

Massachusetts (University of Massachusetts) Annual Report - FY2021

Report Status: Approved as of 08/19/2022

Contributing Organizations

University of Massachusetts

Executive Summary

Overview

The 2021 federal year was the second consecutive year that our research and extension programs operated under conditions imposed by the Covid Pandemic. The impact on our programs varied significantly and while it allowed us to identify and utilize new approaches and technologies, the overall net impact was disruptive as basic university systems and services adjusted to new safety rules in laboratories, classrooms and field sites, decreased budgets from loss of revenue, and reduced staff capacity from vacant positions and unsuccessful searches.

Despite these significant challenges The Center for Agriculture, Food & the Environment (CAFE), which manages both UMass Extension and the Massachusetts Agricultural Experiment Station sustained our unique mission to advance research and public education in agriculture, food systems, natural resources and human health. Even during the pandemic, we continued to progress and succeed in advancing environmental quality, agricultural sustainability, the sustainability of water resources, efficiency of energy utilization, community viability, positive youth development, and the viability of food systems from production to consumption throughout Massachusetts and the region. Our faculty, staff and external partners and stakeholders maintained long-standing programs of research, integrated research and extension and educational outreach to address high-priority public concerns. In addition, CAFE provided focused educational services to targeted individuals and groups in ways that advance the Center's vision and facilitated mutually beneficial exchange between citizens and the university while supporting community access to academic, educational and technical resources.

Critical Issue: Child and Family Nutrition

The primary long-term outcome for our programs focused on Child and Family Nutrition is to advance research and education that helps youth and families in Massachusetts to establish healthy eating habits and physically active lifestyles. FY 21 was an extremely difficult year for these Extension programs because of condition imposed by the pandemic. Many programs take place on site with collaborating community agencies where our staff could no longer go and remote programming in these sites was not a viable option. In these cases, alternate resources and activities were developed and disseminated. Many programs also occur in public school settings where educational staff were not allowed. In some of the cases, remote program was offered and provided as a viable alternative. On the research side, several projects managed to make progress this year, most notably in the area of understanding the health and nutrition experiences of immigrant communities and how these experiences inform the design and delivery of subsequent educational resources and programs

Critical Issue: Climate Adaptation and Education

The primary long-term outcome for our programs focused on Climate Change is to advance research and extension in ways that help Massachusetts landscapes, farms, natural and urban system to be managed in ways that reduce or mitigate the effects or risks associated with future changes in climate or weather. The results of our research have been applied in ways that reduce heat islands, improve water quality and other benefits related to climate change mitigation and enhanced quality of life in urban settings.

Our main progress on the extension side continues to be in the form of enhanced networking, communication and collaboration among stakeholder groups in Massachusetts and the region we are working to address and mitigate climate change. The MA Ecosystem Climate Adaptation Network continued to convene regularly reaching new members and develop resources and tools to work and share information and best practices in climate education and intervention more effectively.

Critical Issue: Commercial Horticulture

The primary long-term outcome for our programs focused on Commercial Horticulture is to advance extension and research in ways that help to create an educated and reliable workforce that can operate agricultural businesses and manage landscapes in Massachusetts in a manner that is both economically profitable and environmentally sustainable. With our integrated (Research and extension programs we made progress in understanding the annual bluegrass weevil and how turf managers can effectively manage it and also identified promising practices for container plant and shrub production that reduced plant stress as well as water use. On the Extension side, our long-standing public education programs in turf, landscape, nursery and greenhouse management continued throughout the pandemic without major disruption, providing a wide variety of web-based, printed materials and resources to help professionals manage turf, landscape, ornamentals, etc., in ways that limit the use of harmful chemicals, conserve and preserve clean water and support the long-term viability of the industry.

Critical Issue: Environmental Stewardship

The primary long-term outcome for our programs focused on Environmental Stewardship is to advance research and extension in ways that enable citizens in Massachusetts and beyond to make informed decisions and take actions to preserve or enhance the quality of our natural resources and ecosystems. Many longstanding extension programs were sustained and progressed throughout the past year. Forest and ecosystem conservation programs relied on the use of advanced technology to assess and promote the continuity of habitats while also relying on peer education networks to inform sound land-use decision. Our Pesticide Education efforts helped thousands of workers throughout Massachusetts obtain or maintain their certification while gaining knowledge and skills for how to apply pesticides in ways that are safe for the environment and for human health. Significant progress was also made to inform policy-making and in delivering training to municipal employees in best environmental practices for watershed management. This is especially important in Massachusetts where local governance creates a critical need for a well-defined and widely disseminated set of consistent practices. On the research side, we were very successful in advancing science on pollinators. Basic research revealed insights into conditions that affect behavior and support pollinator health with clear implications and recommendations for Massachusetts growers and conservationists.

Critical Issue: Extension and Experiment Station Administration

We coordinated approximately 60 faculty research initiatives and provided oversight and supervision to 100 staff. We helped leverage additional resources, maintained research and education farms and facilities, ensured accountability and appropriate liaison with state, regional and federal partners.

Critical Issue: Food Safety and Functionality

The primary long-term outcome for our programs focused on Food Safety and Functionality is to advance research and education in ways that ensure the safety and maximize the health benefits of food grown, processed, prepared and consumed in Massachusetts. Our Extension Food Safety program provided a diverse array of online resources, fact sheets, consultation and real-time instruction (virtual and in-person). Participants gained knowledge and skills to improve their ability to implement food safety practices that ensure a safer food supply and reduce the incidence of food borne illness. On the research side, investigations explored the use of food-based nanotechnology to deliver health benefits to consumers. We also progressed in our understanding of dietary factors related to reducing the incidence of certain cancers. Finally, we conducted studies that increased our knowledge of sanitizing agents that can reduce microbial contamination in food production and processing.

Critical Issue: Sustainable Agriculture and Food Systems

Our Extension Fruit team continued to disseminate research-based information to stakeholders through our website and by conducting a variety of online and on-farm meetings, individual consultations and broadly sharing timely updates and information about invasive insect pest management, climate mitigation strategies and the integration of advanced technology. We produced and maintained a lengthy list of publications that include newsletters, production guides, and fact sheets. Our Vegetable Extension team was similarly engaged maintaining significant web resources, conducting on-farm consultations and demonstrations and also organizing and delivering workshops, many of which were conducted remotely. Our Vegetable Team was also active in regional collaborations, conducting a series of winter virtual twilight meetings in collaboration with URI and UConn. In addition, we played a key role in organizing the New England Vegetable and Fruit Conference with our Extension Vegetable team leader serving as Chair of the Conference Planning Committee. We continued our long relationship with Massachusetts cranberry growers with timely diagnoses of ongoing and emerging problems while providing resources and tools to help with managing invasive pests, diseases and to utilize pesticides in ways that reduce environmental risk.

The research in support of Sustainable Agriculture and Food Systems is extensive with investigations from a wide variety of disciplines that include resource economics, biology, microbiology, biochemistry, plant, soil and insect sciences. A selection of highlighted results appears below:

- An investigation into plant uptake of potentially toxic materials in the soil environment found that at low or appropriate concentrations, engineered nanomaterials can promote crop yield and nutritional quality of agricultural products.
- In an investigation of grass stomata function, we discovered 5 different inbred lines of corn that have significantly different closure rates, helping us progress towards our goals of breeding crops that use water more efficiently
- An experiment to understand heat shock proteins (sHSPs) that protect organelles during plant stress confirmed their presence and isolated mutations that no longer produce these proteins
- An investigation of the model grass, *Brachypodium distachyon* completed three replicates of a growth curve for *Bacillus subtilis* which is a promising candidate for developing plant growth promoting bacteria
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- A long-term investigation of fruit tree root stock continued to identify varieties with promising attributes for fruit quality and stress tolerances
- An investigation of microbial communities on the surface of agricultural grasses we established experimental frameworks for assessing drought stress properties
- In an investigation of rhizosphere processes to improve climate resilience of soils and agricultural sustainability we developed a unique combination of microsensors that allows tracking of rhizodeposition at small spatial and temporal scales. We also developed isotope tracing techniques that permits probing the response of stable soil carbon pools and greenhouse gas emissions to rhizodeposition in cropping systems.
- In research on pollen, we were able to characterize a stigma expressed receptor kinase and understand its contribution to enable the first steps in pollination

Critical Issue: Sustainable Energy

The primary long-term outcome for our programs focused on Sustainable Energy is advance research and education that help businesses, towns and citizens in Massachusetts and beyond adopt practices that conserve energy and increasingly utilize alternative, environmentally friendly and renewable sources of energy. On the research side, we continue efforts to understand systems in fungi for bioconversion of woody material to produce useful chemicals. We are also examining the potential for fuel generation from agricultural waste and were successful in establishing protocols for growing a model organism in a bioreactor that produces hydrogen fuel and a metabolic byproduct.

Solar energy is a major focus of our Extension Clean Energy Program and we provide fact sheets, guidelines and direct consultations on a wide array of solar power topics and frequently working with farmers/landowners to create viable plans that will meet state regulatory requirements. We collaborate with extension staff and across academic disciplines to provide technical support and disseminate information.

Critical Issue: Youth Development

Young people are the future workforce and leaders of our state and our nation. The healthy development of these youth cannot be left to chance. Since 1919, the Massachusetts 4-H Program has provided support, resources and educational opportunities to Massachusetts youth. The mission of Massachusetts 4-H is to assist youth in developing life and work skills that will prepare them to be capable, caring and competent adults. Massachusetts 4-H is an active participant in the national 4-H "Grow Leaders" campaign as we work to prepare our youth to be the leaders of tomorrow. A statewide network of thousands of dedicated volunteers and leaders serve as mentors and role models to 4-H youth throughout the state. Volunteers and collaborators lead a variety of clubs, in school enrichment activities, out of school programs and special interest programs that emphasize experiential learning and help youth build valuable life skills. 4-H Educators collaborate with volunteers to plan and deliver local programs, such as animal science, visual presentation programs, and community service projects that have a lasting effect on youth and a positive impact on the future success and vitality of Massachusetts.

Monthly summaries of our progress in achieving our goals can be found at <https://ag.umass.edu/mass4h/newsletters>

Merit and Scientific Peer Review Processes

Updates

None

Stakeholder Input

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

None

Methods to identify individuals and groups and brief explanation

We have begun developing ways to engage previously underserved or unserved audiences, with attention directed specially at reaching urban audiences in Springfield, MA. Urban stakeholders currently provide input for existing program areas in Nutrition Education and youth development, however the goal is to expand input and participation to a broader range of extension and research activities.

Methods for collecting stakeholder input and brief explanation

There was a transition in leadership for the UMass Extension Board of Public Overseers. The previous Chair, Jack Angley, who represented the Massachusetts Farm Bureau Federation, stepped down. Matt Baron, representing the Massachusetts Forestry Association is the new Chair. New Board Members were nominated to represent the 4-H Foundation. When approved, our Board will have improved input from the youth development perspective.

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

The input we obtain from stakeholders is considered in a variety of ways that inform specific programmatic efforts as well as broad organizational priorities and goals. The recent themes emerging from the broader discussions have been how to effectively deliver programs during the pandemic and how to expand access to Extension programs to audiences that have traditionally been underserved. The more focused input we receive from our collaborators and program participants is directed towards helping us to refine existing programs and identify topics for future efforts that better serve our audiences and constituents. This input is combined with internal feedback we gather from staff, program leaders, department heads and aligned faculty. Center administrators meet two times a month and a major focus of these meetings is to consider this input in ways that allow us to effectively integrate research and applied research with public education, outreach and extension.

Highlighted Results by Project or Program

Critical Issue

Child and Family Nutrition

Immigrant Women's Experiences with Health and Food Access

Project Director

L Cordeiro

Organization

University of Massachusetts

Accession Number

7000271



Immigrant Women's Experiences with Health and Food Access

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

The primary goal of this project is to understand how migration impacts women's health, nutrition, and access to healthy cultural foods. There is a dearth of research on the nutritional status, maternity and postnatal experiences of immigrant women, particularly with respect to how women adapt to new environments and manage their childbearing years, separated, as they are, from traditional support systems and cultural practices. We will use the findings of our literature review, examination of primary and secondary data, and training expertise to hold workshops for NEP staff and community providers on immigrant women's health, maternal and child health, and access to health cultural foods.

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.

Through community engagement, interviews, and surveys of 10-15 immigrant women, as well as secondary data analysis of data on immigrant and refugee women in Massachusetts, our project demonstrated the importance of the migration experience, place of residence, and host communities in facilitating optimal health and nutrition outcomes for immigrant women and their families. In collaboration with the UMass Extension Nutrition Education Program (NEP) staff, we developed a breastfeeding nutrition education module and webinar. All NEP field staff watched the webinar and discussions will be held with the group to determine other training needs. We also collaborated with the Cambodian Mutual Assistance Association of Greater Lowell. These activities increased engagement of our extension educators and community partners in research on their communities and facilitated an accurate interpretation of research findings. We trained and supported three doctoral, two Masters, and one undergraduate student.

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

The target audience for this project were:

- UMass Amherst students

- Community partners
 - Cambodian Mutual Assistance Association of Greater Lowell, MA

 - UMass Extension Nutrition Education Program (NEP) staff and educators

- Community members
 - Cambodians living in Massachusetts

 - Immigrant women living in the U.S.

 - Low income communities

Benefits:

UMass Amherst Students: This project employed five doctoral students, two master's students, and one undergraduate student. Student received training in research and community engagement. Students were closely mentored with success in advancing their time to graduation. Two student successfully completed their doctoral programs, on student will defend his doctoral research in Summer 2022, and one student will sit for her comprehensive doctoral exams in Fall 2022.

Community partners: This project included the community partners as co-authors on manuscripts submitted for publication. We will share our results with the community partners for their use in securing grants for service provision to the community. We provided training to UMass Extension Nutrition Education Program (NEP) staff and educators on breastfeeding. We developed a video-based webinar for easy access of the breastfeeding module during the pandemic. One graduate student worked with Lynne Beattie, NEP Materials, Evaluation, & Training Manager, on the video.

Community Members: This project collected and analyzed data from immigrant/refugee women. We plan to hold community forums to disseminate our findings.

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

We were able to:

1. Raise awareness for community members and policymakers about immigrant women's health, the impact of migration on health experiences and food access.
2. Increase engagement and knowledge of NEP staff through the provision of NEP-identified training session on breastfeeding.
3. Raise awareness in academia on the impact of migration on women's health and food access.
4. Connect with community members to determine what areas to focus on for future research.

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.

Products:

1. Breastfeeding Webinar for NEP field staff
2. IRB protocol/Interview guide

Manuscripts under review in peer-reviewed journals

(*student, # community partner; bold lettering =research team):

1. *Hsiao BJ, Laws H, **Cordeiro LS**, O'Campo P, and **Sibeko L**. Breastfeeding duration lowers allostatic load: a protective mechanism for maternal health. *Breastfeeding Medicine*.
2. **Nelson-Peterman J**, *Modarresi Ghavami S, Carbone E, **Sibeko L**, and **Cordeiro LS**. Food security and food experiences of Brazilian and Cambodian immigrants in Lowell, MA. *Journal of Immigrant and Minority Health*.
3. **Nelson-Peterman J**, **Sibeko L**, #Mouth R, and **Cordeiro LS**. Building on Community Research Partnerships and Training Students in a Multi-phase Community-based Participatory Research Study with Young Women of Cambodian Heritage in Massachusetts. *Health Promotion Practice*.
4. **Cordeiro LS**, *Ahnan-Winarno AD, *Dou N, **Sibeko L**, Johns T, #Mouth R, and **Nelson-Peterman J**. Knowledge, attitudes, and behaviors of traditional maternal health practices among Cambodian women, 15-35 years, living in Massachusetts. *BMC Pregnancy and Childbirth*.

Climate Adaptation and Education

Climate Change Adaptation

Project Director

Melissa Ocana

Organization

University of Massachusetts

Accession Number

7002057



Connection, Coordination and Preparation for Climate Change

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

For National Project:

At the national level, I focus on the need to better connect and coordinate on climate change through networks and collaboratives. This includes climate practitioners and thought leaders across the country working to build partnerships locally, regionally and nationally. I also help set the national agenda for the field of climate adaptation through leadership in our professional society and advising on outreach outputs and grant program directions.

For Mass ECAN Project:

My work is focused on climate change adaptation, which is about responding to and preparing for climate impacts. Everyone is impacted by climate change, but I focus on working with audiences of practitioners and researchers tackling adaptation. They come from a variety of organizations from academia, conservation non-profits, businesses, and state, federal, regional, and local agencies. The work of these practitioners and researchers vary with some focused on implementation projects on the ground to protect people and ecosystems, others conducting research on best practices, and others dedicated to education and outreach. By connecting and building the capacity of those working on these issues, our program has a greater ultimate impact on adaptation practices and outcomes that ensure the well-being of people, wildlife and ecosystems in a changing climate.

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.

For National Project:

At the regional and national level, I continued to connect networks of adaptation networks across the country through our Network of Networks Group for leaders of climate collaboratives. New this year was the founding of a higher level Networks of Networks group to share lessons learned and collaborate among the leads of the federal adaptation networks and forum for regional climate collaboratives. Also new this year, I joined the Steering Committee and helped the fledgling National Extension Climate Initiative to grow.

For Mass ECAN project:

FY 2021 was a busy one despite the challenges of the ongoing pandemic. I continued to provide capacity building and education on climate adaptation, and facilitate connections and peer learning among practitioners and researchers. Through Mass ECAN (Ecosystem Climate Adaptation Network), our statewide community of practice: organized our first remote Fall Events Series, held 3 additional successful Zoom networking events, conducted our first ever member survey, developed onboarding resources for new members, continued to convene five affiliated expert work groups, and launched new outreach toolkit on watershed-scale climate collaboration. I've compiled 2021 Mass ECAN highlights here. I also received our first foundation grant to support a few initiatives over the next two years. Closer to home, I also organized a convening of UMass Extension staff and faculty around climate change to build relationships and understanding of each other's work.

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

For National Project:

The Network of Networks group has grown to 242 members. The new higher-level Networks of Networks gatherings have provided a much needed space for coordination and collaboration among leadership that had not previously been in conversation.

I provided expertise in network building and structure and event planning to help the NECI group get off the ground running and ensure good organizational housekeeping. NECI hosted a Spring Climate Action Forum to accelerate prioritization of actions. In particular, I hosted a networking event to connect Extension staff and faculty across the country as part of the Forum. NECI has already helped elevate climate change in the conversation within USDA Cooperative Extension

For Mass ECAN Project:

Despite the pandemic, I prioritized creating remote opportunities to engage and connect. In this period, we had 163 new members join Mass ECAN. The transition to an all-remote events series in place of our usual in-person conference went extremely well. We were able to drive conversation about timely and emerging adaptation topics (nature based solutions and joint mitigation-adaptation). There were a total of 196 participants over the three events. Evaluations from these events and our member survey provided insights into the experiences of our audience, our impacts and suggestions for improvement. From our member survey (n of 41), some noteworthy findings were:

- 90% of respondents are somewhat or very satisfied with their Mass ECAN experience
- 90% of respondents read at least the majority of newsletters, 43.9% read all
- 82% reported that Mass ECAN was very or somewhat effective at facilitating knowledge sharing and collaboration among practitioners (17% not sure)
- 90% reported that Mass ECAN was very or somewhat effective is Mass ECAN at providing you access to information, resources, and talking points that you can use in your climate adaptation planning and practice (10% not sure)

In terms of outreach and education, our new onboarding recommended reading list helps ensure all new Mass ECAN members are on the same page about adaptation 101. Our Slow the Flow and Climate Communications Work Groups collaborated on the first piece in our new toolkit – an overview of Watershed-Scale Climate Collaboration – which we’ll be building on in the coming year with additional funding. This topic is of great interest at the moment and we hope to encourage more support and engagement in watershed collaboratives across our state.

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

With the collaboration of many partners, we have developed accessible publications that break down effective ways to collaborate and protect people, places and ecosystems from climate-intensified risks and vulnerabilities. These resources include both compelling photographs of the problem as well as bulleted steps to address a multitude of issues. They include: [Watershed Scale Climate Collaboration\(link is external\);](#); [Taking Cues from Nature to Ada12t to Climate Change \(link is external\);](#); [Ada12tation Actions for Resistance, Resilience, and Transformation\(link is external\);](#), [Promoting Peer to Peer Learning for Climate Ada12tation](#)

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.

National-level Climate Adaptation Capacity Building

Project: MASS ECAN

Facilitated Group Meetings and Conferences

- Field trips – (4) 94 participants
- Resistance, Resilience and Transformation Workshop for Conference (1) – 60 participants
- Climate Communication Networking Event for Fall Conference (1) – 23 participants

Facilitate and coordinate six expert work groups (25) – 240 participants

Nature Based Solutions Case Studies (3) – 150 participants

Newsletters (11) – 500 participants

MASS ECAN Website (1) 2737 participants

Workshops, trainings and invited presentations (5) – 173 participants

Project: National-level Climate Adaptation Capacity Building

Facilitate and coordinate peer learning for climate network adaptation network organizers across the country (Facilitated Group Meetings and Conferences)

- ASAP Network of Networks Gatherings (12) – 273 participants
- Cross networks of networks meeting (1) – 8 participants

Participate in committees/groups for national level initiatives to advance the field of climate adaptation. (Committee or Board Service)

- ASAP Group Leads (2) – 12 participants
- National Adaptation Forum Planning Committee (3) – 25 participants

Critical Issue

Commercial Horticulture

Sustainable Landscape Management and Nursery Production

Project Director

Jason Lanier

Organization

University of Massachusetts

Accession Number

7002036



Sustainable Landscape management and Nursery Production

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

The UMass Extension Landscape, Nursery, and Urban Forestry Program works closely with the UMass Extension Turf Program to educate landscape, nursery, urban forestry, and turf professionals by providing educational programming and research-based information on the best horticultural practices and technology for environmental stewardship in nursery and landscape management. The core of the Program is a group of educators and specialists in weed science, entomology, plant pathology, plant materials, alternative pest controls, and diagnostics. Working with the largest and fastest growing commercial agricultural segment in Massachusetts continually challenges the Landscape, Nursery, and Urban Forestry Program to address the industry's immediate problems and to anticipate future educational requirements. The landscape and nursery industry contributes an estimated \$2 billion in sales to the Massachusetts economy, and employs over 12,000 individuals at approximately 5,000 companies. **Examples of the industry's immediate problems for FY21 (the issues we addressed) include but are not limited to: identification of insect, disease, and weed pests; management, identification, biology, and life cycles of invasive insects; management of invasive plants; best management practices when using pesticides to reduce potential impacts to pollinators; management of woody plants and turf in ornamental landscapes; and information pertaining to preventing tick-borne disease. Additionally, there was an overwhelming increase in public concern about jumping/snake worm species in Massachusetts in FY21.**

These issues are of great significance to landscapers, arborists, land managers, nursery owners, and other Green Industry professionals in Massachusetts, New England, and the greater USA and Canada due to the great potential for economic, ecological, environmental, and human health impacts. For example, using a *single* invasive insect as an illustration of potential impacts: the spotted lanternfly (SLF) is considered a major crop pest of peaches (crop value \$4 Million in Massachusetts in 2017) and grapes (crop value \$1.3 Million in Massachusetts in 2019). In addition SLF has been reported to feed on a wide range of plants native or commonly found in the Northeast and promises to be a significant nuisance for the citizens and property owners of Massachusetts, as it becomes established. Educating Green Industry professionals about the potential impacts of, how to identify, and where to report suspected spotted lanternfly specimens can help protect *potentially* \$26.3 million worth of agricultural crops in MA, not to mention the value of managed landscapes in our state. Now that a breeding population of spotted lanternfly has been detected in Fitchburg, MA, this information is more important than ever.

Our stakeholders, as well as the general public of Massachusetts, care deeply about the issues the Landscape, Nursery, and Urban Forestry Program addresses. Our goal is to promote research-based information on the best horticultural practices and technology currently available to the stakeholders we serve. For a snapshot of the demand from stakeholders and the public, the Landscape, Nursery, and Urban Forestry Program website was accessed **533,849 times between 10/1/2020 – 9/30/2021 alone**. (Representing a **14.43% increase** from the same time period in FY20.) Of those, **475,191 represent individual (unique) page views** originating from different machines/devices. Therefore, one could infer that our program's online resources alone reach at least 475,191 individuals. (Representing a **15.77% increase** from the same time period in FY21.)

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 Landscape, Nursery, and Urban Forestry Program conducted the following in FY21 (10/1/2020 – 9/30/2021):

- 2020 Green School – 12 day certification program

- 2 in-person programs (outdoor pest and ornamental ID walks)

- 26 live webinars/virtual events

- 1 short video about insect identification

- 1 short interview about tick borne disease prevention (TickCheck)

- A minimum of 10 invited presentations

- Published 10 Issues of Hort Notes

- Published 21 Issues of the Landscape Message

- Published the 2021 Garden Calendar

- One-on-one consultations – approximately 1,519 weed and insect related phone calls and emails and 2 site visits

- Greeninfo/Master Gardener volunteer consultations - 794 contacts (emails)

- Additional website, fact sheet, news article updates not reported here

These combined 29 in-person/live webinars/virtual events were attended by a total of approximately **4,262 individuals who received approximately 257 hours of education.**

10 issues of Hort Notes were published in FY21. According to Google Analytics, there were **32,654 unique pageviews** and **39,208 total pageviews**. On average, users spent **3 minutes and 33 seconds** reading Hort Notes each time they visited.

21 issues of the Landscape Message were published in FY21. According to Google Analytics, there were **34,163 unique pageviews** and **38,838 total pageviews**. On average, users spent **3 minutes and 7 seconds** reading the Landscape Message each time they visited.

A total of 1,926 individual customers purchased **a total of 8,363** (2021) Garden Calendars between 9/1/2020 and 1/1/2021.

These numbers represent only a fraction of the Landscape, Nursery, and Urban Forestry Program's efforts to conduct and provide **individual day-long programs, certificate programs and multi-day education, individual invited presentations/talks, newsletters**, fact sheets, Professional Disease Guide, Weed Herbarium, **Garden Calendar**, diagnostics (in partnership with the UMass Plant Diagnostics Laboratory), one-on-one education (phone calls, e-mails, social media messages), and external media requests. The details for the items in bold are described in the narrative here, as well as in our outputs/activities. However, for the additional items mentioned here (fact sheets, one-on-one consultations, and other online resources), for the sake of the brevity of this report, these numbers and projects have not been discussed or reported in detail but can be provided upon request.

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

We also maintain partnerships with Massachusetts professional associations, local, state, and federal government agencies, and UMass faculty to tackle the most pressing issues facing the industry. As requested, we provide articles to professional associations to highlight these issues to their members in their own publications and newsletters. Our program has also collaborated on grants and interdepartmental service agreements with the MA Department of Agricultural Resources and the MA Department of Conservation and Recreation. (For example, there is a long-standing interdepartmental service agreement with the MA DCR that again in FY21 provided funding to the Landscape, Nursery, and Urban Forestry Program and the UMass Plant Diagnostics Laboratory.) We work closely with members of Cape Cod Cooperative Extension and Plymouth County Extension as frequently as possible

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

The most important results of the Landscape, Nursery, and Urban Forestry Program's efforts for FY21 are evidenced in the body of work reported on above. If we look at the number of unique visits to the LNUF Program's website, the number of individuals who attended our in-person, live webinars/virtual events, the number of views of our insect identification video, and the number of people who purchased the 2021 Garden Calendar, our program has reached an estimated **481,379 individuals in FY21, an 11% increase from the last reporting year.**

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.

- Community Tree Conference (Facilitated Group Meetings and Conferences) (1) - 181 Participants
- Garden Calendar (Printed Material (newsletter, factsheet, field manual) (8363) - 1962 participants
- Green School 2020 (Teaching Other) (1) - 1962 Participants
- Hort Notes: Clippings from the Garden (Websites or Other Electronic Delivery) (10) - 32654 Participants

- InsectXaminer (Websites or Other Electronic Delivery) (1) - 656 Participants
- Invasive Insect Management (Workshop series or educational course) (7) - 1524 Participants
- Invasive Insect Webinar Series (Websites or Other Electronic Delivery) (8) - 1228 Participants
- Invasive Plant Management Workshops (Single day workshop, presentation or event) (4) 227 Participants
- Invited Presentations (Presentation/Poster (Academic) (10) - 719 Adult Participants, 20 Youth Participants
- Landscape Message (Websites or Other Electronic Delivery) (21) - 34163 Participants
- Landscape, Nursery, and Urban Forestry Program Website (Websites or Other Electronic Delivery) (1) - 475191 Participants
- Landscape, Nursery, and Urban Forestry Walkabouts (Facilitated Group Meetings and Conferences) (2) 55 Participants
- One-on-One Consultations with Stakeholders (Individual Consultations and Site Visits) (2417) 2417 Participants
- Pest Management Weeds, Insects, and Diseases (Single day workshop, presentation or event) (3) - 380 Participants
- Site Visits (Direct - Other) (2) - 2 Participants
- Sustainable Landscape Management (Single day workshop, presentation or event) (3) - 473 Participants
- Sustainable Landscape Management Education (Workshop series or educational course) (2) - 309 Participants
- TickTalk with Tick Report! A Live Webinar Series (Websites or Other Electronic Delivery) (3) - 671 Participants

The members of the Landscape, Nursery, and Urban Forestry Program are valued by stakeholders in Massachusetts, New England, and nationally as experts in their fields as well as trustworthy sources of science-based information. This is clearly evident in the anonymous evaluations we receive from stakeholders following presentations provided by Program faculty and staff. Some notable examples include:

“Wonderful material, excellent examples and clear presentation. Thanks!” **and** “Yes, yes, and yes. This class was filled with useful information throughout and was well delivered by Professor Brazee.” **and** “Excellent presentation! Good info and a coherent flow to the information.” – *Anonymous evaluations of Dr. Nicholas Brazee from UMass Extension’s 2020 Green School*

“Had a great time, learned a good amount, and Randy made weed science hilarious and covered a lot of important basics!” **and** “Randy was informative and kept things light with just a little bit of humor.” **and** “I thought it was going to be super boring at first but it ended up being really interesting and useful. I really appreciated Professor Prostack's remarkably dry sense of humor, that was not lost on me.”

– *Anonymous evaluations of Randy Prostack from UMass Extension’s 2020 Green School*

“Very nice and straightforward presentation.” **and** “Thorough discussion for each topic covered, clear presentation, practically helpful! Thanks!” **and** “The professor was very responsive to all our questions; made himself available for further questions via email. Having the outlines is very helpful.”

– *Anonymous evaluations of Geoffrey Njue from UMass Extension’s 2020 Green School*

“I never realized before this class that turfgrass insect pests were a major gap in my landscape knowledge and having a little introduction into the subject matter will help me educate myself more going forwards.” **and** “This was an excellent class! Thank you, Professor Kostromytska. The content was presented well and all of the slide images were very helpful.” **and** “This was very informative, I didn’t know most of the basics of these pests. It is a great start/overview of the pest field...As an aside, Professor Kostromytska has an amazing narrative and teaching voice and could totally record an audio lecture or podcast series in her field.”

– *Anonymous evaluations of Dr. Olga Kostromytska from UMASS Extension's 2020 Green School*

“Thorough and knowledgeable! Info was pertinent & well presented. Thank you!!” **and** “Thank you, Professor Bayer. This was an excellent class which I very much enjoyed! Always intimidating when trying to tackle all of the Latin for me esp. in the field. Your presentation of the material was manageable and pleasant to absorb. I am looking forward to going back through your lectures in the off season. Have your best day!” **and** “This was a great intro to woody plants, I really like Professor Bayer’s teaching style and presentations. I appreciate that she included a varied amount of information, as the students range from new industry students to seasoned professionals!”

– *Anonymous evaluations of Dr. Mandy Bayer from UMass Extension’s 2020 Green School*

“This has been my favorite lecture thus far - I am so excited about examining the integration of the different subjects we’ve been talking about, and layering that with the human factors to help care for our plants in the best way possible. This lecture made me wish I could take semester long courses on the material!!!” **and** “Very interesting - covered great topics and things to consider - thanks!” **and** “Thanks to Rick for a great presentation!”

– *Anonymous evaluations of Dr. Rick Harper from UMass Extension’s 2020 Green School*

“Thank you Professor Madeiras. I enjoyed this class. It is a significant amount of information and all of it is incredibly interesting.” **and** “Excellent review of basic concepts.” **and** “Clear presentation of material that was well organized and helpful for learning what we need to know for proper diagnoses of plant diseases. Very, very helpful. Thanks!”

– *Anonymous evaluations of Dr. Angie Madeiras from UMass Extension’s 2020 Green School*

“Very patiently and methodically outlines the information.” **and** “Thanks for explaining things the way you do, it helps me retain everything.” **and** “Excellent presentation of detailed information in a manner that was not overwhelming and had common concepts at the core.”

– *Anonymous evaluations of Jason Lanier from UMass Extension’s 2020 Green School*

“Brilliantly conducted and presented with excellent tangible outline and extension materials. If you did a half year course Tawny, I would take it. Excellent teacher (from a teacher).” **and** “Tawny has made a subject that I have never found all that appealing to become much more accessible. Never thought of insect parts to be cute. Loved the pics and diagrams to help understand what to look for in ID. Great teaching approach and personality to tackle a dense topic.” **and** “Tawny is an excellent instructor! Thank you, Tawny. Super interesting topic with an overwhelming amount of data. The detailed notes/outline are greatly appreciated.”

– *Anonymous evaluations of Tawny Simisky from UMass Extension’s 2020 Green School*

Program Support & Teamwork:

It is also very worthwhile to note that (always) but especially during the continuation of the COVID-19 pandemic, having the programmatic support and enthusiastic teamwork from the members of the LNUF Program has been *critical* to our success. While all of the faculty and staff topic experts have provided crucial education needed in FY21 for our stakeholders, there are a few equally important individuals who should be recognized for their efforts this year. In particular, none of these programs would have run smoothly, and far fewer of them would have been done, without the essential support from Ellen Weeks (educational programs coordination and program technical support using Zoom), Doreen York (financial and program support services), and Geoffrey Njue (topic expert, but also program technical support using GotoWebinar).

The Working Group on Improving Microbial Control of Arthropod Pests

Project Director

Olga Kostromytska

Organization

University of Massachusetts

Accession Number

7000502



Microbial Control of Arthropod Pests in turfgrass and landscapes

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

Implementation of the IPM in the turfgrass and landscapes system is challenging, because of the high aesthetic demands and heavy reliance on conventional chemical insecticides. To make matter worse limited options are available for the chemical control of insect pests in the turfgrass. Some active ingredients are losing efficacy due to the resistance to insecticides, use of others becomes restricted and/or pulled from the market. At the same time recent demands on environmentally friendly, less toxic approaches to insect pest management. One of the promising alternatives is biocontrol or microorganisms, such as fungi, bacteria, and their metabolites, nematodes as an alternative to conventional chemicals. However, using living organisms as a way to control insects are challenging and efficacy is greatly dependent on the application techniques, weather condition, and other factors. Another source of reluctance to use biocontrol agents for pest management in turfgrass and landscapes is the lack of the robust efficacy data. The broad goal of the project is to investigate the efficacy of the microorganisms against major turfgrass and landscape insects and promote the use of biocontrol as an effective IPM tool to manage insects in turf and landscapes, by presenting the results of work through training and lectures.

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 research conducted in my lab is largely applied and focuses to solve major issues, and questions arising in the field of pest management of turfgrass insects. During the growing season, we conduct multiple studies to investigate the efficacy of various chemical and biological insecticides against turfgrass pests, and how to optimize available and new management tools. A lot of effort is dedicated to the management of the annual bluegrass weevil, the most destructive and hard to control insect pest in the Northeastern United States. Demand for information about the biology, phenology, and management recommendation for this pest is consistently high. Recently this pest has been developing resistance to major widely used chemical classes of insecticides, and it's affecting the efficacy of other chemical classes. I provide the resource and conduct on-site visits and resistance testing of populations on the Massachusetts golf courses, with relevant for each site recommendations. According to our investigations and testing, pyrethroids resistance in Massachusetts is widespread and levels are high in some locations.

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

The results of the project provided turf managers with the additional alternative tools for insect pest management, which can be used as rotation to mitigate the insecticide resistance development and potentially can limit the use of conventional chemical insecticide in turfgrass and landscape systems. Particularly the efficacy of entomopathogenic nematodes (EPNs) including new commercially available nematode species *Steinernema scarabaei* which in the previous research-proven to be very virulent against various white grubs species. Efficacy of *Bacillus thuringiensis* var galleria was determined in the field and greenhouse studies.

As a possible curative option to control Oriental beetle and Asiatic garden beetle grubs. The results of the studies were shared through the presentation on insect pest management of the turfgrass pests at industry conferences, pest management trainings, and undergraduate courses.

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

Results of my research help to improve the efficacy of the biocontrol agent, microorganisms and integrate them into IPM, promoting the use of the biocontrol agents as alternatives to conventional chemical insecticides, decreasing overall toxicity, and hazards to the environment and non-target organisms. Promoting the use of biocontrol agents, and educating pest managers will increase likelihood of using the biocontrol agents as an alternatives to the chemical insecticides in urban settings. It also will provide an option of reduced risk, or insecticides free approach to management of turfgrass and landscape insects

Critical Issue

Environmental Stewardship

Fish, Wildlife & Biodiversity Conservation

Project Director

Scott Jackson

Organization

University of Massachusetts

Accession Number

7002178



Fish, Wildlife and Biodiversity Conservation

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

In addition to traditional resources such as water, fisheries, wildlife and forest products, natural ecosystems are valued for biodiversity, open space, aesthetics and recreational opportunities. Because we know so little about the myriad ecological connections that organize ecosystems into self-sustaining entities, maintaining and restoring the ecological integrity of ecosystems is an essential component of natural resource conservation. The window of opportunity for effective land conservation in southern New England may be only 10-20 years. After this time, the unprotected landscape is likely to be too fragmented to be of much value for supporting wildlife or sustaining forest-based businesses. Climate change, its impacts on natural resources and the role of natural ecosystems in buffering the impact of climate change on human communities has emerged as one of the most significant and challenging issues of our time. Despite an incomplete understanding of the how climate change will manifest at local and regional scales, land and resource managers will make decisions with the potential to either promote or compromise long-term integrity of natural ecosystems.

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 Fish, Wildlife, and Biodiversity Conservation program represents the coordinated efforts of Extension faculty, professional staff, and external partners to identify and conserve critical natural resources of Massachusetts. The program focuses on important resources and services that ecosystems provide and pursues ecosystem and resource management strategies promoting the sustainable use of natural resources and maintenance of ecological integrity. We focus on research-based outreach strategies and key target audiences that can amplify our efforts and achieve our goals.

Target Audiences

- Landowners

- Community leaders

- Land managers

- Natural resource professionals

- Municipal officials

- Conservation organizations

- Regional Planning Agencies

- Agency personnel

The goal of the program is to facilitate ecological assessment and conservation priority setting to promote strategic land conservation, sustainable use of natural resources, and management to protect and enhance natural resources and ecological integrity

Objectives

- Use landscape-scale modeling and decision support tools to facilitate strategic land conservation and spatially explicit climate adaptation

- Identification and assessment of landscape fragmentation and development of strategies to conserve and restore aquatic and terrestrial connectivity

Approaches and Activities

- Use of the Conservation Assessment & Prioritization System (CAPS), Designing Sustainable Landscapes (DSL), and Critical Linkages to provide landscape-scale information to inform conservation decision-making

- Provide training and technical support to organization and agencies on the use of road-stream crossing assessments to identify opportunities to restore aquatic and terrestrial connectivity

- Work with conservation partners to use ecological assessments and conservation designs to guide land conservation and forest stewardship

- Conduct presentations and workshops on climate change adaptation, landscape connectivity, strategic land conservation, and data sources and tools for conservation

- Maintain the Massachusetts Ecosystem Climate Adaptation Network (Mass ECAN) and the associated MassECAN.org website and online MA Wildlife Climate Action Tool

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

The Fish, Wildlife and Biodiversity Conservation program will provide the following benefits to target audiences.

- Updated ecological assessment data were generated and made available for the 13-state northeastern U.S.
- Landscape models identified climate refugia and assessed regional connectivity
- Road-stream crossing assessments were conducted and those data used in landscape-based connectivity modeling
- Integration of CAPS, DSL, and Critical Linkages data into Biomap3 (Massachusetts) and Nature's Network (USFWS) conservation designs
- CAPS, DSL and Conservation Tools websites provide information about, and links to, data sources and tools to guide land conservation and forest stewardship
- Conservation organizations and agencies have access to datasets based on sophisticated landscape modeling and assistance in using those data to prioritize conservation action
- Municipal officials, landowners, land managers, and natural resource professionals will use spatially-explicit information to guide land management and forest stewardship decisions

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

The Fish, Wildlife and Biodiversity Conservation program uses state of the art landscape models to better understand how human development is impacting natural ecosystems that provide clean air and water, forest products and other natural resources, fish and wildlife, biodiversity that represents raw material for improving human welfare, and a buffer from the adverse impacts of climate change. Online resources such as websites and decision support tools, training programs, networking opportunities, and public education builds capacity at the local, state and regional levels to protect and restore the ecological integrity of natural ecosystems so that they can continue to provide ecosystems services to future generations of Massachusetts residents.

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.

- Massachusetts Climate Adaptation Partnership (2) - 15 Participants serve as convener for the MA Climate Adaptation Partnership. This partnership includes the MA Office of Coastal Zone Management, MA Division of Ecological Restoration, MA Division of Fisheries and Wildlife, Harvard Forest, EcoAdapt, The Nature Conservancy, the DOI Northeast Climate Adaptation Science Center, and UMass Amherst. This is an action-oriented partnership to share and support best practices, conduct research, facilitate engagement, provide technical assistance, and implement projects across Massachusetts for climate change adaptation. This past year, the Partnership oversaw the work of six work groups, focusing on: cold-water streams, salt marshes, Southern New England forests, rivers and streams (“slowing the flow”), climate change communication, and main-streaming nature-based solutions.

- MA Wildlife Climate Action Tool (1) - 30546 Participants
September 1, 2020 through August 31, 2021, the Massachusetts Wildlife Climate Action Tool (www.climateactiontool.org) recorded 36,407 visits from 30,546 users. Of these, 10,767 visits were from 9,115 MA users. Despite the inclusion of “Massachusetts” in the name of the site/tool, 70.2% of the users and 70.4 % of visits were from people outside of Massachusetts, suggesting broad interest in this new type of climate adaptation education tool.

- Workshops, presentations and technical assistance on climate change adaptation (8) - 244 Participants
Over the course of the past year, I conducted eight workshops and presentations on the topic of climate change adaptation reaching 244 participants for a total of 253 contact hours (244 participants x program length).

- Continue Development of CAPS software and related tools (3)

- Funding for graduate research (4) - 7 Participants

- Interpret and apply CAPS results - A technical report on the 2020 Massachusetts CAPS assessment was produced: Compton, B. C., S. D. Jackson, and K. McGarigal. 2020. Conservation Assessment and Prioritization System (CAPS) Statewide Massachusetts Assessment: December 2020. Landscape Ecology Program, University of Massachusetts Amherst. 59 pp. (1) - 800 participants

- Maintain and Enhance MassCAPS Web Site (1) - 1583 Participants

- Service on Graduate Research Committees (1)

- Salt Marsh UAS Project - completion of a technical report summarizing work over the first three years of this research: **Jackson, S.**, A. Davis, K. Fickas, R. Wicks, J. Ward and C. Schweik. 2021. Developing Methods for Remote Sensing of Salt Marsh Condition using Unoccupied Aerial Systems (UAS). Final Report for EPA FY 2015-2016 Wetlands Program Development Grant CD 00A00312-3. July 26, 2021. University of Massachusetts Amherst, MA. 45 pp. (1) - 8 participants

- Workshops on the results and use of CAPS analyses (10) - 399 Participants

- Continue development and refinement of crossing standards, assessment protocols and training materials, and scoring algorithms - A final version of a new data visualization tool, the NAACC Stream Crossings Explorer (NAACC-SCE) was publically released. The tool is built into the search function of the NAACC database, which can be accessed at naacc.org. (1) - 500 Participants

- Maintained the Aquatic Connectivity Scenario Analysis Tool (<http://ecosheds.org/aq-connectivity-tool/#/>). (1) - 500 Participants

- Coordinate and lead the North Atlantic Aquatic Connectivity Collaborative (NAACC) (1) - 500 participants

- NAACC 2 day training workshop (1) - 500 participants

- Maintain and expand content for the "streamcontinuity.org" web site (1) - 3809 Participants

Harnessing Chemical Ecology to Address Agricultural Pest and Pollinator Priorities

Project Director

Lynn Adler

Organization

University of Massachusetts

Accession Number

1023712



FY21 annual report for “Harnessing chemical ecology to address agricultural pest and pollinator priorities”

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

Pollinators are essential for food security and declining for many reasons, including exposure to pesticides and pathogens, declining food resources, changing land use, and global climate. Our work will address how some of these stressors interact to affect pollinator abundance, diversity and health. Taken together, this work represents a comprehensive approach to understand some of the factors involved in pollinator decline.

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.

— Graduate student Carolina Muñoz Agudelo completed an experiment asking whether drought affects pesticide concentrations in pollen of three seed-treated crops: squash, sunflower and cotton. This was a massive undertaking that took up much of spring, summer, and early fall 2021.

- Carolina Muñoz Agudelo also spent spring 2020 working with undergraduate Bryanna Joyce to assess pollen deposition to sunflowers from 14 farms in western Massachusetts as part of a project asking how farm resources and land use surrounding farms affect pollination services.

- Graduate student Alison Fowler published research assessing the impact of sunflower pollen on *Crithidia* in 3 wild-collected *Bombus* species: *impatiens*, *vagans* and *bimaculatus*. We found that sunflower did not reduce *Crithidia* as dramatically in the other two species as in *B. impatiens*. This study also assessed the costs and benefits of sunflower vs. wildflower pollen on microcolony reproduction of infected vs. uninfected bees for wild-reared *B. impatiens*, results are still being analyzed but we do detect a cost of consuming sunflower pollen for reproduction.

- Graduate student Luis Aguirre published work showing that bumble bee infection alters time spent foraging on damaged compared to undamaged tomato plants, suggesting that infection can alter the consequences of leaf damage for pollination services.

- Graduate student (former undergraduate) Justin Roch published his discovery of a new bee species for New England that he discovered while assessing bee diversity on sunflower farms. The major results of this research are about to be submitted for publication; Justin found that both bee sex and flower sex (pollen-producing or pollen-sterile) structure the community of bees found on sunflowers.

- I published results of previous experiments attempting to determine the mechanism underlying the medicinal effect of sunflower pollen. We found no evidence that fatty acids or multiple secondary compounds are responsible for this effect (Adler et al, 2020). I also lead an invited review manuscript evaluating the role of floral traits in transmission of beneficial and pathogenic microbes (Adler et al, 2021).

- I led a new 5-year NSF grant from the Integrative Biology program to understand the role of plant species including Asteraceae in structuring pollinator-pathogen interactions, integrating molecular, individual, species and community levels:

2022-26 NSF IntBio. “Collaborative Research: Integrating molecular, cellular, organismal and community scales to understand how plants structure pollinator-pathogen dynamics.” **L. S. Adler (lead PI)**, L. L. Figueroa (co-PI), R. E. Irwin (PI), C. Myers (PI), M. Povelones (PI), S. Jha (PI), P. Stevenson (co-PI), E. Suárez (Senior Personnel). 1/01/22 - 12/31/26. **\$2,430,711 (\$907,295 to UMass as lead; \$585,424 direct and \$321,871 indirect).**

- I also wrote a new NE SARE Research Innovations grant to assess whether cut flowers from the sunflower family could provide an opportunity for farm plantings that improve pollinator health:

2021-23 NE SARE Research for Novel Approaches LNE21-424R. "Testing the potential for cut flower pollen to improve bumble bee health." **L. S. Adler (PI)**. 3/1/2021-2/28/2023. **\$98,539** (\$89,734 direct and \$8805 indirect).

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

Farmers, land owners, and conservation managers are highly interested in best practices and plantings to support pollinator populations. In addition, ecologists are interested in how community composition affects the outcomes of species interactions. Our research directly addresses these topics.

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

Farmers, land owners, and conservation managers are also highly interested in best practices and plantings to support pollinator populations. For example, I developed an informational survey that was shared by UMass Extension professionals to listservs reaching vegetable farmers, landscapers, turf managers, arborists, nurseries, garden centers, and greenhouse producers. We received 2384 responses, of which approximately 80% were landowners/gardeners and most of the rest (287 respondents) were commercial farmers, landscapers and horticulturalists. Over 95% (2260 respondents) described themselves as 'highly' or 'very highly' interested in using flowering plants to improve pollinator health in their business/land ownership. Similarly, over 97% of respondents said that if we found that specific flowers reduce bee disease, they were 'highly' or 'very highly' likely to recommend or use these flowers in their farm/industry/garden.

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.

- No major changes or problems this year, beyond some delays due to COVID.

Training and professional development: In the past year, Hatch support provided training for two undergraduate students, Bryanna Joyce and Elisa Kola, who contributed to a larger project asking how drought affects pesticide concentration in crops, and how land use around farms contributes to pollination services in sunflower. While not providing financial funding, research supported by this Hatch grant also inspired research by three graduate students (Alison Fowler, Carolina Muñoz Agudelo, and Luis Aguirre).

Disseminating results:

Due to COVID, there has not been as much opportunity for dissemination as usual. During the reporting period information has been disseminated through one invited talk at an international symposium, one undergraduate research presentation, a Farm Day for growers at the S Deerfield research station.

Specifically:

I was an invited speaker at the Pollinator Health Conference, London UK (virtual). I talked about the sunflower research at all this venue.

We provided an outreach event to approximately 20 seventh grade girls from under-represented groups in science through the Eureka! Program.

I presented research in Aug 2020 to around 30 growers at the South Deerfield research tour twilight meeting.

Conference presentations:

From Flowers to Landscapes: The natural processes influencing pollinator health. London, UK (virtual conference). Sept 21-22, 2021.

27th Annual Massachusetts Undergraduate Research Conference Amherst MA, April 23 2021

Amy-Mei Lynch, Hauke Koch, Philip C. Stevenson, Rebecca E. Irwin and Lynn Adler1

Talk: Identifying the Medicinal Component of Sunflower Pollen That Reduces an Intestinal Parasite in Bumble Bees

Products:

Aguirre LG and **LS Adler**. 2022. Interacting antagonisms: Parasite infection alters *Bombus impatiens* (Hymenoptera: Apidae) responses to herbivory on tomato plants. *Journal of Economic Entomology*. <https://doi.org/10.1093/jee/toac023>

Fowler AEG, Giacomini JJ, Connon SJ, Irwin RE and **LS Adler**. 2022. Sunflower pollen reduces a gut pathogen in the model bee species, *Bombus impatiens*, but has weaker effects in three wild congeners. *Proceedings of the Royal Society of London B* 289: 20211909. <https://doi.org/10.1098/rspb.2021.1909>

Adler LS, Irwin RE, McArt SH and RL Vannette. 2021. Floral traits affecting the transmission of beneficial and pathogenic pollinator-associated microbes. *Current Opinion in Insect Science* 44: 1-7. <https://doi.org/10.1016/j.cois.2020.08.006>

Roch JCU, Muñoz Agudelo DCG, **Adler LS** and J Milam. 2021. First records of *Perdita bequaerti* (Hymenoptera: Andrenidae) from New England. *Journal of the Kansas Entomological Society* 94(3): 348-354. <https://doi.org/10.2317/0022-8567-93.4.354>

Adler LS, Fowler AEG, Malfi RLP, Anderson PRU, Coppinger LMU, Deneen PMU, Lopez SU, Irwin RE, Farrell IW and PC Stevenson. 2020. Assessing chemical mechanisms underlying the effects of sunflower pollen on a gut pathogen in bumble bees. *Journal of Chemical Ecology* 46(8): 649-658. DOI: 10.1007/s10886-020-01168-4

Plans for the next year:

- We will prepare results of the drought/pesticide study for publication.
- We are about to submit for publication our work determining how local plant diversity and abundance and surrounding landscape use shape bee diversity. We are also analyzing data and writing up work asking how local plant diversity and abundance and surrounding landscape affect pollination service to crops.
- We will continue to evaluate mechanisms by which sunflower pollen can reduce pathogen infection, including new comparative work with different bumble bee species.
- We are also studying another crop, basil, to understand how its volatiles affect pathogen infection and bee foraging preferences.
- We will conduct a pilot study this summer understanding how plant composition and surrounding land use affect bee diversity and pathogens.

Critical Issue

Food Safety and Functionality

Extension Food Safety

Project Director

Amanda Kinchla

Organization

University of Massachusetts

Accession Number

7002179



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

There are large knowledge gaps within the food industry pertaining to food safety and product development in which food practitioners are at risk of regulatory compliance. The UMass Food Science Extension (FSE) integrates research and outreach education in areas related to food safety, food production, and the principles of food science. Understanding the participants and elements of food systems, Food Science Extension at the University of Massachusetts provides farmers, business owners, and industry partners with support and knowledge essential for growth and success in food 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.

The UMass Food Safety Extension program provides programs or initiatives in which their original academic research and the resulting scholarship are integrated with educational programs, resources, tools, or technologies that meet the needs of citizens, communities, organizations, businesses, government agencies, or policy-makers.

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

Programming activities include a diverse array of delivery modalities including online resources, fact sheets, 1-on-1 consults, real-time instruction (virtual and/or in-person), video demonstrations, peer-review publications, and other mixed approaches to maximize outreach efforts.

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

Participants that are involved in our program to improve their knowledge and food safety practice which in part attributed to improved food safety that will promote a safer food supply and reduce the incidence of public health issues.

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.

-Developed a self-paced online standardized curricula titled, "Successful Food Product Development for New Food Businesses: Managing Food Quality and Safety" aimed at helping new food entrepreneurs better understand how food safety is an important part of the product development process. The training includes 8 self-paced modules.

- Published a Food Value Add website: <https://ag.umass.edu/value-added-food> that shares research activities and technical support local value add a production.

-Research-Extension Project: Freezing Local Blueberries Outputs include: 1.Web-content to deploy the non-proprietary procedures, quality protocols and food safety plan for IQF frozen blueberries 2. Published 3 white papers showing how to evaluate frozen blueberry production 3. Developed a webinar program that shared all of the developed outputs to local producers and processors

-Developed an open-access 3-hour food safety workshop titled "Practical implementation of Preventive Controls" targeted to small and medium food processors affected by FSMA: Food Safety Modernization Act. The content aims to introduce the concepts of food safety management.

-Developed and piloted 5, 2-hour food science STEM based modules that provide fun and hands-on learning experiences aimed at promoting interest and career path gateways to girls and underrepresented communities.

Understanding and Mitigating Risk Factors Associated with Food Production

Project Director
Amanda Kinchla
Organization

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

This multi-researcher project focuses on critical aspects of food safety that will increase the understanding and mitigating of risk factors associated with cleaning, sanitation, cross-contamination, detection, and worker behaviors in food production. This team aims to cover several aspects related to improving food safety through fundamental and applied research, as well as through the dissemination the new knowledge discovered within this work to better provide technical support to producers and processors. Together these activities will contribute to the long-term goal of reducing the overall risk of foodborne illness.

This Kinchla Research Group aims at improving food safety practices and behavior through food safety extension research and activities. The research focus targets developing, assessing, and translating applications for improved practices of food safety for food 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.

Key activities this from this years work include:

- Kamarasu, P., Moore, M.D., Kinchla. Evaluating the risks associated with utilization of modified washing machines in the processing of leafy greens. Hultin Competition, 3-minute Thesis. University of Massachusetts Amherst Food Science Department. Spring 2021.
- Kinchla, A.J.. Harvest New England, Virtual. 2/22/2021 From Field to Shelf: Increasing Profits Through Season Extension and Diversification by Adding Value to Your Farm Products – Which Food Safety Principles Apply? Harvest New England. Virtual, Feb, 24 2021.
- Strategic Research Alliance, UMass Amherst, Virtual. 5/21/2022 Wormald, C.L., Moore M., Kinchla A., Fitzsimmons J., Improving Prerequisite Education Programs to Address Food Safety Knowledge Gaps for Small and Medium Sized Food Processors. Strategic Research Alliance Showcase, May 2021.
- Kinchla, A.J. Project update. Food Safety Management Training for Small and Emerging Food Businesses: Integrating a Food Safety Culture from Concept to Commercialization. USDA NIFA FSOPe Food Safety Outreach Projects. Virtual, February 2021 Roundtable 2/4/21.
- Research Recap: Profitability of Frozen Produce in Retail Markets. January 2021, Vegetable Notes. Volume 33, Number 1.
- Zhang. J.Y., Pandya, J., McClements, D.J., Lu, J., Kinchla, A.J. Advancements in 3D Food Printing: A Comprehensive Overview of Properties and Opportunities. Critical Reviews in Food Science and Nutrition. February 2021.

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

Projects have helped to provide technical information that supports food processors and provides knowledge sharing within the food safety communicator community.

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

Providing technical support and educational resources to food processors and food safety communicators helps to increase knowledge regarding best practices pertaining to food safety which will help to reduce incidence of food borne illness.



FY21 Hatch Gibbons

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

Listeria monocytogenes is a foodborne bacterial pathogen that infects >1,000 individuals and results in >200 deaths annually in the United States. Controlling *L. monocytogenes* contamination is particularly challenging, in part, because of the emergence of resistance to sanitizers used in the food industries. The goal of this project is to use experimental evolution and genomics to identify the conditions that promote increased tolerance to benzalkonium chloride (a commonly used sanitizer in the food industry), and the mutations and genes underlying resistance.

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 grant focuses on critical aspects of food safety that will increase the understanding and mitigating of risk factors associated with cleaning, sanitation, cross-contamination, detection, and worker behaviors in food production. Our *L. monocytogenes* sanitizer resistance project contributes to this focus. We have cultured nine *L. monocytogenes* lineages in sublethal concentrations of the sanitizer benzalkonium chloride for ~400 generations and observed a significant increase in tolerance to the sanitizer. We have sequenced the genomes of these lineages and have identified mutations in 24 genes that likely contribute to increased tolerance to benzalkonium chloride. Our results provide evidence that improper usage of sanitizers can lead to increased tolerance and that a multitude of genes can contribute to *L. monocytogenes* sanitizer tolerance.

Publications -- Tyler D. Bechtel, Lynne A. McLandsborough and John G. Gibbons. Genome sequences of three *Listeria monocytogenes* strains isolated from a food processing facility and a livestock outbreak. *Microbiology Resource Announcements* (in revision)

Presentations -- Tyler D. Bechtel, Lynne A. McLandsborough and John G. Gibbons. Investigating the genetic determinants of *L. monocytogenes* stress tolerance to food-industry relevant stressors through adaptive laboratory evolution. Pioneer Valley Microbiology Symposium, Amherst, MA. March 5, 2022. Poster presentation.

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

The work from this research benefits the food industry. Specifically food processors, with an emphasis on sanitation practitioners. Additionally, findings from this work can provide technical support for food safety communicators (extension educators, technical support teams and/or food safety consultants).

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

Establishing research in *L. monocytogenes* sanitizer resistance provides a better understanding of conditions that lead to *L. monocytogenes* sanitizer tolerance that guides mitigating strategies for the food industry (improving sanitation programs).

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.

For activity 2, we have opted to use experimental evolution and whole-genome sequencing, rather than Genome-Wide Association, to investigate the genetic basis of *L. monocytogenes* persistence. This approach allows us to carefully control key variables, greatly reduces the number of false positive candidate variants linked to particular traits, and observe phenotypic



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

This project focuses on critical aspects of food safety that will increase the understanding and mitigating of risk factors associated with cleaning, sanitation, cross-contamination, detection, and worker behaviors in food production. The Moore Research team contributes to this effort with an emphasis on mitigating and controlling pathogenic risks to food safety and food production and service workers. Specifically, Dr. Moore has been focused on multiple projects related to concentration, detection, and inactivation of viral pathogens of agricultural concern.

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.

Many publications and presentation outputs were produced during the FY21 year, including:

Publications:

- Liu L, **Moore MD*#**. 2020. A survey of analytical techniques for noroviruses. *Food* 9(3):E318.
- Aasi A, Aghaei SM, **Moore MD#**, Panchapakesan B. 2020. Pt-, Rh-, Ru-, and Cu-single-wall carbon nanotubes are exceptional candidates for design of anti-viral surfaces: A theoretical study. *International Journal of Molecular Sciences* 21(15):5211-5233.
- **Moore MD*#**, Suther C, Zhou Y. 2021. Microbiota, viral infection, and the relationship to human diseases and treatment. *Infectious Microbes & Diseases* 3(1):1-3.
- Safavizadeh V, Moggadam MRA, Farajzadeh MA, Mojkar M, **Moore MD#**, Nokhodchi A, Naebi M, Nemati M. 2021. Descriptions in toxicology, interactions, extraction, and analytical methods of Aflatoxins; a 10-year study performed in Iranian foodstuffs. *International Journal of Environmental Analytical Chemistry*. (In Press).
- Huang R, Vaze N, Soorneedi A, **Moore MD#**, Luo Y, Poverenov E, Rodov V, Demokritou P. 2021. A Novel Antimicrobial Technology to Enhance Food Safety and Quality of Leafy Vegetables using Engineered Water Nanostructures. *Environmental Science: Nano* 8:514-526.
- Delshadi R, Bahrami A, McClements DJ, **Moore MD*#**, Williams L. 2021. Development of nanoparticle-delivery systems for antiviral agents: A review. *Journal of Controlled Release* 331:30-44.
- Manuel C, Suther C, **Moore MD*#**, Jaykus L-A. 2021. Comparison of a one-step real-time RT-PCR and a nested real-time RT-PCR for a genogroup II norovirus reveals differences in sensitivity depending upon assay design and visualization. *PLoS One* 16(4): e0248581.
- **Moore MD*#**, Faircloth J, Stoufer S, Kim M, Jaykus L-A. 2021. Generation of ssDNA aptamer candidates against a novel calicivirus protein target. *Viruses* 13: 171

Presentations

Wormald C, **Moore MD**, Fitzsimmons JA, Kinchla A. Improving Preventive Controls Prerequisite Education Programs to Address Food Safety Knowledge Gaps for Small and Medium Sized Food Processors. Poster (Virtual). *Pioneer Valley Microbiology Symposium*. UMass Amherst, Amherst, MA, USA. February 2021.

1. Wormald C, **Moore MD**, Fitzsimmons JA, Kinchla A. Improving Preventive Controls Prerequisite Education Programs to Address Food Safety Knowledge Gaps for Small and Medium Sized Food Processors. Poster. *IAFP Annual Meeting 2021*. Phoenix, AZ, USA. July 2021. *Christina presented this as the winner of an IAFP Student Travel Award.
1. Wormald C, **Moore MD**, Fitzsimmons JA, Kinchla A. Improving Preventive Controls Prerequisite Education Programs to Address Food Safety Knowledge Gaps for Small and Medium Sized Food Processors. Oral Technical Presentation (with Corresponding Poster). *IFT 2021*. Virtual. July 2021. *Christina won 1st Place in the Education, Extension & Outreach Division technical talk competition with this.
1. Kim M, Chen M, **Moore MD**. Real-time detection of norovirus capsid protein with an OmpG nanopore. Poster. *IAFP Annual Meeting 2021*. Phoenix, AZ, USA. July 2021. *Minji presented this as the winner of an IAFP Student Travel Award.
1. Stoufer S, Varona M, Anderson J, Brehm-Stecher B, **Moore MD**. Understanding conditions that affect recovery of nonenveloped virus from aqueous solution using magnetic ionic liquids. Poster. *IAFP Annual Meeting 2021*. Phoenix, AZ, USA. July 2021.
1. Soorneedi A, **Moore MD**. Concentration and Detection of Human Noroviruses from Food and Environmental Samples Using Engineered Norovirus Binding Bacteria. Poster. *IAFP Annual Meeting 2021*. Phoenix, AZ, USA. July 2021.
1. Soorneedi A, Vaze N, Demokritou P, **Moore MD**. A novel engineered water nanostructure-based surface disinfection technique against coronaviruses. *World Society for Virology 2021: Tackling Global Viral Pandemics*. Short Technical Talk. Virtual. 16-18 June 2021.
1. Kamarasu P, **Moore MD**. Enhanced inactivation of foodborne viruses by cinnamaldehyde nanoemulsions require a lipid envelope. *World Society for Virology 2021: Tackling Global Viral Pandemics*. Short Technical Talk. Virtual. 16-18 June 2021.
1. Stoufer S, Varona M, Anderson J, Brehm-Stecher B, **Moore MD**. Optimizing recovery of non-enveloped virus from aqueous solution using magnetic ionic liquids. *World Society for Virology 2021: Tackling Global Viral Pandemics*. Short Technical Talk. Virtual. 16-18 June 2021.
1. Stoufer S, Varona M, Anderson J, Brehm-Stecher B, **Moore MD**. Recovery of Human Norovirus Surrogate from Aqueous Suspension Using Magnetic Ionic Liquids. *Pioneer Valley Microbiology Symposium*. UMass Amherst, Amherst, MA, USA. February 2021.
1. Kim M, Pham B, Chen M, **Moore MD**. Norovirus Detection Using Nanopore Sensing. Accepted Poster but Canceled due to SARS-CoV-2 Pandemic. *Gordon Research Conference Nanoscale Science and Engineering for Agriculture and Food Systems*, June 2020. (Canceled due to Pandemic).
2. Suther C, Stoufer S, **Moore MD**. Broad detection of norovirus GII using recombinase polymerase amplification and applications using intercalating dyes. Poster (Virtual). *International Association for Food Protection Annual Meeting 2020*, October 2020.
3. Huang R, Vaze N, Soorneedi A, **Moore MD**, Luo Y, Poverenov, Rodov V, Demokritou P. Engineered Water Nanostructures: A Novel Antimicrobial Platform to Improve the Safety and Quality of Leafy Vegetables. Poster (Virtual). *International Association for Food Protection Annual Meeting 2020*, October 2020.
4. Kim M, Pham B, Chen M, **Moore MD***. Detection of Norovirus Capsid Protein using an Outer Membrane Protein G. Poster (Virtual). *International Association for Food Protection Annual Meeting 2020*, October 2020.
5. Kamarasu P, **Moore MD**. Enhanced inactivation of foodborne viruses by cinnamaldehyde nanoemulsions require a lipid envelope. Poster (Virtual). *International Association for Food Protection Annual Meeting 2020*, October 2020.
6. Stoufer S, Varona Ortiz O, Anderson J, Brehm-Stecher B, **Moore MD**. Recovery of Human Norovirus Surrogate from Aqueous Solution Using Magnetic Ionic Liquids. Poster (Virtual). *International Association for Food Protection Annual Meeting 2020*, October 2020.

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

This work provides foundational knowledge for understanding pathogens (Norovirus) and mitigating strategies aimed at identifying solutions to improve sanitation practices for food processors.

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

Identifying solutions to improve food safety helps to decrease incidence of foodborne disease that helps to protect our food supply which contributes to public health.

Critical Issue

Sustainable Agriculture and Food Systems

Closing Out (end date 09/07/2023)

Function of Chloroplast and Mitochondrial Small Heat Shock Proteins in Stress Tolerance

Project Director

Elizabeth Vierling

Organization

University of Massachusetts

Accession Number

1024718



Function of Chloroplast and Mitochondrial Small Heat Shock Proteins in Stress Tolerance

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

The goal of the proposed research is to determine how specific proteins, the small heat shock proteins (sHSPs) found in plant chloroplasts and mitochondria, act to protect the function of these important organelles during plant stress. sHSPs are proposed to act as “molecular chaperones” to protect other proteins from irreversible stress-induced damage. Our goal is to determine the specific targets protected by these sHSPs towards finding mechanisms to enhance crop stress tolerance.

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.

We confirmed that three sHSPs predicted to localize to mitochondria are found in these organelles in *Arabidopsis thaliana*. We completed isolation of plant mutants that no longer produce the three mitochondria-targeted sHSPs and confirmed absence of these proteins through immunoblotting analysis after generating specific antibodies to detect each protein. Mitochondria have been isolated from control and heat-stressed plants and will be used to detect changes in the protein composition of the organelles as a first step to determining what proteins/processes might require these sHSPs.

In studies of the chloroplast-localized sHSP we have generated a new mutant using CRISPR technology.

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

This project has been performed by undergraduate students and one MS student receiving training in genetics, molecular biology and biochemistry. One MS thesis and two honors theses have been completed, and one honors thesis is in progress. Work will be presented at the upcoming meeting of the American Society for Biochemistry and Molecular Biology in April 2022.

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

Students trained by this project participated in setting up facilities for a workshop for 12 high school teachers involving polymerase chain reaction of plant material. Teachers will have the opportunity to integrate the experiment into their curriculum.

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.

One student trained by this project entered medical school, another is a lab technician, and one is entering a PhD program. A postdoc has gained experience mentoring undergraduate researchers.

[Harnessing Chemical Ecology to Address Agricultural Pest and Pollinator Priorities](#)

Project Director

Jaime Pinero-Ramirez

Organization

University of Massachusetts

Accession Number

1024599



"Harnessing Chemical Ecology to Address Agricultural Pest and Pollinator Priorities"

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

In Massachusetts, several invasive insect species are either already affecting or pose a serious threat to the specialty crop industry. Stakeholders have voiced the need to address the most destructive invasive insects threatening their crops. In recent years, there has been interest in reduced-risk materials with insecticidal properties for the invasive pest spotted wing *Drosophila*

(SWD), a vinegar fly that attacks berries and other soft-skinned fruits such as peach and cherry. Of particular interest are low-cost materials that could be used as attractants in traps or as insecticidal food-based baits, as opposed to broad-spectrum insecticides applied to the foliage against some pests. In this project, we will determine whether materials that are commonly available in households can be used to attract adult SWD to traps. Efforts will be made to develop an inexpensive insecticidal bait. The response of female codling moth and Oriental fruit moth, two important pests of apple, pear, and related crops, to lures

that are based on plant material will be quantified under laboratory and field conditions. Our ultimate goal is to develop a food

bait for SWD that is inexpensive and effective. This project also seeks to improve the effectiveness of monitoring systems for codling moth and Oriental fruit moth. If successful, results may lead to the development of more effective monitoring systems for

these two moth pest species.

Our Major Goals for this project are to:

Develop chemical ecology tools, information, and deployment strategies to support sustainable agriculture by reducing damage by pests in crops and ornamentals such as potatoes, brassicas, cucurbits, apples, blueberries, and sweet corn, while maintaining pollinator health in economically important agricultural systems.

(2)

Work to find ways to minimize the impact of pesticides and discover new pesticides that reduce the impact on pollinators,

herbivores, microbes and natural enemies of pests.

(3)

Conduct Extension and Outreach to facilitate adoption and awareness of science-based chemical ecology to support sustainable crop production and promote human health and welfare

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.

Improved efficacy of *Drosophila suzukii* lures is desirable to improve monitoring systems and potentially for the development of more effective management tactics. Given that commercially available lures are based on fermentation materials, and captures of unwanted insects hinder trap performance and increases sorting time then the development of more selective lures and baits is highly desirable. We previously identified diluted Concord grape juice as a highly attractive bait to male and female *D. suzukii*. This material is inexpensive and readily available. Thus, it is more accessible to small-scale growers around the world. Here, we sought to optimize the attractiveness of diluted Concord grape juice to adult *D. suzukii* by (1) evaluating the effects of bait fermentation, and (2) quantifying the effects of adding table salt to the bait prior to fermentation. Our findings indicate that the level of attractiveness of fresh diluted Concord grape juice to male and female *D. suzukii* was enhanced when this bait was aged for up to two weeks, a result that was mirrored by the captures of non-target insects. Such an increased level of attractiveness of fresh diluted Concord grape juice to *D. suzukii* was further augmented when the bait was aged in the presence of 2% table salt, relative to fresh diluted Concord grape juice aged in the absence of table salt. The captures of non-target insects was reduced drastically increasing bait selectivity. Diluted Concord grape juice is a feasible monitoring option for small-scale growers around the globe who are not able to monitor or manage *D. suzukii* populations because commercially available baits are too expensive or are inaccessible.

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

The primary target audience for this project is represented by hundreds of small- and mid-scale fruit farmers located in Massachusetts. Research-based information generated by this project has been disseminated across New England states. Efforts have been made to reach a diverse audience including under-represented, low-income, and beginning farmers. The main goal of this project is to conduct research on the chemical and visual ecology of *Drosophila suzukii*, in order to develop or optimize monitoring and attract-and-kill approaches that are inexpensive and grower-friendly.

The University of Massachusetts Stockbridge School of Agriculture and UMass Extension faculties and staff are committed to providing research-based information, including findings from our own research, to commercial growers and to Extension specialists. Research findings have been disseminated mostly through growers and academic conferences, Newsletter articles, grower-oriented publications. Our outreach efforts have reached approximately 400 fruit growers. In addition, online presentations were given to academic groups (researchers, students) in Australia and Mexico, reaching about 75 people.

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

The attractiveness of diluted Concord grape juice to spotted-wing drosophila (SWD) was previously established by the Pinerolab. This is an inexpensive and readily available material that could be used by small-scale fruit growers for monitoring purposes. In a series of field evaluations that were conducted we determined that diluted grape juice is about three times more attractive to female SWD than commercial lures and this material attracts about three times fewer non-target insects. We have optimized the attractiveness of diluted grape juice by adding 2% table salt, which influences the fermentation process. This increases the attractiveness of the diluted grape juice when fermented in the presence of salt for one week. Because this bait is very inexpensive (cost per trap is \$ 0.09) then we believe that many growers will be willing to use this material for monitoring purposes. Given the expected high number of SWD that will be trapped, this system may help decrease local SWD populations, particularly earlier in the season. Other beneficiaries are home-owners who can use effective and inexpensive materials to trap-out SWD. This may help decrease SWD infestations with limited or less insecticide use.

Six growers reported using traps baited with diluted Concord grape juice for SWD monitoring. In addition, the broader public, including consumers, may benefit from this project because by using diluted Concord grape juice in traps the berry crops may receive less insecticides applied against SWD than when no traps are deployed. The monitoring system developed assisted growers who used it in their decision about whether or not to spray insecticides. For one grower, the monitoring system decreased insecticide use by 30%.

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.

- Journal Article Published 2021
Wen, X., Stoffolano, J.G., Greamo, B., Salemme, V., and Piñero, J.C. 2021. Effects of diluted Concord grape juice laced with sodium chloride and selected boron-containing compounds on attraction, consumption, crop contractions, and mortality of adult *Drosophila suzukii* Matsumura (Diptera: Drosophilidae). *Pest Management Science*. DOI 10.1002/ps.6683.
- Journal Article Published 2021
Bolton, L.G., Piñero, J.C., and Barrett, B.A. 2021. Olfactory cues from host- and non-host plant odor Influence the behavioral responses of adult *Drosophila suzukii* (Diptera: Drosophilidae) to visual cues. *Environmental Entomology* 50: 571-579 <https://doi.org/10.1093/ee/nvab004>.
- Journal Article Published 2021
Piñero, J.C., Stoffolano Jr., J.G., Chiu, K., Colletti, K., Dixon, Z., Salemme, V., Crnjar, R. and Solla, G. 2021. Effects of chitosan and erythritol on labellar taste neuron activity, proboscis extension reflex, daily food intake, and mortality of male and female spotted winged *Drosophila*, *Drosophila suzukii*. *Journal of Insect Physiology* 131(3):104240 <https://doi.org/10.1016/j.jinsphys.2021.104240>.
- Journal Article Submitted 2022
Piñero, J.C., Godoy-Hernandez, H., Giri, A., and Wen, X. Sodium chloride added to diluted Concord grape juice prior to fermentation results in a highly attractive bait for *Drosophila suzukii* (Diptera: Drosophilidae). *Frontiers in Ecology and Evolution* (submitted).
- Piñero, J.C. 2021. Online presentation 'An overview of semiochemicals used for invasive fruit fly (Tephritidae and Drosophilidae) management'. Turkish Ministry of Agriculture and Forestry Online International Workshop on Biotechnical Methods, 3.25.2021 (attendees: 125).

Identifying the Genes that Control Unisexual Flower Development in Maize

Project Director

Madelaine Bartlett

Organization

University of Massachusetts

Accession Number

1024691



Identifying the Genes that Control Unisexual Flower Development in Maize

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

This project investigates the genetic underpinnings of floral development in maize (corn). Understanding what the genes are that control flower development is essential in crop engineering, and will open the door to improving yield in corn and in other grass crops.

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 last year, we have made progress towards generating the plant material and genetic lines necessary for identifying and dissecting the function of floral developmental genes. We have also made progress in understanding how these genes work, through analyzing flower development using techniques like scanning electron microscopy.

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

We published a major paper in January 2022 that discussed some of our results from this project (Klein et al, PNAS, 2022). PI Bartlett has discussed this work at numerous seminar visits and conferences. In addition, this project has trained undergraduates and graduate students in plant genetics, biotechnology, tissue culture, and bioinformatics.

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

This work has added to our fundamental knowledge of how plant development proceeds. This knowledge has the potential to benefit the broader public with increased seed yields, and a stable, abundant food supply.

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.

We have published one paper related to this project during the reporting period:

Klein H**, Gallagher J**, Demesa-Arevalo E, Abraham-Juárez MJ**, Heeney M*, Feil R, Lunn JE, Xiao Y, Chuck G, Whipple C, Jackson, DJ, **Bartlett, ME** (2022). Recruitment of an ancient branching program to suppress carpel development in maize flowers. *PNAS*. DOI:10.1073/pnas.2115871119

[Vegetable Extension Program](#)

Project Director

Susan Scheufele

Organization

University of Massachusetts

Accession Number

7002068



Vegetable Extension Program

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

The UMass Extension Vegetable Program delivers research-based educational programming and conducts applied research to meet the needs of vegetable farmers statewide and to enhance the economic, human, and environmental health and sustainability of the vegetable industry in Massachusetts. This year, as the COVID-19 pandemic waxed and waned, our team continued to conduct virtual programming while also doing several in-person on-farm Twilight Meetings, and maintained a broad range of projects and activities and even increased our output in several key areas. Our success this year was due to our team's dedication to our mission of serving our commercial growers and the people of the Commonwealth.

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 July, Hannah Whitehead was hired as a new Extension Educator III with expertise in vegetable production and pollinator health. This new hire brought the team back up to four full-time year-round staff members.

This summer we were allowed to hire students, which was not allowed under University COVID policies during 2020. We hired two part-time students who assisted with field research and farm scouting from June through August. One student was supported by funding from CAFÉ via the Summer Scholars program. This student, Jordan Smith, went on to pursue a fifth-year Master's degree in Plant and Soil Sciences, and cited her experience over the summer working for the Vegetable Extension Program as a main motivator for pursuing this advanced degree.

We conducted a record number of research trials (10) at the UMass Crop and Animal Research and Education Farm with funding from grants, industry, the IR4-project, and grower support.

We made a concerted effort to increase our reach this year, through email and phone consultations (up 100 over last year) as well as farm visits (up 49 visits on 12 more farms compared to last year).

We had a record number of phone, email, text, and video chat consultations this year (N=222) after adding a new "Contact Us" section on our website and promoting it in our newsletter every week. These new modes of consultation allowed us to identify many new beginning farmers and others who were in need of assistance, or growers who we had not had contact with previously.

Results from an experiment on disease-resistant cucumber varieties was **published in Plant Disease Management Reports**, a peer-reviewed journal read by Extension professionals.

Research: 10 research trials were conducted at the UMass Crop and Animal Research and Education Center, South Deerfield, MA or on a collaborating commercial farm on the topics below. Results are shared with grower and Extension audiences through newsletter articles, Extension journals, and presentations.

- Evaluating Cucumber Varieties for Cucurbit Downy Mildew Resistance and Yield

- Evaluating Cucumber Varieties for Bacterial Wilt Resistance in a High Tunnel

- Evaluating Varieties of Spinach for Winter-Production and Resistance to Downy Mildew

- Reducing Damping-Off in Winter Spinach Production Using Cover Crops and Seed Priming

- Seed treatments for control of Cabbage Root Maggot in Radishes

- OMRI-Approved Fungicides to control Alternaria Leaf Spot in Broccoli

- New Fungicide Efficacy on Head Rot in Broccoli

- OMRI-Approved fungicides to Control Cercospora Leaf Spot in Swiss Chard

- Sentinel Plot to Monitor for Cucurbit Downy Mildew

- OMRI-Approved Insecticides to Reduce Wireworm Damage in Sweet Potatoes

Regional Collaboration:

educators from across the Northeast region participated in weekly pest alert calls, sharing updates about activity of common pests and getting support identifying new and uncommon pests or production issues. This information is used to inform our weekly Pest Alerts column in our newsletter, Vegetable Notes. The group also shares information by email, and helps to facilitate priority setting and collaborative, regional grant writing.

This year our interim Vegetable Program Leader, Sue Scheufele, served as the General Chair of the New England Vegetable and Fruit Conference Executive Committee, overseeing planning and implementation of our regional biennial grower conference with >2,000 attendees.

Program Sustainability

Professional Development: Our team is dedicated to professional development and supporting staff to continue to pursue expertise. Staff participated in the following workshops and trainings:

- McKeag (21)
 - McKeag, L. PSA Train the Trainer Refresher Office Hour - Module 1. Produce Safety Alliance. 10/1/20.
 - McKeag, L. Southern Region Integrated Produce Safety Conference. Southern Center for Food Safety Training, Outreach, and Technical Assistance. 10/6/20.
 - McKeag, L. PSA Train the Trainer Refresher Office Hour - Module 2. Produce Safety Alliance. 10/8/20.
 - McKeag, L. PSA Train the Trainer Refresher Office Hour - Module 3. Produce Safety Alliance. 10/15/20.
 - McKeag, L. PSA Train the Trainer Refresher Office Hour - Module 4. Produce Safety Alliance. 10/22/2020.
 - McKeag, L. PSA Train the Trainer Refresher Office Hour - Module 5-1. Produce Safety Alliance. 10/29/20.
 - McKeag, L. UMaine Remote PSA Grower Training. UMaine Extension. 11/5/20.
 - McKeag, L. PSA Train the Trainer Refresher Office Hour - Module 6. Produce Safety Alliance. 11/12/20.
 - McKeag, L. Biodegradable Mulch Meeting. UConn Extension. 11/18/20.
 - McKeag, L. PSA Train the Trainer Refresher Office Hour - Module 7. Produce Safety Alliance. 11/19/20.
 - McKeag, L. Long island Ag Forum. Cornell Cooperative Extension. 1/5/21.
 - McKeag, L. Climate Adaptation Fellows weeklong workshop. Climate Adaptation Fellowship. 1/11/21.
 - McKeag, L. NECAFS Annual Meeting. NECAFS. 2/17/21.
 - McKeag, L. Dry Farming Collaborative Winter Meeting. Oregon State University. 2/25/21.

- McKeag, L. Ox Farm Packhouse Consultation. UVM Extension. 3/3/21.
- McKeag, L. Soil moisture sensor session for CAF. Climate Adaptation Fellowship. 3/23/21.
- McKeag, L. Guiding Resilience: 4-part Legal Workshop for Farm Service Providers. Farm Commons. 4/1/21.
- McKeag, L. Bridging the GAPS: Approaches for Treating Irrigation Water On-Farm. University of Florida. 4/18/21.
- McKeag, L. Extension Climate Adaptation Meeting. UMass Extension. 5/6/21.
- McKeag, L. Climate Change Communication. National Extension Climate Initiative. 9/2/21.
- McKeag, L. Tilmor Cultivation Equipment Meeting. Brookfield Farm. 9/15/21.
- Whitehead (3)
 - Field Day at South Deerfield Farm, UMass Extension. July 27, 2021.
 - SETAC Short Course: Pesticide Risk Assessment for Pollinators, Society of Environmental Toxicology and Chemistry. October 28, 2021.
 - Soil Health Webinar, UMass Extension. Oct 8, 2021
 - Higgins (11)
 - Higgins, G. AgBiome Pesticide Updates. October 28, 2020.
 - Higgins, G. MarroneBio Pesticide Updates. Steve Bogash. November 12, 2020.
 - Higgins, G. Summit Agro Pesticide Updates. Jim Frank & Eric Tedford. November 13, 2020.
 - Higgins, G. High Tunnels After Dark. UNH Extension. December 1 & 8, 2020.
 - Higgins, G. Certis Pesticide Updates. Greg Rogers. December 7, 2020.
 - Higgins, G. Great Lakes EXPO, December 8-10, 2020
 - Higgins, G. Long Island Agricultural Forum. February 2021.

- Higgins, G. Farm Labor Housing & COVID Policy Update. MA Department of Agricultural Resources & MA Department of Labor. February 19, 2021.
 - Higgins, G. Greenhouse Management Webinars – Red Wagon Plants & Edgewater Farm. Vermont Vegetable & Berry Growers’ Association. March 24, 2021.
 - Higgins, G. Soil Health Research & Extension Update from Your Neighbors in New York. Joseph Amsili, Cornell Cooperative Extension. October 6, 2021.
- Scheufele (7)
 - AgBiome Pesticide Updates. October 28, 2020.
 - MarroneBio Pesticide Updates. Steve Bogash. November 12, 2020.
 - Summit Agro Pesticide Updates. Jim Frank & Eric Tedford. November 13, 2020.
 - High Tunnels After Dark. UNH Extension. December 1 & 8, 2020.
 - Certis Pesticide Updates. Greg Rogers. December 7, 2020.
 - Great Lakes EXPO, December 8-10, 2020
 - Soil Health Webinar, UMass Extension. Oct 8, 2021

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

Services: We Treated seed from 5 growers in five different states generating \$490 in revenue through our [Hot Water Seed Treatment](#) service.

Fundraising: We raised \$7,500 in sponsorships and \$4,000 in donations this year, for a total of \$11,500 in program funds.

Grants Submitted: 5 new grant proposals were submitted and 4 were awarded (totaling \$571,933). Several of these represent new projects or collaborations with faculty at institutions we have never worked with before, and with industry partners.

Below are outlined several key outcomes and accomplishments from the past year.

Education

96 on-farm consultations were provided to 18 farms, with at least 166 crop observations made, over the 2021 growing season.

We **organized 15 workshops** for 1371 growers and agricultural service providers. The bulk of these workshops were presented virtually due to the COVID-19 pandemic but we were also able to host 3 on-farm Twilight Meetings across the state.

We co-organized the **Southern New England series of 4 virtual twilight meetings** in winter of 2020-21 with our Extension neighbors to the south, URI and UConn, on topics including vegetable pests of the year, winter spinach, greenhouse seedling production, and high tunnel fertility. Attendance was very good at these online, collaborative programs, with **869 total live attendees** and **652 subsequent views** online during the reporting period.

36 growers and agricultural service providers attended **food safety trainings** delivered and organized by Lisa McKeag. This Produce Safety Alliance certification needed to be re-imagined for delivery online, and participants were very pleased with the quality of the program, here is some of the participant feedback: Lisa and Michael did an excellent job in doing this seminar, I got a lot out of it; Extremely helpful; Very clear and great clarifications; It was very helpful and we will make a lot of changes to improve our systems.

The **New England Vegetable & Fruit Conference** went virtual this year, and planning the online conference represented a major undertaking for our team, since Sue Scheufele is currently the General Chair of the Planning Committee. Transitioning the 3-day conference to an online format took considerable effort, but we look forward to good turnout during the 5-day online event in mid-December 2021.

Publications: Production of the **New England Vegetable Management Guide** was postponed this year due to the on-going COVID-19 pandemic and the canceling of the New England Vegetable and Fruit Conference where Guides are distributed. The NEVMG also exists as a website, which received 211,212 total and 178,795 unique page views between October 1, 2020-September 30, 2021.

The **Vegetable Program website**, ag.umass.edu/vegetable, is another critical place for stakeholders to access a wide range of educational materials including factsheets, project outcomes, resources, and access services. According to Google Analytics, there were 414,550 total page views and **356,373 unique page views** originating from different machines/devices to this site between October 1, 2020-September 30, 2021. The **Food Safety sub-section** of this site was updated to reflect changes to the “Do I Need to Comply?” section and the site was **visited 656 times** by 540 unique users. This fall we established a new page on our website to host research reports, after several requests from fellow ag service providers and grower

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

Our newsletter, **Vegetable Notes**, is arguably our most important output every year. It delivers timely information about weather, crop production practices, pest activity, and so much more to **over 2,874 readers** including commercial growers, Extension personnel, ag service providers, and home gardeners/consumers. This year, we published **26 issues** featuring **6 new articles** were published.

We **published 1 new factsheets** or other new resources for the website this year.

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.

- Articles published in refereed publications (Published Article (News, Professional, Trade) (1)

- Grants Awarded and Submitted (Grant Submission or Other Funding Proposal) (5)

- New England Vegetable Management Guide - Online (Websites or Other Electronic Delivery) (1) - 178795 Participants

- On farm consultation (Individual Consultations and Site Visits) (96) - 25 Participants

- Phone and Email Consultations (Individual Consultations and Site Visits) (222) - 150 Participants

- Presentations at Professional Conferences & Meetings (Presentation/Poster (Academic) (12) - 675 Participants

- Regional Pest Scouting Network (Directe Other) (1) - 17 Adults
- Research Trials (Research Project (Applied Research) (10)
- The New England Vegetable and Fruit Conference (Facilitated Group Meetings and Conferences) (1) - 606 Participants
- UMASS Food Safety Program Website (Websites or Other Electronic Delivery) (1) - 540 Participants
- Vegetable Educational Programming (Facilitated Group Meetings and Conferences) (15) - 1371 Participants
- Vegetable Notes - Newsletter (Printed Material (newsletter, factsheet, field manual) (32) - 5743 Participants
- Vegetable Program Website (Websites or Other Electronic Delivery) (3) - 356373 Participants
-

Beneficial Use of Residuals to Improve Soil Health and Protect Public, and Ecosystem Health

Project Director

B Xing

Organization

University of Massachusetts

Accession Number

1020675



"Beneficial Use of Residuals to Improve Soil Health and Protect Public, and Ecosystem Health"

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

The objectives at UMass Amherst are 1) to evaluate the fate, processes, toxicity and plant uptake of contaminants (e.g., engineered nanomaterials, organic compounds, antibiotics and resistance genes, micro/nanoplastics) in soil-water-plant systems, and 2) to examine the roles and functions of biochar produced from biomass wastes/residuals in soil improvement, plant growth, remediation, and environmental quality.

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.

For this reporting period, we have published 15 refereed journal articles in high-impact journals. We tested how copper (Cu) nanomaterials increased the growth and yield of crop (e.g., lettuce and tomato) and decreased the disease incidence. In addition, we evaluated the effects of phosphorus ensembled nanomaterials on nutrient uptake and distribution in soybean (*Glycine max* L.) under simulated precipitation. We wrote two critical reviews on engineered nanomaterials and one review on microplastics in the environment. We also studied the reduction of silver ions to silver nanoparticles by biomass and biochar, and the reaction of substituted phenols with lignin char. Furthermore, we examined how pyroligneous acid mitigated dissemination of antibiotic resistance genes in soil.

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

Most of our research results have been published in high-impact journals. As a result, our data, methods, and papers are accessible by readers, communities of interest, and the public. Also, some of our results were presented at conferences/meetings, and discussed in my courses as new trends and findings.

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

Engineered nanomaterials were thought to be toxic to plants, which is true at high concentrations. However, our recent data demonstrate that at low or appropriate concentrations, engineered nanomaterials can promote crop yield and nutritional quality of agricultural produces. Also, they can help to mitigate the impact from plant disease by increasing resistance. Therefore, our work will promote the application of nanotechnology in agriculture to increase the use efficiency of nutrients and pesticides while protecting the environment, particularly under a changing climate. Pyroligneous acid as a product from biochar production could help to reduce the dissemination of antibiotic resistance genes in soil, which is significant for agroecosystems where animal manures are often used as fertilizers. In our research on microplastics (MPs), MPs seem to reduce lipid digestion in simulated human gastrointestinal system, which may affect human digestion health and nutrient assimilation.

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.

Nothing to report for major changes or problems encountered in approach.

Graduate students, undergraduate students, postdoc, and visiting joint Ph.D. students were trained in the lab.

The results are disseminated through classroom teaching, conferences/meetings, conversations, and journal publications.

For the next reporting period (2021-2022), we will continue to work on the benefits of biochar (including hydrochar) as soil amendment. We will write a critical review on production and characterization of hydrochars and their applications in soil improvement and environmental remediation. In addition, we will study the properties and characterizations of microplastics (MPs) and nanoplastics (NPs) in soil, water and plant, and how MPs and NPs affect growth of plants and microbes. Furthermore, we will continue to examine the application and role of engineered nanomaterials in promoting crop yields and nutritional values of foods and sustainable agriculture.

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- Wang, C.X., X.F. Liu, J. Li, L. Yue, H.Y. Yang, H. Zou, Z.Y. Wang and B.S. Xing. 2021. Copper nanoclusters promote tomato (*Solanum lycopersicum* L.) yield and quality through improving photosynthesis and roots growth. Environmental Pollution. 289: article 117912
- Zhao, J., M.Q., Lin, Z.Y. Wang, X.S. Cao and B.S. Xing. 2021. Engineered nanomaterials in the environment: Are they safe? Critical Reviews in Environmental Science and Technology. 51:14, 1443-1478.
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- Cao, X.S., C.X. Ma, F.R. Chen, X. Luo, C. Musante, J.C. White, X.L. Zhao, Z.Y. Wang and B.S. Xing. 2021. New insight into the mechanism of graphene oxide-enhanced phytotoxicity of arsenic species. Journal of Hazardous Materials. 410: article

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- Dang, F., Y.N. Huang, Y.J. Wang, D.M. Zhou and B.S. Xing. 2021. Transfer and toxicity of silver nanoparticles in the food chain. *Environmental Science: Nano*. 8: 1519-1535.
- Guo, H.Y., F. Han, H.P. Shang, S.C. Xiong, M. Huynh, L. Thistle, L.T. Meng, L.L. He and B.S. Xing. 2021. New insight into naturally formed nanosilver particles: role of plant root exudates. *Environmental Science: Nano*. 8: 1580-1592.
- Jiang, Z.X., H. Zheng and B.S. Xing. 2021. Environmental life cycle assessment of wheat production using chemical fertilizer, manure compost, and biochar-amended manure compost strategies. *Science of the Total Environment*. 760: article 143342.
- Li, Q.Q., C.X. Ma, J.C. White and B.S. Xing. 2021. Effects of phosphorus ensembled nanomaterials on nutrient uptake and distribution in *Glycine max* L. under simulated precipitation. *Agronomy*, 11: article 1086.
- Peng, H.B., H.Y. Guo, P. Gao, Y.W. Zhou, B. Pan and B.S. Xing. 2021. Reduction of silver ions to silver nanoparticles by biomass and biochar: Mechanisms and critical factors. *Science of the Total Environment*. 779: article 146326.
- Tan, H.W., T.T. Yue, Y. Xu, J. Zhao and B.S. Xing. 2020. Microplastics reduce lipid digestion in simulated human gastrointestinal system. *Environ. Sci. Technol*. 54: 12285-12294.
- Li, J., Q.Q. Li, C.E. W. Steinberg, Q. Zhao, B. Pan, J.J. Pignatello and B.S. Xing. 2020. Reaction of substituted phenols with lignin char: Dual oxidative and reductive pathways depending on substituents and conditions. *Environ. Sci. Technol*. 54:15811-15820.
- Zheng, H., R.R. Wang, Q. Zhang, J. Zhao, F.M. Li, X.X. Luo and B.S. Xing. 2020. Pyroligneous acid mitigated dissemination of antibiotic resistance genes in soil. *Environment International*. 142: article 106158.

Closing Out (end date 09/07/2023)

Molecular characterization of plant-microbe interactions

Project Director

Li-Jun Ma

Organization

University of Massachusetts

Accession Number

7000504



Molecular Characterization of Plant Microbe Interactions

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

The goals of my hatch project are to use cutting edge genetics to understand molecular mechanisms that underpin the disease development of plant pathogens; to use these results to develop molecular markers for the functional dissection of fungal-plant interactions; and to characterize the molecular mechanisms of the identified fungal effectors and plant resistance proteins. These studies will also establish a pipeline for evaluating the molecular mechanisms of effectors, provide new insight into how plant pathogens infect host plants and have the potential to reveal new avenues for plant disease control.

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.

We have sequenced two *F. oxysporum* strains that infect sweet basil (Fob) based on the screening results on Fob strains collected by UMass Prof. Robert Wick. We will conduct comparative analysis once the assembly and annotation is finished.

1. We have substantially improved the performance of CRISPR-Cas9 protocol and have generated multiple effector mutants and tested disease phenotypes (publication characterized these mutants are under development).
2. We have affirmed our disease assay procedure and identified the focal area to investigate the fungal-host interact at the elongation zoom of the mature roots. We just submitted the manuscript capturing this development (Martinez Soto D, et al 2022).

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

The postdoctoral research, Domingo Martinez Soto gave an oral presentation on the comprehensive analysis of effectors at a concurrent section of the 31st Fungal Genetic Conference. This study set up a foundation to build up testable hypothesis on the evolution and function conservation among all candidate effectors.

Using the recently acquired confocal microscope, we have successfully tagged a total of 12 *Fusarium* effectors and 4 *Peronospora belbahrii* effectors with RFP. Using heterologous expression system, we observed fluorescent signals for all the transformants. Functional characterization of a candidate apoplastic effector confirms that this effector has a single-stranded, right-handed parallel β -helix topology as a typical pectate lyase. The highlight of the past year is the success in study apoplastic effectors using heterologous expression system. However, we are facing the road block with cytoplasmic effectors and will be a focus for the coming year research.

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

PI Ma presented knowledge gained through this project at the “Fusarium Biology in the 21st century” symposium at University of Minnesota, visited department of Plant and Environmental Sciences Virginia Tech, and presented at the Department of Molecular Biology, University of Wyoming.

PI Ma also shared the research ““Don't kale my vibe: How fungi make plants sick” to general public at the Science CAFÉ (<https://www.youtube.com/watch?v=kYinins8H0o>).

Graduate student Kelly Allen presented at the Dominican College Science Seminar: “ Building Healthier Crops Using Plant Disease Resistance” (<https://www.youtube.com/watch?v=ykXpKw6Mw7I>)

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.

- Sohrab V, López-Díaz C, Di Pietro A, Ma LJ, Ayhan DH. Tefinder: A Bioinformatics Pipeline for Detecting New Transposable Element Insertion Events in Next-Generation Sequencing Data. *Genes* (Basel). 2021. doi: 10.3390/genes12020224. PMID: 33557410.

- o Yong Zhang, Pei-Lun Kao#, Akaansha Rampal#, Sibongile Mafu, Sergey N. Savinova and Ma L-J*. 2021. High-throughput screening assays to identify plant natural products with antifungal properties against *Fusarium oxysporum*. In Jeffery Colman (Eds). *Fusarium Wilt, Methods in Molecular Biology*, Springer Nature.
- o Guo L, Yu, H-L, Wang B, Vescio K, Delulio GA, Yang H, Berg A, Zhang L, Edel-Hermann V, Steinberg C, Kistler HC and Ma L-J*. 2021. Metatranscriptomic comparison of endophytic and pathogenic *Fusarium*-*Arabidopsis* interactions reveals plant transcriptional plasticity. *MPMI* 34, 1071–1083, <https://doi.org/10.1094/MPMI-03-21-0063-R>

[Understanding pollen - pistil interaction as a basis towards improving reproductive yields in plants](#)

Project Director

Alice Cheung

Organization

University of Massachusetts

Accession Number

7000493



Understanding pollen-pistil interactions as a basis towards improving reproductive yields in plants

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

Our project addresses how pollen, which transport sperm to the ovule for fertilization to produce seeds, can traverse the female reproductive tissues to arrive at its target, the female gametophyte to release sperm to fuse with the female gametes. Both the male and female are involved in assuring success, so neither is a passive party. The project focuses on understanding how interactions between pollen and pistil enable fertilization.

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 pollination, the first step is pollen grains are deposited on the stigma, the receptive surface of the pistil. In the past four years, we have achieved the major goal described in the original summary, of characterizing a stigma expressed receptor kinase (a sensor for changes), RK7 (now called ANJEA), and understand its contribution to enable the first steps in pollination. We have discovered a major role for ANJEA, in cooperation with a related receptor called FERONIA, in supporting germination. This work was done in the model plant *Arabidopsis*. We have also extended the work to the related crop plant, *Brassica rapa*. Findings are similar to in *Arabidopsis*. In addition, since *B. rapa* is a self-incompatible species, i.e. pollen and pistil in the same genetic background of controlling self-incompatibility cannot successfully produce offspring. The arrest is on the stigmatic surface. We found that the FERONIA-ANJEA partnership also is critical in mediating prevention of incompatible pollen from germination.

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

Our target audience would be the farming community interested in achieving interspecific crosses so that favorable traits could be introduced into domesticated crops. The genes and mechanisms we discover can help the cross-barrier research community to design strategy for higher success efficiency.

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

Pollen has captivated the interest of the broader public for a long time, probably even before when microscopy has revealed the fascinating and diverse surface morphology of the pollen grains, and the realization they are the agents of male fertility. Academic research has provided more picturesque impressions about how the pollination process unfolds, starting with the pollen grains producing a tube on the stigmatic surface to penetrate the female tissues. These findings produce among the most captivating scientific images of biological processes that captures the imagination of the public and are often used in platforms that introduce science to the public, including K-12 students and their teachers. On the more practical side, the

knowledge introduces to the public about how seeds are produced, and that plants need to be nurtured to maturity for fertilization success and the environment is critical for plants to maintain male and female fertility. This also brings awareness to the public on how protecting the environment is crucial for food security.

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.

There has not been major changes or problems encountered in the approach. The project has provided training for several undergraduates, and thus far one of them, having contributed as a co-author, in one of our papers currently under review, has gone on to a PhD program. Another is a currently a senior in our lab and plans to pursue a 5th year MS degree with us. A graduate student has received one semester of support from the project, and is currently preparing two manuscripts for publication prior to graduation, both include studies on several pollen-produced proteins. Our findings have been disseminated in journal articles and the PI's seminars on and off-campus. Student presentations in formal meeting forums had not been many, largely due to Covid-associated concerns.

For the current, and final year, of the project, we plan to wrap up one set of study involving intra- and inter-specific pollen-pistil interactions, and hope to get that published.

Publications FY 2021:

Zhang L, Huang J, Su S, Wei X, Yang, L, Zhao H, Yu J Wang J, Hui J, Hao, S, Song S, Cao Y, Wang M, Zhang X, Zhao Y, Wang Z, Zeng W, Wu H-M, Yuan Y, **Cheung AY**, Duan Q. 2021. FERONIA-regulated reactive oxygen species mediate self-incompatibility in *Brassica rapa*. *Current Biology* (May 18, 2021); doi: 10.1016/j.cub.2021.04.060.

Liu C, Shen L, Xiao Y, Vyshedsky D, Peng C, Sun X, Liu Z, Cheng L, Zhang H, Han Z, Chai J, Wu H-M, **Cheung AY**, Li C. 2021. Pollen PCP-B peptides unlock a stigma peptide-receptor kinase gated mechanism for pollination. *Science* 372, 171-175. doi: 10.1126/science.abc6107. PubMed PMID: 33833120.

Critical Issue

Sustainable Energy

Closing Out (end date 09/07/2023)

[The Science and Engineering for a Biobased Industry and Economy](#)

Project Director

James Holden

Organization

University of Massachusetts

Accession Number

7000517



"The Science and Engineering for a Biobased Industry and Economy "

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

The production of organic-rich agricultural waste, especially non-cellulosic waste, creates disposal problems for farmers and food processing centers. In Massachusetts, the organic waste cannot enter solid municipal waste or wastewater treatment plants without first undergoing treatment due to eutrophication of local rivers, streams, and estuaries. This waste can be degraded and partially converted into H₂, which can be used as an energy product, by high-temperature microbes. The high temperatures accelerate the reaction rates meaning that smaller reactors can be used for conversion and also kill pathogens and degrade certain compounds (e.g., the antibiotic Ceftiofur used to treat dairy cows with mastitis) present in the waste.

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 FY21 reporting period, the goals of our project were to establish protocols for growing our model organism in a bioreactor in continuous-feed (i.e., chemostatic) mode on defined growth substrates such as 0.5% maltose, 0.1% formate, and a combination of these two substrates. We also worked on establishing our analytical processes such as hydrogen gas headspace measurements and diagnostic enzyme activity assays to optimize our process.

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

The graduate student working on this project participated in the regional NSF Innovation Corps (I-Corps) training program. I-Corps enables the transformation of invention to impact and reduces the time to translate a promising idea from the laboratory to the marketplace. The student conducted 26 so-called 'customer discovery' interviews nationally with prospective customers, waste generators, and city and state officials to define the greatest commercial needs and applicability of the process we are developing.

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

Nothing to report. The COVID19 pandemic severely limited our ability to reach the broader public.

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.

One key piece of equipment in the lab, a gas chromatograph for measuring hydrogen gas, broke down and needed to be replaced. Production and supply chain issues meant that it took several months before a replacement could be obtained.

As noted above, the graduate student working on this project participated in the NSF I-Corps professional development and training program that is specifically focused on translating scientific ideas in the lab into commercial opportunities.

No publications or other products

Critical Issue

Youth Development

[Hampden County 4-H Urban Programs](#)

Project Director

Lauren Dubois

Organization

University of Massachusetts

Accession Number

7002067



Urban 4-H STEAM Program

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

The Urban 4-H STEAM Program reaches over 300 youth in Springfield and Holyoke. The program enhances the Science, Technology, Engineering, Art, and Math (STEAM) skills of young people in grades K-9. Through partnerships with seven community centers and schools, Massachusetts 4-H provides programming based on its heralded national 4-H curricula. All of the young people we serve come from low-income families; the majority are young people of color, and they are underserved and underrepresented in the educational system compared to their white counterparts in towns and cities throughout the state.

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 we ran both in-person and virtual programs for the youth we serve.

4-H STEAM Water unit: Discovering and understanding the properties of water; how water is used in the development of technology.

4-H Neuroscience unit: Introduction to psychology and brain sciences with an overview of brain anatomy and closer look at vision.

4-H Engineering unit: Introduction to variety of engineering careers; how engineers use software.

4-H Computer Science units: Unplugged activities introduce computational thinking; block coding introduces computer science.

4-H Tales for Tails (Cloverbuds) unit: Basic activities combine art and literary competency while teaching about biomes and animal adaptations.

4-H Resume/Cover letter workshop: Explaining the difference between a resume and cover letter and why each is important as well as how to create them.

4-H STEAM Exploration unit: Basic activities combine art and science and teach chemistry and physics principles while exploring careers in STEAM fields.

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

Our mission is to increase interest in STEAM through hands-on learning that is directly connected to higher education. We want the youth in our programs to see themselves in STEAM careers and we provide exploration of different career pathways within the fields of STEAM. We accomplish this partly in collaboration with UMass Amherst faculty and staff as well as community experts. Most importantly, we utilize teens from the community to support us in engaging the young people at our programs. These young adults are trained to facilitate programming, and in doing so learn various skills essential to their professional development.

As a result of this, we were able to offer stipend positions to six young adults from the community. One of them is currently pursuing a degree in Biomedical Engineering, specializing in prosthetics, at WNEU. The other five will be pursuing either higher education or vocational training within a STEM field. The young people in our programs identify with these teen facilitators, who instill in them the desire to follow a STEM pathway. These young people then see themselves in STEM careers; becoming a doctor, engineer, etc. is now a real possibility to them.

Based on 2021 post-program questionnaires, we can quantify the impact the program has. Over 90% liked the activities we did and 89.5% liked learning about STEM. 96.5% understood STEM better, and 85.5% were interested in learning more. Even though it was the first time being exposed to STEM for 79% of them, 71.5% said they think they'd enjoy a career in STEM.

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

The activities of the Urban 4-H STEAM provide hands-on learning opportunities to enrich young people's education. For many, it is their first time being exposed to these skills and fields, especially the highly-coveted skills of computational thinking and computer science. Based on the needs expressed by our community partners, we connect every activity to fields in higher education and STEAM-related careers. The program content is age and grade specific at each location, ensuring uniformity in design, training, evaluation, and desired outcomes.

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.

- o **4-H STEAM** - After School program workshops (Workshop series or educational course) - We ran 4 different programs at 8 different sites in Holyoke and Springfield

1. 4-H STEAM (water unit)

2. 4-H Cloverbud program

3. 4-H Neuroscience program

4. 4-H Resume/cover letter workshop - total of (8) - 205 Youth participants - 105 Female/100 Male

60	White; (Not of Hispanic Origin)
66	White; (Hispanic Origin)
28	Black or African American; (Not of Hispanic Origin)
5	Asian or Pacific Islander; (Not of Hispanic Origin)
46	Unreported

o **Urban 4-H STEAM** - Fall 2021 Programs (5) - 54 Youth Participants 23 Female/31 Male

#	Race/Ethnicity
9	White; (Not of Hispanic Origin)
32	White; (Hispanic Origin)
13	<ul style="list-style-type: none"> ▪ Black or African American; (Not of Hispanic Origin)

o **4-H Virtual In School Program** - Neuroscience, Engineering, and Computer Science were the 3 subjects taught (3) - 279 Youth Participants - 129 Male/150 Female

#	Race/Ethnicity
8	White; (Not of Hispanic Origin)
178	White; (Hispanic Origin)
53	Black or African American; (Not of Hispanic Origin)
8	Asian or Pacific Islander; (Not of Hispanic Origin)
32	Black or African American; (Hispanic Origin)

o **STEM Ambassadors** Program staff meetings with collaborators and college student mentors. (10) - 10 adult Participants

#	Race/Ethnicity
1	White; (Not of Hispanic Origin)
3	White; (Hispanic Origin)
6	Black or African American; (Not of Hispanic Origin)

Type

Projects / Programs without a Critical Issue

Not Provided

Projects/ Programs

0