegetables, potatoes, grains, and wild blueberries and other interests of growers, which allow researchers and administrators to learn more about the needs of the stakeholders in attendance. Overall, the station makes every effort to allow all groups and individuals to express their suggestions and concerns about station-sponsored research through the mechanisms discussed above.

<ul style="list-style-type: none"> • Methods to identify individuals and groups and brief explanation. 	<ul style="list-style-type: none"> • Use Advisory Committees • Use Internal Focus Groups • Use External Focus Groups • Needs Assessments • Use Surveys • Other (Identify and analyze issues) <p><u>Cooperative Extension</u> - Extension's programming is deeply and broadly grounded in traditional and non-traditional stakeholder individuals, and the general public. In the agriculture and food systems sectors the major stakeholders are identified through coordinating and advisory committees such as the Board of Agriculture, Agricultural Council of Maine, Maine Wild Blueberry Commission, Maine Potato Board, Maine Organic Farmers and Gardeners Association, the Maine Sea Grant Policy Advisory Board, and the Maine Board of Pesticides Control. In the youth development sector the major stakeholders are identified through coordinating and advisory committees such as the Maine 4-H Foundation Board, advisory boards of the 4-H Camp and Learning Centers, and the Maine Science, Technology, Engineering and Math Collaborative. For all of our programming, UMaine Extension maintains a list of all known stakeholder groups, and these groups are contacted on a regular basis, and meets regularly with county-based extension associations and program focused advisory groups.</p> <p><u>Experiment Station</u> - In the agricultural and forestry sectors, the major stakeholder groups are identified through coordinating and advisory committees such as the Board of Agriculture, the Forestry Research Advisory Committee, and the Coordinating Committee of the Maine Cooperative Fish and Wildlife Research Unit. MAFES provides input on potential committee members as do the current member stakeholder groups. For agriculture and forestry, MAFES maintains a list of all known stakeholder groups, and these groups are contacted on a regular basis. Individual stakeholders are identified in a variety of ad hoc ways including through faculty and department/school contacts as well as UMaine Extension.</p>
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<ul style="list-style-type: none"> • Methods for collecting stakeholder input and brief explanation. 	<ul style="list-style-type: none"> • Meeting with traditional Stakeholder groups • Survey of traditional Stakeholder groups • Meeting with traditional Stakeholder individuals • Survey of traditional Stakeholder individuals • Survey of the general public • Meeting specifically with non-traditional groups • Meeting specifically with non-traditional individuals • Meeting with invited selected individuals from the general public • Other (Research using relevant current and first-source data) <p>Extension and the Experiment Station collect input through formal organization processes (e.g. 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 (e.g. Maine Wild Blueberry Commission Advisory Committee, Maine Potato Board, Cooperative Forestry Research Unit). Faculty researchers meet with and collect input from both traditional and non-traditional stakeholders at the group and individual level.</p> <p>In addition, Extension faculty and professionals collect information through direct contact and surveys of traditional and non-traditional during outreach programming, community forums, and monthly volunteer county extension executive committees, as well as regular meetings with community, regional, and state partners (staff and elected officials of county government; state legislators; school teacher and youth groups; and local, county and state commodity organizations.</p>
<ul style="list-style-type: none"> • A Statement of how the input will be considered and brief explanation of what you learned from your stakeholders. 	<ul style="list-style-type: none"> • In the Budget Process • To Identify Emerging Issues • Redirect Extension Programs and Redirect Research Programs • In the Staff Hiring Process • To Set Priorities

Cooperative Extension

A new Extension programming direction came through our successful Telstar Freshman Academy, a yearlong, experiential program designed to foster resilience and high aspiration for high school youth in rural Oxford County. In 2018, the University of Maine System funded the Pathways Early College program at UMaine's Bryant Pond 4-H Center. This is a new initiative that will provide dual enrollment opportunities for high school juniors and seniors in Oxford County, with recruitment targeting first generation college students. The program's goal is to increase the number of students matriculating to UMS campuses, and to increase retention rates, especially among first generation college students.

A very large investment in infrastructure and programming was realized in June 2018, with the opening of the \$8 million University of Maine Cooperative Extension Diagnostic and Research Laboratory in Orono. This was the culmination of years of needs assessments, planning, stakeholder input, and funding. In 2014, Maine voters approved an \$8 million bond referendum to support Maine agriculture, facilitate economic growth in natural resource-based industries, and monitor human health threats related to ticks, mosquitoes, and bedbugs through the creation the new facility. The new lab brings together scientists researching animals, agriculture, insects, and plants under one roof. 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 will benefit 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.

Maine Agricultural and Forest Experiment Station

The Maine Agricultural and Forest Experiment Station staffs the Board of Agriculture comprised of a wide range of members representing the major agriculture sectors in Maine along with aquaculture interests. The purpose of the Board of Agriculture is to provide input to the University of Maine and the University of Maine System on matters related to agriculture. Highlights of the spring 2019 meeting included the Board of Agriculture meeting with newly-elected Governor Janet Mills to acquaint her with the Board's work and to learn about her priorities for agriculture and support of the University of Maine. During the winter 2019 meeting, the Board decided to initiate a review of the College of Natural Sciences, Forestry, and Agriculture, Maine Agricultural and Forest Experiment

	<p>Station, and Cooperative Extension capacity to support critical agricultural sectors including aquaculture.</p> <p>An overarching theme from stakeholders is the recognition that research and extension are a unique resource that regularly produce significant social, environmental, and economic benefit for the people of our state. The ability to provide the full spectrum of help in understanding and identifying issues, researching and addressing issues, and disseminating quality information takes a critical infrastructure driven by high-level expertise.</p> <p>A related theme is that funding is key to ensuring the ability for research and extension to create these social, environmental, and economic benefits for the people of Maine. An ongoing commitment to funding repays this investment many times over.</p> <p>Stakeholders have voiced the need for greater economic capacity research. All segments of the agricultural community express the need to maintain the Experiment Station research farms and greenhouses. They are also concerned about maintaining research capacity for modern science to support the food and agriculture sectors. Stakeholders are strongly supportive of county-based Extension outreach as a mechanism for refining statewide programs to meet unique local needs.</p> <p>Stakeholders have been impacted through the Maine Food and Agriculture Initiative, that is a partnership among the UMaine College of Natural Sciences, Forestry, and Agriculture and the Maine Agricultural and Forest Experiment Station. This initiative supports stakeholder-driven agricultural research and extension education for Maine. Examples of recent projects include:</p> <ul style="list-style-type: none">• Improving barley quality and yields for emerging high-value markets• Identifying Profitable Vegetable and Small Fruit Varieties for Maine (Y1-3)• The use of portable Doppler radar microphone to assess honey bee colony size and health• Investigation and Education on the Potential Food Allergenic Residues in Composts• Soil solarization for enhanced weed control in vegetables• Elderberry Virus Survey• Evaluation of Onion and Shallot Varieties for Maine Farmers
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	<ul style="list-style-type: none"> • Testing Maine's wild and cultivated elderberries for Tomato Ringspot Virus (ToRSV)" <p>In the area of youth development, Stakeholders are strong advocates for programming in support of STEM; early college and youth aspirations; immigrant, vulnerable, and underserved populations. With this support, UMaine Extension has continued and enhanced our work in such programs as:</p> <ul style="list-style-type: none"> • Sparking Student Interest in STEM Careers through 4-H Ambassadors • Students Follow a Researcher® on Expeditions in the Field • Tech Wizards Students Helping Solve Real Community Problems • Supporting Career Awareness in Youth in Aquaculture • Bolstering Learning Environments of Vulnerable Youth • Meeting Learning Standards through Open Air Classrooms • Building Community and Connecting Youth to the Outdoors • Reducing Summer Learning Loss • Reducing Obesity in Youth • 4-H@UMaine Giving Youth a Preview of the College Experience
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IV. Planned Program Table of Contents

No.	Program Name in order of appearance
1.	The Maine Food System
2.	Positive Youth Development
3.	Sustainable Community & Economic Development
4.	Climate Change
5.	Sustainable Natural Resources

V. Planned Program Activities and Accomplishments

Please provide information for activities that represent the best work of your institution(s). See Section V of the Guidance for information on what to include in the qualitative outcomes or impact statements. Add additional rows to convey additional accomplishments. You may expand each row as needed.

No.	Title or Activity Description	Outcome/Impact Statement	Planned Program Name/No.
1.	Supporting Maine’s Potato Industry through IPM	<p>The \$500 million potato industry is the largest agricultural sector in Maine, encompassing over 500 businesses generating over \$300 million in annual sales, employing over 2,600 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 amount of pesticides that are applied.</p> <p>UMaine 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 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.</p> <p>The economic impact from Extension’s pest monitoring and educational programs for the 2019 season is estimated at over \$19 million.</p>	The Maine Food System/1

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<p>2.</p>	<p>Enhancing Sustainability of Maine & Eastern US Potato Production</p>	<p>A UMaine agronomist chairs and is a major contributor to NE1731 Collaborative Potato Breeding and Variety Development Activities to Enhance Farm Sustainability in the Eastern US. This multidisciplinary, regional project utilizes existing strengths and resources of the potato breeding and variety development community in the eastern US, and it encourages the pooling of regional resources and promotes increased communication within the potato community located in the northeast, mid-Atlantic and southeast. The overarching goal of this project is to identify new potato varieties for use in the Northeastern, mid-Atlantic and southeast US, which will contribute to a more sustainable and profitable potato industry. The target audience includes potato growers, potato processors, home gardeners, and consumers of potatoes and potato products.</p> <p>From ME, Caribou Russet was released during 2015 for fry processing and russet fresh market and was produced on 448 seed acres during 2018. It is being rapidly adopted due to high yields, scab and verticillium resistance, and excellent consumer quality. Caribou Russet typically requires ~25% less nitrogen fertilizer than the standard fry processing variety, Russet Burbank. Lower nitrogen fertilizer rates help reduce costs for growers, while also decreasing the risk of nitrogen loss to the environment. Several potato varieties developed through the collective efforts of NE1731 are currently in the top 100 U.S. varieties including (acres, rank): Lamoka (3458, 7), Waneta (1125, 18), Caribou Russet (448, 32), Lehigh (334, 40), Pike (233, 46), Keuka Gold (162, 57), Reba (132, 64), Andover (107, 70), Niagara (101, 71), Brodie (87, 77), Eva (80, 78), NY115 (75, 84), and Harley Blackwell (66, 89).</p>	<p>The Maine Food System/1</p>
<p>3.</p>	<p>Boosting Maine Grain Production</p>	<p>Recent successes in building New England's local organic wheat economy have inspired new markets for a variety of food grains. Our region now boasts scores of businesses (e.g., mills, bakeries, malt houses, and distilleries) with business models centered around locally grown organic</p>	<p>The Maine Food System/1</p>

		<p>grains. Concurrently, the need for local sources of organic and non-GMO feed grains continues to increase. Research focuses on the three critical factors that prevent expansion of organic grain production in our region: robust weed and disease management strategies, efficient legume green manure systems, and engaged end-users with strong social networks. The target audience for this project is current and aspiring organic grain farmers, processors, and end-users in New England. Annual surveys of winter grain conference participants show that farmers and processors continue to make changes to their organic grain businesses based on what they have learned from a Maine Agricultural and Forest Experiment Station project.</p> <p>In Maine, 73% of farmer respondents reported having changed at least 1 practice, and on average 6.5 practices, as a result of what they learned over the last 4 years from the project’s organic grain events and resources. These included changing a weed or fertility management system, calibrating their grain drill to achieve a target plant density, purchasing a new piece of equipment, and expanding markets and networks. Processors reported developing new sources and markets for local grains (71%) and increasing local grain purchases (43%). As a result of these changes, 77% of respondents reported at least one, and on average 5 improvements in their grain-based business, including improved grain yields and quality, expanded networks and access to markets, and enhanced profitability.</p> <p>The rapid expansion of the craft brewing and distilling industries in the Northeast has created demand for locally grown and malted barley, and the need for research-based information on which malting barley varieties are best adapted to Maine growing conditions and the craft malting process. The target audience for this project includes farmers who grow small grains and grain legumes in Maine and northern New England and their crop advisors. Working with Maine's two malthouses, a researcher has identified varieties that have better sprout tolerance and malting qualities than the current standard variety. In 2019, Maine Malt House of</p>	
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		<p>Mapleton grew replicated 3-acre blocks of the standard variety, Newdale, and two new varieties, KWS Tinka and LCS Genie. The new varieties yielded 15% and 9% more than Newdale, respectively. Maine Malt House malted and analyzed 4500-lb lots of each variety, which were then brewed and taste-tested by Allagash Brewing Company. They presented their results at the 2020 Maine Grain Conference held by University of Maine Cooperative Extension on March 13. All three varieties malted and brewed well. While there were differences among them in some malt quality measures and flavor profiles, all would be acceptable varieties for Maine's craft brew industry.</p>	
<p>4.</p>	<p>Developing New Tools to Strengthen Maine's Unique Wild Blueberry Industry</p>	<p>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, producing and utilizing 101.6 million pounds in 2016. That same year fresh blueberries accounted for 380,000 pounds, and 101.2 million pounds were processed. In total, fresh and processed wild blueberries were valued at \$27.7 million (NASS 2017). The target audience includes 500 wild blueberry landowners, frozen processors, and other industry stakeholders. Wild blueberries rely on bees and other pollinators to produce fruit. Bee health and population declines threaten wild blueberry production. Increasing frequency of honey bee colony losses referred to as Colony Collapse Disorder has heightened the need to monitor the health of bee colonies. An Experiment Station faculty member working with an undergraduate student and two electrical engineers at the University of Maine developed a portable Doppler radar unit which provides estimates of colony strength. It measures colony foraging that has been shown to serve as a satisfactory proxy for overall colony health. A commercial version has been tested and will be marketed in 2020.</p>	<p>The Maine Food System/1</p>

<p>5.</p>	<p>Supporting Maine Aquaculture</p>	<p>The production of cultured shellfish has increased steadily over the past several decades throughout the northeastern U.S. There are now more than 350 culture operations generating products with a gate value in excess of \$50 million. In Maine, the primary cultured species are blue mussels (<i>Mytilus edulis</i>) and eastern oysters (<i>Crassostrea virginica</i>), which have a farm-gate value of roughly \$1.3 million and \$1.75 million, respectively. Recent disease outbreaks and increases in the abundance and distribution of other pest species, however, have highlighted how over-reliance on one or two species leaves the industry vulnerable to epizootics. The principal target audience is the shellfish culture industry along with the scientific community studying the physiology, ecology and genetics of commercially important bivalve shellfish.</p> <p>Mussel research focused on the development of hatchery and settling protocols for blue mussel production explored a variety of nutritional sources for the cost-effective conditioning of blue mussel broods and different rope types for efficient setting of bluemussel seed. A commercially available dried algal diet (Ori-One) promoted gonad development equal to that of live algae, but would not stay in suspension without vigorous aeration which often prompted the broods to spawn early. To test setting methodologies, researchers provided late-stage larvae with one of two types of settlement; a "Portuguese"-style rope (natural fiber) or a "fuzzy" New Zealand-style mussel rope. The major impacts and conclusions drawn from this work include:1) The use of live algal feeds is preferable to dried algal diets during the conditioning of blue mussel brood stock, and 2) Despite a reduced surface area for settlement, a natural-fiber, Portuguese-type rope is optimal for promoting high-density mussel settlement without excessive fouling.</p> <p>An Experiment Station scientist conducted a survey of oyster growers in the Northeast about their experience with and concern about blister worm. Analysis of this survey indicates that while few farmers have experienced economic losses from blister worm infestations, concern over</p>	<p>The Maine Food System/1</p>
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		<p>the loss of sales, product value, and farm reputation remains high. Following the survey workshops were conducted with oyster growers in the fall and winter of 2018/2019 that covered the results of the survey, the findings from the field treatments, the development of blister worm management plans, and discussing future research needs. During this research three separate species were identified that infest oyster and scallops in the region. In addition to <i>P. websteri</i> which has been observed in the Northeast for decades, <i>P. onagawawensis</i> and <i>P. neoceaca</i> were found to occur with some regularity on northeastern shellfish farms. These species occur worldwide. Experiment Station scientists are working with international colleagues to investigate how shellfish culture has affected the spread of these three species and may be involved in the infestation dynamics. The integrated research and education project on blister worm has assisted Maine oyster growers in the development of best management plans for reducing the impact of blister worm on their farms. Research was also conducted to determine the impact of oyster aquaculture on benthic community structure. Polychaete worms and other infaunal species residing in marine sediments create bioturbation (mixing and overturn of sediments) through their feeding, tube-building, burrowing and ventilating activities. This activity influences nutrient fluxes between the sediments and overlying water and the composition of sedimentary communities. Changes in organic deposition can significantly alter community structure and rates and patterns of bioturbation. The research revealed that the organic loading in sediments under three oyster farms in Maine was only marginally higher than in areas adjacent to but outside of the influence of farms. Similarly, there were only minor changes in species composition and abundance of macrofauna in the sediments under farms. The major conclusion is that, at the densities currently deployed at Maine farms, oyster aquaculture has a minor impact on benthic community structure.</p>	
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<p>6.</p>	<p>Supporting Food Producers with Food Safety</p>	<p>The 2011 Food Safety Modernization Act (FSMA) was a significant change to food safety regulations in the US, 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 (PSR) and the Preventive Controls for Human Food Rule (PC). The overall goal of these rules is to make America’s food system safer. For produce farmers, the impact of the changes are the greatest since this industry has not been regulated so thoroughly before. Many farmers remain uncertain of how the regulations affect their work.</p> <p>In 2019, Extension provided three-day PC trainings to over 30 food producers in Maine and three seafood Hazard Analysis Critical Control Point (HACCP) courses with 60 seafood processors and one Meat and Poultry course with 23 participants. We have scheduled PSR training to over 200 farmers. In addition to these trainings, Extension provided one-on-one consulting and education for over 30 food producers, providing services ranging from facility design, sanitation, thermal process design/validation, and food safety plan guidance.</p> <p>As a result of participation in these FSMA trainings, over 60 food producers have implemented food safety plans. One company in particular exemplifies the implementation of knowledge gained by participating in all three trainings and receiving one-on-one consulting. In the six years that Extension has been working with this company, this company has grown from producing 200 units a week to over 8,000, and grown from 2 employees in 2012 to 12 full-time and 5 part-time employees in 2019. In 2020, they are planning to build a new building capable of producing over 20,000 units a week.</p>	<p>The Maine Food System/1</p>
<p>7.</p>	<p>AgrAbility...Supporting Farmers of All Abilities to Remain Active on the Farm</p>	<p>The average U.S. farmer is 58 years old, and farming is the sixth most dangerous job in America. An estimated 5,700 farmers, farm family members, or farm workers in Maine have a chronic health condition or</p>	<p>The Maine Food System/1</p>

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		<p>disability, such as post-traumatic stress disorder, traumatic brain injury, or aging-related issues, such as arthritis or hearing loss. In addition to farmers, fishermen, forest workers, and migrant workers face similar challenges for remaining successful in production agriculture.</p> <p>Funded through USDA/NIFA, Maine AgrAbility helps Maine farmers, loggers and fishermen facing physical or cognitive challenges, to enhance their ability to farm and live independently, which improves their quality of life and economic sustainability. AgrAbility specialists assess issues and offer adaptive recommendations. They provide education about safe work methods and connect people with other resources through this nonprofit partnership between Extension and Alpha One. The program supports the capacity of health and agricultural professionals to provide assistance and services for farmers and farm workers with disabilities.</p> <p>Since the project began in 2010, Maine AgrAbility has provided technical information to over 800 farmers and conducted on-site assessments for over 100 agricultural workers. The diverse agricultural operations include dairy and livestock operations, Christmas tree farms, fruit orchards, agritourism, vegetable and maple syrup production, hay sales, managing woodlots and lobstering. A 2019 program evaluation suggests that participants experienced an increase in economic viability and sustainability, and that AgrAbility suggestions made their farm business more accessible, or using their existing resources differently allowed them to start building up their farm again into a viable and stronger business.</p>	
8.	Master Gardener Volunteers	<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</p>	The Maine Food System/1

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		<p>educational resources, which are key contributors to the success of these projects.</p> <p>The Master Gardener Volunteers (MGV) Program provides participants with a minimum of 40 hours of in-depth training in the art and science of horticulture. Trainees receive current, research-based information from our 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 community. Of the 937 active MGV, 144 were trained in 2019. In total, they donated 33,500 hours to a variety of educational and food security projects throughout the state including support of: 53 community gardens 50 school gardens 57 demonstration gardens, and 66 youth programs involving 4,129 youth in horticulture activities this year. MGVs reported that they: increased community partnerships, assessed community needs and assets, engaged positively in their community, increased consumption of home-grown food, and developed new or expanded gardens. 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>	
9.	<p>Maine Harvest for Hunger: Mobilizing to Support Food Insecure Citizens</p>	<p>Maine has the highest rate of food insecurity in New England, and ranks 12th in the U.S. The USDA estimates over 13.6 percent of Maine households, over 182,000 individuals, are food insecure. Twenty percent, or 1 in 5 children are food insecure. Twenty-three percent of seniors have marginal, low, or very low food security. Thirty-seven percent of food-insecure people do not qualify for food stamps or other government</p>	<p>The Maine Food System/1</p>

		<p>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 has 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 groups to grow, glean, and donate quality produce to distribution sites (pantries, shelters, community meals) and directly to neighbors in need, to mitigate hunger, improve nutrition and health, and help recipients develop lifelong positive nutritional habits. In addition, educational programs such as Hancock County’s Eat Well Volunteers, have focused on engaging food pantry recipients in learning appropriate methods of cooking and using fresh produce, and state-wide Extension programs help teach Mainers to grow more of their own fresh garden produce.</p> <p>Since 2000, MHH participants have distributed over 3 million lbs. of food to citizens grappling with hunger. In 2019, donations of over 193,000 lbs. of fresh produce from over 120 Maine farms went to 207 hunger alleviation distribution sites. A corps of 365 volunteers and 8 corporate partners from 12 counties logged over 6,000 hours, and the value of the produce is estimated at over \$327,000. Now in its 20th season, MHH has continued to improve the efficiency of supplying fresh produce to food pantries across Maine through building partnerships. For example, through MHH volunteer planning and communications, several food pantries are now sending trucks and vans directly to the farm where gleaning is taking place.</p> <p>Maine has approximately 130 community gardens and many of them are supported by Extension staff and Master Gardener Volunteers. As a result, more than 30 of them now have added an MHH area to their community garden and have contributed almost 20,000 lbs. of our 2019 totals. In Penobscot County, volunteers anonymously sponsor food insecure families by collaborating with the Maine Family Institute to distribute fresh</p>	
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		<p>produce to the families, which has resulted in their increased consumption of fresh fruit and vegetables.</p>	
<p>10.</p>	<p>Protecting Maine’s Layer Poultry Industry</p>	<p>Maine has a poultry industry generating nearly \$39 million during 2019, with over 3.5 million layers. Of Maine’s 8,200 farms, many raise hens to sell eggs, either on a large scale (in which case, the FDA mandates testing for Salmonella enterica subspecies Enteritidis, also known as SE), for home consumption, or for sale to neighbors. In any case, testing for SE is a prudent plan.</p> <p>The UMaine Veterinary Diagnostic Laboratory (VDL)’s certified salmonella testing allows poultry farms to meet FDA standards for Salmonella enteric enteritidis (SE) screening. Because the VDL provides FDA-mandated salmonella testing for medium- to large-sized egg producers in Maine, New Hampshire and 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. Although not required by law, backyard flock owners are encouraged to test, in order to protect public health. In 2019, the VDL tested 124 sets of samples (1258 environmental swabs) submitted for FDA regulatory testing. We tested 873 blood samples. As small to midsize egg producers become aware of the advantages of salmonella screening, we expect test utilization to grow.</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 higher than 10% of production. UM VDL is part of a team to keep Maine’s poultry industry strong and healthy.</p>	<p>The Maine Food System/1</p>

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<p>11.</p>	<p>Protecting Maine’s Dairy Industry</p>	<p>Maine currently has 8,200 farms, and many of these farms have dairy animals. 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. As well, organic and small ruminant dairies are producing a diverse collection of artisanal cheeses and alternative milk products. For public safety and quality control reasons, all dairy producers must keep pathogenic bacteria out of their dairy animals and their dairy products. It is important for them to identify and cull these chronically infected animals to protect the public, and to avoid spreading this disease on their dairies.</p> <p>The UMaine Veterinary Diagnostic Laboratory (VDL) offers a local, responsive resource for culturing milk samples (bulk tank or individual animal samples), along with water samples, thus providing a key piece of information for producers, Extension staff, and milk processors. The VDL helps protect Maine’s dairies, both large and small. In 2019, the VDL cultured over 1,600 milk samples for mastitis.</p> <p>Effective responses to animal illnesses are only possible when the disease is identified. Maine’s dairy owners benefit from local, responsive mastitis diagnostic service. At the 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.</p>	<p>The Maine Food System/1</p>
<p>12.</p>	<p>Enhancing Human Health Using Direct Education and Behavioral and Environmental Tools</p>	<p>Maine has the highest obesity rates when compared to other states within the Northeast region. An estimated 28% of 10-17-year-olds, and 13% of 18-25-year-olds in Maine are considered overweight or obese. Overweight and obesity are related to poor dietary behaviors and put Mainers at</p>	<p>The Maine Food System/1</p>

		<p>greater risk for developing chronic diseases in adulthood. About 35% of adults in Maine have hypertension, and about 11% have diabetes. Maine ranks 12th and 21st among the 50 states for these two chronic diseases, respectively. Children and college students need health and nutrition information because they are in transitional periods of life, childhood and "emerging adulthood". As they grow in independence, they shift their support systems, expand those who are influential in their lives and form their own individual health behavior patterns which set the stage for their future lives and health status. When their health choices include poor dietary and physical activity choices, excessive weight gain maybe the consequence.</p> <p>Extension and MAFES have been involved in research and educational programming to understand and promote healthy nutritional habits in children, young adults, and adults.</p> <p><u>Children (ages 10-17) - EFNEP:</u> In an effort to stop rising childhood obesity rates, UMaine Extension Maine Expanded Food and Nutrition Education Program (EFNEP) implements direct education to Maine’s low-income children to improve 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 2019, 2,056 youth participated in Maine EFNEP. Youth participated in an average of 6 classes over 2 months. Of the 2,056 youth that participated in EFNEP, 1,936 completed a pre and post survey.</p> <p>As a result of participating in EFNEP:</p> <ul style="list-style-type: none"> • 77% of youth improved their abilities to choose foods according to current Dietary Guidelines or improved nutrition knowledge. 	
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		<ul style="list-style-type: none"> • 38% of youth improved their daily physical activity practices. • 53% of youth used safe food handling practices more often. • 46% of youth improved their ability to prepare simple, nutritious, affordable food. <p><u>Young Adults - (ages 18-25) - Behavioral and Environmental Tools:</u> To pinpoint changes that will provide and encourage healthier habits, 75 communities are using a new tool developed by a team of land-grant university researchers. Over 2,000 college students were surveyed from the following institutions: University of Rhode Island, West Virginia University, University of Tennessee, University of Maine, Rutgers University, South Dakota State University, University of Nebraska-Lincoln, and University of Florida. Results indicated that college students would like better support for mental health and healthy eating options on campus, and are more satisfied with physical activity resources. Using the audit and survey tool, college campuses and others can make sure they are using resources efficiently and making the changes that will have the biggest impact on the health of community members.</p> <p>Researchers also put together the Healthy Community Index, so that each community can see how its audit score compares to others. So far, 75 communities have used these new tools and can work towards making changes to their policies and improvements to their health environments. These changes make healthy habits an easier, more sustainable choice for more people.</p> <p>A Behavioral Environment Survey was further developed and refined. More than 2,000 participants from eight campuses took the survey and data was collected on perceived environmental healthfulness, along with health behaviors such as dietary intake, physical activity, health related quality of life, and body mass index. The analyses showed that a strong psychometrically sound survey was developed and that students reported poorer mental health and dietary resources on campus, but reported</p>	
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		<p>higher physical activity resources. Based on these findings, college campuses can now collect information on students’ perceptions about the healthfulness of their campus. This information can be used to inform policy changes and/or promotional activities to attract potential students.</p> <p><u>Adults - (25 and over): EFNEP, and Dining with Diabetes:</u> To improve the food security and the diet of Maine’s low-income adults, UMaine Extension implements direct education through EFNEP to improve 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. In fiscal year 2019, 560 adults participated in Maine EFNEP, and the education reached a total of 2,110 individuals in the program families. Of the 560 adults, 257 completed pre and post surveys. As a result of participating in EFNEP:</p> <ul style="list-style-type: none"> • 37% eat fruit more often each day • 34% eat vegetables more often each day • 28% drink soda less often • 34% make small changes each day to be more active • 45% thaw frozen food at room temperature less often • 36% plan meals before shopping more often • 31% make a list before shopping more often <p>Extension also delivered the Dining with Diabetes program in Washington County, which has high rates of diabetes, diabetes-related hospitalizations, diabetes-related lower extremity amputations and diabetes-related deaths. Few Washington County residents participate in self-management education and support programs to develop the skills needed to care for themselves. Barriers to participation include cost, lack of insurance, complexity of education programs and the absence of formal diabetes education programs in the county.</p> <p>In 2014, Extension created the Dining with Diabetes Down East program, and since that time has presented it in ten communities and over 300</p>	
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		<p>participants. The free program consists of 4 weekly 2-hour classes. Each session includes a presentation, cooking demonstrations, sampling of dishes and facilitated discussion. In 2018, we launched a Dining with Diabetes website with a video series, and online publications addressing topics such as introduction to simplified diabetes meal planning, how to eat to control blood sugar, how to eat to control blood pressure and how to eat to control blood cholesterol. These are the primary risk factors for diabetes complications. In addition, the video series was recorded to DVDs that are used in Native American healthcare facilities, Calais and Houlton hospitals and the Senior Companion Program. This has expanded the reach of diabetes education to those who are unable to participate directly in the Dining with Diabetes Down East program.</p> <p>Program evaluation reveals that 94% lowered weight, blood sugar, blood pressure or cholesterol. Based on published research, the program will likely result in decreased disability, death, and health care costs. For example, approximately \$96,000 is saved in Medicare costs for each year hemodialysis is postponed due to improved diabetes control. Reported participant influence on children and grandchildren may positively impact their elevated lifetime risk for diabetes.</p>	
<p>13.</p>	<p>Helping Beginning Farmers - So You Want to Farm in Maine?</p>	<p>Interest in agriculture and starting new farms in Maine has increased dramatically over the past fifteen years. One third of Maine’s farmers are beginning farmers with fewer than 10 years of experience. Forty-seven percent of new farm businesses fail within the first five years. Current farmers thinking about changing farm enterprises and new farmers interested in starting a farm often lack skill, knowledge and confidence in areas such as business planning, access to capital, rules and regulations affecting agriculture operations, and marketing.</p> <p>Since 2011, UMaine Extension has provided educational outreach through its “So You Want to Farm in Maine” (SYWTFIM) series to enhance the skills,</p>	<p>The Maine Food System/1</p>

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		<p>business management knowledge, and confidence of new and established farmers. The programs are live, live-streamed, and archived. One-on-one consultations help potential farmers to best utilize natural resources, web-based resources, and seek appropriate guidance from other agricultural service providers.</p> <p>Since 2011, the SYWTFIM series has reached over 900 participants from all Maine counties and out-of-state. Since 2014, an online new farmer self-assessment has been used 200 times, and Extension staff have consulted with 600 new farmers statewide. In 2019, 64 beginning farmers participated in SYWTFIM, and Extension provided 122 consultations. Participants reported:</p> <ul style="list-style-type: none"> • increasing research • developing more robust business management tools • completing enterprise budgets • developing business plans • conducting market research • developing marketing plan 	
<p>14.</p>	<p>Reducing Summer Learning Loss</p>	<p>The U.S. has an identified need to improve student proficiency in STEM disciplines and to better prepare young adults for the workforce. Low-income students are particularly in need, as they tend to lose grade equivalency in summer due to lack of learning opportunities.</p> <p>To increase science proficiency for Maine youth and to prevent summer learning loss, Extension created and delivered the 4-H Summer of Science (SOS) curricula, exposing youth to informal science, technology, engineering, and math in a fun and meaningful way. The program occurs where youth already are, focuses on reducing barriers to STEM learning, and uses teens and college interns as teachers and mentors. The teen teacher position is often the first paid position for many of the teens.</p>	<p>Positive Youth Development/2</p>

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		<p>In 2019, over 3,600 youth and 700 volunteers participated in 50 community sites in 10 Maine counties, and curriculum included ocean literacy and engineering. Eleven undergraduate interns, 41 teens and 12 4-H staff provided program delivery of the weekly activities. 4-H Summer of Science not only helped grade school youth in Maine enjoy STEM learning in the summer, it also fostered career development, leadership, resiliency, and responsibility in the Maine teens who delivered the program in their neighborhoods. The teens and college interns identify many skills they gain in SOS, including responsibility, time management, communication, leadership skills, and career development.</p>	
<p>15.</p>	<p>4-H Ambassadors Sparking Student Interest in STEM Careers</p>	<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 in construction and maintenance of transportation and energy systems.</p> <p>In 2019, the 4-H STEM Ambassador program staff trained 116 college students to develop and deliver informal STEM-based educational experiences. These volunteers committed 1,740 hours of time including training, preparation and program delivery. 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.</p> <p>The 4-H STEM Ambassador program continues to grow to reach more youth, and engage more UMaine System college students as we engage more partners in our efforts. In 2019, over 850 youth were engaged in at least 6 hours of hands-on science, engineering and mathematics. Youth participants agree they want to learn more about science and feel they are</p>	<p>Positive Youth Development/2</p>

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		<p>good at science, and feel college could be for them. Our 4-H STEM Ambassadors quickly develop confidence in their abilities as teachers and leaders in STEM education. Over the next twelve months we will extend the program to other higher education institutions in Maine. As part of a successful NSF grant to UMaine, expansion to select Maine Community Colleges will begin in 2020.</p>	
<p>16.</p>	<p>4-H Summer Camp-Building Community and Connecting Youth to the Outdoors</p>	<p>Research has shown that positive social and emotional learning experiences can significantly impact youth development and 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>UMaine Extension 4-H Camp and Learning Centers provide programs and opportunities for youth ages 4-17, many from underserved populations, with transformational experiences designed to develop a sense of place and belonging, and confidence in the outdoors. Our programs provide the opportunity to spend each day in a positive learning environment or to live for a week or more alongside trained adult educators, mentors, and caring peers. Our summer camp programs provide youth a wealth of opportunities of programs to choose from, focusing on ecology education, the arts, and outdoor skills, youth can create meaningful experiences that fit their needs.</p> <p>In 2019, the 4-H summer camps served 2,454 youth from all 16 counties in Maine, 22 states, and 6 countries. Through living and working together, campers and staff became part of an interconnected community committed to a sustainable future. Youth and program alumni report that the 4-H Camp and Learning Center experience has helped them develop</p>	<p>Positive Youth Development/2</p>

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		greater self-confidence, civic engagement, and personal and academic success.	
17.	Meeting Learning Standards through Lakeside and Open-Air Classrooms	<p>Educators in Maine K-12 schools are tasked with aligning their lessons in meaningful ways with local and national learning standards. A number of studies have shown that active learning and hands-on lessons create better learning results for students.</p> <p>To succeed in meeting standards and improving student learning, teachers are looking beyond the walls of their classrooms to integrate different academic content areas and engage students in active learning environments. Gardens, vernal ponds, forested land, and outdoor classrooms have become more popular at schools across Maine, but teachers often lack the professional support to know how to best use these spaces to incorporate curricula. UMaine Extension 4-H Camp and Learning Centers staff take students outdoors to deliver STEM based lessons, and mentor teachers in how to integrate the lessons within the context of the learning standards.</p> <p>UMaine Extension’s 4-H Camp and Learning Centers’ Open Air Classroom at Tanglewood/ Blueberry Cove and Lakeside Classroom at Bryant Pond provide residential, nature and school-based programs that help schools to meet learning standards, and engage students in active learning. In 2019, the 4-H Camp and Learning Centers provided programming for over 6,000 students from more than 60 Maine school groups.</p>	Positive Youth Development/2
18.	Fostering Positive Science Identities in Youth	Educators in the United States, and in Maine, are continuing work to foster interest and positive science identities in youth. They are also searching for ways to engage youth in local, place-based STEM activities, while using best practices for science learning and meeting local state and national standards. Youth enjoy and learn from experiential learning activities, particularly activities that have local and personal relevance and	Positive Youth Development/2

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		<p>applicability. University researchers continue to explore ways to communicate research to public audiences, including K-12 age youth.</p> <p>As a way to bring UMaine research to youth audiences, Extension in 2014 developed 4-H Science Toolkits - curricula with associated materials available for loan from Extension offices. These toolkits are available to formal and informal educators at no cost, and the curriculum can be downloaded online. New toolkits have been recently developed or are being developed in mineralogy, meteorites, data science, forestry, solar energy, and aquaculture. Toolkits are standardized so that each serves a classroom group of 25 youth.</p> <p>The toolkit lending library has nearly 200 individual kits in almost 50 unique STEM subjects. In 2019, over 150 adults borrowed the 4-H Science/STEM toolkits, reaching over 2,000 youth with free hands-on STEM learning. This number is expected to grow with the availability of new toolkits and their use by 4-H STEM Ambassadors, UMaine researchers, and with many faculty adding funding for the creation of 4-H toolkits to their grant proposals. Outside sponsors have also sponsored 4-H toolkits, and the program is also part of a \$20 million National Science Foundation grant to UMaine. By reducing a significant barrier for 4-H volunteers, club leaders, 4-H staff, and other educators, these STEM toolkits are bolstering STEM learning to Maine youth.</p>	
<p>19.</p>	<p>Supporting Career Awareness in Youth, and an Aquaculture Industry Workforce</p>	<p>Maine communities have a long tradition of harvesting healthy seafood and taking care of the environment. Maine aquaculturists are a leading supplier of fresh, sustainable and locally grown seafood and, as a result the aquaculture sector is one of the fastest growing industries in Maine, with over \$137 million in sales output, 1,078 full and part-time jobs, and \$56 million in labor income. In order to feed the pipeline of this growing industry, effective workforce development programs must provide the flow of talent needed to create and sustain a robust aquaculture industry.</p>	<p>Positive Youth Development/2</p>

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		<p>Research has found that paid work experience in high school is a strong predictor of positive adult employment outcomes and that early work experiences can provide valuable opportunities for teens to learn new skills, gain experience, expand their networks, and develop positive relationships with adults. With roots in agriculture and animal science, 4-H is a natural fit for aquaculture advancement programs.</p> <p>For the past two years, Extension has partnered with the UMaine Center for Cooperative Aquaculture Research Center (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.</p> <p>As a result of the program, 15 high school students have successfully completed the six-week, paid Aquaponics Internship Program at CCAR. All interns reported improved growth in three key areas of workforce needs identified by industry participants: management skills, core aquaculture skills, and technical skills. Through participation in the 4-H/CCAR Internship Program, Maine youth are being given an opportunity to lead the way in the growing aquaculture industry.</p>	
<p>20.</p>	<p>Parent Education Program Promotes Early Screening and Intervention for Developmental Delays</p>	<p>The first three 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% to 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</p>	<p>Sustainable Community & Economic Development/3</p>

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		<p>children who receive early treatment for developmental delays are more likely to graduate from high school, hold jobs, live independently, and avoid teen 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 four counties, and are part of a statewide network of Maine Families Home Visiting Programs. In 2019, 10 certified parent educators provided 2,164 home visits to 239 families with 229 children living in four counties. Using the Parents As Teachers model parent educators met with families in their homes and 1) Provided families with current information on child development and parenting, 2) Shared activity ideas and ways to engage and nurture their child’s optimal development, and 3) Provided connections and linkages to community resources.</p> <p>In our Knox-Lincoln county office, 88% percent of children enrolled had a timely screening for developmental delays. 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>In our Waldo county office, 100% of respondents to the annual parent survey reported that Maine Families Waldo County helped them to know how to make their home safer for their children, keep their children healthy and understand their child’s growth and development.</p>	
<p>21.</p>	<p>Helping Entrepreneurs in Pricing Skills</p>	<p>Small businesses are very important to the economic vitality of Maine’s rural economy. More than 20% of the jobs in rural Maine are created by small-scale entrepreneurs. However, many of these entrepreneurs lack the business skills needed to successfully start and grow their businesses.</p>	<p>Sustainable Community & Economic Development/3</p>

		<p>Research shows that helping rural entrepreneurs improve their business skills will improve their chances for success. One of the most important business management skills is pricing. Yet, many small-scale entrepreneurs lack the knowledge and skills necessary to develop a profitable pricing strategy that can help ensure financial success.</p> <p>During the past year, the UMaine Extension conducted pricing workshops across the state, presented a pricing webinar in collaboration with the Maine Food Strategy, and taught a pricing seminar at a statewide conference for Maine entrepreneurs. The goal of this program was to help existing and aspiring Maine entrepreneurs improve their pricing knowledge and skills so they could develop profitable pricing strategies for their businesses. The program was conducted by Extension faculty and covered topics such as: key elements of pricing, pricing methods and models, pricing strategies, price elasticity of demand, profit margin and cost analysis.</p> <p>More than 70 rural entrepreneurs from across Maine participated in this highly successful training. They included specialty food producers, farmers, craft artists, food retailers, environmental consultants, bookkeepers and other small rural businesses.</p> <p>As a result of attending these educational programs, Maine entrepreneurs improved their knowledge and skills of pricing, plan to adopt the pricing techniques they learned, and to set profitable prices for their products and services moving forward. Eighty-seven percent planned to set a new, more profitable, price for their product or service, and 97% planned to adopt the pricing techniques learned during the training. The average participant reported a 157% increase in their knowledge of pricing as a result of attending the workshops. Changes they plan to make within six months of the training included: incorporate the value or their time and profit into their pricing, conduct a thorough cost analysis, research the market before setting prices, and restructure their current pricing</p>	
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		<p>structure. Several workshop participants who attended follow-up one-on-one consultations said they subsequently created pricing strategies that led to increased profitability for their businesses.</p>	
<p>22.</p>	<p>Recipe to Market Program: Growing Successful Food Entrepreneurs</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, the University of Maine Cooperative Extension developed the <i>Recipe to Market</i> 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.</p> <p>Since its inception, Extension has conducted 28 programs in 9 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, 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 percent 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.</p> <p>Long-term survey results indicate that participants used the new knowledge they gained from attending <i>Recipe to Market</i> to make more effective business decisions, develop new food products, and write and</p>	<p>Sustainable Community & Economic Development/3</p>

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		<p>revise business and marketing plans. The survey results also indicate that 27% of the <i>Recipe to Market</i> multi-session 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 <i>Recipe to Market</i> multi-session programs since 2007.</p>	
<p>23.</p>	<p>Advancing New Empirical Models to Analyze Social and Economic Dimensions of Resilience</p>	<p>Working with the state of Maine a University of Maine faculty member contributed a new modeling approach to sector growth change. The "thematic" approach combines new ways of thinking about the labor market and supply chains by building patterns of change between industries. This work has resulted in a technical report which has directly fed into the now published state of Maine Development Plan released in December 2019 (Maine Economic Development Strategy 2020-2029 A Focus on Talent & Innovation https://www.maine.gov/decd/sites/maine.gov.decd/files/inline-files/DECD_120919_sm.pdf)</p> <p>The work identified four "thematic areas" in which Maine possesses current strengths, growing global demand exists, and there is a potential for job creation particularly at the intersections of these strengths. Students directly worked with the researcher on the state economic development planning process. This has allowed the faculty member to train and help develop the skills of graduate students in econometric and spatial modeling as well as dissemination and presentation skills. During the process of creating the Maine Economic Development Strategy 2020-2029, University of Maine faculty and student work was presented to thousands of individuals across the state as the government communicated the results of the economic analysis.</p>	<p>Sustainable Community & Economic Development/3</p>

<p>24.</p>	<p>Insights into Land Owners' Resource Management Behaviors & Implications for Resource Management Goals</p>	<p>As natural resource dependent regions and communities experience economic, environmental and social shocks, new opportunities for decision support emerge. A UMaine faculty member participated in a multistate study of land owners' resource management behaviors, examining, among other factors, land owners' participation in state resource management programs and plans for future land management activities. Research was gathered from Maine, Massachusetts, New York, and Vermont. This collaborative exploratory research revealed variation across states and regions in the use of wills, trusts, and conservation easements and participation in preferential tax programs by forest landowners. Observations and findings from the work offer guidance to stakeholders and researchers engaging with landowners to achieve resource management goals.</p> <p>First, more of the family forest owners surveyed used tools or participated in programs that were less complex and of shorter duration. Use of wills exceeded that of trusts, and participation in preferential tax programs was greater than use of conservation easements. Second, patterns in landowner behaviors varied somewhat across study regions and states. Use of trusts and participation in preferential tax programs varied more across states and sub-regions than the use of wills and conservation easements. These regional patterns could reflect varying entry requirements of preferential tax programs as well as costs of tool use and program participation. In addition, the relative affluence of owners and development pressures in the distinct study regions could explain differences in expected returns from the use of different tools and participation in different programs. Third, different associations were observed between owner and land/forest ownership characteristics and estate planning and conservation behaviors. These findings confirm prior work indicating the novelty of estate planning decisions from other land management decisions and the urgency of studying forest landowner behaviors beyond harvest decisions. Lastly, the results hint at the potential importance of regional and state contextual effects and encourage</p>	<p>Sustainable Community & Economic Development/3</p>
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		<p>researchers and stakeholders to better document contextual factors as well as the location and timing of specific resource management behaviors. Given the aging demographics of current family forest landowners in the Northeast, society can expect numerous owner and management transitions in the decade ahead. Better anticipating and documenting such transitions can benefit individual owners and regional natural resource managers tasked with maintaining services from forested ecosystems.</p>	
25.	<p>Cultural and cooperative dynamics of sustainable behaviors and institutions</p>	<p>Examples of economic cooperation abound yet many aspects concerning what motivates cooperation and policies to foster it merit research and analysis. A UMaine scientist designed a research program motivated by the fact that natural resource conservation often comes at a cost to the individual but provides benefits to a group sharing that resource. As such, conserving natural resources such as soil, water, forests and fish often constitutes an altruistic or cooperative act.</p> <p>The project facilitated the creation of a cooperation science workshop toolkit to share the project’s research synthesis with local audiences and around the world. The toolkit was also the core of a cooperation science workshop at the Mitchell Center for Sustainability Solutions. The workshop provided natural resource scientists and advisors in fisheries, forestry, and agriculture a streamlined introduction to how to use cooperation dynamics in building sustainable resource use institutions. The toolkit is a non-technical overview amenable to a general audience, and is available in PDF format at: https://timwaring.files.wordpress.com/2018/10/cooperation-science-toolkit.pdf</p>	<p>Sustainable Community & Economic Development/3</p>
26.	<p>Maine Climate Change Adaptation Providers (CCAP) Network</p>	<p>In order to be successful in helping communities adapt to changing environmental conditions, practitioners must have opportunities to communicate, identify mutual goals and activities, and learn from one another. UMaine Extension chairs the Climate Change Adaptation</p>	<p>Sustainable Community & Economic Development/3</p>

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		<p>Providers Network, a framework and forum for sharing issues and solutions with coastal communities.</p> <p>Extension created CCAP in 2010, and today it is a group of approximately 65 professionals from 28 diverse organizations representing local, state and federal government, universities, research institutes and nonprofit organizations. Through CCAP, researchers, subject matter experts, facilitators, policy, and planning professionals share best practices and transferable lessons; completed, ongoing, and future projects; as well as opportunities for funding, training, and events for continued knowledge exchange.</p> <p>In 2018, CCAP members collaborated to advance a National Academy of Sciences Sea Level Rise Project and a National Estuarine Research Reserve System Science Collaborative examining coastal resilience in midcoast Maine. A collaboration between Bowdoin College and Casco Bay Estuary Partnership advanced efforts to support municipal planning related to large precipitation events. Sea Grant/UMaine Extension and other CCAP members supported municipal climate adaptation planning processes, including in the communities of Belfast and Harpswell. The group also developed a longitudinal survey instrument to track long term trends in climate adaptation activity, and conducted a survey of Maine municipal officials on climate changes in their communities, from which results were made available in 2019.</p> <p>2019 CCAP activities focused on professional development for CCAP members, partnering with the NH Coastal Adaptation Working Group to conduct a marine legal symposium. Funding has also been secured through a NOAA grant for CCAP to develop a similar marine law workshop for municipal officials; and to develop a CCAP Network web presence.</p> <p>With NOAA funding, Extension is developing a website to provide information such as: preparing the ground for climate change adaptation</p>	
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		<p>to assessing risk and vulnerability, identifying and assessing adaptation options, implementation, monitoring and evaluation. This resource will assist service providers in determining where a community is in the process and what technical resources and expertise are needed, allowing CCAP network members to provide targeted assistance.</p>	
<p>27.</p>	<p>Long-Term Watershed Monitoring to Understand Environmental Change</p>	<p>The Bear Brook Watershed in Maine is one of the longest running whole forested watershed manipulation experiments in the world. For over 25 years, the experiment has studied the effects of air pollution on forested watershed chemistry, hydrology and ecology. The particular focus has been on atmospheric deposition of nitrogen and sulfur interacting with our changing climate.</p> <p>The science generated from this research has contributed to everything from our understanding of the benefits and shortfalls of the U.S. Clean Air Act, to data used to understand the impacts of biomass energy on forest sustainability. The Bear Brook Watershed in Maine was chosen as one of the key case studies to highlight by the U.S. Environmental Protection Agency in its review of the secondary effects of atmospheric sulfur and nitrogen pollution. The experimentally treated watershed has demonstrated the impacts we would have experienced without the federal policy, and has documented the effects of long-term nitrogen enrichment on forest function.</p> <p>The studies of nitrogen have been assisted by a whole ecosystem stable isotope experiment that will inform scientists about ecosystem response to air pollution and climate for decades to come. The Bear Brook Watershed in Maine also was featured in a paper that was the first to document recovery from acid rain in forest soils, a finding that has been widely documented, including by this project, in streams and lakes. The project also contributed to the scientific interest in the interaction of phosphorus with nitrogen in forest ecosystems using a unique double</p>	<p>Climate Change/4</p>

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		manipulation design at both the whole watershed and plot scales. The project provides one of the most robust data sets in Maine on forest soil carbon, an increasingly important management and policy interest in Maine.	
28.	Carbon dynamics and climate-growth relationships in Maine's Acadian Forest ecosystem	<p>Forests play a central role in the international discussion of climate change, as they provide the potential to partially mitigate the adverse effects of climate change through carbon sequestration and storage. Managing forests under changing climatic conditions is a growing challenge for forest managers in Maine and beyond. Establishing the link between past stresses and forest productivity is critical to devising management strategies that enhance our forests' ability to adapt to changing conditions.</p> <p>The Howland Forest of central Maine, with its long-running CO2 flux tower, provides an ideal location in which to explore the relationship between local atmospheric CO2 flux and annual variation in above ground tree growth (i.e., carbon sequestration). Results from this work have identified an important link (including a shifted lag period) between annual CO2 flux and annual tree growth at the Howland Research Forest (Maine), which has generated investigations of this relationship at six additional research sites across the US.</p>	Climate Change/4
29.	Advancing Renewable Energy and Energy Efficiency in Maine	An imperative exists to break down barriers to renewable energy and energy efficiency adoption in Maine. A UMaine faculty member developed a free, open-source, online decision support tool to help stakeholders quantitatively think through and evaluate the local and global economic, environmental, and social costs and benefits of hydropower dams. The researcher conducted three group participatory multi-criteria decision analysis (MCDA) workshops in which the tool was tested. Nine stakeholders from six different entities (local, state, and national in scope) attended the most recent workshop and spent eight hours learning about	Sustainable Natural Resources/5

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		<p>MCDA, using the decision support tool, and engaging in a group negotiation exercise to attempt to come to consensus on what to do with a series of dams coming up for relicensing along the Penobscot River. Consensus was reached, with the group agreeing to model preferences that favored dam removal first and increased fish passage second. Participants agreed this type of tool and process would be useful for deciding between renewable energy options, rather than just focusing on hydropower.</p>	
<p>30.</p>	<p>Integrated Model to Analyze Policy Implications on Maine’s Forest Economy and Ecosystem Services</p>	<p>Forests provide many critical ecosystem services (ES), including production of fiber resources, carbon sequestration, climate change mitigation, protection of freshwater, and preservation of cultural values. In Maine, the economy depends heavily on its forest as it accounts for over 6% of the total GDP and has an estimated annual economic impact of \$8.5 billion. However, Maine's forest resources face increasing pressure from land use changes, shifts in ownership, declining markets, disturbance agents, and climate change. A prototype of the Maine Integrated Forest Ecosystem Service (MIFES) model has been developed and periodically updated. MIFES is a dynamic optimization model of forests and land use that maximizes the net present value of economic surplus for the forestry industry. The model optimizes the timing of harvesting, the area of forests, and investment in managing forests through replanting, competition suppression, thinning, and other practices at multiple scales (including stand/local) and is linked to a global timber supply model to account for market and policy influences beyond Maine. The model is currently functioning and capable of estimating trends in growing forest stocks, the provision of harvested biomass and industrial roundwood, and forest carbon sequestration in both standing forests and harvested wood products for 8 forest types in the state of Maine.</p>	<p>Sustainable Natural Resources/5</p>

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<p>31.</p>	<p>Eastern White Pine Health and Responses to Environmental Changes</p>	<p>Eastern white pine trees face a number of increasing stresses. Organisms that have been present for long periods in Eastern forests are behaving in unprecedented, unexpected manners that need to be explained. For example, the extent to which <i>Calicopsis pinea</i> reduces wood quality and lumber yield remains poorly understood, and potential actions for reducing <i>C. pinea</i> damage have not been tested. White pine needle damage has recently gained attention, but the long-term effects of repeated defoliation remain undocumented. Further, organisms native to North America, such as needle fungi and <i>M. macrocarices</i>, are associated with unprecedented white pine health issues, and it is uncertain if the situation is developing into larger problems that will affect white pine health and productivity on a broader scale. University of Maine leadership of the Multistate NE1601 Eastern White Pine Health and Responses to Environmental Changes helped to produce a highly useful field guide to white pine health. <i>Field Manual for Managing White Pine Health in New England</i> was published by the Maine Agricultural and Forest Experiment Station in June 2019. It provides essential information about pests, pathogens, site conditions, and climate associated with white pine health issues in the eastern US. The manual makes management recommendations for improving white pine health and reducing economic losses. A pdf version is available at: https://umaine.edu/mafes/publications/miscellaneous-publications/.</p>	<p>Sustainable Natural Resources/5</p>
<p>32.</p>	<p>Wildlife Diversity and Habitat Quality as Indicators of Forest Management and Ecosystem Health</p>	<p>Wildlife managers and all stakeholders who value the American woodcock have expressed concern about its population status. A 2018 US Fish and Wildlife Service report “showed a significant decline for the Eastern and Central Management Regions.” An UMaine researcher participated in an evaluation of American Woodcock (<i>Scolopax minor</i>) response to young forest best management practices on private lands. The faculty collaboration with the Wisconsin Young Forest Partnership (WYFP) yielded new management insights. Woodcock surveys indicated a positive impact of harvesting aspen forest on displaying male woodcock abundance.</p>	<p>Sustainable Natural Resources/5</p>

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		<p>Researchers confirmed that forest habitat best management practices for woodcock were effective and should continue to be implemented. The study emphasized the need for thorough evaluation of new citizen science programs so that resources are used effectively, quality data are generated, and project outcomes are achieved. Due to the study's results, a regional wildlife partnership greatly altered the purpose and structure of its monitoring program.</p>	
33.	<p>Communicating Wildlife Research Results to the Public</p>	<p>Public outreach to key target audiences is important in applied research given that transfer of information and ideas for implementation is critical to promote change in knowledge, attitudes, and behaviors. A UMaine faculty member presented programs on wildscaping or birdscaping to four Audubon chapters and garden clubs in Maine. Participants eagerly sought ideas to improve wildlife habitat on private lands including "the backyard." By working with organizations like Maine Woodland Owners (formerly, Small Woodland Owners Association of Maine), project researchers were able to reach a large number of family forest owners with each event. Not all outreach efforts require in-person programming. Two new websites were constructed to promote the woodcock migration study and new research initiatives of the Midwest Migration Network (see Eastern Woodcock Migration Research Cooperative (https://www.woodcockmigration.org) and Midwest Migration Network (https://midwestmigrationnetwork.org). These websites have reached thousands of individuals and organizations which helps researchers to share information and create opportunities for collaboration.</p>	<p>Sustainable Natural Resources/5</p>
34.	<p>Population Studies of Brook Trout and Arctic Charr</p>	<p>The University of Maine continues to conduct research to address emerging challenges of climate and invasive species for sustainable freshwater (and migratory) fisheries and fish conservation. According to the report <i>Eastern Brook Trout: Status and Threats</i>, Maine possesses more intact brook trout habitat than all other states in the eastern range. The Pine Tree State also claims the only remaining Arctic charr populations in</p>	<p>Sustainable Natural Resources/5</p>

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		<p>the lower 48 United States. Research continued on two major population genetics projects. One involved summarizing the population structure of 72 wild brook trout populations in three major drainages in Maine, including the St. John (mostly Fish River Drainage), Androscoggin (mostly Dead River) and Penobscot Rivers (mostly West Branch). These drainages support populations with and without histories of historical stocking (aquaculture inputs). The data suggest substantial genetic structure by drainage and that historical stocking of hatchery sources did not leave a lasting mark on many populations. In another project, analysis began of the population genetics of Maine's 12 relict landlock Arctic charr populations. These populations are the only remaining indigenous Arctic charr populations in the USA outside of Alaska, and under review by the USFWS due to challenges they face from invasive species and climate change. As part of this reanalysis of old and new samples, Experiment Station research documented that one population that was previously thought to be a non-native introduction is actually a native population.</p>	
<p>35.</p>	<p>Development of environmental DNA (eDNA) tools to detect and quantify invasive, native and stocked species</p>	<p>Perhaps the greatest pragmatic challenge for monitoring increases in range of invasive species, reductions of range in indigenous species, or the success of stocking cultured fish, is simply the ability to efficiently detect and quantify aquatic species. Advances in sensitive DNA polymerase chain reaction (PCR) amplification technologies are emerging as tools to address these detection challenges by targeting the trace amounts of DNA, called environmental DNA (eDNA), shed by fish and other organisms in their aquatic environments. Several noteworthy accomplishments were achieved in the area of eDNA during the last year. Probably the biggest development was securing a \$20 million EPSCoR RII Track 1 grant funded by NSF that will support extensive new eDNA research, student training, and outreach for the next 5 years. In addition to project elements related to ecosystem-based fish restorations, this project also supports using eDNA to understand shellfish recruitment and aquaculture, harmful algal blooms, and climate-related range shifts of coastal species.</p>	<p>Sustainable Natural Resources/5</p>

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		<p>Work continues with NOAA/NMFS on new assays for Maine's diadromous fish assemblage and on testing the detection and quantification capabilities of such assays. For Rainbow Smelt, research was completed on a Maine Outdoor Heritage Funded project with Wells National Estuarine Reserve to test detection of Rainbow Smelt in four streams that vary in smelt abundance. Work started with MDIFW to conduct eDNA surveys for invasive mudpuppy (salamanders), a cryptic species that appears to be spreading in multiple Maine lakes and associated waterways following historical introduction to one stream. A new collaboration began with the Gulf of Maine Research Institute to combine eDNA with sonar data to quantify Atlantic herring abundances.</p>	
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