

Maine (University of Maine) Annual Report - FY2021

Report Status: Approved as of 07/08/2022

Contributing Organizations

University of Maine

Executive Summary

Overview

Executive Summary Overview

The University of Maine Cooperative Extension and the Maine Agricultural and Forest Experiment Station (MAFES) have served the people of Maine for more than 100 years. Over 190 faculty and professionals contribute to outreach and research benefiting Maine. We ensure our 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 interaction with cooperators and constituents. Together, we reach many of Maine's most diverse people and we make special efforts to serve the handicapped, racial minorities including Native Americans, and new immigrant communities.

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

MAFES is the College of Natural Sciences, Forestry, and Agriculture's center for applied and basic research. Experiment Station 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 2021, we continued to focus on five critical issues: 1) Climate Change, 2) Positive Youth Development, 3) Sustainable Community and Economic Development, and 4) Sustainable Natural Resources, and 5) Maine Food System.

Cooperative Extension

Extension continued our work within the Maine Food System, focusing on agricultural sustainability, policy, research, production, processing, commerce, nutrition, food security and safety. Agriculture, commercial fishing, and food processing include Maine's largest and fastest growing industries, with \$5 billion in overall economic impact. Maine agriculture is diverse including potatoes, wild blueberries, maple, dairy, grains, livestock, poultry, fruits, vegetables, and ornamental horticulture. Even though Maine is 90 percent forested, the state has 7,600 farms and Extension plays a pivotal outreach role in supporting a majority of them, with many of our recommendations to Maine's agricultural community based on research conducted at Experiment Station farms.

Our Diagnostic and Research Laboratories for Veterinary Diagnostics, Aquatic Animal Health, Arthropod, and Plant Disease Diagnostics continued research contributions to agriculture, public health, communities, and wildlife. The lab benefits Maine by protecting natural resource- and food-based economies, adding to food safety and human health, and providing unique diagnostic and testing services to farmers and the public.

We continued our traditional focus in 4-H Positive Youth Development, providing experiential educational programs for thousands of Maine youth who participated through clubs, camps, schools, and afterschool. 4-H youth were actively involved with their own learning and many of our programs integrated STEM. Our 4-H volunteers supported youth in citizenship, leadership, and life skills development, and also gained skills for their own personal and professional development. Our four 4-H Camp and Learning Centers provided outdoor, experiential learning for clubs, schools, and community.

Our work continued in sustainable community and economic development and included small business and community development programs contributing to viable businesses, households, and communities by contributing to gainful employment, quality of place, and more effective use of limited public resources, as well as parenting education, community leadership, facilitation, and volunteer management.

Through the Marine Extension Team (MET) we collaborated with Maine Sea Grant to provide research and programming to coastal Maine communities and fishing industries, and we enhanced our collaboration with the Climate Change Institute (CCI) through the joint appointment of a faculty member who also serves as the State of Maine Climatologist.

Extension had significant digital outreach this past year with our websites receiving more than 3.1 million views in 2021. We had more than 5,000 customers register for workshops, events, webinars and more through our online registration system, and we have over 700 research-based publications available as free downloads.

Maine Agricultural and Forestry Experiment Station

With 44,000 acres of wild blueberries, Maine is the leading producer of lowbush, or “wild” blueberries in the world. Experiment Station scientists supported the industry through research on blueberry pests and diseases, enhanced production methods, integrated pest management, pollinator conservation, food processing and product development, and analyzing the health benefits of blueberries.

Large- and small-scale potato growers face significant production challenges due to climate change, plant diseases, pests and high input costs. Potatoes are the leading agricultural commodity in Maine with total sales of over \$540 million and employing over 6,100 people. Experiment 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 be more resistant to diseases. Several new varieties have been released in recent years in an industry partnership with the Maine Potato Board. Other researchers continue to expand our fundamental understanding of common and emerging potato pests and diseases (Colorado potato beetle, PVY virus, pink rot, black rot) and work to develop improved monitoring and control methods.

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

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

The forest and wood products industries of Maine are in the midst of significant change with important economic ramifications for the state. Experiment 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 to increase management efficiency, creating new composite and structural building materials, 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. Our faculty also have projects that advance wildlife conservation, aquatic ecosystem conservation, and fisheries management in Maine.

Critical Issue: Climate Change

Extension

Maine’s Marine Extension Team (MET), a collaboration of Extension and Sea Grant, continued to help communities gain the capacity to make informed decisions on the management of coastal and marine resources that promote ecological and economic sustainability. MET members worked with communities to address problems and respond to opportunities in four major areas: ecosystem health; sustainable coastal communities; fisheries and aquaculture, and coastal community resilience. Our projects included:

Soft-shell clam research and monitoring investments help to protect Maine’s second most valuable fishery: Research funding to the Downeast Institute to track soft-shell clam settlement, growth rates, and survival, and provide state and local shellfish managers with information to better equip them for the challenges of sustaining and/or enhancing clam populations in a dramatically changing marine

environment. These efforts are helping to inform new measures to better manage soft-shell clam resources during a period of warming seawater and help mitigate a 40-year trend of declining landings.

Social Resilience in Midcoast Maine: The MET collaborated with key partners in Midcoast Maine to improve regional coordination to address barriers to climate adaptation in coastal communities and reduce climate-related threats to the region's most vulnerable populations.

Signs of the Seasons Increases Community Science Engagement: This program continued to provide data to advance climate change research, improve participants' understanding of climate science, and promote scientific engagement and climate stewardship in Maine communities.

Collaborating Toward Climate Solutions: The MET helped a research team work with coastal communities to assess needs and develop potential solutions to ongoing and anticipated climate impacts. We worked with participating communities to support their climate change adaptation and planning efforts such as those related to stormwater infrastructure, sea level rise and working waterfront infrastructure, community science, and educational programs for addressing climate knowledge and preparedness.

Maine Ocean and Coastal Acidification Partnership: Many species that are economically valuable to our coastal communities are also vulnerable to coastal ocean acidification. With leadership and coordination from Extension and Sea Grant, Maine Ocean and Coastal Acidification Partnership helps coordinate the work of governmental agencies and private organizations and citizens who are studying and implementing means to reduce the impacts of or help adapt to ocean and coastal acidification.

Maine Climate Change Adaptation Providers Network: Maine Sea Grant and Extension developed and continue to lead the Maine Climate Change Adaptation Providers Network in partnership with the Maine Department of Environmental Protection, and CCAP continued coordinating with Maine's Climate Council action plan.

Extension and the UMaine Climate Change Institute partnered to create a faculty split appointment Assistant Extension Professor of Climate Services and Assistant Professor, who also is the Maine State Climatologist and has collaborated extensively with Extension on climate change through his research appointment at the CCI, was heavily involved in the work of the Maine Climate Council, and has conducted research and developed important tools for Maine agriculture and communities such as the climatereanalyzer.org.

Experiment Station

Irrigation and Climate Change: To effectively adapt to climate change (e.g. changing precipitation patterns), Maine vegetable and small fruit producers are considering water use efficiency in their irrigation practices. The Experiment Station is evaluating the effects of four different "cues to irrigate" on crop yield, quality, and environmental impact. The results of the study will allow farmers who run diversified vegetable systems to make informed decisions about whether precision irrigation technology is economically and environmentally advantageous. This project evaluates the effects of four different cues to irrigate on crop yield, quality, and environmental impact: feeling the soil, watering with times, and precision irrigation technology, and a control. Field trials were conducted research sites in Vermont and Maine over two years. Preliminary analysis suggests that cucumber yield was significantly different ($p < 0.5$) between the control (no irrigation) and feel of soil treatments, and the control and the soil moisture sensor treatments. However, yield was not significantly different between the feel of soil and soil moisture sensor treatments. The number of cucumbers harvested in all plots were not significantly different from one another, meaning that any differences were due to unit weight.

In tomatoes, there was a small difference between feel of soil and timer treatments, suggesting that tomatoes were more tolerant of wet conditions than cucumbers. Tomato yield was lower in the soil moisture sensor treatment as compared to the feel of soil treatment. However, some measures of quality (gloss) were lower in the control treatment. We are looking into the disease/water relationship to explain this. In peppers, there was no statistical difference between the feel of soil and soil moisture sensor treatments, though the crop clearly suffered from too much water (in the timer treatment) and too little water (in the control treatment). Notably, the only treatments that were not statistically different from one another were feel of soil and soil moisture sensor treatments. As with cucumbers, there were not differences between treatments in the number of fruit (with the notable exception of difference between control treatments and feel of soil treatments). However, total yield differences were statistically different between all treatments ($p < 0.01$) except feel of soil and soil moisture sensors.

There was little difference in the amount of water applied in the feel of soil treatment and the soil moisture sensor treatment, but that the timer treatment received more water and was more prone to leaching. We collected leachate using buried lysimeter pans, pumping water samples out on a weekly basis. Soil nitrate test results (PSNTs) did not statistically differ significantly between the plots, indicating that

the amount of plant-available nitrogen wasn't very different between treatments. However, there was a small observable difference, with lower PSNT results found most often within the timer treatment.

Water use efficiency is an issue of public concern in an era of climate change. Though water has historically been plentiful in the Northeast region of the United States, climate change forecasts tell us that more droughts and dry periods will likely that affect this region. Agriculture is just one use of freshwater resources, and in some parts of the Northeast agricultural industries have already come into conflict with other users (i.e. municipalities, industry, and conservation groups). To ensure a future where agriculture continues to exist as a viable industry, farmers must make the best use of water as a limited resource. This requires that farming communities better understand (a) how much water their crops need, (b) how to apply water at the right time, in the right amounts, and (c) how to best leverage available technology to meet both production and environmental conservation goals. The results of this research support farmers to make sustainable management decisions related to water management in diversified vegetable production systems.

Critical Issue: Positive Youth Development

Extension

In 2021, our 4-H Positive Youth Development program provided experiential educational and leadership programs for Maine youth, emphasizing the building of life skills necessary to be successful adults. Youth ages 5-18 participated in 4-H through clubs, camps, schools, and afterschool programs. Within the wide variety of 4-H programs we have a special focus on science, technology, engineering, and math (STEM) to help foster interest in these areas as avenues to successful careers. In all programs, youth were actively involved with their own learning, choosing which project areas they would like to learn about and working with volunteers and educators to further their own learning. Our four 4-H Camp and Learning Centers provided outdoor, experiential learning for clubs, schools, and community, and we continued to expand Extension's youth programming through these venues. As always, volunteers were key to the success of Maine 4-H. Our volunteers worked in partnership with youth to focus on citizenship, leadership, and life skills development through "hands-on" learning experiences. In addition to making a difference in the lives of young people, volunteers also gained skills for their own personal and professional development.

Building STEM Literacy in Youth - Extension provided experiential educational and leadership programs through 4-H clubs, camps, schools, and afterschool programs, and continued our focus on STEM in order prepare our youth for the millions of STEM-related jobs of the the future. Given the remote and diverse communities that are home to Maine youth, informal education through 4-H can help minimize inequities in rural youth STEM education and career pipelines.

Our *4-H Summer of Science* staff used summer of science experiential learning activities to reduce student summer learning loss and spark their interest in science. 4-H SOS focuses on programming where youth already are, and uses positive 4-H youth development programs to reduce barriers to involvement in STEM. Maine 4-H staff and Summer of Science college interns developed and modified four science activities that in 2021 were delivered in 7 Southern Maine communities at 12 sites including summer lunch programs, Public Housing, elementary schools, community youth clubs, and summer camps. Over 4 weeks, with the support of Maine 4-H staff and adult volunteers, 31 teen teachers and four college interns engaged 450 youth. One activity focused on designing and testing the design of facemaskse connecting current world events related to the pandemic to the engineering design process.

The *4-H STEM Ambassadors* program continued to be virtual to allow for multi-campus student teams and increased access for more distant community partners regardless of local program model (remote, in-person, hybrid). In 2021 the program reached more than 300 students, grade 3-8, across 18 sites with the help of 39 volunteer Ambassadors and staff. Through this program, youth come to view the Ambassadors as mentors and leaders in their community while also developing skills in STEM. The program occurs through all 7 campuses of the University of Maine System.

Connecting Maine Youth with Coastal Ecosystems through eDNA as a partner in the University of Maine's 5-year NSF EPSCoR grant, Extension connected University research to Maine youth through 4-H STEM Toolkits that are being used to teach youth about cutting-edge UMaine research. We developed experiential learning activities designed to teach youth about sustainable fisheries and how environmental DNA contributes to knowledge about them.

Micro-credentialing through UMaine System - Extension provides valuable skills to both youth and adult learners and in 2020 we began developing and issuing micro-credentials through the UMaine System. In 2021, these included micro-credentials in Food Safety, Aquaculture, and 4-H STEM Ambassadors, and 4-H Outdoor Leadership. Earners ranged from current UMaine System students to general public adults. These credentials can be used to showcase skills earned through Extension, and are verified by the University of Maine System. Micro-credentials help earners make competencies visible, beyond what is seen on a transcript or resume; demonstrate skills in real-world settings; gain work experience and receive valuable performance feedback; differentiate and stand out to employers; better

articulate the skills developed to potential employers; enhances digital identity; share badges and be recognized. All micro-credentials/badges can be shared on social media and professional sites, such as LinkedIn as well as on your website, e-portfolio or resume.

UMaine Extension 4-H Camp and Learning Centers - Extension's four 4-H Camp and Learning Centers provided programs for youth ages 5-17, many from underserved populations, to have transformational experiences designed to develop a sense of place and belonging, and confidence in the outdoors. Our programs include both day and residential summer camps, onsite open air classrooms for schools, and school-based programs, as well as adult programming and workshops. We have a well-developed virtual component to our programs that gives them added depth and maximizes accessibility. Our Learning Centers typically attract over 2,500 youth each summer, and provide school programming for over 6,000 students from more than 60 Maine school groups. In 2021, our Centers operated safely through the pandemic, delivering full spring, summer, and fall programming at the Centers, including programs in water ecology, forest ecology, wilderness survival, and conservation education.

Helping Youth Make Good Nutritional Choices - In 2021, 853 youth participated in Maine EFNEP. As a result of participating in EFNEP:

- 83% of youth improved their abilities to choose foods according to current Dietary Guidelines or improved nutrition knowledge.
- 47% of youth improved their daily physical activity practices.
- 47% of youth used safe food handling practices more often.
- 50% of youth improved their ability to prepare simple, nutritious, affordable food.

Critical Issue: Sustainable Community and Economic Development

Extension

Mobilizing Support for Food Insecure Citizens - Since 2000, UMaine Extension's Maine Harvest for Hunger (MHH) program has mobilized gardeners, farmers, businesses, schools, and civic groups to grow, glean, and donate high-quality fresh produce to food pantries, shelters, and community meal sites throughout Maine. In 2021, 424 MHH volunteers grew, gleaned and distributed 168,304 lbs of fresh produce, valued at \$284,434, to 228 food security agencies located throughout the state. Since 2000, MHH participants have distributed more than 3.2 million pounds of food to citizens grappling with hunger.

Recipe to Market - There has been a growing interest in value-added food production in Maine. From farmers looking to add value to their raw products, to Maine families interested in turning their favorite recipes into viable food businesses. In response to this growing demand, UMaine Extension developed the Recipe to Market program in 2007 and has been offering it to statewide audiences annually ever since. The goal of the program is to help potential and existing food entrepreneurs acquire food science and business knowledge and skills to successfully bring a value-added food product to market. Since 2007, Extension has conducted 36 programs in 10 counties reaching 480 participants across the state. During the pandemic the RTM Team also supported food businesses by offering virtual trainings on "Pivoting During the Pandemic – How Food and Beverage Businesses Creatively Thrived in 2020." 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.

Master Gardener Volunteers (MGV) - Extension provides direct and virtual home horticulture programs to Maine residents and offers training that provides opportunities for gardeners to connect with meaningful service projects in their community. MGV are lifelong learners who educate home gardeners, address community efforts related to horticulture, and support Extension's educational efforts. Of our 990 active MGV, 145 were trained in 2021 and they donated 28,830 hours to a variety of educational and food security projects throughout the state including community gardens, school gardens, demonstration gardens, and youth programs.

Extension Parent Educators are part of a statewide network of Maine Families Home Visiting Programs. In 2021, 10 certified parent educators provided 1,698 home visits to 169 parents/caregivers with 174 children living in five counties. Using the Parents As Teachers model parent educators met with families in their homes and then virtually due to the pandemic, 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.

The Marine Extension Team (MET) developed the course *Art and Science of Virtual Facilitation*, and delivered it to provide skills, knowledge, a variety of approaches and practice for interacting in virtual settings. They created and delivered *Aquaculture ME!* as a way to provide educators with the tools, resources, and cross-sector connections to advance aquaculture education in the classroom, and helps promote environmental literacy and project-based learning for Maine students. And they delivered *Using Direct Marketing* to help Maine seaweed businesses weather the pandemic, collaborating with industry members to develop and pilot a seaweed direct marketing

initiative, which included a new online platform for Maine seaweed farmers to sell their products directly to consumers and to engage in direct sales with restaurants. *Aquaculture in Shared Waters* continued to build capacity in the aquaculture workforce, and stimulate business development and diversification in the seafood sector.

Experiment Station

Farmers in a Resilient Rural Economy: Small farmers and growers provide for the food security of the State of Maine and capture value from the tourist population for local communities. These producers, and the communities in which they live, are vulnerable to both economic and climactic risk factors. Supporting this sector in its economic, physical, and mental health promotes the well-being of Maine's rural communities and the State as a whole. Experiment Station faculty are researching the the challenges and opportunities facing small farmers, growers, and other participants in Maine's rural economy. This research will help inform the design of programs and policies seeking to make Maine's rural economy more resilient to economic and climate-related risk factors. In addition, it helps rural stakeholders, particularly small farmers and growers, improve their resilience and create dynamic businesses well suited to the preferences of their consumer base. In the past year, owing to the effects of the COVID-19 pandemic on the food system and rural communities, these efforts are more important than ever. This project has at its core the mission of conducting capacity research to support and enhance agriculture and rural life in the state of Maine. By improving the availability of data on the risks facing agricultural producers, agricultural businesses, and rural communities; by fostering a better understanding of how decision-makers view, quantify, and mitigate those risks; and by using this data and this understanding to help craft appropriate responses and data-driven policies, this project contributes directly to these goals.

Critical Issue: Sustainable Natural Resources

Experiment Station

Forest Health Research: One of the most serious threats to North American forests is the introduction of non-native insects. Although only a small portion (< 10%) of the non-native insects in North American forests have a significant impact, those that do cause damage costing over \$70 billion annually. Many policies have attempted to reduce the introduction of non-native insects, but new insects continue to arrive and establish in North American forest ecosystems, including urban and community forests. Experiment station faculty looked at historical and current forest pests of North America in ways that will allow researchers to better predict, prepare for, and control them. Data from this work will be integrated into a new software tool that will predict the impact of non-native forest insects before they arrive in North America. This software will be publicly available and can be used by researchers, arborists, students, or the general public. In addition, research aimed at monitoring and managing browntail moth will have ecological, economic, and public health benefits.

Soil Health and Chemistry Research: Natural climate solutions, including increasing levels of organic matter to sequester soil carbon, are being emphasized at the federal and state levels. Although policies are being proposed to increase soil carbon storage, many questions remain about the effectiveness of this practice in slowing the rate of atmospheric CO₂ increase. In particular, long-term stability of sequestered carbon under changing environmental conditions is unclear. Experiment station faculty completed computational DFT studies have shown that Fe²⁺ and Fe³⁺ cations and their hydrolytic species form complexes with low-molecular weight organic acids through physical electrostatic interactions. They have also shown that these electrostatic mechanism also extends to Fe oxide nanoclusters. Because of the high charge density of the Fe nanocluster, the reactions are kinetically very rapid making chemical characterization of the intermediate steps of the aggregation process experimentally challenging. Aggregation dynamics are also inherently challenging to characterize due to the presence of numerous, intermediate metastable structures. Our studies describes how both quantum and classical physical models can be used to obtain a molecular understanding critically important soil processes and how they may be affected by the changing climate. These studies contributes to better understanding of soil processes to allow better management systems to mitigate climate change impacts on the environment.

Horticultural Practices Research: Experiment Station faculty addressed needs related to sustainability in the U.S. horticulture industry in the context of a broader multi-state project on sustainable practices, economic contributions, consumer behavior, and labor management in the horticulture industry. Propagating and growing plants in the horticulture industry is resource intensive, and systems that reduce resource usage (e.g., water) and improve efficiency would improve sustainability. Moreover, the selection, propagation, and evaluation of native plants for the industry, and identification of future invasive plants, support the emerging trend toward ecologically conscious landscape design and management that takes into account native ecosystems and ecosystem services and a reduced reliance on nonnative or invasive plants.

Faculty evaluated a prototype plant rooting system that relies on an aeroponic design ("submist") for successful rooting of stem cuttings from several species. The system proved beneficial for some species and for some measures of plant rooting, but not for others, indicating that further refinement is needed or that the systems will be more beneficial for some species than for others. However, water

use was much lower in the submist systems, even while plant performance was generally comparable to plants propagated in traditional overhead mist systems. Faculty also collected additional data on the potential for a native shrub, mountain fly honeysuckle, to perform in field soils, with comparisons to nonnative varieties developed from close relatives (honeyberry) in Asia. Over several years, native mountain fly honeysuckles grew poorly relative to nonnative honeyberries, which produced substantially more shoot growth and fruits than native plants.

The evaluation of aeroponic propagation systems brings the technology a step closer to commercial adoption. The recent work suggests that some optimization is appropriate prior to wholesale industry adoption. Although industry members expressed interest in constructing systems now, our work highlights important considerations for a successful implementation of these water-saving propagation systems. The landscape design and management segments of the horticulture industry benefitted from recent field trials of a native honeysuckle that was, we believe, never before evaluated in horticultural landscapes. Although the shrub appears poorly suited to the full-sun landscape in which it was evaluated, key insights about differences between native and nonnative relatives in growth and invasive potential will be of use to designers and landscapers who seek out native plants or wish to avoid planting potential invasive species.

Critical Issue: The Maine Food System

To support the Maine Food System, Extension outreach and the Experiment Station research focused on agricultural sustainability and interrelated work in policy, research, production, processing, commerce, nutrition, food security, and food safety.

Through the *Maine Food and Agriculture Center* partnership between Extension and the Experiment Station, Extension outreach supports the majority of Maine's 7,600 farms and many of our recommendations to our agricultural community come directly from research at Experiment Station farms. With \$5 billion in economic impact, agriculture, commercial fishing, and food processing include Maine's largest, fastest growing, and most promising industries. The MFAC encompasses the burgeoning food economy, provides access to programs and expertise available at all 7 of Maine's public universities, and creates opportunities for cross-campus and cross-discipline coordination.

Extension

Potatoes are Maine's leading agricultural commodity with total sales of over \$540 million, employing over 6,100 people, and over \$112 million in income to Maine citizens; Extension's IPM saves Maine's potato industry an estimated \$10 million in losses avoided, yield increases and reduced pesticide use. *Maine's fruit tree industry* benefited from Extension's IPM with over \$5 million in losses avoided, and over \$1 million savings in pesticide savings in purchase costs. *Maine's wild blueberry industry* with 480 growers on 44,000 acres, annually produces as many as 100 million pounds of blueberries, and has a direct and indirect economic impact of over \$250 million to the state's economy. Extension specialists and researchers supported blueberry growers through field and lab work. We support *crop productivity and efficiency* by addressing pollinator population enhancement, weeds, pest insects, and diseases; Extension outreach and research efforts have enabled growers in Maine to remain competitive in the world marketplace and contribute significantly to the state's economy.

Maine's dairy industry generates more than \$570 million a year for the state's economy, contributes more than \$25 million in state and local taxes, and provides more than 4,000 jobs for Maine people. Dairy producers must keep pathogenic bacteria out of their dairy animals and products. Through direct support of farmers, research and pathogen screening at our Diagnostic Laboratory, Extension protects public health and jobs. *Maine's maple production* is the third largest in the United States with an annual statewide economic contribution of \$48 million in output, 805 full and part time jobs, and over \$25 million in labor income. Extension outreach with maple producers and leadership in an annual International Maple Grading School supports this internationally recognized industry.

Our Diagnostic and Research Laboratories for Veterinary Diagnostics, Aquatic Animal Health, Arthropod, and Plant Disease Diagnostics continued research contributions to agriculture, public health, communities, and wildlife and protecting natural resource- and food-based economies, adding to food safety and human health, and providing unique diagnostic and testing services to farmers and the public.

The Marine Extension Team (MET), a collaboration of Extension and Sea Grant, played a primary role in the design and implementation of a project to improve the processes used in *sea scallop* farming, the economics of the industry, and to support the development of high value cultured scallop products. MET also worked with partners to create a technical solution to address sea scallop farming equipment issues that can harm growing scallops and ruin crops. MET supported Maine's *Atlantic salmon* aquaculture industry by providing research and extension field support to develop IPM strategies against the salmon louse.

Experiment Station

Potato Improvement: Recent Eastern potato releases were grown on 3,127 ME and NY seed acres in 2021 with a seed value of ~\$10.9M. The resulting seed crop has the potential to plant 31,274 acres in 2022 with a ware value estimated at \$101.6M. Nationally, varieties released by Experiment Station faculty since 2007 were grown on 7,369 seed acres during 2021 with an approximate seed value of \$25.8M and potential ware production value of \$239.4M. Several varieties developed through the Station are in the top 100 U.S. varieties based on seed acreage, including (acres, rank). Caribou Russet was released by ME during 2015 for fry processing and russet fresh market. It is being rapidly adopted due to high yields, scab and verticillium resistance, and excellent consumer quality. Certified seed acreage rose to 1475 acres (#16 in the US) during 2021. Caribou Russet's cash farm value to ME seed growers was ~\$5.2 M during 2021 and the estimated cash farm value when this seed crop is planted, grown, and sold in 2022 is ~\$47.9M; it is also being evaluated and adopted in many other countries.

Dairy and Beef Cattle Research: In the U.S., it is calculated that \$4.2 billion are lost each year during hay and silage production, due to microbial decomposition. Currently, the most used hay preservative, propionic acid, has limited efficacy. For silage, bacterial inoculants have been equivocal in preventing the extensive protein decomposition in legumes. Previous research suggests that certain technical lignins have antimicrobial activity and can safeguard proteins against breakdown. These properties could be adapted to prevent spoilage, considering their low cost compared to established preservatives. Experiment Station faculty hypothesize that technical lignins can be used to prevent hay and legume silage spoilage. This work supports the dairy and beef industries through higher profitability for hay and silage producers, higher profitability for livestock operators, reduced greenhouse gasses emissions from spoiled feed, and reduced feed waste.

Healthy Eating: College students are at increased risk for unhealthy dietary behaviors and poor mental health, putting them at risk for developing obesity and chronic disease. The average weight gain in college of 3-4.3kg in the first year at school puts students at higher risk of obesity by age 35-37, and young adults aged 18-24 have the highest prevalence of mental illness. The Experiment Station is researching the relationship between behaviors that influence diet quality such as nutrition literacy, and developing methods to improve these behaviors for better HRQOL and chronic disease prevention in young adults. This work helped establish the relationship between nutrition literacy, diet quality, and health-related quality of life. By taking a community-based research approach to program planning, college students will have a say in what type of health program will work best to meet the health needs of their peers. Developing health programming on college campuses that targets both healthy eating and mental health is a way to reach a large portion of the population who are at risk for future chronic diseases. By developing intervention strategies on college campuses that improve health behaviors and prevent chronic disease, young adults will leave college with the ability to maintain good health practices, which play a major role in improving individuals' quality of life and ensuring an able workforce and economic stability. The Experiment Station supported training dozens of food science and nutrition students in the specialty of sensory evaluation. These students have taken that training to employers at Maine enterprises, and to major corporations such as Coca Cola and Conagra.

Merit and Scientific Peer Review Processes

Updates

(No significant changes)

UMaine Extension faculty and professionals engage in an ongoing process to plan and adjust programs in ways that meet the needs of Maine citizens. To maintain relevant programming, faculty and staff engage in formal and informal review by discipline-specific review panels and advisory groups. This results in defined programming intentions for the near- and long-term, while ensuring it is dynamic allowing us to address emerging issues. The process involves independent review within local advisory structures, and collaborative review within statewide programmatic teams. Programming merit and success for faculty members is also reviewed by faculty peers through reappointment, promotion, and post-tenure processes established by the faculty and administration and codified in employment contracts. A unique process exists for non-faculty programming professionals who undergo annual reviews by supervisors, and peer reviews every 4 years.

We partner with regional Extension programs in the Northeast Region whose active vision is to coordinate translational research, education, outreach, and diversity programming to address problems, opportunities, and workforce development. Our primary mission is to enhance institutional cooperation and improve coordination of regional Extension program initiatives for the Northeast. Partners include the following universities: Connecticut, Cornell, Delaware, Delaware State, District of Columbia, New Hampshire, Maine, Maryland, Maryland Eastern Shore, Massachusetts, Penn State, Rhode Island, Vermont, Rutgers, West Virginia, and West Virginia State.

The Experiment Station uses its standard scientific review process for faculty. This year we modified the review process to use an independent, internal review process using our Research Council members as reviewers. The external review system had become unsustainable due to issues recruiting external reviewers, staffing capacity to manage the complex process, and unfamiliarity of external reviewers to capacity funded projects. We also modified the process for new faculty who need to develop their first projects.

For the modified process, Experiment Station faculty prepare a pre-proposal reviewed by the Research Council, which is composed of senior faculty from most of the units on campus with Experiment Station appointments. Following the Research Council review to ensure that the proposed work falls within the purview of the Experiment Station, addresses an important need to the state identified by stakeholders, and that the project director possesses the expertise to conduct the research, full proposals are developed. The full research proposals are then sent to two Research Council members and the Associate Director for a detailed merit 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 by the Associate Director a final time before being submitted to USDA for final approval.

Stakeholder Input

Actions to seek stakeholder input that encouraged their participation with a brief explanation

(No significant changes)

The Extension and Experiment Station Plan of Work is based on updated needs assessment that includes multiple components to encourage direct participation through targeted solicitation of stakeholders, evaluation of current first-source data, and public input. Extension and the Experiment Station have learned from our constituents that high-quality engagement is best when the issue is current, and we engage stakeholders as needs and issues arise. Our matrix of programs involves citizen and volunteer group input, and our work is guided by the community, and commodity stakeholders with whom we have close working relationships. Selected examples:

- Partnerships with 16 county executive committees that provide direction and advice to extension programs and help to prioritize regional efforts.
- Interactions with the UMaine Board of Agriculture, formed by state statute, that advise us on agricultural research and extension priorities.
- Participation at monthly meetings of the Agricultural Council of Maine (AGCOM) as a way to maintain effective communication with the wide array of agricultural organizations in the state.
- The Maine Wild Blueberry Commission that represents growers and processors. The Maine Potato Board that is composed principally of Maine potato farmers who offer advice and support for research.
- The Maine 4-H Foundation Board that is a partner with Extension's 4-H Program.
- Advisory boards that guide the work of our most important programs. Examples: Maine Sea Grant Policy Advisory Board, Tanglewood 4-H Camp Board, Bryant Pond Learning Center Board, the Maine Board of Pesticides Control, Forest Resources Advisory Committee, and the Coordinating Committee of the Maine Fish and Wildlife Research Unit.

We partner with discipline-specific groups such as the Maine Organic Farmers and Gardeners Association; Maine Science, Technology, Engineering and Math Collaborative; and the Sportsman's Alliance of Maine.

We have an ongoing dialogue with Maine Legislators and County Commissioners to communicate our extension and research focus areas and to respond to the needs that have been identified through their constituents.

Our research facilities host field days for apples, small fruits, vegetables, potatoes, grains, wild blueberries, and other growers, that allow researchers and administrators to learn more about stakeholders needs.

Methods to identify individuals and groups and brief explanation

(No significant changes)

UMaine has deep historical connections to the fabric of life in Maine communities. Extension and Experiment Station stakeholders are primarily identified through:

- Historical and ongoing connections with traditional stakeholders, proactive relationship building with emerging stakeholders, and ever-evolving interactions within our communities.

- Informal and formal interactions with coordinating and advisory committees, and traditional stakeholder groups, including using them as sources of referral for new stakeholder groups and individuals with an interest in research and extension programs.
- The budget appropriations process with funders such as county commissioners and the Maine State Legislature.
- Active recruitment and retention of people who are traditionally underserved and underrepresented in our programs and employee groups.
- New groups and individuals will be identified through internal focus groups to the university, as well as external focus groups comprised of federal and state officials and traditional and nontraditional stakeholders.
- Extension and the Experiment Station maintains lists of all known stakeholder groups, and these groups are contacted on a regular basis.

Methods for collecting stakeholder input and brief explanation

(No significant changes)

Extension staff work within program teams to maintain a connection to stakeholder and citizen issues and continuously reassess needs. Our staff review their programming intentions for upcoming years and maintain a five-year vision. As part of the process, they review information from ongoing merit review processes and the needs assessment, and update programming priorities as needed.

The Experiment Station collects input through formal organization processes (Board of Agriculture, Forest Resources Advisory Committee, and Maine Cooperative Fish and Wildlife Research Unit Coordinating Committee), and feedback on research programs of faculty via stakeholder grant review programs (Wild Blueberry Commission of Maine Advisory Committee, Maine Potato Board, Cooperative Forestry Research Unit). Extension and Experiment Station staff meet with and collect input from both traditional and non-traditional stakeholders at the group and individual level.

A statement of how the input will be considered and brief explanation of what you learned from your stakeholders

(No significant changes)

Extension and Experiment Station administrators will use needs assessment data, that includes stakeholder input, to help prioritize our programs relative to our budgetary capacity, and to inform extension and research teams and individuals about emerging issues that will help them prioritize and focus research and extension programs appropriately and effectively.

Highlighted Results by Project or Program

Critical Issue

Climate Change

Supporting Maine Marine, Agriculture, and Resilient Communities

Project Director

Jonathan Prichard

Organization

University of Maine

Accession Number

7002494



Marine Extension Team Supporting Coastal Communities and Resources

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Climate change is requiring Maine communities to build the capacity to make informed decisions on the management of coastal and marine resources that promote ecological and economic sustainability.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Maine's Marine Extension Team (MET), a collaboration of Extension and Sea Grant, continued to help communities gain the capacity to make informed decisions on the management of coastal and marine resources that promote ecological and economic sustainability. MET members worked with communities to address problems and respond to opportunities in four major areas: ecosystem health; sustainable coastal communities; fisheries and aquaculture, and coastal community resilience. A 25-member advisory committee helps identify stakeholder needs and ensures that our work is relevant to the people of Maine.

Briefly describe how your target audience benefited from your project's activities.

Maine's Marine Extension Team projects included:

Soft-shell clam research and monitoring investments help to protect Maine's second most valuable fishery: These efforts are helping to inform new measures to better manage soft-shell clam resources during a period of warming seawater and help mitigate a 40-year trend of declining landings.

Social Resilience in Midcoast Maine: This effort is addressing barriers to climate adaptation in coastal communities and reduce climate-related threats to the region's most vulnerable populations.

Signs of the Seasons Increases Community Science Engagement: This program is advancing climate change research, improve participants' understanding of climate science, and promote scientific engagement and climate stewardship in Maine communities.

Collaborating Toward Climate Solutions: These activities are supporting communities in their climate change adaptation and planning efforts such as those related to stormwater infrastructure, sea level rise and working waterfront infrastructure, community science, and educational programs for addressing climate knowledge and preparedness.

Maine Ocean and Coastal Acidification Partnership: Many species that are economically valuable to our coastal communities are also vulnerable to coastal ocean acidification. With leadership and coordination from Extension and Sea Grant, Maine Ocean and Coastal Acidification Partnership helps coordinate the work of governmental agencies and private organizations and citizens who are studying and implementing means to reduce the impacts of or help adapt to ocean and coastal acidification.

Maine Climate Change Adaptation Providers Network: Maine Sea Grant and Extension developed and continue to lead the Maine Climate Change Adaptation Providers Network in partnership with the Maine Department of Environmental Protection, and CCAP continued coordinating with Maine's Climate Council action plan.

Briefly describe how the broader public benefited from your project's activities.

The partnership between Cooperative Extension and Maine Sea Grant benefits Maine broadly by marrying Extension's outreach and programming experience with Sea Grant's marine research and knowledge of coastal communities and issues. Through research and outreach the Marine Extension Team builds the capacity of coastal communities and marine industries to make informed decisions on the management of coastal and marine resources that promote ecological and economic sustainability.

Cues to irrigate in Northeast diversified vegetable production systems

Project Director
Rachel Schattman
Organization
University of Maine
Accession Number
1022424



Determine the effects of three cues to irrigate

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

To effectively adapt to climate change (specifically changing precipitation patterns), Maine vegetable and small fruit producers must give more consideration to water use efficiency, specifically in their irrigation practices. Through this project, I evaluate the effects of four different "cues to irrigate" on crop yield, quality, and environmental impact (specifically water quality). The results of the study will allow farmers who run diversified vegetable systems to make informed decisions about whether precision irrigation technology is an economically and environmentally advantageous investment.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

"Cues to irrigate" are defined as the reasons why farmers decide to turn irrigation water on and off. This project evaluates the effects of four different cues to irrigate on crop yield, quality, and environmental impact (specifically water quality). The four different cues include feeling the soil (a common practice among Northeast farmers), watering with timers, and precision irrigation technology (i.e. Watermark sensors). A control treatment receives no supplemental irrigation. All treatments receive water through ambient precipitation.

Field trials have been conducted at two research sites (in Vermont and Maine) over two years (2019 and 2021), though which my team has generated preliminary results. A final year of data collected will be conducted in Maine in 2022. Preliminary analysis suggests that cucumber yield was significantly different ($p < 0.5$) between the control (no irrigation) and feel of soil treatments, and the control and the soil moisture sensor treatments. However, yield was **not** significantly different between the feel of soil and soil moisture sensor treatments. The number of cucumbers harvested in all plots were not significantly different from one another, meaning that any differences were due to unit weight.

In tomatoes, there was a small difference between feel of soil and timer treatments, suggesting that tomatoes were more tolerant of wet conditions than cucumbers. The sandy soil at the Burlington VT site was very well drained, and there was little opportunity for the soil to be truly saturated. Tomato yield was lower in the soil moisture sensor treatment as compared to the feel of soil treatment. However, some measures of quality (gloss) were lower in the control treatment. We are looking into the disease/water relationship to explain this.

In peppers, there was no statistical difference between the feel of soil and soil moisture sensor treatments, though the crop clearly suffered from too much water (in the timer treatment) and too little water (in the control treatment). Notably, the only treatments that were not statistically different from one another were feel of soil and soil moisture sensor treatments. As with cucumbers, there were not differences between treatments in the number of fruit (with the notable exception of difference between control treatments and feel of soil treatments). However, total yield (weight) differences were statistically different between all treatments ($p < 0.01$) except feel of soil and soil moisture sensors.

There was little difference in the amount of water applied in the feel of soil treatment and the soil moisture sensor treatment, but that the timer treatment (where we irrigated for the same amount of time every day) received more water and was more prone to leaching. We collected leachate using buried lysimeter pans, pumping water samples out on a weekly basis.

Soil nitrate test results (PSNTs) did not statistically differ significantly between the plots, indicating that the amount of plant-available nitrogen wasn't very different between treatments. However, there was a small observable difference, with lower PSNT results found most often within the timer treatment (which had the most water applied).

While we have not yet completed the full financial analysis of the different treatments, our preliminary data suggests that there are not as many differences in yield/quality between treatments managed through feel of soil and soil moisture sensors as we expected. This leads us to anticipate that investing in soil moisture sensors may not be worth the investment for diversified farmers in the Northeast. However, this conclusion may be revised pending data analysis from the Maine research site, where soils are heavier and the potential for over-watering is higher.

Briefly describe how your target audience benefited from your project's activities.

There were two target audiences for this work: (1) commercial vegetable and small fruit growers in Maine and the Northeast, and (2) agricultural advisors and researchers. First, commercial vegetable and small fruit growers want to know what is at stake when they irrigate based on common cues (i.e. feel of soil) as opposed to investing in more expensive and more precise approaches (i.e. Watermark sensors). Results from this project can be used by farmers to compare effects of different irrigation management decisions on crop yield and quality, as well as environmental outcomes. By translating our findings into financial terms (sacrificed income and costs of implementation), this project will allow growers to quickly and effectively assess whether investing in soil moisture monitoring would benefit their operation or not. Second, this research has been used, and will be used further, to inform conversations with the Northeast community of researchers and outreach

professionals working in specialty crop water use efficiency. For example, at the Northeast Water Use Symposium held in December 2019, soil moisture sensors were the topic of many discussions and presentations. Few of these presentations focused on diversified vegetable systems, and few applied research findings to the farm management context. Additionally, this research has been used in special sessions with farmer/agricultural advisors enrolled in the Climate Adaptation Fellowship, a USDA NE SARE funded professional development project where participants learn about climate adaptation strategies for Northeast diversified vegetable and small fruit operations. The results of this project will make a meaningful contribution to the field of water use efficiency research and outreach by investigating its relevance in a diversified agricultural system.

Specifically, presentations have been made to farming and agricultural advisor audiences (audiences included the University of Maine Climate Change Institute, the Maine Wild Blueberry Commission, the Vermont Vegetable and Berry Growers Association, the Maine Vegetable and Fruit School, and participants in the USDA-SARE funded Climate Adaptation Fellowship). In the coming year, we will also be developing fact sheets summarizing our research findings, giving additional presentations, and submitting scholarly publications.

Briefly describe how the broader public benefited from your project's activities.

Water use efficiency is an issue of public concern in an era of climate change. Though water has historically been plentiful in the Northeast region of the United States, climate change forecasts tell us that there will likely be more droughts and dry periods that affect this region. Agriculture is just one use of freshwater resources, and in some parts of the Northeast agricultural industries have already come into conflict with other users (i.e. municipalities, industry, and in some cases conservation groups). To ensure a future where agriculture continues to exist as a viable industry, farmers must make the best use of what is quickly becoming understood as a limited resource. This requires that farming communities better understand (a) how much water their crops need, (b) how to apply water at the right time, in the right amounts, and (c) how to best leverage available technology to meet both production and environmental conservation goals. The results of this research support farmers to make sustainable management decisions on their farms, specifically related to water management in diversified vegetable production systems.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Scholarly publications (2021)

Niles, M. T., Beavers, A. W., Clay, L. A., Dougan, M. M., Pignotti, G. A., Rogus, S., Savoie-Roskos, M. R., **Schattman**, R. E., Zack, R. M., Acciai, F., Allegro D., Belarmino E. H., Bertmann F., Biehl, E., Birk, N., Bishop-Royse, J., Bozlak, C., Bradley B., Brenton, B. P., Buszkiewicz, J., Cavaliere, B. N., Cho, Y., Clark, E. M., Coakley, K., Coffin-Schmitt, J., Collier, S. M., Coombs, C., Dressel, A., Drewnowski, A., Evans, T., Feingold, B. J., Fiechtner, L., Fiorella, K. J., Funderburk, K., Gadhoke, P., Gonzales-Pacheco, D., Greiner Safi, A., Gu, S., Hanson, K. L., Harley, A., Harper, K., Hosler, A. S., Ismach, A., Josephson, A., Laestadius, L., LeBlanc, H., Lewis, L. R., Litton, M. M., Martin, K. S., Martin, S., Martinelli, S., Mazzeo, J., Merrill, S. C., Neff, R., Nguyen, E., Ohri-Vachaspati, P., Orbe, A., Otten, J. J., Parmer, S., Pemberton, S., Al Abdeen Qusair, Z., Rivkina, V., Robinson, J., Rose, C. M., Sadeghzadeh, S., Sivaramakrishnan, B., Torres Arroyo, M., Voorhees, M., & Yerxa, K. (2021). A Multi-Site Analysis of the Prevalence of Food Security in the United States, before and during the COVID-19 Pandemic. *Current Developments in Nutrition*, nzab135. <https://doi.org/10.1093/cdn/nzab135>

Roesch-McNally, G., Wiener, S., Reyes, J., Rottler, C., Balachowski, J., & **Schattman**, R.E. (2021). Supporting practitioners in developing effective decision support tools for natural resource managers. *Journal of Soil and Water Conservation* 76(4): 73A-78A. doi:10.2489/jswc.2021.0618A

Schattman, R. E., Trinity, L., Clark, E., & Merrill, S. C. (2021). Awards: Untapped motivation for agricultural conservation behavior. *Elementa: Journal of the Anthropocene* 9(1): 00120. <https://doi.org/10.1525/elementa.2021.00120>

Schattman, R. E., Caswell, M. J., & Faulkner, J. W. (2021). Eyes on the horizon: Temporal perspectives of climate risk and agricultural decision making. *Society and Natural Resources*. doi:10.1080/08941920.2021.1894283

Other publications (2021)

Presentations (2021)

Schattman, R. E., Saunders, O., Ferla, A., McKaeg, L., Roszell, C., Barker-Plotkin, J., Cowles, R., Jones, J., Ernst, E., Manabe, N., & Siciliano, G. (2021). Climate adaptation on the farm. New England Vegetable and Berry Growers Association (NEVBGA) bi-annual conference. December 13, 2021 (online).

Schattman, R. E., Lane, E. D., & Kaplan, M. (2021). Building a climate adaptive community in agriculture. American Society of Adaptation Professionals, Network of Networks Meeting. December 10, 2021 (online).

Schattman, R. E., Birkel, S., Lilley, J., Waterman, B., Crocket, B., McKaeg, L., & Ferla, A. (2021). Climate and water management. Maine Organic Farmers and Gardeners Association (MOFGA) Farmer to Farmer Conference. November 5, 2021 (online).

Schattman, R. E., Carpenter, A., Roszell, C., Barker Plotkin, J., & Fitzbeauchamp, R. (2021). Soil management and carbon sequestration. Maine Organic Farmers and Gardeners Association (MOFGA) Farmer to Farmer Conference. November 1, 2021 (online).

McGann, T., & **Schattman**, R. E. (2021). Urban and Rural Foresters' Perceptions of Global Change and Adaptive Management in the Northeastern US. Society of American Foresters 2021 National Convention. Abstract ID Number: 148. November 6, 2021 (online).

Schattman, R. E. (2021). The social science of conservation. Presentation to USDA-NRCS Conservation Planners, as part of the required professional development series. Recorded webinar to be used annually between 2021-2026. 2,300 participants/year. (I)

Merrill, S.C., **Schattman**, R. E., Trinity, L., & Clark, E. (2021). Motivators of agricultural conservation practice adoption. Presentation to the Vermont EPSCoR Research Slam (Burlington, VT). August 9, 2021.

Schattman, R. E., Lane, E. & Kaplan, M. (2021). Building a community of climate communicators in agriculture. International Association of Society and Natural Resources (IASNR) Annual Conference (online). June 24, 2021.

Schattman, R. E. & Yerxa, K. (2021). Food Access and Food Security in Maine Since the Coronavirus Outbreak. Maine Association of Nutrition and Dietetics (MAND) Virtual Annual Conference (online). April 15, 2021.

Schattman, R. E. (2021). Effects of the Maine 2020 Drought on Agriculture Producers. 28th Annual Harold W. Borns Jr. Symposium, University of Maine Climate Change Institute (online). April 5, 2021.

Schattman, R. E. (2021). Irrigation strategies for diversified farmers. Maine Vegetable and Fruit School, University of Maine Extension. March 31, 2021 (online).

Schattman, R. E. (2021) Water management in specialty crops: An overview of research from the University of Maine Agroecology Lab. Presentation to the Maine Wild Blueberry Commission. January 26, 2021. (I)

Gordon, T., Lilley, J., Jemison, J., Birkel, S., & **Schattman**, R. E. (2021) 2020 Drought review and preparation for the future. Presentation at the Maine Agriculture Trade Show. January 21, 2021 (online). (I)

Schattman, R. E. (2021) Climate communication: Challenges and strategies. Presented to the Northeast Climate Adaptation Fellowship. January 15, 2021.

Critical Issue

Positive Youth Development

[Educating and empowering Maine youth through hands-on experiential education, self-directed learning, and community-based experiences](#)

Project Director



4-H Ambassadors Sparking Student Interest in STEM Careers

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

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.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Since 2014, Extension's 4-H STEM Ambassadors program has enrolled and trained more than 500 UMaine System students who have facilitated in-person, hands-on learning experiences fostering youth STEM enjoyment, literacy, and identity, reaching more than 6,000 Maine youth aged 8-14 in classrooms, libraries, and afterschool clubs across the state. In the fall of 2020, to meet university and community COVID guidelines, Extension redesigned the program to be virtual, including a training, mentoring, and experiential STEM programming.

Briefly describe how your target audience benefited from your project's activities.

The shift to a virtual program allowed for multi-campus student teams and increased access for more distal community partners regardless of local program model (remote, in-person, hybrid). In 2020, the 4-H Stem Ambassadors program reached more than 200 students, grades 3-8, across 11 sites with the help of 34 volunteer Ambassadors and 4-H staff facilitators. And in 2021 the program reached more than 300 students, grade 3-8, across 18 sites with the help of 39 volunteer Ambassadors and staff.

Briefly describe how the broader public benefited from your project's activities.

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, and becoming connected to research, resources, and scientists at Maine's public universities.



4-H Passport Around the World

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Due to the pandemic, for the last two years many youth were home, isolated, and not connecting with others. In Maine there were many cases of families wanting to join 4-H but there is no club in their geographic area for them to join. In addition, during the pandemic many of these clubs were not meeting, resulting in even more youth without access to 4-H & peer-to-peer interactions. Maine is also a state where much of its diversity is concentrated around large cities, leaving many youth in rural areas without opportunities for exposure to diversity of cultures, people, and ideas.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

In 2021, Extension partnered with Greenheart Exchange to create a virtual 4-H club to give Maine youth an opportunity for connection with youth from all over the world. 4-H Passport Around the World was a virtual short-term club that met weekly for three different, six-week sessions for a total of 18 sessions. Greenheart Exchange teens gave short presentations about their country, followed by a hands-on activity connecting with their culture, and time for questions and discussion. Teens presented from Ghana, Ukraine, Thailand, Bangladesh, Kosovo, and beyond, exposing youth to cultures and countries they may not have known about before.

Briefly describe how your target audience benefited from your project's activities.

By participating in 4-H Passport Around the World, youth learned about other countries and cultures. Parents said that by participating their child gained a greater understanding and appreciation for the similarities and differences of cultures other than their own. Not only did this virtual club provide connection, but it did so in a way that opened the minds and hearts of teens in Maine to diverse cultures and people. Some comments from participants:

"Thank you for sending the power point from the Ukraine session. It was very interesting, and has Katie intrigued enough to look for more information. She's looking forward to learning about Indonesia this week." (Parent)

"We have been cooking a traditional meal from each country, which has been really fun. My son (almost 8) has joined in too. I hope you will consider extending this program. (Parent)

"Today we all listened to Sheikh- he was fantastic! I can't thank you enough for bringing this unique opportunity to Maine. We So appreciate it!

"I don't know why I started with a bad attitude. That was so interesting and I want to visit and try more recipes. Did you sign me up for more traveling workshops?" (Youth member)

Briefly describe how the broader public benefited from your project's activities.

For more than 100 years, 4-H has welcomed young people of all beliefs and backgrounds, giving kids a voice to express who they are and how they make their lives and communities better. Through life-changing 4-H programs, Maine youth have taken on critical societal issues, such as addressing community health inequities, engaging in civil discourse and advocating for equity and inclusion for all. During a pandemic that isolated many Maine rural youth from their peers and from engagement with the broader world, 4-H Passport Around the World provided them with opportunities for exposure to diversity of cultures, people, and ideas.



4-H Summer Camp and Learning Centers Connecting Youth to the Outdoors and Building Community

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

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.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

UMaine Extension 4-H Camp and Learning Centers provide programs for youth ages 4-17, many from underserved populations, to have transformational experiences designed to develop a sense of place and belonging, and confidence in the outdoors. Our programs include both day and residential summer camps, onsite open air classrooms for schools, and school-

based programs, as well as adult programming and workshops. We have a well-developed virtual component to our programs that gives them added depth and maximizes accessibility. Our Learning Centers typically attract over 2,500 youth each summer, and provide school programming for over 6,000 students from more than 60 Maine school groups.

Briefly describe how your target audience benefited from your project's activities.

In 2021, our 4-H Camp and Learning Centers came through the pandemic safely:

- Delivering full spring, summer, and fall programming at the UMaine 4-H Learning Centers at Blueberry Cove, Bryant Pond, and Tanglewood, including programs in water ecology, forest ecology, wilderness survival, and conservation education.
- Collaborating with NH and VT to develop an AgriSTEM curriculum and deliver it virtually and in person among the 3 states to 594 students, including summer campers at 4-H centers.
- Continuing to support Telstar Freshman Academy at Bryant Pond, offering daily, yearlong, experiential learning designed to engage students in an outdoor setting.
- Continuing to deliver the NorthStar Youth Mentoring program that connects young people with caring adults through community engagement, cultural exchange, and adventure challenge and leadership. The program is grounded in in-person contact, and also uses virtual contact for family and other activities.
- Continuing, through Tech Wizards, to provide STEM education and service-learning to help youth learn life and workforce skills, improve academic performance, and aspire to pursue post-secondary education, leading to fulfilling careers and participation in their communities.
- At Greenland Point in Washington County, one of Maine's most impoverished counties, offering hands-on, ecology-focused education, and through scholarships making sure that price is not an obstacle to anyone who wants to come to camp.
- Open Air Classroom and summer camps at Tanglewood and Blueberry Cove offering programs tailored to community needs, including youth development programs for schools seeking to address the learning loss students had faced during the pandemic.

Briefly describe how the broader public benefited from your project's activities.

Our 4-H Camp and Learning Centers provided programs for youth ages 4-17, many from underserved populations, to have transformational experiences designed to develop a sense of place and belonging, and confidence in the outdoors.



4-H Summer of Science

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Research shows that low-income students have less than average access to science education, and a STEM achievement gap is perpetuated during summer months for low-income students, who lose more grade equivalency due to lack of out-of-school and summer learning opportunities. An increase in STEM education can lead to better employment opportunities and increase the likelihood of youth furthering their education.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Summer of Science seeks to improve student proficiency in STEM, introduce them to STEM careers, and support low-income students in an effort to decrease summer learning loss. SOS is unique in utilizing Teen Teachers - often a first paid position for high school students. Partnering with other youth organizations, interns and teen teachers lead activities for youth in grades 3-6. Teens and interns gain skills in career development, time management, leadership, public speaking, and group work. UMaine Extension created the 4-H Summer of Science program to increase science proficiencies in local communities and prevent summer learning loss by providing informal hands-on experiential learning opportunities in STEM to Maine youth and engaging Maine youth in low-income areas in meaningful experiential STEM activities. Maine 4-H staff and Summer of Science college interns developed and modified four science activities that in 2021 were delivered in 7 Southern Maine communities at 12 sites including summer lunch programs, Public Housing, elementary schools, community youth clubs, and summer camps.

Briefly describe how your target audience benefited from your project's activities.

Over 4 weeks, with the support of Maine 4-H staff and adult volunteers, 31 teen teachers and four college interns engaged 450 youth. One activity focused on designing and testing the design of facemasks - connecting current world events related to the COVID-19 pandemic to the engineering design process. 4-H staff use summer of science experiential learning activities to assist with summer learning loss and work towards 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. By engaging in Summer of Science activities, these youth are well poised to return to their academic school year with reduced summer learning loss and an increased interest in science.

Briefly describe how the broader public benefited from your project's activities.

Research shows that youth involved in 4-H are more likely to pursue future courses or a career in science, engineering or computer technology, which can lead to improved employment opportunities. For Maine elementary school youth, Summer of Science supports narrowing their STEM achievement gap during summer months, and for the teens trained to deliver programming, it also fosters their career development, leadership and sense of responsibility.



Northeast Collaborative 4-H AFRI Project

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Many rural students lack exposure to and an appreciation of STEM disciplines and their value and importance as a source of most future employment opportunities. And in 2021 schools were challenged to expand their use of remote learning experiences to students and to find and create content and delivery mechanisms. At the same time they were challenged to find ways that remote learning could be created in such a way a to help students experiencing social isolation during the pandemic to engage with their peers and enhance their social and behavioral skills.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

A collaboration of Extension 4-H programs from Vermont, Maine, and New Hampshire received a USDA Agriculture and Food Research Initiative (AFRI) grant to support school enrichment for rural, remote learners. The tri-state Extension Collaborative developed an AgriSTEM curriculum designed to be delivered by 4-H professionals virtually. Local 4-H Centers distributed curriculum kits containing a computer tablet equipped with various synchronous and asynchronous learning tools. The tablets were used to bridge the home learning environment and traditional classroom by encouraging collaborative learning and acting as a means of documenting learning. Curriculum kits also included hands-on materials for each lesson. Each

student received their own set of materials to use in the classroom and/or at home and to keep as their own. Programs facilitated this year were: Cultivating Roots: An Introduction to Hydroponics; Food Systems Feed Us: From Farm to Table; The Power of Wind; STEMgineer, and Pizza Garden.

Briefly describe how your target audience benefited from your project's activities.

In 2021, 594 students participated in the AFRI program across the 3 states. We also delivered programs to campers at local 4-H centers. Classroom teachers reported that students used their tablets as a way to document, enhance, and evaluate their learning during each lesson. Students were able to access lesson materials individually while simultaneously learning in a group setting. This achieved the dual benefits of hands-on learning and social interaction, whether in person or virtually. By performing experiments, gathering data, reviewing content, and reflecting on their learning together, students gained a deeper understanding of AgriSTEM concepts. Many teachers indicated they would apply AgriSTEM concepts to other classroom modules, especially in science.

Briefly describe how the broader public benefited from your project's activities.

Students in these three states - Maine, New Hampshire and Vermont - were exposed to the STEM disciplines, increasing their awareness of them generally and also as a path for employment opportunities. And collaborations between Extension and local school systems and teachers were built as the program was developed and delivered; this AgriSTEM program is serving as a model for similar efforts with other schools in these states with growing numbers of youth benefiting from it, ultimately serving youth, communities, businesses, and local economies.

Critical Issue

Sustainable Community and Economic Development

[Removing Barriers to Access and Opportunity to Support a Resilient Rural Economy](#)

Project Director

Jonathan Malacarne

Organization

University of Maine

Accession Number

1021689



Removing Barriers to Access and Opportunity to Support a Resilient Rural Economy - Results

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Small farmers and growers provide for the food security of the State of Maine and capture value from the tourist population for local communities. These producers, and the communities in which they live, are vulnerable to both economic and climactic risk factors. Supporting this sector in its economic, physical, and mental health promotes the well-being of Maine's rural communities and the State as a whole.

This project generates insight into the challenges and opportunities facing small farmers, growers, and other participants in Maine's rural economy. It helps inform the design of programs and policies seeking to make Maine's rural economy more resilient to economic and climate-related risk factors. In addition, it helps rural stakeholders, particularly small farmers and growers, improve their resilience and create dynamic businesses well suited to the preferences of their consumer base. In the past year, owing to the effects of the COVID-19 pandemic on the food system and rural communities, these efforts are more important than ever.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The project seeks to achieve changes in knowledge, action, and condition under four primary objectives. Each objective and the associated achievements are discussed below.

1. Identify barriers to accessing services and markets among rural - and particularly, agricultural- communities in Maine.

Major activities:

- Undertook a collaborative study between the School of Economics at the University of Maine and the Maine Department of Agriculture, Conservation and Forestry (DACF) to understand the need for investment in agricultural storage and processing infrastructure in the State of Maine.
- Analyzed data from a wild blueberry industry survey conducted as part of this project last year.
- Engaged with stakeholders in the grain industry to understand the feasibility of connecting Maine grain producers to high-valued markets.
- Joined a group of researchers at the University of Maine and the University of Vermont seeking to better understand food access and procurement behavior in rural communities during the COVID-19 pandemic.
- Sought funding to undertake projects to identify and lower barriers to access to services and markets in rural communities.

Key Accomplishments

- Completed a report on the economic impact of expanding agricultural processing infrastructure in the state of Maine.
- Enrolled a group of wild blueberry growers into a program providing access to technical support to begin selling product via the web and via an internet-based food hub.
- Presented on the current state of access to and use of markets and services in the Maine wild blueberry industry.
- Obtained funding to continue research into food access and procurement in rural communities.
- Obtained funding to work with beginning farmers and ranchers to improve their risk management and ability to access support services.

2. Estimate the impact of economic and environmental risk factors on the wellbeing of small-scale agricultural producers and rural communities.

Major activities:

- Analyzed data from last year's wild blueberry industry survey to understand the extent to which industry participants are concerned about and prepared to deal with economic and environmental risk.
- Prepared a manuscript on the COVID-19 pandemic and its impact on Maine farm operators and food consumers.
- Sought funding to continue studying risk perceptions and avoidance behavior among food producers and food consumers.

Key Accomplishments

- The prepared manuscript on the COVID-19 pandemic and its impact on Maine farm operators and food consumers was accepted and is forthcoming in the Maine Policy Review.
- Presented work on "COVID-19 and the Maine Food System" to various stakeholder groups.
- Presented generalizable work on the impact of risk and risk avoidance technologies on vulnerable agricultural communities at a variety of academic conferences.
- Obtained funding to continue studying risk perceptions and avoidance behavior among food producers and food consumers in Maine, across the United States, and abroad.

3. Characterize the demand for small farm products - including but not limited to willingness-to-pay for various attributes of production and distribution, demand for new and existing products, and impact of distribution channels on farmer and rural community welfare.

Major activities:

- Advised a thesis by School of Economics Master's student Lauren Miller titled, "Consumer Beliefs and Associated Price Premiums for Agricultural Traits in Maine Markets"
- Worked with stakeholders in the grains industry to survey consumers and institutional buyers to better understand willingness to pay for products identified as local, organic, or heritage.

Key Accomplishments

- School of Economics Master's student successfully defended the thesis described above and obtained a job as an agricultural economist with the USDA.
- Surveys of grain consumers and institutional buyers will be in the field this fall.

4. Generate insight into how economic agents make decisions in the face of risk and how exposure to risk affects the decision-making of economic agents.

Major activities:

- Advising a thesis by School of Economics Master's student Ana Maria Ospina Tobar that uses experimental games to understand how farmers learn about risk and choose among risk mitigation strategies.
- Collaborated with researchers at the University of Vermont and the University of Maine to understand how food consumers responded to the risk environment posed by the COVID-19 pandemic.
- Seeking funding for...

Key Accomplishments

- o Obtained funding for three projects focused on risk exposure and decision-making under risk. One project will work with beginning farmers and ranchers in Maine. One will study learning about technologies with stochastic benefits, which applies to nearly all risk-reducing technologies.

Briefly describe how your target audience benefited from your project's activities.

The activities and results of this project have been disseminated to communities of interest through a variety of academic conference presentations, presentations to industry and stakeholder groups, and public webinars (listed below). They have also been disseminated through peer reviewed publications, industry reports, and working papers (listed below). The project director regularly interacts directly with stakeholders through agricultural field days and industry meetings.

In addition, much of this project's research takes place in collaboration with University of Maine Cooperative Extension, as well as Cooperative Extension at the University of Vermont, Cornell University, and the University of Wisconsin. Research projects into the wild blueberry industry and the grains industry have explicit extension plans detailing the fact sheets and outreach events that will be produced over the lifetime of the project. The Project Director regularly prepares industry reports that are shared in printed form and via presentations with agricultural stakeholders in various Maine industries.

Briefly describe how the broader public benefited from your project's activities.

This project has at its core the mission of conducting capacity research to support and enhance agriculture and rural life in the state of Maine. By improving the availability of data on the risks facing agricultural producers, agricultural businesses, and rural communities; by fostering a better understanding of how decision-makers view, quantify, and mitigate those risks; and by using this data and this understanding to help craft appropriate responses and data-driven policies, this project contributes directly to these goals.

The project has also created a number of opportunities for training and professional development (described below).

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Major Changes/Problems:

The COVID-19 pandemic has limited the project's ability to carry out in-person activities, notably surveys and in-person dissemination events. At the same time, the pandemic has highlighted the need for research in all of the project's primary objectives. Still, progress was made toward all project objectives over the current reporting period. The current reporting period was especially fruitful in securing funding that will allow for further activities in pursuit of the various project objectives in the coming reporting period.

List of Publications:

- 1) **Malacarne, J.G.**; Lilley, Jason; and McBrady, Nancy. The Response of the Maine Food System to the Onset of COVID-19. (forthcoming)
- 2) Baily, Megan, Bell, Kathleen P., Crawley, Andrew, Gabe, Todd, **Malacarne, J.G.**, Rubin, Jonathan. (2021). Economic Impacts of Investments in Food and Agricultural Processing Infrastructure in Maine. Report for Maine Department of Agriculture, Conservation, and Forestry.
- 3) Boucher, S. R., Carter, M. R., Flatnes, J. E., Lybbert, T. J., **Malacarne, J. G.**, Marennya, P., & Paul, L. A. (2021). Bundling stress tolerant seeds and insurance for more resilient and productive small-scale agriculture (No. w29234). National Bureau of Economic Research.

Presentations and Other Products/Outputs (excluding publications, patents, & plant variety protection applications):

- 1) Boucher, S. R., Carter, M. R., Flatnes, J. E., Lybbert, T. J., **Malacarne, J. G.**, Marenya, P., & Paul, L. A. "Bundling stress tolerant seeds and insurance for more resilient and productive small-scale agriculture". North East Universities Development Consortium. Virtual. 2021.
- 2) **Malacarne, J.G.**, Paul, L., Flatnes, J.E., Boucher, S., Carter, M.. "Salient Risks and Contract Quality: Estimating Demand for Index Insurance in Mozambique and Tanzania" Northeastern Agricultural and Resource Economics Assoc. Virtual. 2021.
- 3) **Malacarne, J.G** "A Brief Look at the State of Maine's Wild Blueberry Industry". April 2021.
- 4) **Malacarne, J.G** "A Brief Look at the State of Maine's Wild Blueberry Industry". January 2021.
- 5) **Malacarne, J.G** "COVID-19 and the Maine Food System". Maine Ag Trade Show. January 2021.
- 6) **Malacarne, J.G.** "COVID-19 and the Maine Food System", School of Economics, University of Maine. December 2020.

Successful Grant/External Support Applications:

5) Rural experiences with food insecurity and health during COVID-19 and strategies for future resilience (\$149,805)

Investigators: Rachel Schattman (PI), Kate Yerxa, **Jonathan Malacarne** (Co-PI, 30%)

Sponsor: USDA - NIFA - Agriculture and Food Research Initiatives (AFRI)

Project Dates: 3/1/22 – 2/28/25

4) Equipping New Farmers with Practical Skills and Knowledge (\$582,400)

Investigators: David Handley (PD), **Jonathan Malacarne (10%)**, Colt Knight, Tori Lee Jackson

Sponsor: USDA - NIFA

Project Dates: 9/1/2021 - 8/30/2024

3) Facilitating uptake of resilience-enhancing technologies with stochastic benefits by subsidizing learning (\$626,186)

Investigators: **Jonathan Malacarne (PI, 100%)**, Stephen Boucher, Meizal Popat,

 Lourenco Manuel

Sponsor: USDA-NIFA Beginning Farmer and Rancher Development Program

Project Dates: 9/1/21 – 8/30/24

2) Identifying Research and Policy Priorities for Enhanced Resilience and Equity in Smallholder Coffee Production (\$12,500)

Investigators: **Jonathan Malacarne (100%)**

Sponsor: National Coffee Association

Project Dates: 6/1/21 – 8/31/21

1) Economic Impacts of Enhanced Agricultural Processing Capacity in Maine (\$10,677)

Investigators: Todd Gabe (PI), Megan Bailey, Kathleen Bell, Andrew Crawley,

Sponsor: ME Department of Agriculture, Conservation & Forestry

Project Dates: 5/10/21 – 8/10/21

Opportunities for training and professional development:

Over the past year, this project has:

- Trained 3 undergraduate students survey design, survey coding, project management, and data analysis.

- Trained 7 graduate students in qualitative and quantitative methods, survey design, survey coding, survey enumeration, and communicating results to stakeholders.

- The Project Director designed and taught an undergraduate class at the University of Maine titled “The Maine Farm and Food Economy”, which has as its primary goal bringing students into closer contact with agricultural producers and agriculture service providers in the State of Maine. The class had 18 students and will be visited by 14 guest speakers filling various roles in the Maine Farm and Food Economy.

Plans for the next reporting period:

In the next reporting period, I plan to make the following progress toward the goals listed below:

1. Identify barriers to accessing services and markets among rural - and particularly, agricultural- communities in Maine.
 - Engage directly with beginning farmers and ranchers to understand perceptions of risk and build capacity to deal with risk.

 - Conduct a second round of surveys with wild blueberry growers focused on market access and use of agricultural insurance products.

 - Launch a new survey focusing on access to food and food procurement behavior.

2. Estimate the impact of economic and environmental risk factors on the wellbeing of small-scale agricultural producers and rural communities.
 - Prepare a manuscript on the impact of drought and water management policy on agriculture in the Northeast.

 - Prepare manuscripts and collect additional data that speak to how shocks – environmental, economic, public health – affect food procurement and food security in rural and urban communities.

3. Characterize the demand for small farm products - including but not limited to willingness-to-pay for various attributes of production and distribution, demand for new and existing products, and impact of distribution channels on farmer and rural community welfare.

- Analyze data and prepare manuscripts on food procurement behavior in the Northeast.
- Conduct surveys with consumers and institutional purchasers of grain products, focusing on willingness to pay for goods carrying the traits of local, organic, and heritage.

4. Generate insight into how economic agents make decisions in the face of risk and how exposure to risk affects the decision-making of economic agents.

- Design a flexible, experimental game that allows decision-makers to virtually learn about risk and the benefits of risk-reducing technologies.
- Prepare manuscripts documenting the effects of negative shocks on household welfare and the potential of risk-reducing technologies to mitigate these effects.

Boosting profitability and sustainability of Maine's natural resource-based industries and supporting viable communities

Project Director

Jonathan Prichard

Organization

University of Maine

Accession Number

7002363



Food Insecurity - Maine Harvest for Hunger

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Maine has the highest rate of food insecurity in New England and ranks 19th in the nation. The USDA estimates that 11.4 percent of Maine households are food insecure. Furthermore, nearly 1 in 5 children are food insecure and 23 percent of Maine seniors are experiencing marginal, low, or very low food security. It is especially challenging for food insecure people to afford high quality, fresh, nutritious food, and donations of fresh produce to Maine's emergency food system have declined significantly in recent years. With hunger affecting people of all walks of life in all communities, it is essential that every measure be taken to feed our neighbors in times of need.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

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 fresh produce to food pantries, shelters, community meals sites throughout Maine. Our work involves: maintaining databases of sites accepting produce donations, organizing volunteer opportunities, developing partnerships with farms and organizations, training volunteers, and building awareness of the extent, causes, and impacts of food insecurity.

In 2021, 424 MHH volunteers grew, gleaned and distributed 168,304 lbs of fresh produce, valued at \$284,434, to 228 food security agencies located throughout the state. Notably this year, Spiller Farm celebrated 21 years of partnering with MHH; a relationship that has yielded 246,688 lbs over the years. In addition to welcoming us to glean surplus crops, they intentionally

planted extra knowing trained volunteers could be trusted to safely and efficiently get it to where it's needed. And Old Town Elementary School's free farm stand offered 4,138 lbs gathered onsite and gleaned from area farms. Open to the public in an easily accessible site, this low-barrier program reached hundreds of individuals in a limited resource community.

Briefly describe how your target audience benefited from your project's activities.

From backyards, to farms, to school gardens, Maine Harvest for Hunger is enhancing access to healthy food and offering volunteers a truly meaningful way to engage with their community.

Briefly describe how the broader public benefited from your project's activities.

Since 2000, MHH participants have distributed more than 3.2 million lbs. of food to citizens grappling with hunger.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will **not** change the content in the highlighted result.

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Master Gardener Volunteers and Home Horticulture

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Public and private gardens are important tools for enhancing both physical and mental health. They also play a key role in sustaining the health and vitality of our natural communities. Since the beginning of the pandemic, gardening has been on the rise in Maine with our offices experiencing a tremendous influx of gardening questions. As it becomes more and more challenging to sort through information online, Maine gardeners need access to reliable research-based information, now more than ever and home gardener success also results in improved food security and has an economic role in our green industry.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Extension provides direct and virtual home horticulture programs to Maine residents and also offers a Master Gardener Volunteers (MGV) program provides participants with a minimum of 40 hours of in-depth training in the art and science of horticulture. MGV 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. In 2021, Master Gardener Volunteers played a vital role in connecting communities with educational resources through one-on-one mentoring, social media and programming.

Briefly describe how your target audience benefited from your project's activities.

In 2021, Extension's home horticulture programming directly reached 12,256 adults and 896 youth through in-person and virtual programs. This included over 5,223 questions, received via email, phone calls and walk-ins that were answered for home gardeners. An additional 14,579 home gardeners were reached indirectly through garden-related videos, newsletters, newspaper columns, and publications from Extension.

The MGV program provides opportunities for gardeners with all levels of experience to connect with meaningful service projects in their community. Master Gardener Volunteers are lifelong learners who educate home gardeners, address community efforts related to horticulture, and support the educational efforts of the University of Maine Cooperative Extension. Of our 990 active MGV, 145 were trained in 2021. In total, they donated 28,830 hours to a variety of educational and food security projects throughout the state including community gardens, school gardens, demonstration gardens, and youth programs. As a result of participating in this program, MGVs reported that they:

- Utilized Extension to identify pest problems and determine research based management strategies,
- Increased consumption of home grown food,
- Adopted techniques to improve soil quality,
- Developed new or expanded gardens,
- Implemented practices that improve efficiency, reduce inputs and negative impacts,
- Inspired to pursue further horticulture training, Increased community partnerships.

Briefly describe how the broader public benefited from your project's activities.

As a result of Extension horticulture programs, participants reported developing new or expanding existing gardens; increased their consumption of home-grown food; adopted sustainable gardening practices involving soil quality, improving efficiency, and adopting IPM strategies; and using Extension to identify pest problems and to determine research-based management strategies. And many volunteers who 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. Communities benefit by receiving support for community oriented gardening and beautification projects through Master Gardener Volunteers.



Parent Education Program Promotes Early Screening and Intervention for Developmental Delays

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

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.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

UMaine Extension Parent Educators work from two offices covering five counties, and are part of a statewide network of Maine Families Home Visiting Programs. In 2021, 10 certified parent educators provided 1,698 home visits to 169 parents/caregivers with 174 children living in five counties. Using the Parents As Teachers model parent educators met with families in their homes and then virtually due to the pandemic, 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.

Briefly describe how your target audience benefited from your project's activities.

In our 2 county-based offices, over 86% of our clients had a family-centered assessment completed and documented during the program year. Over 75% of children enrolled had a timely screening for developmental delays (75% in Knox-Lincoln County, and 80% in Waldo County). In cases where a delay was discovered 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.

Briefly describe how the broader public benefited from your project's activities.

Studies have shown that children who receive early treatment for developmental delays are more likely to graduate from high school, hold jobs, live independently, and avoid teen pregnancy, delinquency, and violent crime, which results in a savings to society of about \$30,000 to \$100,000 per child.

Impact Statement (Optional)

Use this space to talk about the impact that this result had, in layman's terms. Adding comments here will not change the content in the highlighted result.

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In 2-3 sentences, briefly describe the issue or problem that your project addresses.

There has been a growing interest in value-added food production in Maine. From farmers looking to add value to their raw products, to Maine families interested in turning their favorite recipes into viable food businesses. In response to this growing demand, UMaine Extension developed the Recipe to Market program in 2007 and has been offering it to statewide audiences annually ever since. The goal of the program is to help potential and existing food entrepreneurs acquire food science and business knowledge and skills to successfully bring a value-added food product to market.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Since 2007, Extension has conducted 36 programs in 10 counties reaching 480 participants across the state. The program is offered in either single or multi-day formats, in person or virtually, and is designed to help participants understand licensing/regulations, processing/packaging, the specialty food industry and acquire business management knowledge and skills. The RTM team provided similar content for the Wild Blueberry Conference winter/spring 2021 and was able to reach additional participants statewide. The RTM Team also supported food businesses during the pandemic by offering a panel session at the Maine Ag Trades Show via Zoom titled “Pivoting During the Pandemic – How Food and Beverage Businesses Creatively Thrived in 2020.” The team invited 4 small businesses to discuss the impacts of the pandemic on their businesses and how they creatively pivoted to stay in business and to thrive during the pandemic. These businesses ranged from a brewery in Ellsworth, to a value-added products/blueberry farm in Ornesville Township to a cheesemaking business in Whitefield, that also created a new distribution business to support their fellow cheesemakers.

Briefly describe how your target audience benefited from your project's activities.

As a result of RTM programs, more than 90% of participants said they improved their knowledge and skills and plan to adopt business and food processing/safety practices they learned during the program. Long-term survey results indicate that participants used the new knowledge from RTM to make more effective business decisions, develop new food products, and write and revise business and marketing plans. The survey results also indicate that 27% of the RTM multi-session participants subsequently started food businesses.

Briefly describe how the broader public benefited from your project's activities.

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.

Critical Issue

Sustainable Natural Resources

Sustainable Practices, Economic Contributions, Consumer Behavior, and Labor Management in the U.S. Environmental Horticulture Industry

Project Director

Bryan Peterson

Organization

University of Maine

Accession Number

1025127



In 2-3 sentences, briefly describe the issue or problem that your project addresses.

This project addresses needs related to sustainability in the U.S. horticulture industry in the context of a broader multi-state project on sustainable practices, economic contributions, consumer behavior, and labor management in the horticulture industry. Propagating and growing plants in the horticulture industry is resource intensive, and systems that reduce resource usage (e.g., water) and improve efficiency would improve sustainability. Moreover, the selection, propagation, and evaluation of native plants for the industry, and identification of future invasive plants, would support the emerging trend toward ecologically conscious landscape design and management that takes into account native ecosystems and ecosystem services and a reduced reliance on nonnative or invasive plants.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

I evaluated a prototype plant rooting system that relies on an aeroponic design ("submist") for successful rooting of stem cuttings from several species. The system proved beneficial for some species and for some measures of plant rooting, but not for others, indicating that further refinement is needed or that the systems will be more beneficial for some species than for others. However, water use was much lower in the submist systems, even while plant performance was generally comparable to plants propagated in traditional overhead mist systems. A manuscript on this work was published during the project period, and another is in preparation from work completed during the project period. Several additional research projects in development will characterize limitations to successful plant propagation.

I also collected additional data on the potential for a native shrub, mountain fly honeysuckle, to perform in field soils, with comparisons to nonnative varieties developed from close relatives (honeyberry) in Asia. Over several years, native mountain fly honeysuckles grew poorly relative to nonnative honeyberries, which produced substantially more shoot growth and fruits than native plants. Comparisons between nonnative honeyberries and known invasive honeysuckles of Maine showed that growth of nonnative varieties is intermediate between native mountain fly honeysuckles and known invasive honeysuckles, with implications for the invasive potential of nonnative honeyberry. A manuscript of these results is in preparation. In addition to work with native honeysuckles, I maintained a field trial of native serviceberries for ongoing evaluation.

Briefly describe how your target audience benefited from your project's activities.

Our evaluation of aeroponic propagation systems brings the technology a step closer to commercial adoption. Our recent work suggests that some optimization is appropriate prior to wholesale industry adoption. Although industry members expressed interest in constructing systems now, our work highlights important considerations for a successful implementation of these water-saving propagation systems. The landscape design and management segments of the horticulture industry benefitted from recent field trials of a native honeysuckle that was, to my knowledge, never before evaluated in horticultural landscapes. Although the shrub appears poorly suited to the full-sun landscape in which it was evaluated, key insights about differences between native and nonnative relatives in growth and invasive potential will be of use to designers and landscapers who seek out native plants or wish to avoid planting potential invasive species.

Briefly describe how the broader public benefited from your project's activities.

The broader public benefits from efforts to make the U.S. horticulture industry more ecologically and environmentally sustainable. Increases in sustainability improves lives by producing higher quality consumer products with fewer precious resources, and generating new types of consumer products (e.g., more native plants with ecological function in native landscapes). The general public benefits from efforts to make landscapes more diverse, which in turn makes them more resilient to disturbances and stresses such as those introduced by climate change or pests or diseases.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

I coauthored several journal articles during the project period:

Rihn, A.L., C.R. Hall, B.J. Peterson, A.P. Torres, M.A. Palma, and H. Khachatryan. 2021. Changes in production practices by green industry growers from 2009 to 2019. *Journal of Environmental Horticulture* 39:123-130.

Burnett, S.E., B.J. Peterson, and M. Peronto. 2021. Propagation of five species in a commercial-scale submist system. *HortTechnology* 31:274-279.

Moran, R.E., B.J. Peterson, G. Fazio, and J.A. Cline. 2021. Low temperature tolerance of apple shoots following exposure to warm temperatures in late winter. *HortScience* 56:642-649.

I coauthored a conference presentation during the project period:

McMurchie, E., B.J. Peterson, T.D. Leandro, and L. Clark. 2020. New pieces of the *Chusquea* puzzle: A revision and recircumscription of *Chusquea* sect. *Serpentes* (Poaceae: Bambusoideae: Bambuseae). *Botany* 2020 (Virtual).

My work provided 1 undergraduate student with training opportunities in the lab and field. As a part of this experience, the student completed an independent study project on research in tissue culture propagation, and is currently preparing an abstract, poster, and presentation for a student research symposium.

Closing Out (end date 09/07/2023)

Mechanisms of organic matter and phosphorus adsorption to mineral surfaces: Experimental and computational chemistry approaches

Project Director

Tsutomu Ohno

Organization

University of Maine

Accession Number

1023004



Mechanisms of organic matter and phosphorus adsorption to mineral surfaces: Experimental and computational chemistry approaches

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

'Natural climate solutions', including increasing levels of organic matter to sequester soil carbon, are being emphasized at the federal and state levels. Although policies are being proposed to increase soil carbon storage, many questions remain about the effectiveness of this practice in slowing the rate of atmospheric CO₂ increase. In particular, long-term stability of sequestered carbon under changing environmental conditions is unclear. This study addresses this question.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

During this reporting period, our computational DFT studies have shown that Fe²⁺ and Fe³⁺ cations and their hydrolytic species form complexes with low-molecular weight organic acids through physical electrostatic interactions. We have also shown that these electrostatic mechanism also extends to Fe oxide nanoclusters. Because of the high charge density of the Fe nanocluster, the reactions are kinetically very rapid making chemical characterization of the intermediate steps of the aggregation process experimentally challenging. Aggregation dynamics are also inherently challenging to characterize due to the presence of numerous, intermediate metastable structures.

However, molecular dynamics (MD) simulations can provide chemical insight into the interactions (electrostatic and non-ionic van der Waals dispersion forces) between Fe nanoclusters with OM molecules and inorganic ions typically present in soil solutions. MD simulations rely on force fields to describe the potential energy landscape of the reaction as a function of interatomic potentials acting on every atom present in the simulation box throughout the trajectory. We are currently modifying the 'CLAYFF' force field which was designed for clay sized fractions on the micrometer-scale to better model particles on the nanometer-scale. Optimization of the Lennard-Jones sigma and epsilon parameters is using a system consisting of 1 Fe nanocluster, 3 Na⁺ atoms, 10 Cl⁻ atoms, and 512 water molecules using the 4-site OPC3 model. The parameterization of Fe, O, H atom types present in this system is now finalized. The AMBER/GAFF force field parameters for the atom types present in OM molecules are now being appended into the modified CLAYFF force field.

Briefly describe how your target audience benefited from your project's activities.

Our studies describes how both quantum and classical physical models can be used to obtain a molecular understanding critically important soil processes and how they may be affected by the changing climate.

Briefly describe how the broader public benefited from your project's activities.

These studies contributes to better understanding of soil processes to allow better management systems to mitigate climate change impacts on the environment.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Ohno, T., J.D. Kubicki, and A. Amirbaham. 2022. Molecular orbital study of Fe(II) and Fe(III) complexation with salicylate and citrate ligands: Implications for soil biogeochemistry. *Soil Sci. Soc. Am. J.* DOI 10.1002/saj2.20339

Patel, K.F., C. Tatariw, J.D. MacRae, T. Ohno, S.J. Nelson, and I.J. Fernandez. 2021. Repeated freeze-thaw cycles increase extractable, but not total, carbon and nitrogen in a Maine coniferous soil. *Geoderma* 402:115353.

Buresova, A., V. Tejnecký, J. Kopecky, O. Drabek, P. Madrova, N. Reichova, M. Omelka, P. Krizova, K. Nemecek, T.B. Parr, M. Omelka, T. Ohno, and M. Sagova-Mareckova. 2021. Litter chemical quality and bacterial community structure influenced decomposition in acidic forest soil. *Eur. J. Soil Biol.* 103:103271.

Patel, K.F., V. Tejnecký, T. Ohno, V. L. Bailey, R.L. Sleighter, and P.G. Hatcher. 2021. Reactive oxygen species alter chemical composition and adsorptive fractionation of soil-derived organic matter. *Geoderma* 384:114805.

Patel, K.F., C.Tatariw, J.D. MacRae, T. Ohno, S.J. Nelson, and I.J. Fernandez. 2021. Snowmelt periods as hot moments for soil N dynamics: A case study in Maine, USA. *Environ. Monit. Assess.* 192:777.

Reducing the impacts of tree and forest pests

Project Director

Angela Mech

Organization

University of Maine

Accession Number

1022855



Reducing the impacts of tree and forest pests

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

One of the most serious threats to North American forests is the introduction of non-native insects. Although only a small portion (< 10%) of the non-native insects in North American forests have a significant impact, those that do cause damage costing over \$70 billion annually. Many policies have attempted to reduce the introduction of non-native insects, but new insects continue to arrive and establish in North American forest ecosystems, including urban and community forests. This project will look at historical and current forest pests of North America in ways that will allow us to better predict, prepare for, and control them.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Goal 1. Collect data necessary to quantify the drivers of impact for hardwood specialist and generalist non-native forest insects. Data will be used to create predictive models that can be used to assess the risk of causing tree mortality for non-native species not currently established in North America but that have a high probability based on interception data. Traits of the insects and their host trees, including evolutionary histories, were found to drive the level of damage of non-native

insects, but some drivers differed for hardwood specialist insects compared to conifer specialists. Results found that wood-boring insects associated with phytopathogens posed the highest risks to hardwoods, particularly on tree species with an intermediate wood density, while different traits influenced the level of impact for conifer specialists.

Goal 2. Test the efficacy of releasing *Laricobius nigrinus* eggs in the field (instead of adults) as a new potential protocol for the control of hemlock woolly adelgid. Soil emergence tents recovered five times as many adult *Laricobius nigrinus* underneath trees where *L. nigrinus* eggs were released when compared to control trees that had no egg releases, providing strong evidence that this deployment method is valid. This study suggests that altering current protocols and releasing *L. nigrinus* in the egg stage rather than as adults could be less labor intensive and a more cost-effective approach to hemlock woolly adelgid biological control – qualities needed in the struggle to manage HWA populations.

Goal 3. Initiate work regarding the development of an effective management plan for browntail moth. Lab bioassays were conducted and preliminary results are finding a number of biopesticides that are effective at significantly reducing BTM larval populations. In addition, a monitoring pilot study tested the effectiveness of the female pheromone for trapping BTM males. The study found a preferential trap type and lure purity preference. Both projects will be incorporated into future endeavors towards a long-term management plan.

Briefly describe how your target audience benefited from your project's activities.

The target audience for this research will be the scientific community, national and regional agencies that deal with invasive forest pests, land managers in affected areas, municipality representatives, the general public, extension agents, and tree care associates. Results were presented at multiple regional and national meetings. Attendees at these meetings included scientists from academic institutions and state and federal agencies, and students. Progress of projects have also been presented to the public through multiple interviews as well as webinars.

Briefly describe how the broader public benefited from your project's activities.

Data from this work will be integrated into a new software tool that will predict the impact of non-native forest insects before they arrive in North America. This software will be publicly available and can be used by researchers, arborists, students, or the general public. In addition, research aimed at monitoring and managing browntail moth will have ecological, economic, and public health benefits.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Training and Professional Development

This work constituted the main research components of two Masters of Science theses and a postdoctoral fellowship.

List of Publications

Schulz, A.N., Mech, A.M., Ayres, M.P., Gandhi, K.J.K., Havill, N.P., Herms, D.A., Hoover, A.M., Hufbauer, R.A., Liebhold, A.M., Marsico, T.D., Raffa, K.F., Tobin, P.C., Uden, D.R., and Thomas, K.A. (2021) Predicting insect invader impact: focusing on the trees to see the forest. *Biological Invasions* DOI: 10.1007/s10530-021-02621-5

Presentations and Other Products/Outputs

- (podcast) Mech, A. How do we protect our forests from invasive species? 2021 The Maine Question Podcast: S5E1. <https://umaine.edu/podcasts/2021/09/23/s5e1-how-do-we-protect-our-forests-from-invasive-species/>
- Groden, E., Boyd, K., Hwang, H., Cole, B., and Mech, A. 2021. Browntail Moth research at the University of Maine: A report of activities and findings (2016-2020).

- o Mech, A.M. Brown-tail moth: of all the towns, you had to fly into mine. North American Forest Insect Work Conference. May 2021. Virtual Conference [Invited Speaker].
- o Schulz, A.N., R.A. Hufbauer, C.F. Aoki, M.P. Ayres, K.J.K. Gandhi, N.P. Havill, D.A. Herms, A. Hoover, A.M. Liebhold, S. Maco, T.D. Marsico, K.F. Raffa, K.A. Thomas, P.C. Tobin, D.R. Uden, and A.M. Mech. May 2021. Synthesis and utilization of big data for forecasting the impacts of non-native forest insects in North America. North American Forest Insect Work Conference. May 2021. Virtual Conference.
- o Schulz, A.N., A.M. Mech, C.F. Aoki, M.P. Ayres, K.J.K. Gandhi, N.P. Havill, D.A. Herms, A.M. Liebhold, S. Maco, T.D. Marsico, K.F. Raffa, K.A. Thomas, P.C. Tobin, D.R. Uden, and R.A. Hufbauer. April 2021. Forecasting impact of non-native, phytophagous insects relies on different factors based on host tree specialization. 2021 International Association for Landscape Ecology- North America Annual Meeting. April 2021. Virtual Conference.
- o Thomas, K.A., A.N. Schulz, A.M. Mech, C.F. Aoki, M.P. Ayres, K.J.K. Gandhi, N.P. Havill, D.A. Herms, A.M. Liebhold, S. Maco, T.D. Marsico, K.F. Raffa, P.C. Tobin, D.R. Uden, and R.A. Hufbauer. April 2021. The impact of non-native insects on forest trees relies on different factors based on host tree specialization. Entomological Society of America Pacific Branch Meeting. April 2021. Virtual Conference.
- o Gonzalez, L.*, Mech, A., Dell, J. and Costa, J. A very Lari story: A look into *L. nigrinus* egg releases and oviposition. 30th Southern Appalachian Forest Entomology & Pathology Seminar. March 2021. Virtual Conference
- o Mech, A.M. Predicting Invasiveness of Non-native Insects. Invasive Species Council of British Columbia Conference. February 2021. Virtual Conference [Invited Speaker].

How loss versus invasion of a species alters connected land-water ecosystems

Project Director
 Amanda Klemmer
 Organization
 University of Maine
 Accession Number
 1022147



How loss versus invasion of a species alters connected land-water ecosystems

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Goal: Investigate how addition (invasion) versus removal (extirpation or harvest) of a species alters the stability and function of connected land-water ecosystems that support Maine's natural resources.

Objectives:

1. Measure how harvest of rockweed impacts intertidal food webs, as well as the transfer of seaweed (wrack) to upland beach ecosystems. The results will help determine the sustainability of harvest along the coast of Maine.
2. Survey impacts of differing riparian buffers from forest harvest to understand connected forest-stream food webs. This will help to increase sustainability of riparian buffer best management practices for forest harvest companies in western Maine.
3. Experimentally test how additions (invasions) and losses (extirpations or harvest) of different species affect connected land-water ecosystems. Understanding the landscape scale consequences of species additions and losses will help support Maine's natural resources, such as resource harvest, fisheries, and tourism.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Objective 1: Measure how harvest of the rockweed impacts intertidal food webs, as well as the transfer of seaweed (wrack) to upland beach ecosystems. The results will help determine the sustainability of harvest along the coast of Maine.

Field work is completed for this objective and we have some results that are published and some preliminary results that will be published soon. We found that rockweed biomass does decrease 2-4 weeks post-harvest, although there is high variation depending on the site and where along the Maine coast the harvest is occurring. However, 1-year post harvest, rockweed biomass recovers and is not significantly different than non-harvest rockweed sites. In addition, rockweed biomass does correlate with some bird guilds, however others do not have a statistically significant association with rockweed biomass. Rockweed subsidies to upland ecosystems, in the form of wrack, increase 2-4 weeks post harvest, but we do not know the long term effects on subsidies. In addition, we are still working on laboratory processing of intertidal invertebrates, and so do not have final results to present on rockweed harvest effects on invertebrates.

Objective 2: Survey impacts of differing riparian buffers from forest harvest to understand connected forest-stream food webs. This will help to increase sustainability of riparian buffer best management practices for forest harvest companies in western Maine.

We found that buffer type can significantly impact stream invertebrates, detritus breakdown, and stream invertebrate subsidies to terrestrial ecosystems 15 years post forest harvest. Interestingly partial harvest and clearcut harvest are the most similar in their impacts. We are still working on the meta-analysis and research summary for forest harvesters.

Objective 3: Experimentally test how additions (invasions) and losses (extirpations or harvest) of different species affect connected land-water ecosystems. Understanding the landscape scale consequences of species additions and losses will help support Maine's natural resources, such as resource harvest, fisheries, and tourism.

We found that species ranges are shifting in the intertidal zone of Maine over the past 10-15 years, with species that were lower in the intertidal moving up in elevation. The areas of biggest change regarding species range shifts in the intertidal are at the lowest and highest elevations, meaning that the extreme ends of the ecosystem experiences the most change.

In addition, a review paper on the relationship between macrodetritivores and detritus breakdown in wetlands shows that some wetlands around the world depend on macrodetritivores, while others either don't even have macrodetritivores as a part of their food web, or if they do they don't contribute to detritus breakdown in a substantial way. Therefore, losing key macrodetritivores species will have large implications in some systems, while in others will not have any impact.

Next, we found that adding terrestrial insect subsidies or terrestrial leaf subsidies to pond food webs has implications for reciprocal subsidies back to terrestrial ecosystems.

Briefly describe how your target audience benefited from your project's activities.

Objective 1:

For understanding the effects of Rockweed harvest along the coast of Maine, I am working with a multitude of collaborators and stake-holders. Their involvement spans conceptualization of design, feedback on methods, carrying out of experimental harvest, and dissemination of results. I am working with Brian Olsen (UMaine), Jessica Muhlin (Maine Maritime Academy), and Hannah Webber (Schoodic Institute) are my main academic collaborators on the project. We also have the following 21 stakeholder groups: Acadia National Park (government/conservation), Maine Coastal Island National Wildlife Refuge (government/conservation), Maine Department of Marine Resources (government/regulating agency), Maine Department of Inland Fisheries and Wildlife (government/regulating agency), US Fish and Wildlife Service (government/regulating agency), Phycoliffe LLC (industry/harvester), North American Kelp (industry/harvester), Acadian Seaplants (industry/harvester), Ocean Organics (industry/harvester), Source Inc. (industry/harvester), Maine Sea Grant (government/moderating agency), Island Institute (NGO/conservation), Maine Natural History Observatory (NGO/conservation), the Nature Conservancy (NGO/conservation), Maine Audubon (NGO/conservation), Schoodic Institute (NGO/conservation), Frenchman Bay Partners (NGO/Land Trust), Maine Coast Heritage Trust (NGO/land trust), Gulf of Maine Council on the Marine Environment (government/conservation), Maine Seaweed Council (NGO/land trust), and over 100 coastal Maine landowners.

Over this reporting period, there were multiple presentations to both scientific and public audiences as well as disseminating a research updates newsletter to all stakeholders, including the 100 coastal landowners. We held a webinar on September 14th, 2021 that 23 stakeholders attended.

Objective 2:

I will be working in a transdisciplinary team of multiple academic partners across units and universities, including: Hamish Greig (University of Maine Orono (UMO)-School of Biology and Ecology (SBE)), Shawn Fraver (UMO-School of Forest Resources (SFR)), Mindy Crandall (Oregon State University-College of Forestry), Steve Coghlan (UMO-Wildlife, Fisheries, and Conservation Biology (WFCB)), Robert Northington (Husson University), and Neil Thompson (UMaine Fort Kent). In addition, we are working with multiple forest harvest companies via the Cooperative Forestry Research Unit (CFRU), the CFRU itself, and Manomet Maine Inc.

For objective two, there was a presentation that was open to the public and attended by multiple people in the forest harvest industry and conservation organizations (both government and NGO). We also made progress towards a research summary document that will be disseminated to stakeholders in the forestry industry.

Objective 3:

For the test of addition/loss of species that fall under each of projects in Objective 1 and 2, the above listed collaborators will still be involved. In addition, I worked with additional researchers from multiple universities and government agencies: for long-term species range shifts in Maine's intertidal, I worked with the North Eastern Temperate Network of the National Park Service; for changes in freshwater invertebrate assemblages in Colorado, I worked with Dr. Howard Whiteman from Murray State University, Dr. Hamish Greig (UMaine), and Dr. Jared Balik (North Carolina State).

For objective three, I presented my work at the Ecological Society of America Conference, worked with an undergraduate from Puerto Rico, and got a publication accepted in a peer reviewed journal.

Briefly describe how the broader public benefited from your project's activities.

Maine is a state that relies heavily on its natural resource based economy, including harvests, fisheries, and tourism. Multiple of its natural resource harvests are in need of scientific research to better inform the conservation and management of the resources. In addition, better understanding what invasions and extirpations of species of concern does to ecosystem function can help management of Maine's ecosystems at a landscape scale. Our research in Maine's intertidal showed that species ranges are shifting in elevation, leading to the loss of species in one community and the addition of that species to a novel community.

The forest harvest industry in Maine has best management practices for riparian buffers that are conservative for the sustainability of the freshwaters that lay within the forests. However they need scientific research on the balance between what is sustainable for the forests and freshwaters and maximizing their economic benefit from that land. Preliminary results from our research show that buffer type does affect multiple stream ecosystem functions 10-15 years post-harvest. However, the variation in those results depend on multiple ecosystem characteristics, such as stream size, forest type, etc. We will continue to try to understand that variation by doing a meta-analysis and research synthesis that will be available to our forest industry stakeholders.

Rockweed (a rocky intertidal seaweed) is another natural resource harvest that very recently has had its management and sustainability come into light due to court cases with the Maine Supreme Court. Managing rockweed harvest to balance ecosystem sustainability with economic benefit is depending on current research to inform policy. Preliminary results from our rockweed harvest research show that harvest does have short-term impacts on rockweed biomass and bird communities, however those effects are variable and decrease through time. In addition, rockweed harvest might actually have short-term positive effects on wrack subsidies to upland ecosystems.

Not only does this research inform government and NGO conservation groups, it also will help industry better manage its natural resources and guide the public as to whether they want to use their land for harvest. This research has been directly disseminated to Maine's forest and seaweed industries, as well as state and federal regulating industries, through presentations, fact sheets, newsletters, and webinars. Ideally, this will lead to management strategies that sustain our healthy natural resources while maintaining economic growth for Maine's natural resource industries.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

What opportunities for training and professional development has the project provided?

This project has resulted in scientific research training for over 20 undergraduate UMaine students, 1 undergraduate student from Universidad de Puerto Rico Recinto de Rio Piedras, 3 MS students at UMaine, and 3 PhD students at UMaine. I employ a tiered mentor approach in my lab, and so therefore multiple of my graduate students have been co-mentors of undergraduate independent research projects increasing the professional development of the graduate students.

PhD student Hannah Mittelstaedt was a 2020 Switzer Fellow for the work she did contributing to this research. Through that fellowship she had multiple professional development opportunities, including meeting with law makers.

Project Director Klemmer took a course on ecological modeling as a part of her professional development.

How have the results been disseminated to communities of interest?

There have been multiple publication and scientific conference talks that have disseminated results to scientific audiences. In addition, newsletters and webinars have been used to present results to diverse stakeholder groups (described in detail above).

List of Publications

Wissingner, S.A., Klemmer, A.J., Braccia, A., Bush, B., Batzer, D.P. 2021. Relationships between macroinvertebrates and detritus in freshwater wetlands. *Freshwater Science*. + Corresponding Author. *Note: Invited by Journal Editor, I am the corresponding author and co-organized review paper with Batzer in memoriam of late colleague, Wissingner.*

Johnston, E.J.*, Klemmer, A.J., Blomberg, E.J., Baron, A.*, Tudor, L., Watson, V.K.**, Welch, L., Olsen, B.J. 2021. Macroalgae composition in rocky intertidal habitats alters occupancy of multiple bird guilds. *Marine Ecology Progress Series*. *Note: Klemmer and Olsen contributed equally as co-PIs. First graduate student advisee publication.*

Presentations and Other Products/Outputs (excluding publications, patents, & plant variety protection applications)

Presentations:

Klemmer, A.J. 2021. Engaging with stakeholders and extension team for applied research. Invited by the Maine Sea Grant. *Online dueto COVID-19*

Klemmer, A. J., Shepard, I., McIntosh, A.R. 2021. Subsidy trophic level differentially affects bottom-up and top-down food-web interactions. Ecological Society of America Conference 2021 Virtual Meeting.

Mittelstaedt, H.N., Braun, L.A., Olsen, B.J., Kozlowski, A. Weed, A. Miller, K. , Klemmer, A.J. 2021. Elevational changes in community structure of rocky intertidal invertebrates and macroalgae due to climate change. Ecological Society of America Conference 2021 Virtual Meeting

Johnston, E., Braun, L., Mittelstaedt, H.N., Olsen, B., Webber, H., Muhlin, J., Klemmer, A.J. 2021. Bottom-up food-web impacts of commercial scale resource harvest on coastal bird communities. Ecological Society of America Conference 2021 Virtual Meeting

Integration of Research and Extension Activities (meeting Section 204 of AREERA definition)

Yes. As a part of my rockweed harvest research, I work with Maine Sea Grant extension team members, Esperanza Stancioff and Jaclyn Robidoux.

List of Graduate Students

1. Mitchel Paisker: MS 2017-2019
2. Amy Baron: MS 2016-2020
3. Laura Braun: MS 2020-current
4. Hannah Mittelstaedt: PhD 2018-current
5. Hannah Webber: PhD 2017-current
6. Elliot Johnston: PhD 2018-current

List of Grants, Contracts, and External Support Applications and Awards

2021 Klemmer, A.J., Greig, H.S., Whiteman, H., Balik, J. National Science Foundation. RAPID: *Does a range shifting species alter ecosystem function phenology?*

\$170,877

2021 Klemmer, A.J., Muhlin, J. Webber, H., Mittelstaedt. Maine Sea Grant Biannual Awards. *Connecting ecological and human communities: Interactive effects of harvest and climate change on cross-ecosystem rockweed subsidies.*

\$149,459 (not funded)

??2021 Klemmer, A.J. Rocky Mountain Biological Laboratory: *Changes to predator and invertebrate populations alter connections of terrestrial and freshwater ecosystems.*

\$2500

2021 Classen A., Billick, I., Adair, C., Ezenwa, V. and J. Hoeting. NSF Biological Integration Institute: *The Ecological Consequences of Disrupting the Environmental Clock (ECODE).*

Role: Named & funded Research Fellow & contributed to proposal writing.

\$12,499,984 (not funded)

2020 Klemmer, A.J., Olsen, B.J., Mittelstaedt, H. National Park Service – Cooperative Ecosystem Studies Unit. *Environmental correlates of rocky intertidal community structure.*

\$120,348

Project Director

Andrei Alyokhin

Organization

University of Maine

Accession Number

1024187



Harnessing Chemical Ecology to Address Agricultural Pest and Pollinator Priorities

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

We aim to provide a greater understanding of the ecology of pests, pollinators and natural enemies. This will assist with generating recommendations for a more integrated approach to pollinator and pest management. Increased knowledge is likely to help conserve important pollinator and natural enemy populations and improve their services in agriculture and other ecosystems. Our program in Maine focuses on the Colorado potato beetle and potato-colonizing aphids.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Our first set of experiments aimed on expanding the existing toolbox for controlling the Colorado potato beetle, *Leptinotarsa decemlineata* (Coleoptera: Chrysomelidae), which is one of the most notorious pests of the potato, *Solanum tuberosum*. Potato beetles are capable of developing resistance to various insecticides in relatively few generations. Novel and effective means of controlling Colorado potato beetle populations are constantly required to protect potato crops and prevent loss of yield. The knockdown of gene function through ribonucleic acid interference (RNAi) has been demonstrated in Colorado potato beetles, suggesting the use of this technology as a means of beetle management. We tested a novel double-stranded RNA (dsRNA) based insecticide with the active ingredient, ledprona, in variable dose laboratory bioassays, followed by field studies. Exposure to ledprona resulted in both increased beetle mortality and decreased foliage consumption in all four instars and adult beetles. Effects decreased from earlier to later life stages. No ovicidal activity was detected. Onset of mortality was slower compared to the existing chemical insecticides. Nevertheless, field applications of formulated ledprona to potato plots resulted in their protection comparable to that provided by spinosad and chlorantraniliprole. Based on the results of this study, formulated ledprona has attributes to become a useful tool in controlling Colorado potato beetle populations that is likely to be a good fit in integrated pest management protocols.

Our second set of experiments focused on *Dickeya dianthicola* (Samson), which is an important pathogen causing blackleg disease of potato. Previous work suggested that insects might vector Pectobacteriaceae between plants, but no conclusive work has confirmed this. Green peach aphids (*Myzus persicae* Sulzer) and Colorado potato beetles (*Leptinotarsa decemlineata* Say) are aggressive potato pests and related to known vectors of several species of bacteria other than *D. dianthicola*. We sought to determine if these insects vector *D. dianthicola* for potato infection. Neither insect species showed olfactory discrimination based on the presence of infection in laboratory tests, but beetles were repelled by uninfected foliage treated with 2,3-butanediol, a primary *Dickeya* metabolite. Beetle recruitment to plants was not affected by their infection status; however, aphids preferred uninfected foliage when conspecifics were present. In the laboratory, neither insect acquired or transmitted *D. dianthicola* through feeding. In the field, neither insect's abundance was significantly correlated with disease spread. Overall, this study did not find indications that *D. dianthicola* is vectored by the tested insect species. Therefore, efforts to limit *Dickeya* spread should focus on sanitation, water management, and seed screening – not on the control of these insect species.

Briefly describe how your target audience benefited from your project's activities.

Farmers will soon have a new insecticide with a novel mode of action against the Colorado potato beetle in their disposal. This is especially important given the beetle's propensity to develop insecticide resistance. Farmers, crop consultants, and extension personnel also now know that contrary to earlier suggestions, Colorado potato beetles and potato-colonizing aphids do not transmit *Dickeya dianthicola*. This allows a better focus in developing IPM plans for this pathogen while preventing unnecessary insecticide applications.

Briefly describe how the broader public benefited from your project's activities.

Improvements in potato protection from insect pests and pathogens reduce costs of potato production and the amounts of insecticide residues present on tubers and in the environment.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Rodrigues, T. B., S. K Mishra, K. Sridharan, E. R. Barnes, **A. Alyokhin**, R. Tuttle, W. Kokulapalan, D. Garby, N. J. Skizim, Y. Tang, B. Manley, L. Aulisa, R. D. Flannagan, C. Cobb, and K. E. Narva. 2021. First sprayable double-stranded RNA-based biopesticide product targets proteasome subunit beta type-5 in Colorado potato beetle (*Leptinotarsa decemlineata*). *Frontiers in Plant Science* 12:728652. <https://doi.org/10.3389/fpls.2021.728652>

Insinga, J.K., **A. Alyokhin**, J. Hao, T. Ge, N. F. Marangoni, A. Baron. 2021. *Dickeya dianthicola* is not vectored by two common insect pests of potato. *PhytoFrontiers* 1: 160-172. <https://doi.org/10.1094/PHYTOFR-12-20-0049-R>

Mishra, S., J. Dee, W. Moar, J. Dufner, Beattie, J. Baum, N. P. Dias, **A. Alyokhin**, A. Buzza, S. I. Rondon, M. Clough, and S. Menasha. 2021. Selection for high levels of resistance to double-stranded RNA (dsRNA) in Colorado potato beetle (*Leptinotarsa decemlineata* Say) using non-transgenic foliar delivery. *Scientific Reports* 11 (2021): 6523. <https://doi.org/10.1038/s41598-021-85876-1>

Alyokhin, A. 2021. How does RNA interference work in insect pest management? *CropLife*, January 19, 2021. <https://www.croplife.com/crop-inputs/insecticides/how-does-rna-interference-work-in-insect-pest-management/>

Increasing Health-Related Quality of Life and Diet Quality in Young Adults

Project Director

Jade McNamara

Organization

University of Maine

Accession Number

1023884



Increasing Health-Related Quality of Life and Diet Quality in Young Adults

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

College students are at increased risk for unhealthy dietary behaviors and poor mental health, which is putting them at risk for developing obesity and chronic disease. The average weight gain in college is between 3-4.3kg in the first year at school which puts students at higher risk of obesity by age 35-37. Additionally, young adults aged 18-24 years old have the highest prevalence of mental illness. This research aims to explore the relationship between behaviors that influence diet quality such as, nutrition literacy, and to develop methods to improve these behaviors for better HRQOL and chronic disease prevention in young adults.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

1. Continue the development and refinement of survey tools that assess the mediators of health-related quality of life (HRQOL) and diet quality in young adults.

A survey instrument that capture nutrition literacy was developed and validated to assess function, interactive, and critical nutrition literacy in young adults. The sample will includes over 800 college students, who were recruited via campus email listservs. Surveys also included dietary behaviors, HRQOL scale, and stress management scale. Quantitative methods such as correlation analyses, confirmatory factor analysis, and multiple regression analyses were used to establish relationships between diet quality, nutrition literacy, and health-related quality of life.

2. Assess and communicate the relationship between HRQOL, mediators of diet quality (i.e., nutrition literacy), and diet quality of young adults in the state of Maine.

For this objective, online surveys were distributed to over 800 college students that captured HRQOL, mediators of diet quality, and diet quality of young adults. Quantitative methods such as correlations, analysis of covariance, regression models, and path analysis were used to assess relationships. Outcomes were disseminated at international nutrition and health conferences and used to inform the development of intervention methods to improve HRQOL and diet quality in young adults.

3. Develop intervention methods to improve HRQOL and diet quality in young adults through community based participatory research using both qualitative and quantitative methods.

Using the data and results collected in objective 1 and 2, a community advisory board (CAB) was established to develop and inform health programming at the University of Maine. The CAB includes college students (n=5) and faculty to work to inform health programming. External funding was awarded to support the CAB and the implementation of the health program that will be designed.

Briefly describe how your target audience benefited from your project's activities.

This work helped establish the relationship between nutrition literacy, diet quality, and health-related quality of life. By taking a community-based research approach to program planning, college students will have the say in what type of health program will work best to meet the health needs of their peers. Developing health programming on college campuses that targets both healthy eating and mental health provides an opportunity to reach a large portion of the population who are at risk for future chronic diseases.

Briefly describe how the broader public benefited from your project's activities.

By developing intervention strategies on college campuses that improve health behaviors and prevent chronic disease, young adults will leave college with the ability to maintain good health practices, which play a major role in improving individuals' quality of life and ensuring an able workforce and economic stability.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

McNamara J, Mena N, Neptune L, Parsons K. College Students' Views on Functional, Interactive and Critical Nutrition Literacy: A Qualitative Study. *Int. J Environ. Res. Public Health*. 2021;18(3):1124.

Bedoyan J, McNamara J., Olfert MD, Byrd-Bredbenner C, Greene G. W. Establishing criterion validity for the Revised Critical Nutrition Literacy Tool in US college students. *J Edu Health Promot*. 2021;10(1):37.

Neptune L, Parsons K, Reynolds A, Sullivan A, Byrd-Bredbenner C, McNamara J*. Health-Related Quality of Life in Sexual Minority College Undergraduate Students. *American Society of Nutrition*. 2021.

Sullivan A, Neptune L, Parsons K, Reynolds A, Byrd-Bredbenner C, McNamara J*. The Impact of Grit on Health Outcomes in College Students. *American Society of Nutrition*. 2021.

Parsons K, Neptune L, Reynolds A, Sullivan A, Byrd-Bredbenner C, McNamara, J*. The Impact of Health Behaviors on Health-Related Quality of Life in College Students. *American Society of Nutrition*. 2021.

Reynolds A, Parsons K, Neptune L, Sullivan A, Byrd-Bredbenner C, McNamara J*. The Influence of Intuitive Eating on Weight Satisfaction in College Students. *American Society of Nutrition*. 2021.

Barr M, McNamara J. Cross-sectional examination of Dietary Quality and Mindful Eating Behaviors among Pregnant and Postpartum Women. *Society of Nutrition Education and Behavior*. 2021.

Biology and Management of Beneficial and Pest Insects in Wild Blueberry

Project Director

Philip Fanning

Organization

University of Maine



In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Lowbush (wild) blueberry (*Vaccinium angustifolium*), is a perennial, field fruit crop and a culturally and economically important crop in the state of Maine. In the last decade, growers have suffered low prices and increased cost of production due to the invasive vinegar Spotted-wing Drosophila. This increased cost of production has been especially challenging to small growers, some of who have left the industry. Determining new economically feasible strategies will help mitigate its impacts greatly.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

In the current reporting period (October, 1, 2020 – September, 30, 2021), my lab has made progress on all three of the objectives of this project. Outputs of the project included 10 presentations in local and national meetings/extension events, the publication of four peer-reviewed articles and two technical reports. In addition, I submitted six grants (Totaling: \$1,299,236 million, Awarded: \$485,576, Fanning total: \$143,613). A graduate student was recruited and began conducting research on the objectives in this project, as were 2 undergraduate researchers. Specifics of the research conducted in each objective are outlined in detail below.

1. Determine the identity and abundance of native larval and pupal parasitoids of drosophilids in wild blueberry in Maine.

To survey native parasitoids of drosophilids continued into the fall with the use sentinel traps baited with fruit in 5 locations in Maine, including in semi-natural and wild blueberry sites. These sites included no, low and high agricultural inputs. Traps were baited with organic store-purchased raspberries and bananas and were held at the field sites for 2-3 day to allow them to be naturally infested with drosophilids including *D. suzukii*, and *Drosophila melanogaster*. Thus providing a host for potential *Drosophila* parasitoids. In total 16 traps were deployed at each site, and each site was sampled twice late in the season, typically when populations are at their highest based on previous research. Traps were removed from the field and returned to the laboratory where they were held in a growth chamber and emergence of parasitoids was checked regularly. This years traps have yet to be assessed for emerging parasitoids. But last year's data suggest the *Drosophila* parasitoids might be scare in Wild Blueberry landscapes.

*2. Monitor *D. suzukii* adults and larval infestation to develop better tools to inform management strategies.*

This year we continued to collect data at sites with established weather stations and some additional locations spread across the wild blueberry production region in Maine. Throughout the cropping period this year at 14 cooperating grower's sites, monitoring of *D. suzukii* adults and larval infestation were conducted on a weekly basis. The fields were maintained by the growers using typical wild blueberry production practices. The results of monitoring further supported the successful validation of the newly developed action thresholds for *D. suzukii* in wild blueberry. In addition, the spatial and temporal pattern associated with infestation associated with *D. suzukii* at the perimeter of the fields was studied at 6 sites, with each site sampled multiple times throughout the cropping period. Interestingly, *D. suzukii* exhibited a strong perimeter driven behavior. Consistent with last year's data the earliest infestation being observed at the edge of fields and infestation moving in as adult numbers increase. These data strengthen the potential for effective treatments targeting the pest just at the field perimeter, and will help growers time these treatments, thus reducing inputs and costs for growers.

*3. Test and optimize the use of perimeter applications and novel behavioral strategies for the control of *D. suzukii*.*

This project aims to test novel behavioral strategies at the perimeter of fields, the goal of these novel strategies is to reduce inputs of traditional insecticides, which can have non-target effects and can be a barrier to growers accessing new markets due to their maximum residue levels. In 2021, we expanded on the products tested in 2020, additional data was collected on a new food-based behavior modifying product, Decoy Spotted-wing Drosophila, in development by a collaborator's lab in Oregon State University, additionally we tested a new bait, Combi protect[®] and a new attract-and-kill product SWD ACTARA

(ISCA Inc.). These experiments were conducted in a replicated trial, laid out in a randomized block design at the University of Maine, Blueberry Hill Farm. After treatments were applied, assessments of adult *D. suzukii* and larval infestation level in response to treatments was assessed. Data analyses is ongoing, however, preliminary results indicate that the efficacy of this behavioral strategy is dependent on adult densities.

Briefly describe how your target audience benefited from your project's activities.

In the project to date, the target audience reached included the state, regional, national, and international scientific community and growers impacted by the invasive vinegar fly, Spotted-wing *Drosophila* (SWD), *Drosophila suzukii* through publications and presentations at conferences. In the state of Maine, multiple presentations were made to growers, processors, and other stakeholders of wild blueberry (see Presentations and Other Products/Outputs below). These stakeholders provided a report on the activities of this project mailed out. Nationally, I was involved in a national webinar titled: A decade of SWD: Lessons for management, I organized and talked at symposium and presented at the Eastern Branch Meeting of the Entomological Society of America, focusing on advances by Early Career Professionals, and presented at Internationally at the International Society of Horticultural Sciences, International Vaccinium Symposium, August 2021.

This project has led to new tools and information for growers to reduce inputs by growers and better target applications through perimeter applications when appropriate. It is estimated that these perimeter applications, reduce the amount of insecticides used per application by ~90% in larger fields. This information is been actively shared with growers through multiple media.

Briefly describe how the broader public benefited from your project's activities.

Results were disseminated through 12 presentations in local and national meetings, and the publication of four peer-reviewed articles, 2 trial reports and a technical report is currently in preparation for the growers and processor of wild blueberry in Maine. The local presentations included multiple virtual and in-person field talks to growers, processor and other stakeholders across Maine, on *D. suzukii* control and insect integrated pest management. During the growing season I also prepared reports on the status of insect pest in wild blueberry and sent them out to growers via e-mail. Nationally, I was involved in a national webinar titled: A decade of SWD: Lessons for management. I organized a symposium and presented at the Eastern Branch Meeting of the Entomological Society of America focusing on advances by Early Career Professionals and internationally at the International Society of Horticultural Sciences, International Vaccinium Symposium, August 2021. The four peer-reviewed journal articles that were published include a review by national in international collaborators on the last decade of research into the management of *D. suzukii* (Tait et al., 2021), also a global collaboration investigating the population genomics of *D. suzukii* that revealed interesting data on migration patterns of the species (Lewald et al., 2021). Fanning et al. (2021) was a national synthesis of trials which I led to look at the use of feeding stimulants to improve insecticides efficacy. Additionally, we are currently preparing a technical report for the growers and processors of wild blueberry in Maine, which will be mailed out to all individuals on a mailing list maintained by the University of Maine.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Major changes or problems encountered in approach:

No major changes to report. In the previous reporting period with COVID-19, it continued to negatively impacted the opportunities for training and professional development.

Plans for the next reporting period:

To accomplish the goals outlined, we intend to continue field sampling and analyses to address project objectives. In the upcoming reporting period, we will continue to sample native parasitoids of drosophilids in Maine's wild blueberry. This work might also be expanded to the release of classical biological control for *D. suzukii*, as part of a recently funded SCRI project in which my lab is involved. The biological control agent, *Ganaspis brasiliensis* is currently going through the permitting processing. If this is successful, I intend to recruit a Ph.D. student to work on aspects relating to this work. For objective 2 and 3, we will continue to sample at our grower cooperators sites and testing perimeter drive control strategies to develop more tools and management strategies that will reduce inputs and costs for growers. Specifically, we will focus on understanding the biology of *D. suzukii* at locations where we set up stations in this previous reporting period. This will continue to be part of the training of an MS student. The student will also present the findings in local, and national level meetings.

List of Publications

1. Lewald, K., Abrieux, A., Wilson, D., Lee, Y., Conner, W., Andreazza, F., Beers E., Burrack H., Daane, K., Diepenbrock, L., Drummond, F., **Fanning, P.**, Gaffney, M., Hesler, S., Ioriatti, C., Isaacs, R., Little, B., Loeb, G., Miller, B., Nava, D., Rendon, D., Sial, A., Da Silva, C., Stockton, D., Van Timmeren, S., Wallingford A., Walton, V., Wang, X., Zhao, B., Zalom, F., and Chiu J. (2021). Population genomics of *Drosophila suzukii* reveal longitudinal population structure and signals of migrations in and out of the continental United States. G3: Genes, Genomes, Genetics. , jkab343, <https://doi.org/10.1093/g3journal/jkab343>
2. Tait, G., Mermer, S., Stockton, D., Lee, J., Avosani. S., Abrieux, A., Antora, G., Beers, E., Biondi, A., Burrack, H., Cha, D., Chiu, J., Choi, M-Y., Cloonan, K., Crava, C., Daane, K., Dalton, D., Dipenbrock, L., **Fanning, P.**, Ganjisaffar, F., Gomez, M., Gut, L., Grassi, A., Hamby, K., Hoelmer, K., Ioriatta, C., Isaacs, R., Klick, J., Kraft, L., Loeb, G., Rossi-Stacconi, M., Nieri, R., Pfab, F., Puppato, S., Rendon, D., Renkema, J., Rodriguez-Sona C., Rodgers, M., Sassu, F., Schoneberg, T. Scott, M., Seagraves, M., Sial, A., VanTimmeren, S., Willingford, a., Wang, X., Yeh, D. A., Zalom, F. and Walton, V. (2021) *Drosophila suzukii* (Diptera: Drosophilidae): A Decade of Research Towards a Sustainable Integrated Pest Management Program. Journal of Economic Entomology. 1–25 <https://doi.org/10.1093/jee/toab158>
3. **Fanning, P.**, Lanka, S., Mermer, S., Collins, J., Van Timmeren, S., Andrews, H., Hesler, S., Loeb, G., Drummond, F., Wiman, N., Walton, V., Sial, A., and Isaacs, R. (2021). Field and Laboratory Testing of Feeding Stimulants to Enhance Insecticide Efficacy Against Spotted-Wing Drosophila, *Drosophila suzukii* (Matsumura). Journal of Economic Entomology, 114, 1638-1646.
4. Abeli, P., **Fanning, P.**, Isaacs, R., and Beaudry, R. (2021). Blueberry fruit quality and control of blueberry maggot (*Rhagoletis mendax* Curran) larvae after fumigation with sulfur dioxide. Postharvest Biology and Technology, 179, 111568.
5. **Fanning, P. D.**, and Isaacs, R. (2020). Efficacy of Systemic Insecticides for Control of Blueberry Stem Gall Wasp, 2019. *Arthropod Management Tests*, 45(1), tsaa049.
6. **Fanning, P. D.**, and Isaacs, R. (2020). Efficacy of Foliar Applied Insecticides for Control of Blueberry Stem Gall Wasp, 2019. *Arthropod Management Tests*, 45(1), tsaa050.

Research presentations

1. Integrated pest management for spotted-wing Drosophila in Blueberry. **Fanning, P.** 12th International Society of Horticultural Sciences, International Vaccinium Symposium, August 2021. Virtual Conference.
2. Picky pest: Effect of humidity on behavior and survival of Spotted-wing drosophila. **Fanning, P.**, and Isaacs, R. Member Symposium: Research Advances in Invasive Pests By Early-Career Scientists. Oral Presentation. Entomological Society of America Eastern Branch Meeting, March 2021. Virtual Conference.

Extension presentations

1. Post-bloom insect pest management considerations. Fanning, P. Talk to growers in Stockton Springs, ME. Held in person on 6/23/2021.

2. Organic Wild Blueberry Pest Management. Fanning, P. Talk to growers in Brunswick, ME. Held in person on 6/23/2021. (6 People).
3. Insect pest management in Wild Blueberry. Fanning, P. Talk to growers in Cherryfield, ME. Held in person on 6/5/2021. (18 People).
4. Pollinators and Pollination in Wild Blueberry. Fanning, P. Wild Blueberry Virtual Conference Series. Held virtually due to COVID-19, February 2021. (54 people).
5. Insect pests- focusing on Spotted-wing Drosophila. Fanning, P. Wild Blueberry Virtual Conference Series. Held virtually due to COVID-19, February 2021. (45 people).
6. Wild Blueberry Diseases and Pollinators. Fanning, P. 80th Annual Maine Agricultural Trade Show. Held virtually due to COVID-19, January 2021. (103 people).
7. Insect Pest Management in Wild Blueberry. Fanning, P. 80th Annual Maine Agricultural Trade Show. Held virtually due to COVID-19, January 2021. (106 people).
8. A decade of SWD: Lessons for management. Burrack, H., Loeb, G., Fanning, P.D., Isaccs R., Daane, K., Sial, A. A., Rodriguez-Saona, C., and Gómez, N. Online webinar to a national and international audience of growers and stakeholders.
9. SWD Insecticides – Impact on Natural Enemies 8 December 2020. (401 people, since watched by 129 times on YouTube: https://www.youtube.com/watch?v=Rk-13Gov24&feature=emb_logo).
10. Insect Pest Management Update. Fanning, P. Talk to growers in Appleton, ME. 7 October 2020. (18 people).
11. Insect Pest Management Update. Fanning, P. Talk to growers in Crawford, ME. 6 October 2020. (7 people).

Recovering Microbial Communities in the Gastrointestinal Tract from Dysbiotic States

Project Director

Suzanne Pellegrini

Organization

University of Maine

Accession Number

1021726



Studying microbes in various types of animal agriculture 2021

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The central efforts of my lab are to increase our understanding of the interactions between animal (or human) hosts and their resident gut microbiota, and investigate solutions for using microorganisms to resolve disordered communities and host health. My ongoing and proposed research activities investigate the microbiome in several animal hosts with implications for a wide variety of research applications and to Maine health, agriculture, and ecological management sectors. In particular,

much of my work centers on the importance of spatial location in understanding host-microbe interactions and how to harness them. This is applicable in understanding how diet might affect animal performance via a variety of microbial metabolic pathways, and whether the host can even benefit from microbial byproducts based on ability to absorb nutrients at different parts of the tract. It is applicable to designing effective probiotics to achieve the desired impact, be it colonization of the GI tract in a specific location, or ousting a gut pathogen. This knowledge of healthy hosts can broadly be used to understand dysbiosis in microbial communities, and whether the disordered community is the cause of poor host health or is merely the effect of a change in the host immune system which caused a shift in the host's control of resident microbiota.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The primary goal of this research is to better understand the interaction of animal host, gut microbiota, and diet in relation to gastrointestinal health and animal production. The long-term goal, beyond the scope of this project-period, is to identify dietary or microbial therapies to curate a microbial community which incorporates these genotypic or phenotypic factors.

Specific objectives included:

- a. Develop an in vitro co-culture-based model by which to study host-microbe interactions in gastrointestinal tissues more clearly and reproducibly.
- b. Identify microbial genotypic or phenotypic factors which contribute to or mitigate host tissue inflammation.

What was accomplished under these goals?

Over the end project period, 7 peer-reviewed journal articles were published or submitted for review; 28 presentations were given; 11 press interviews were given; 1 research symposium was organized and hosted (15 speakers); 1 seminar series was organized and hosted (12 speakers); 18 funding proposals which relate to this work in some way were submitted; and 6 proposals were awarded. A significant amount of research was completed, which refined our laboratory protocols and added new research capacity to the Ishaq Lab, contributed to the professional development of student research trainees, and set the basis for collaborative research on a campus-, state-, national-, and international scale. Overall, 7 graduate students, 10 undergraduates, and one research assistant were trained as part of this project or on techniques and theory related to this work, including lab skills in microbiology, cell culture, co-culture of microbes and host cells, microscopy and imaging, biopsy and sample collection, project management, data collection and curation, writing scientific reports, and presenting scientific information. Of the students trained here who have matriculated during the project period, two are pursuing veterinary medicine degrees, two are research assistants, and one has just begun a graduate degree. Further, this has provided my training and professional development as an early-career researcher, including formally mentoring graduate students, managing multiple lab projects concurrently, soliciting a larger number of funding awards concurrently, and integrating my research into my teaching curricula.

Project Objectives That Were Met

Objective 2: Identify microbial genotypic or phenotypic factors which contribute to or mitigate host tissue inflammation, is ongoing, and has been supported by four projects in progress. Collectively, these have led to 1 publication, 2 manuscripts in preparation, 6 presentations including 1 by a graduate student, 1 master's thesis in preparation, 1 graduate and 4 undergraduate students trained in research, 5 research proposals, and research collaborations with researchers at 4 different institutions which are anticipated to generate more publications and proposals in the next year. The research scopes are related to animal and human health, host-microbiomes, and the intersection of diet-microbe-host, all of which have relevance to Maine communities and industry: "Harnessing gut microbiota to reduce inflammation using broccoli-sprout diets", "The developing gut microbiome in lambs and correlation to lamb immune response" Yeoman et al., "Interactions between diet, gut microbial communities, and the immune system in mice, as a model for inflammation and cancer in humans", Zeng et al., and "Water temperature, lobster microbes, and shell disease". The lobster microbiome project has also created a new collaboration, which has led to an Affiliated Faculty position for me at the UMaine Aquaculture Research Institute.

Briefly describe how your target audience benefited from your project's activities.

Target audience

This research is of most interest to animal producers and farmers, clinicians (veterinary and medical), animal managers (including domestic, captive, and wild), public health professionals, the scientific community, scientific students/trainees, and the general public (Maine and otherwise). More specifically, this may include the Maine Department of Agriculture, the Maine Beef Producers Association, the Maine Dairy and Nutrition Counsel, and the Maine Sheep Breeders Association. At the student level, this may include 4H and university-based student groups. While I do not have an Extension appointment, I worked with University of Maine Cooperative Extension personnel to ensure that target audiences received the knowledge and material benefits of this research, as needed.

How have the results been disseminated to communities of interest?

Results are disseminated through open-access, peer-reviewed publications; news interviews; presentations at scientific, stakeholder, or public venues (many offered virtually); and through my professional social media platforms. As of Sept 2021, these collectively have >2,200 followers, with >23,500 visitors and >42,000 views of the website alone (cumulative since 2016). During the project reporting period (Oct 2019 to Sept 2021), this included >17,000 visitors and >32,800 views of the lab website. [The Ishaq Lab webpage](#), [Facebook](#); [@DrSuelshaq, Twitter](#); [@DrSuelshaq, Instagram](#); [@DrSuelshaq, LinkedIn](#), and [Tumblr](#); [@DrSuelshaq](#).

During this reporting period, I gave the following presentations to stakeholders:

1. "My science journey", invited presentation and discussion of my career path to undergraduate women in STEM, UMaine WiSTEMM group, March 21, 2021
2. Invited Keynote at the [Imagination Lancaster](#) group symposium (Lancaster, UK), May 2022. Declined due to lack of travel funds.
3. Ishaq, S. "Moose rumen microbes and you." The Wildlife Society Nutritional Ecology Working Group Webinar, March 9, 2021.
4. Virginia Commonwealth University Biology Department seminar series, Richmond, VA, (virtual), "[How to make a career out of poop](#)", March 22, 2021
 1. presented on my research and career path to 114 undergraduates, graduates, faculty
5. Worcester Technical High school, Worcester, MA, (virtual), "How to make a career out of poop", Jan 20 and 28, 2021
 1. presented on my research and career path to ~60 high school juniors and seniors in a STEM technical program
6. Genomes to Phenomes (G2P) group, University of Maine. Co-hosted a session with grad student Alice Hotopp, on gut microbes and survival of reintroduced animals. Oct 30, 2020.
7. University of Maine Cooperative Extension Oxford County 4-H Teen Science Cafe (virtual), "[Gut microbes on the farm](#)", Oct 15, 2020.
8. [BioME \(Bioscience Association of Maine\) Virtual Coffee Hour](#), "[What is a microbiome and where can I get one?](#)" Oct 14, 2020. I introduced myself and my research to 65 participants, who are biomedical professionals and state representatives in Maine.

What have you accomplished in your project to date that fulfills the intent of capacity research to support and to enhance agriculture in its broadest aspects, rural life, forest resources and forest management, and wildlife management?

All of my research, as directly or indirectly related to this project, supports or enhances agriculture, rural life, or wildlife management, and is described in more detail under the Outcomes Statement. Broadly, my research supports agricultural animal health and disease transmission, wildlife disease carriage and potential risk to livestock, animal production and the interplay of diet and gut microbiome, the use of diet to mediate disease in humans by way of gut microbiome function, microbiome development or microbial transmission in aquaculture systems, or aquaculture animal health.

Short-term outcome; change in knowledge: This project produced a significant positive change in knowledge, as demonstrated by the 6 peer-reviewed publications, and 18 presentations, given in this annual reporting period. Details are provided in the previous sections.

Medium-term outcome; change in action: This project has produced some change in action, with many individual project outcomes still in development and extending past the end of this reporting period and project timeline. Developing microbial-based therapeutics has not yet been accomplished, however the knowledge gained will support this eventual change in action. This project has successfully developed educational materials for producers on feeding practices, gut health, or probiotics. All scientific journal publications listed in the outcomes statement are available free through open-access licensing, and have been shared on social media and e-mail to facilitate their distribution to target audiences, see previous sections for more details. The most pertinent of these include Dankwa et al. 2021; and Rabee et al. in review. Additional publications are in development. "The Impact of salt on beef cattle intake, digestion, rumen fermentation with low-quality forages" involved 2 UMaine undergraduate researchers, and animal science researchers at Montana State University. I taught DNA sequence analysis to these 2 undergraduates for their senior research Capstone project. "Camel rumen microbial metatranscriptome in response to different diets", which involves 2 undergraduate students, one at UMaine completing their Capstone project, and one involved through the UMaine NSF Research Experience for Undergraduates (REU) program, both of whom will be authors, as well as a collaborative animal scientist at the Desert Research Institute in Egypt.

Long-term outcome; change in condition: The long-term outcomes of this project involves supporting the agricultural industry in Maine and other locations, and this extends beyond the timeline of this project, although it is underway through efforts described in previous sections. These include improving sustainability, reducing the spread of gastrointestinal pathogens to humans via the reduction of disease in livestock, improving animal health and wellbeing in the production industry, and improving feed efficiency. Understanding livestock, wild, and environmental microbial communities can assist in developing best practices for each of those.

Briefly describe how the broader public benefited from your project's activities.

Open-access research

I strongly support open-access to published data in public repositories, for example, [NCBI](#), and in particular, adding to collections which seek to use meta-analysis to push research fields forward, including The Global Rumen Census and Hungate 1000. My 'other scholarly activities' represent my contribution to the scientific field, both in review and in leadership. I am an editor at a well-known, interdisciplinary scientific journal, *PLoS ONE*, which publishes work on animal science, microbial ecology, microbiology. I was invited to act as a guest editor for the *PLoS ONE* section of a multi-journal special call published in 2020: [Microbiomes Across Biological Systems](#). I also review a large number of scientific manuscripts per year ([tracked by Publons](#)), thus contributing to the quality and rigorousness of scientific publications. I am a member of a handful of scientific organizations, through which I participate in scientific conferences and scientific community communications.

Engaging animal science professionals in research

Several of my projects directly work with Maine stakeholders, including livestock producers, blueberry producers, ecologists, and the aquaculture industry. Through my public presentations, I engage with stakeholder audiences to share my work. Thus far, these audiences have included producer groups in New England, and 4-H participants in Maine. During 2020, I mentored Shana Hanson, owner of 3 Streams Farm in Belfast, ME, in research proposal development, experimental design, and research project management. In early spring of 2020, Shana contacted me about serving as a research mentor and technical advisor for a research proposal to North Eastern SARE. Shana and I met virtually on a weekly to monthly basis, to develop her proposal on tree leaf silage as small farm animal feed to improve farm economic security, act as organic parasite control, and increase forestation on agricultural land. Ultimately, the proposal was not funded but Shana is continuing her work on leaf silage.

Social media engagement

I regularly engage with scientific, student, and public audiences through my professional social media platforms, which as of March 2022, collectively have >2,500 followers, with >28,000 visitors and >58,000 views of the website alone in countries around the globe.

- [The Ishaq Lab webpage](#)
- [Facebook; @DrSuelshag](#)
- [Twitter; @DrSuelshag](#)
- [Instagram; @DrSuelshag](#)
- [LinkedIn](#)
- [Tumblr; @DrSuelshag](#)

Leading an international research working group

Following the success of and interest in my essay in 2019 ([Ishaq et al. 2019](#)), I organized the [Microbes and Social Equity working group](#). Since Jan 2020, I lead the ~130-member group with meetings every 2 -3 months. Our members include researchers from 90 institutions and 22 countries, at different levels of career trajectory, working in a variety of research fields which touch on microbiology, health, public policy, and more. As of 2022 oversee the Directors which support certain administrative, social media, or professional development activities of the group. The MSE working group Mission Statement is: “The Microbes and Social Equity (MSE) Working Group posits that microbial exposures across ecosystems, urban and rural settings, and individuals are sociopolitical. Our purpose is to connect microbiology with social equity research, education, policy, and practice to understand the interplay of microorganisms, individuals, societies, and ecosystems. Collectively, we seek to generate and communicate knowledge that will spark evidence-based public policy and practice, supporting equity and sustainability for all.” Leading this group has generated seminar series, symposium, journal special collections, publications for myself and other researchers, and research proposals (details provided in the respective sections).

Organization of scientific seminar series

In spring 2021, I organized a [14-speaker seminar series](#), featuring experts on varying topics in microbes and social equity. This series was attended by >300 people, and used for teaching materials at Bowdoin College (personal communications, Anne McBride) and Quinnipiac University (personal communications, Shawna Reed), among others. The 2021 series paved the way for a summer symposium, described below. I am also organizing the [2022 speaker series](#), currently in progress, which has attracted 257 attendees (521 registrants) as of 03/07/2022.

Organization of scientific meetings or sessions

Microbes and Social Equity (MSE) Working Group 2021 symposium: “[Microbes, Social Equity, and Rural Health](#)”. Virtual. June 14-18, 2021. Organized by **Ishaq, S.L.**, Friedman, M., Grieneisen, L., Wolf, P., Wissel, E., Lichtenwalner, A., Ferguson, C. This featured 15 speakers across 5 themed days with 3 plenary-style talks/day, followed by 90 min of small-group discussion led by speakers and MSE members. Participants were encouraged to “problem solve” a suggested topic or one of their own choosing to create action items that were meaningful to them, such as ideas for curricula development, identifying research needs or best practices, suggestions for engaging research in policy, and more. The symposium hosted 254 participants from 22 countries, students and researchers from various fields and career levels, Maine State legislators, and the public. The symposium led to an invitation to contribute a perspective piece on organizing interdisciplinary working groups and conferences to *Challenges*, the journal for the inVIVO Planetary Health group.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Publications:

After author names, numbers denote: 1 undergraduate or 2 graduate students I mentored in peer-reviewed scientific journal articles.

1. Rabee, A.E., Sayed Alahl, A.A., Lamara, M., Ishaq, S.L. 2021. Fibrolytic rumen bacteria of camel and sheep and their applications in biofuel production. *PLoS One*. *In press*.
2. Choi², O., Corl, A., Lublin, A., **Ishaq, S.L.**, Charter, M., Pekarsky, S., Thie, N., Tsalyuk, M., Turmejan, S., Wolfenden, A., Bowie, R.C.K., Nathan, R., Getz, W.M., Kamath, P.L. 2021. High-throughput sequencing for examining *Salmonella* prevalence and pathogen – microbiota relationships in barn swallows. *Frontiers in Ecology and Evolution* 9:681.
3. **Ishaq, S.L.**, Parada Flores, F.J., Wolf, P.G., Bonilla, C.Y., Carney, M.A., Benezra, A., Wissel, E., Friedman, M., DeAngelis, K.M., Robinson, J.M., Fahimipour, A.K., Manus, M.B., Grieneisen, L., Dietz, L.G., Chauhan, A., Pathak, A., Kuthyar, S., Stewart, J.D., Dasari, M.R., Nonnamaker, E., Choudoir, M., Horve, P.F., Zimmerman, N.B., Kozik, A.J., Darling, K.W., Romero-Olivares, A.L., Hariharan, J., Farmer, N., Maki, K., Collier, J.L., O’Doherty, K., Letourneau, J., Kline, J., Moses, P.L., Morar, N. **2021**. [Introducing the Microbes and Social Equity Working Group: Considering the Microbial Components of Social, Environmental, and Health Justice](#). *mSystems* 6:4. Special Series: Social Equity as a Means of Resolving Disparities in Microbial Exposure
4. **Ishaq, S.L.**, A. Hotopp², S. Silverbrand², J.E. Dumont, A. Michaud, J. MacRae, S. P. Stock, E. Groden. **2021**. [Bacterial transfer from *Pristionchus entomophagus* nematodes to the invasive ant *Myrmica rubra* and the potential for colony mortality in coastal Maine](#). *iScience* 24(6):102663. Featured in multiple news posts in Maine.
5. Zeng, H., Safratowich, B.D., Liu, Z., Bukowski, M.R., **Ishaq, S.L.** **2021**. [Adequacy of calcium and vitamin D reduces inflammation, \$\beta\$ -catenin signaling, and dysbiotic *Parasutterella* bacteria in the colon of C57BL/6 mice fed a Western-style diet](#). *Journal of Nutritional Biochemistry* 92: 108613.
6. Dankwa², A.S., U. Humagain², **S.L. Ishaq**, C.J. Yeoman, S. Clark, D.C. Beitz, and E. D. Testroet. **2021**. [Determination of the microbial community in the rumen and fecal matter of lactating dairy cows fed on reduced-fat dried distillers grains with solubles](#). *Animal* 15(7):100281. Journal impact factor 2.4.

Presentations:

After author names, numbers denote: 1 undergraduate or 2 graduate students I mentored. Asterisks note presenter.

1. Choi^{*2}, O.N., Corl, A., Wolfenden, A., Lublin, A., **Ishaq, S.L.**, Turjeman, S., Getz, W.M., Nathan, R., Bowie, R.C.K., Kamath, P.L. “High-throughput sequencing for examining *Salmonella* prevalence and pathogen -microbiota relationships in barn swallows.” [69th Annual - 14th Biennial Joint Conference of the Wildlife Disease Association & European Wildlife Disease Association](#). (virtual) Aug 31e Sept 2, **2021**.
2. Arshad¹, M., Fludgate¹, P., Emera Rabee, A., **Ishaq, S.** “Preliminary results of camel rumen microbial make up”. University of Maine REU Research Symposium (virtual). Aug 13, **2021**.

3. The Microbes and Social Equity Working group, "Special Session 17: "Microbiomes and Social Equity" (19205).", Ecological Society of America 2021. (virtual). Aug 5, 2021.
4. **Ishaq***, S.L., Lee, G., Turner, S. M., MacRae, J., Hamlin, H., Bouchard, D. "The effect of simulated warming ocean temperatures on the bacterial communities on the shells of healthy and epizootic shell diseased American Lobster (*Homarus americanus*).", Ecological Society of America 2021. (virtual). Aug 2-6, 2021. (accepted talk)
5. Hotopp2*, A., Silverbrand2, S., Ishaq, S.L., Dumont, J., Michaud, A., MacRae, J., Stock, S.P., Groden, E. "Can a necromenic nematode serve as a biological Trojan horse for an invasive ant?" Ecological Society of America 2021. (virtual). Aug 2-6, 2021. (poster)
6. **Ishaq*, S.L.** "Do we have a right to microbes?" University of Maine eDNA Ethics Workshop 2021. Orono, ME. July 8, **2021**. (invited presentation, and panel/workshop discussion lead)
7. Holman*2, J., **Ishaq, S.L.**, Li, Y., Zhang, T.. Prevention of Inflammatory Bowel Disease by Broccoli-sourced and Microbially-produced Bioactives. ASM Microbe/ISME World Microbe Forum 2021 (virtual). June 20-24, **2021**. (poster)
8. **Ishaq*, S.L.**, Lee, G., MacRae, J., Hamlin, H., Bouchard, D. The Effect Of Simulated Warming Ocean Temperatures On The Bacterial Communities On The Shells Of Healthy And Epizootic Shell Diseased American Lobster (*Homarus americanus*). ASM Microbe/ISME World Microbe Forum 2021 (virtual). June 20-24, **2021**. (poster)
9. Pierce*1, E., Hosler2, S., **Ishaq, S.** Ideal Conditions for Cryptosporidium Attachment and Infection. UMaine Student Research Symposium (virtual). April 16, **2021**. (poster). Several hundred staff, faculty, and members of the public attend this symposium.
10. **Ishaq, S.L.** Virginia Commonwealth University Biology Department seminar series (virtual), "How to make a career out of poop", March 22, **2021**.
11. **Ishaq, S.L.** Worcester Technical High school (virtual), "How to make a career out of poop", Jan 20th and 28th, **2021**.
12. Yeoman*, C., Lachman, M., **Ishaq, S.**, Olivo, S., Swartz, J., Herrygers, M., Berardinelli, J. "Development of Climactic Oral and Rectal Microbiomes Corresponds to Peak Immunoglobulin Titers in Lambs." Conference of Research Workers in Animal Diseases (CRWAD) 2020. (revised to virtual) Dec 5, **2020**.
13. **Ishaq, S.L.** "Framing the discussion of microorganisms as a facet of social equity in human health", inVIVO Planetary Health 2020 meeting. [Jun 17-20, 2020 in Amsterdam, Netherlands cancelled]. (Virtual) Dec **2020**. (invited)
14. **Ishaq*, S.L.**, Hotopp2, A., Silverbrand2, S., MacRae, J., Stock, S.P., Groden, E. "[Can a necromenic nematode serve as a biological Trojan horse for an invasive ant?](#)" Entomological Society of America 2020. (revised to virtual). Nov 15-25, **2020**. (invited)
15. **Ishaq, S.L.** University of Maine Medicine [seminar series](#) (virtual), "[A crash course in the gut microbiome](#)", Nov 6, **2020**. >50 participants from across Maine biomedical audiences.

16. **Ishaq, S.L.** and Hotopp, A. Genomes to Phenomes (G2P) group, University of Maine. "Gut microbes and survival of reintroduced animals". Oct 30, **2020**.
17. **Ishaq, S.L.** University of Maine Cooperative Extension Oxford County 4-H Teen Science Cafe (virtual), "[Gut microbes on the farm](#)", Oct 15, **2020**.
18. **Ishaq, S.L.** BioME (Bioscience Association of Maine) Virtual Coffee Hour, "[What is a microbiome and where can I get one?](#)" Oct 14, **2020**

Improvements in vegetable crop management and evaluation of vegetable varieties for Maine

Project Director

Mark Hutton

Organization

University of Maine

Accession Number

1013220



Improvements in Vegetable Crop Management for Open Field and Protected Culture in Maine

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

This project is a broad fully integrated applied research program that addresses the needs and priorities of the Maine and New England mixed vegetable growers. Maine vegetable growers face many difficult challenges to economically viable vegetable production, not the least of which is Maine's short growing season. Maine and New England vegetable growers are also confronted with an increasingly demanding clientele looking for high quality local produce year round and little researched-based information on winter production.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

During the past year, our research program focused on two areas: reduced tillage (RT) and no till (NT), as well as, cultivar evaluation and development of production practices for celery and artichokes. We used a systems approach to investigate the effects of tarping, tillage, and soil management on soils, productivity, weeds, and labor to inform and guide farmers in RT and NT decision-making. We leveraged the Long-Term Permanent Bed experiment (LTPB), established in 2014, that has compared six tillage intensities ranging from conventional tillage to no-till. Within tillage treatments, three subplot treatments were: 1) unmulched, bare soil 2) annual 5 ton per acre applications of oat straw (ME); and 3) annual manure-based deep compost (locally sourced, 4cm depth). Our research inherited these valuable management legacies from past treatments to address our research objectives. We tested the effects of tarping, tillage, and additional soil management practices in a two year rotation that includes a direct seeded beet crop (Yr 1; 2020) and a double crop of lettuce and fall broccoli (Yr 2; 2021).

The 2021 celery research evaluated three planting systems were: 1) 2-rows on black plastic mulch, 2) 2-rows on bare ground, and 3) 3-rows on bare ground using ten celery cultivars. The 2-row bare ground and 2-row plastic mulch produced the greatest yields. Bachata consistently produced the greatest yields at each harvest. In addition to Bachata, Waltz produced high yields at the first harvest. Tango and Tall Utah had the lowest yields at the first harvest. In the second harvest, Bachata yields were greater than Command, Conquistador, and Tall Utah. In the last harvest, Bachata continued to produce the greatest yields – more than Command, Tall Utah, Tango, and Waltz.

The 2021 artichoke project evaluated three mulch system: bare ground, black plastic, and straw mulch using four cultivars "Colorado Star", Green Globe Improved", Imperial Star", "Tavor", and "Wonder". Artichokes on black plastic produced more small and total marketable buds by weight than plants in the straw mulch. Those on bare ground also outperformed straw plots for total marketable weight. Green Globe Improved produced a greater number of very small and total buds than any

other variety in this trial. Imperial Star and Tavor were mid-level performers, both of which we found to be more attractive than Green Globe Improved. The proportion of total buds that were large enough to be marketed individually (> 3" diameter) was not statistically different across mulches or cultivars..

Briefly describe how your target audience benefited from your project's activities.

In March 2021, we hosted a series of lunchtime webinars, for farmers to share and learn about tarping practices with session topics and speakers guided by emerging farmer questions. This 3-week series had a total of 151 attendees and featured farmers from across the NE region and beyond sharing how tarping is being used on their farm. Topics included using tarps for holding beds, succession plantings, cover crop termination, enabling spring field entry, and handling problem soils and weeds.

We followed up with all attendees from our in-person 2019 workshops (112) as well as those that attended our farmer-to-farmer webinar series offered earlier in the year (151). We emailed these farmers a short, online survey that asked them to share and reflect on how they used tarps in the previous year. We reached 23 farmers through this survey (about 10% of event attendees), where they shared how they used tarps, what benefits they found, any issues or concerns that they had and if they are planning to try it again next year. Common on-farm applications trialed included overwinter tarping for early spring crops (e.g., onions and greens), mid-season tarping ahead of fall crops including carrots, brassicas and greens, killing cover crops like rye and vetch, tarping in high tunnels targeting winter annual weeds, and full season applications to help suppress perennials or kill sod. Across all of these applications, they shared that tarping provided a number of benefits when compared to untarped beds and/or previous management, including:

- Less tillage. 52% used less intense tillage (e.g. shallower or gentler tools) and 62% made fewer tillage passes.
- Greater flexibility in field management. 76% found tarps helped hold beds weed-free until needed and 33% found tarps helped with spring field access.
- Better weed management. 91% found fewer weeds with 86% spending less time hand weeding.
- Improvements in crop establishment and yields. 48% found better soil conditions for planting (e.g. moisture, tilth) and 33% found better crop yields.

The results of the celery and artichoke experiments were presented to Maine vegetable growers during their annual meeting.

Briefly describe how the broader public benefited from your project's activities.

The vegetable research conducted at Highmoor Farm is used by Maine and New England vegetable growers to improve their profitability while also improving on-farm soil quality. Additionally, improving/increasing vegetable production in the region contributes to regional food security.

[Palatable, Healthful Foods for Maine](#)

Project Director
Mary Camire
Organization
University of Maine
Accession Number
1013201



Palatable, Healthful Foods for Maine

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Climate change and the COVID-19 pandemic challenge both the Maine food system and consumers. Understanding changing consumer needs and preferences is important for the food industry to grow and thrive.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

An Internet consumer survey revealed that Americans tend to eat whole lobsters away from home. In years prior to the pandemic, 60.7% of respondents ate lobster or products containing lobster more than twice per year; the percentage dropped to 44.6% in 2020. Slightly more than half of the respondents typically ate cold-water lobsters with claws, 22.5% ate cold- and warm-water lobster and 16.2% were unsure what kind of lobster they ate. Whole lobsters were not commonly cooked at home. Almost a quarter of respondents prefer to eat lobster in a restaurant than prepare the shellfish at home. Lack of knowledge about handling and cooking live lobsters was a barrier to home cooking for 14.1-18.1% of the survey group. Nearly one-third of respondents (n = 439) said they preferred frozen and refrigerated lobster products to live lobsters, which were selected by 671 people. Opportunities may exist for lobster processors to expand their markets for more consumers who do not want the work and stress of preparing a live whole lobster. Consumer education about cooking whole lobsters is also needed, whether by Internet videos or in-store demonstrations. While some people eat lobster year-round, all seasons except the popular summer season may be opportunities to promote lobster products for celebrations. Another online consumer survey focused on kombucha and other low-alcohol fermented beverages. Of the 2,149 qualifying respondents, only 21.2% had consumed kombucha in the past year. The BEVQ-15 responses indicated that kombucha consumers were more likely to have a higher weekly beverage intake overall. They also consumed more sugar-sweetened beverages, alcoholic beverages, and milk beverages than those who did not consume kombucha (p<0.0001). Kombucha consumption was associated with younger adults and higher education. Adults aged 65-74 years were over-represented among respondents. Frequent kombucha consumption (> 1X/week) was positively associated with giving kombucha to children, consuming other fermented foods, and preference for more particulates and cloudier appearance in kombucha. Health benefits were the top reason (30.2%, n = 136) for kombucha consumption. Respondents who did not drink kombucha in the previous year chose no particular reason (33%) followed by disliked the taste (28.6%) as their top reasons for not consuming the beverage.

We interviewed Maine residents (n = 58) at least 65 years old who took part in the Meals on Wheels program to learn how older people coped with food supplies during the pandemic. One-quarter of those interviewed had low food security and 11 people had very low food security. DETERMINE scores were not significantly related to age or region of residence. There was relatively little participation in the SNAP program and few people took advantage of other resources such as food pantries and the Senior Farmers Market Nutrition Program. Food security among older Maine residents during the COVID-19 pandemic may be related to factors other than income, such as lack of transportation or geographic isolation.

Briefly describe how your target audience benefited from your project's activities.

The Maine lobster industry can use this information to develop new products to meet changing consumer preferences. The growing kombucha industry may learn more about the habits and preferences of American kombucha consumers and uncover obstacles to encouraging new consumers. The Maine Agencies on Aging, food pantries, and other services that supply food to older people may be able to better tailor their services to the needs of older Maine residents by overcoming physical barriers to food procurement.

Briefly describe how the broader public benefited from your project's activities.

Consumers may enjoy a broader selection of lobster products and fermented beverages if these industries implement the findings of our research. Older Americans have higher health risks, thus ensuring food security among this group benefits overall public health.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

The pandemic severely limited our ability to conduct sensory evaluation studies. We hope to recruit more students to assist in completing the sensory research in the final year of the project. One student completed the food security study as part of her honors thesis. The kombucha survey formed the basis of a M.S. thesis, and the lobster survey will be presented as a thesis defense in 2022. The findings of these studies will be presented at the American Society for Nutrition and Institute of Food Technologists conferences in 2022. Maine agencies involved with the nutrition of older adults have received a report of that research.

Bouchard, D., Camire, M. E., Davis, C., Shaler, G., Dumont, R., Bernier, R., & Labbe, R. (2021) Attitudes toward aquaculture and seafood purchasing preferences: Evidence from a consumer survey of Atlantic States, *Aquaculture Economics & Management*, 25:4, 411-429, DOI: [10.1080/13657305.2020.1869859](https://doi.org/10.1080/13657305.2020.1869859)

Akomea-Frempong, S., Skonberg, D.I., Camire, M.E., & Perry, J.J. (2021). Impact of blanching, freezing, and fermentation on physicochemical, microbial, and sensory quality of sugar kelp (*Saccharina latissima*). *Foods*, 10(10): 2258. <https://doi.org/10.3390/foods10102258>

Brickman, L. (2021). Identifying Cofactors Contributing to Food Insecurity in Elderly Maine Residents Living at Home. Honors Thesis, University of Maine, May 2021.

Helping create a safer, healthier, more accessible and increasingly productive food system

Project Director

Jonathan Prichard

Organization

University of Maine

Accession Number

7002354



EFNEP and Food Security

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

In 2019, the poverty rate in Maine was 11.8%, representing 153,131 people living in poverty. One in 9 individuals and 1 in 7 children lived in food insecure households. Yet, Feeding America projected that 1 in 8 people and 1 in 6 children could experience food insecurity in 2021 due to the pandemic. The pandemic exacerbated greater health disparities among low-income populations. The combination of high rates of food insecurity and obesity of Maine adults will continue to put a strain on current health promotion programs and continue to raise health care costs for the nation.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

To improve the food security and the diet of Maine's low-income parents and caregivers, UMaine Extension implements direct education (remotely in 2021) 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. Program outcomes are measured for all adults using validated pre/post program surveys.

Briefly describe how your target audience benefited from your project's activities.

In 2021, 453 adults participated in remote delivery of Maine EFNEP, and of those 304 graduated (67%). Post-program surveys indicated that as a result of participating in EFNEP:

- 33% eat fruit more often each day,

- 31% eat vegetables more often each day,

- 26% drink soda less often,

- 54% showed improvement in one or more physical activity indicators,
- 35% plan meals before shopping more often,
- 27% make a list before shopping more often,
- 36% use a weekly or monthly food spending plan.
- 61% showed improvement in one or more food safety practices

Briefly describe how the broader public benefited from your project's activities.

The combination of high rates of food insecurity and obesity of Maine adults will continue to put a strain on current health promotion programs and continue to raise health care costs for the nation. Through EFNEP, UMaine Extension used education to support participants' efforts toward self-sufficiency, nutritional health, and well-being. While direct program participants improved their diets, improved their nutrition practices, stretched their food dollars farther, handled food more safely, and increased their physical activity levels; the program more broadly impacts the families of EFNEP participants and especially the children in those families. Through their EFNEP-educated adults and caregivers, children are learning nutrition and other health practices that will last them a lifetime.



EFNEP and Food Security

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Briefly describe how the broader public benefited from your project's activities.

Extension used EFNEP to support participants' efforts toward self-sufficiency, nutritional health, and well-being. With 80 percent or more EFNEP families report living at or below 100 percent of poverty, this is important because chronic disease and poor health disproportionately affects low-income and minority audiences. Our EFNEP participants improved their diets, improved their nutrition practices, stretched their food dollars farther, handled food more safely, and increased their physical activity levels. And, importantly, as parents and caregivers they similarly influenced family members and those in their care.



Integrated Pest Management for Maine Potatoes and Fruit Trees

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The \$500 million potato industry is the largest agricultural sector in Maine, encompassing more than 500 businesses generating more than \$300 million in annual sales, employing over 2,600 people, and providing over \$112 million in income to Maine citizens. The crop has its challenges from insect and pathogens alike. Costs to manage these pests can eat up profitability of the crop, and insecticide applications used to manage these pests can pose threats to the applicators, nontarget species and the environment. And Maine's tree fruit sector is vibrant, active and growing.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The University of Maine Cooperative Extension Diagnostic Research Laboratory provides pest identification and integrated pest management education to commercial and home clients.

Extension's Potato Integrated Pest Management program worked with 27 farms to monitor pest populations in potato fields in Northern and Central Maine. Using insect traps and field scouting, farms were visited weekly during the growing season to determine pest population status, and growers were given field reports and up-to-date management recommendations. Data collected from the potato farms were shared with potato growers throughout the state, the Northeastern states and Eastern Canada through a weekly newsletter, with 470 subscribers. Growers utilizing the information available through the IPM program have been able to successfully manage potato pests using minimal pesticide applications, because sprays were only used when population data indicated a specific need for control. Yields were improved or pesticide sprays reduced, and due to less pest damage, profitability was maintained or improved.

Extension's Tree Fruits Program staff developed and delivered research-based information on the production of tree fruit crops, primarily apples, through publications, workshops, meetings, farm visits, correspondence, and telephone consultations. We conduct annual meetings including on Preseason Integrated Pest Management in March and a Summer Tour in July. Periodic newsletters address current cultural practices and pest management strategies. We maintain applied research plantings in cooperation with the Maine Agricultural & Forest Experiment Station.

Briefly describe how your target audience benefited from your project's activities.

In 2021, the Extension's IPM research and identification efforts saved Maine's potato industry an estimated \$10 million in losses avoided, yield increases and reduced pesticide use; for an expenditure of \$95,000, the return was 110 to 1. And our IPM program saved Maine's fruit tree industry over \$5.1 million in losses avoided, and over \$1.1 million savings in pesticide savings in purchase costs.

Briefly describe how the broader public benefited from your project's activities.

Integrated Pest Management (IPM) is a comprehensive approach to solving pest problems with a the goal of providing safe, effective, economical, environmentally sound, and socially sensitive outcomes. Extension's IPM program meets those goals in its support Maine's agricultural sectors.



Maine Agricultural Mediation Program (MAMP)

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Resolving disputes through administrative appeals or litigation is costly, time-consuming, and stressful for everyone involved. It can take years for a case to filter through the courts, the impact on a farm or family can be devastating, and costs can multiply across local and state agencies. By contrast, mediation generally resolves disputes with only a few meetings to resolve disputes, providing a low-cost alternative to appeals or often expensive litigation and bankruptcy. Each case that is resolved through mediation saves time, attorney and court fees, travel, and the family's mental and physical well-being.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Extension is home to the Maine Agricultural Mediation Program (MAMP), part of the USDA Agricultural Mediation Program. The MAMP provides alternative dispute resolution through mediation to farmers, their lenders and others directly affected by the actions of certain USDA agencies, neighbor disputes, and workplace and family disagreements that affect the farm. Mediation is voluntary and confidential, and involves a trained, impartial mediator helping participants to resolve disagreements. In 2020, the MAMP held 19 mediations and provided coaching to 4 farms. All cases were resolved without needing to progress to the courts.

Briefly describe how your target audience benefited from your project's activities.

The Farm Service Agency estimates the typical cost savings for a simple adverse decision case is \$10,000, and as much as \$40,000 can be spent on cases that extend over years. In addition to savings in staff time, savings to producers and/or participants includes preservation of assets, properties and relationships. The MAMP estimates that as much as \$300,000 is saved annually through agricultural mediation in Maine.

Briefly describe how the broader public benefited from your project's activities.

The MAMP supports Maine's agricultural communities and those who engage with it by providing alternative dispute resolution through mediation to farmers, their lenders, and others directly affected by the actions of certain USDA agencies, neighbor disputes, and workplace and family disagreements that affect the farm. Resolving disputes through mediation saves time, attorney and court fees, travel, and the family's mental and physical well-being; it supports all sides involved in disputes.



Sharing PFAs Resources with Farmers

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Low levels of PFOS, PFOA and other PFAS are present in our environment. Higher levels are sometimes found near airfields that may have used fire-fighting foams, factories that used these chemicals, or land with a history of using certain waste materials or biosolids containing PFOS, PFOA, or other PFAS. Crops may be grown on soil that has these PFAS, but how much of these chemicals are in the crop depends on the type of crop, what part of the crop is edible, soil properties, and levels in the soil. These chemicals may end up in the milk and meat of animals fed crops like hay containing PFAS. These chemicals can also move from the soil into the groundwater and into well water. Consuming contaminated milk, meat, plants, or water are potential ways people can be exposed to these chemicals. The state of Maine has allocated significant funding for dealing with issues related to PFAS and is dedicated to supporting the landowners who are affected by land application of wastewater sludge and septage, AFFF, Department of Defense sites, landfills or other PFAS sources.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

UMaine Extension has made a dynamic set of resources about on-farm PFAS contamination available online to the public in one location. [“Guide to Investigating PFAS Risk on Your Farm”](#) is a comprehensive collection of resources about contamination from Per- and Polyfluoroalkyl Substances in Maine. Topics include Maine’s response to contamination at agricultural sites, steps to determining risks and mitigation options for farms, and information on the sources of PFAS contamination. The new website is updated as the research and resulting information evolves. The resources are from multiple Maine state agencies, including the Departments of Agriculture, Conservation and Forestry, Health and Human Services, Environmental Protection, and Maine CDC. Supporting organizations contributing information include UMaine Extension, Maine Farmland Trust and Maine Organic Farmers and Gardeners Association.

Briefly describe how your target audience benefited from your project's activities.

At a time when concern about PFAs is burgeoning in Maine, Maine farmers, homeowners and the general public now have a single web-based source for up-to-date information from a myriad of trusted sources including including Departments of Agriculture, Conservation and Forestry, Health and Human Services, Environmental Protection, and Maine CDC; as well as contributing organizations including Extension, Maine Farmland Trust and Maine Organic Farmers and Gardeners Association.

Briefly describe how the broader public benefited from your project's activities.

The conversation about concern about PFAs is broadly public as an issue that has health implications for all citizens in Maine and nationally. The development of this web-resource is a first step in Extension's outreach to bring research-based information to a concerned public. We are also currently developing deeper activities involving staffing and other resources.



So You Want to Farm in Maine

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Current farmers thinking about changing farm enterprises and new farmers interested in starting a farm may lack the skill, knowledge and confidence to investigate their options to start, adapt, and maintain a profitable land-based business. Major issues farmers and potential farmers need to overcome include access to capital, understanding of rules and regulations affecting agriculture operations, and marketing options.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

To enhance the business management knowledge, skills, and confidence of new and established farmers, UMaine Extension developed the *So, You Want to Farm in Maine* (SYWTFIM) series in 2015 and since then 292 people have participated through face-to-face, video-linked, webinar, live-streamed, Zoom, and archived sessions. Participants representing part-time farmers, full-time farmers, and prospective farmers attended to learn about agriculture enterprise selection, business planning, record keeping, market research, regulations, and resource identification.

UMaine Extension created the *So, You Want to Farm in Maine* short-course in 2015. Traditionally offered in person, this is the third year it is available online only. It is designed to introduce farm business management topics to those who are starting farms in Maine. The 2021 session was a bit different as participants include 44 aspiring farmers as well as 11 UMaine undergraduates, providing the opportunity for richer discussions and connections between those interested in starting Maine farms imminently, as well as students with a variety of backgrounds and experience. The undergraduates are teamed with aspiring farmers to create draft business plans over the course of five weeks. Farmers have the opportunity to receive USDA Farm Service Agency borrower training credit, and undergraduates receive one credit.

Briefly describe how your target audience benefited from your project's activities.

We assessed participant knowledge change using a post program evaluation. Participants responding to a program evaluation reported having moderate to considerable knowledge and understanding of the following topics following the program:

- Goal setting and farm business management plan development; enterprise budget development and evaluating profitability;

- land and asset assessment;

- marketing and marketing research;

- recordkeeping (production and financial);

- estate planning and insurance; permits, licenses, and regulations;

- Credible sources of production information and pricing;

- taxes (local, state and federal);

- financial management. Successful completion of this course qualifies participants for FSA Borrower Training Credit.

In 2021, participants who chose to get FSA certification included enterprise budgets totalling over \$139,000 in projected income. Participants since 2015 reported increasing their understanding of the 20 major topics presented by 68% and the Farm Service Agency has provided \$2.7 million in farm direct loans as a result of Maine farmers attending this approved borrower training.

Briefly describe how the broader public benefited from your project's activities.

So You Want to Farm in Maine benefits the broader public by supporting local farms, agriculture and business. The state has over 7,600 farms, more than any other New England state and in 2021, Extension supported a majority of these farms. The SYFTFIM program is one way we extend that support to new and evolving farmers.



In 2-3 sentences, briefly describe the issue or problem that your project addresses.

During 2021, the University of Maine Veterinary Diagnostic Laboratory (VDL) stayed open, providing service to farmers and veterinarians as requested. The VDL provides services to the veterinarians, livestock producers, and animal owners of the state, performing 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.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

In 2021, the VDL allowed egg producers in Maine to keep marketing their product by providing FDA-required screening for Salmonella enteritidis (SE) on midsize to large egg farms. We helped dairies find out whether their cows were affected by mastitis, and if so, what “bugs” were responsible. We helped horse, sheep, goat and cattle owners check to see if their animals need worming, and if so, with what kind of product; we also helped them find out if their chosen product actually worked in their animals. We helped the state animal welfare vets discover whether animals had died due to neglect or cruelty by providing fact-based forensic information via conducting necropsies.

The lab also assisted UM academic researchers by assisting with sample preparation for histologic studies, by collaborating on studies where pathology assistance is needed (including a patent for a biomedical device), and by providing microbiological testing in a new study of multi-drug resistant Staphylococcus aureus (MRSA). We are collaborating with other animal science faculty and with the Maine Department of Inland Fisheries and Wildlife (IFW) on studies of moose health, and are investigating methods for reducing the risk of meningeal worm (*Parelaphostrongylus tenuis*) transmission from white tailed deer to domestic ruminants.

Briefly describe how your target audience benefited from your project's activities.

In 2021, UMaine VDL staff processed more than 3,500 samples and helped inform more than 140 clients about their animals' health. We have helped our staff and clients comply with restrictions imposed by the pandemic, and used creative strategies to keep our productivity within normal limits, at the same time as offering new services. While the Covid-19 pandemic changed the manner in which we operated, we remained open and active continuously during 2021 and we conducted 105 necropsies of many species of animal, from woodchuck to horses in the new UM VDL necropsy room. We were able to host a virtual REU program during summer 2021, and provide an in-person summer program.

Briefly describe how the broader public benefited from your project's activities.

Our lab hires a small number of student workers of diverse backgrounds, who benefit the lab by providing energetic, curious and detail-oriented efforts. These students help us adapt our methods to develop better teaching and outreach materials for farmers, at the same time as they receive mentoring, and develop skills and knowledge that will help them in their veterinary careers. The VDL combines service, research and education to improve agriculture, the food system, and the quality of life in Maine.

Type

Projects / Programs

Projects / Programs without a Critical Issue

0

Not Provided