

**2019 Annual Report of Accomplishments and Results**

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| New Hampshire   |
| University of New Hampshire Cooperative Extension (UNHCE) |
| New Hampshire Agricultural Experiment Station (NHAES)     |

**I. Report Overview**

The NIFA reviewer will refer to the executive summary submitted in your Plan of Work. Use this space to provide updates to your state or institutions as needed.

**1. Executive Summary (Optional)**

This report reviews the research, education and outreach activities from the New Hampshire Agricultural Experiment Station (NHAES) and the University of New Hampshire Cooperative Extension (UNHCE). Many of our activities are synergistic. NHAES covers the costs for the UNH farms, dairies, and greenhouses that are used in common with UNHCE. NHAES provides split salary funding for several UNHCE faculty and direct research support for a number of UNHCE activities. Therefore, a portion of UNHCE FY2019 achievements are the result of NHAES support and, likewise, some of the achievements and dissemination of NHAES research are facilitated by UNHCE. Other activities of UNHCE and UNHCE are distinctive. An overview of activities, outputs and/or outcomes for both units are described below.

**UNHCE**

UNH Cooperative Extension is the primary outreach unit for the University of New Hampshire. UNH Extension provides applied research and practical education in agriculture and natural resources as a well as in youth and family development and community and economic development. The people of New Hampshire benefit from Extension programs directly as participants or indirectly through improvements to the economy, environment and society. As a university outreach program, UNHCE has a network of professional educators located in all ten New Hampshire counties. Staff partner with stakeholders, volunteers and faculty to design and conduct educational programs that meet societal, environmental and economic needs.

During 2019, UNHCE reached a significant portion of New Hampshire residents with information or assistance. In addition, 5,481 trained volunteers in ten counties spent over 206,317 hours implementing educational programs. Volunteers from UNHCE’s fourteen volunteer programs including Master Gardeners, Lay Lake Monitors, Marine Docents, Wildlife Coverts, Natural Resource Stewards, Coastal Research

Volunteers and 4-H Leaders help UNHCE reach people throughout the state and region. The work of UNHCE volunteers was valued at \$5.27 million in 2019 alone.

**NHAES**

A large proportion of NHAES research is focused on discovery; the outcomes of these activities may require a few to several years or even decades (plant breeding) before their findings lead to innovations in agriculture and aquaculture, nutrition, climate change, natural resources or supporting rural economies, which are important to producers and citizens. Disseminating best practice, without the discovery research component, is primarily a responsibility of UNHCE.

NHAES is housed in the College of Life Science and Agriculture (COLSA). Notable personnel changes in FY2019 include the retirement of Macfarlane Research Greenhouse manager David Goudreault. After a national search, greenhouse technician Luke Hydock was promoted to manager. UNH alumnus Amber Kittle was hired as the new greenhouse technician. Luke Hydock is the primary liaison for a remodel and expansion of the Macfarlane greenhouses that began in the summer of 2019 and is scheduled to be completed by the end of FY2020. In addition to the expansion by 6800 sq. ft. (27%), new growing space will provide improved climate control and biosecurity for greenhouse research.

The Department of Agriculture, Nutrition and Foods Systems recruited sociologist Dr. Analena Bruce as an assistant professor. Her research focus is agriculture of the middle: studying market factors that impact the viability of small and mid-size farms in New England.

Five agricultural facilities managed by NHAES are the Woodman Horticultural Research Farm, Macfarlane Research Greenhouse, Fairchild Dairy Teaching and Research Center, Kingman Research Farm, and the Organic Dairy Research Farm (ODRF) on the Burley-Demeritt properties. The first three are within two miles of campus, and Kingman and the organic dairy are within six miles of campus. The proximity of NHAES farms and greenhouses to campus also provide excellent opportunities for hands-on learning and part-time jobs for undergraduates that help them build their résumés. These facilities provide research facilities for both NHAES and UNHCE. A summary of the activities supported at NHAES facilities is shown in Table 1 below.

The farm, dairy, and greenhouse facilities supported by NHAES are important resources for educational programs at the university. In the last academic year, 53 classes visited or carried out experiential learning at NHAES farms and greenhouses. These venues also are popular for visits by the public and special events such as the UNH/Granite State Dairy Promotion Open Barn and School to Farm Day (1750 visitors; Fairchild Dairy), Spring Greenhouse Open House (~2500 Macfarlane Greenhouses), for Research Field Days (Connecting the Dots for Pollinator

Conservation [160], Durham farm day [60], and the Under the vine Vines field day [100] at Woodman Farm. Kingman Farm and the Organic Dairy Research Farm are popular with the public for cross-country skiing, hiking, and snowmobiling. UNH dining services bought lettuce from the aquaponics facility at Kingman Farm. Excess produce and fish from research projects at the Woodman and Kingman Farms were donated to local food pantries (Cornucopia in Durham, St. Vincent De Paul in Exeter, and the NH Food Bank). Each year, a portion of NHAES capacity funding (state and/or federal) is used to maintain and/or upgrade research capacity at the farms, dairies, and greenhouses.

| <b>Activity or event</b>   | <b>Kingman Agronomy<br/>Woodman Horticulture<br/>Farms</b>  | <b>Fairchild Dairy Teaching<br/>and Research Center</b>   | <b>Macfarlane Research<br/>Greenhouses</b>  | <b>Organic Dairy Research<br/>Farm</b>  |
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| <b>Research projects</b>   | 29  | 12  | 33  | 12  |
| <b>Student workers and<br/>researchers (#)</b>                               | 44  | 44  | 52  | 38  |
| <b>University courses</b>  | 12  | 27  | 4   | 10  |
| <b>Field days, open houses,<br/>public visitors (estimated<br/>visitors)</b> | 6 events ~ 405 visitors   | 8 events total ~3500<br>visitors  | 1 field day event ~2500<br>visitors   | 655   |
| <b>Workshop, tours, casual<br/>education (participants)</b>                  | 18 (328)  | 26 (232)  | 8 workshops, tours ~300   | 18 events ~292 visitors   |
| <b>Community support</b>   | Eggplant (40 boxes),<br>squash (1200) and Brussel<br>sprouts (1000 stems)<br>donated to Cornucopia<br>food pantry | donations of manure to<br>gardeners; rumen<br>inoculates for sick cows;<br>adjacent fields used for<br>falconry, dog training,<br>para-sailor takeoff and<br>landing, UNH student<br>Organic Vegetable farm | Not applicable  | Hiking and snowmobiling for<br>town of Lee residents on<br>designated trails through<br>woodlands |
| <b>Facility<br/>Repairs/renovation</b>                                       | Paving of roadway leading<br>to Woodman; repair of<br>barn foundation   | 15 small repairs and<br>equipment replacement   | upgrade from Argus<br>Classic to Argus Titan<br>environmental control<br>software | replace ventilation fan,<br>replace vertical feed mixer   |

**UNHCE Communications:**

Extension communication and marketing efforts are focused on new audience engagement and lead generation that drives people to our website offerings. Program staff in all areas, work in concert with support units, to effectivity reach strategic outreach and engagement goals by utilizing a robust set of communication channels, including email newsletters, television, syndicated magazine articles, social media, podcasts and website.

In FFY 2019, Extension resources, specialists or volunteers were cited more than 100 times in state media, which includes the Union Leader (largest newspaper in NH), WMUR (only statewide TV station), NH Public Radio, Foster’s Daily Democrat (second-largest newspaper in NH), and the Concord Monitor (capitol area paper). In FFY19, NIFA communications highlighted “Early-Season Heating Shows Promise Boosting Ginger Harvest”, story about research conducted by Becky Sidemen, who has a co-appoint with UNH Extension and the NH Agricultural Experimental Station.

The main Extension Facebook page posts reached about 940,000 users in FFY19. This was a 32 percent increase over the previous year. Across Extension there are 33 Facebook pages, 16 Twitter accounts and 8 Instagram accounts. The Extension website logged more than 1.3 million pages views in FFY19, a 35% increase over the previous year. About 830,000 direct marketing emails were sent from Extension programs in FFY19.

**NHAES communications:** NHAES news and information about research, news, and events reach a wide audience of stakeholders, including producers, policy makers, and industry representatives throughout the state and region as well as at the national level. Strategic communications efforts include traditional media relations, social media engagement, directed email, and multimedia storytelling.

In FFY 2019, NHAES news ran in numerous national media outlets, including the New York Times, Washington Post, NPR, USA Today, The Atlantic, and the Boston Globe. Statewide media distribution was extensive, including in the Union Leader (largest newspaper in NH), WMUR (only statewide TV station), NH Public Radio, Foster’s Daily Democrat (second-largest newspaper in NH), and the Concord Monitor (capitol area paper). In FFY19, **NIFA communications highlighted NHAES research six times in NIFA Update, and five times in Fresh from the Field.** Featured stories include:

- Wood Pellets the Solid Choice in Reducing Greenhouse Gases
- Early-Season Heating Shows Promise Boosting Ginger Harvest
- New England Streams Impacted by High Salt Concentrations
- UNH Researchers Find Drastic Decline in N.H.’s Bumble Bees

Facebook content reached more than 2 million users. This was a 10.2 percent decrease over last year, primarily due to changes in the Facebook algorithm. However, NHAES saw a 40.6 percent increase in engagement, or page likes. Twitter impressions surpassed, 400,000, a more than 40 percent increase over FFY 2018. The NHAES website logged more than 44,400 page views, a slight increase over last year. Directed email reaches nearly 1,200 key stakeholders who receive the NHAES weekly news bulletin, a 20 percent increase in subscribers.

## HIGHLIGHTS

### Childhood Obesity

NHAES Outputs: Peer reviewed papers: seven

- Dr. Jesse Stabile Morrell NC1193 Using Behavioral and Environmental Tools to Identify Weight Related Factors Associated with Health in Communities of Young Adults “Integrated nutritional and social science research across monitors factors and behaviors that impact weight gain of college students. UNH undergraduates in nutrition and graduate students in dietetics carry out of evaluations of seven components of the healthy campus audit.” Major findings from AY 2019 “Data from the College Health and Nutrition Assessment Survey at UNH showed gender differences: in the prevalence of weight misperception and its relationship to life satisfaction, perceived stress, and relationship with healthy behaviors, prevalence and frequency of binge drinking, and level of eating competence... Data to date support sex-specific, target interventions may be important in the promotion of healthy weight.” Progress report AY19 NHAES # 1010738

### Food Safety

NHAES: Outputs: Peer reviewed papers and dissertations published: five

- Assoc. Prof. Stephen Jones “Oyster aquaculture in northern New England has realized incredible increases ... in the past 10 years, yet the associated economic benefits are threatened by the northward emergence and increased incidence of pathogenic bacteria strains of *Vibrio parahaemolyticus*. Accession #1010499.” Genomics distinguish benign and pathogenic regional strains of *Vibrio*. Jones and his students have “successfully developed risk forecasting capacity at a harvest-area scale that can be used anywhere in New England... The major impact of this project is providing information to shellfish growers and regulators that allows them in near real-time to adjust culture and harvest practices that protect the health of shellfish consumers while minimizing costs to the industry.” Final report #1010499

### Global Food Security and Hunger

UNHCE

The Food and Agriculture program delivers education and technical assistance to residents, agricultural businesses and the food system. In 2019:

- 4,056 people attended programs and staff made 844 onsite visits to farms
- 45 farms participated in pest monitoring programs; 506 individuals earned professional credits
- Volunteers answered 4,170 home and garden questions through Extension's Infoline
- 173 individuals obtained ServSafe® certification

**NHAES** Outputs: Peer reviewed papers and Dissertations published: 35

- Prof. Pete Erickson NC2042 Management Systems to Improve the Economic and Environmental Sustainability of Dairy Enterprises. "Wet brewer's grains are a common by-product of the brewing industry and could provide an alternative to corn and soybean meal as energy and protein supplements to growing dairy heifers" ... "In a study with yearling dairy heifers, wet brewer's grains can substitute adequately for corn and soybean meal... For a typical NH dairy farm, raising 100 head of heifers, substituting wet brewer's grain for corn and soybean meal would result in an estimated savings of \$7,300 per year." Progress report #1016574
- Assoc. Prof. Iago Hale NE9 "Conservation and Utilization of Plant Genetic Resources" The kiwiberry is a novel horticultural crop of potential economic importance to New England growers..." This project used DNA fingerprinting to distinguish kiwiberry accessions and marker-assisted breeding to facilitate kiwiberry breeding. (Hale and coworkers ) have produced the first sex-linked molecular marker for kiwiberry. By identifying sex of a plant 3-4 years before the kiwiberries vines become fertile, this assists growers to plant vineyards with balanced numbers of female vines, and male pollinizers. This project also released a comprehensive, online kiwiberry production guide and enterprise analysis for the Northeast ([www.northeastkiwiberries.com](http://www.northeastkiwiberries.com)) "that has been downloaded over 2000 times in the first seven months." Progress report #1017760
- Dr. Cathy Neal UNHCE Extension specialist and NHAES researcher 'Sustainable solutions to Problems affecting Bee Health.' NC1173\_old "Lack of good quality habitat is a major factor contributing to widespread pollinator declines in recent years. Pollinators need a diversity of wildflowers and other plants that provide a continuous sequence of bloom on which they can feed throughout the season... Prior research identified appropriate species selection, site preparation and weed management as the biggest challenges to successfully planting wildflower meadows.... A thorough habitat assessment should be conducted on farms before investing in supplemental pollinator plantings (that) may or may not be economically justified. ..." within a species, there may be large differences in pollinator attractiveness by cultivar ... Lists of pollinator-friendly plants should reflect differences at the cultivar level in order to be useful to people choosing plants for their pollinator gardens." Final Report #101449

**Climate Change and Sustaining Natural Resources**

### **UNHCE**

Natural Resources staff and volunteers work closely with public and private partners to safeguard the state's land, water, air and living communities. In 2019:

- Forester recommendations resulted in \$1.7 million in additional total production value and nearly \$61,000 in additional tax revenue for municipalities
- Staff advised 1,171 landowners who manage over 150,000 acres
- 234 communities received technical assistance; 500+ natural resources professionals were trained

### **NHAES Outputs:** Peer reviewed papers published: 33

- Assoc. Prof. A Stuart Grandy "Soil organic matter (SOM) influences most key soil processes including water holding capacity, soil aggregation, porosity, and erosion potential... soil was collected from a long-term diversity experiment at the Eastern Nebraska Research and Extension Center in Mead, NE. Gross rates of N mineralization were measured along with microbial biomass, carbon use efficiency, respiration, enzyme activity, and total C and N." ... Results confirmed.. "diversified crop rotations positively impact ecosystem processes in temperate agroecosystems by increasing yield resilience, crop productivity, and soil quality." Final report #1007001
- Asst. Prof. Dan Howard "Wind energy is increasingly promoted and viewed as a sustainable compliment to traditional land uses such as agriculture and grazing, although we lack a clear understanding of the ecological effects of wind turbine vibration on soil-living organisms... Subterranean invertebrates... facilitate... the decomposition of organic matter, the aeration of soils, and soil nutrient cycling, and insects such as burying beetles that feed and/or breed on carrion represent one important group of decomposers in this community... We were able to rigorously examine the effect of soil vibrational noise on Nicrophorus beetle reproductive behavior,.. and resulting brood demographics... produced 23% fewer offspring, leading to a 12% reduction in overall brood mass... We documented declines in Nicrophorus burying beetle populations at a site proximate to wind energy developments in Oklahoma." Final Report # 1010114
- Assoc. Wil Wollheim "Water quality problems are known to result from a variety of human activities... However, many water quality problems are reduced because of processes in water bodies themselves.." One issue "being addressed by this research" is "to what extent surface waters help clean up non-point pollution inputs. ...Findings will help to prioritize management activities that are cost effective..."The target audience for this research includes policy makers and land managers trying to address water quality problems. ..Key findings "Reservoirs may at times be nitrogen sources, not just nitrogen sinks. When algal blooms occur, all inorganic N is assimilated or denitrified, allowing N fixing algae to become abundant, introducing more N to the system... This has implications as to

whether the removal of dams in New England is likely to lead to increases or decreases in nitrogen fluxes to the coast”. Progress Report #1013433

## **Supporting a Rural Economy**

### **UNHCE**

The Community and Economic Development program helps cultivate civic leaders, revitalize downtowns and grow the local and regional economy. With Extension’s support, in 2019:

- 5 communities worked with over 150 businesses
- 51 community leaders graduated from Main Street Academy
- towns and one county launched efforts to strengthen their economies
- 200 entrepreneurs convened at business networking events in Concord

**NHAES:** Outputs: peer reviewed papers and dissertations published: four

- **#1015411** Prof. John Halstead NE1749 Enhancing Rural Economic Opportunities, Community Resilience, and Entrepreneurship. The PD and collaborators in the UNH Paul College were “asked by the New Hampshire Department of Environmental Services to provide an economic analysis of the benefits and costs of lowering the standard for arsenic in NH drinking water” (from 10 to 5 parts per billion) The target audience were legislators and policy makers in NH. “CHANGE IN CONDITION: Our research led to the conclusion that the benefits of reduced mortality/morbidity from the reduction in the incidence of e.g. bladder and lung cancers far outweighed the costs of additional water treatment to remove arsenic. ... The NH state legislature... approved the reduction to 5 ppb, and the new standard was signed into law by New Hampshire’s governor.” <https://colsa.unh.edu/nhaes/article/2020/04/drinkingwater>

## **Youth and Family**

UNHCE The Youth and Family program offers education in youth development, healthy living, youth and family resiliency and STEM. In 2019, Extension’s Youth and Family program:

- Engaged 27,000+ participants
- Supported 1,500 educators and volunteers
- Provided technical assistance to 250 people and organizations

- Helped 12 schools improve their wellness policies, affecting 3,037 students

**UNH Professional Development & Training (PD& T)**

UNH Professional Development and Training (PD&T) serves hundreds of regional businesses with professional training offered onsite and in Manchester, Portsmouth, Nashua and Durham, NH. Custom training programs are built for key businesses, cities and civic organizations. PD&T partners with organizations such as chambers of commerce, state and local government and UNH better understand regional workforce need. In 2019, UNH Professional Development and Training enrolled 5,794 participants in 419 classroom programs, a 45% increase over 2018. An additional 380 students participated in on-line programs. Specific focus included Stormwater Center programs, drone certification, new certification and several workshops focused on substance abuse and the opioid crisis and customized leadership academy for City of Manchester executive leaders.

**II. Merit and Scientific Peer Review Processes**

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

| Process  | Updates   |
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| <p><b>1. The <u>Merit Review Process</u></b></p> | <p><u>Merit Review Process</u></p> <ul style="list-style-type: none"> <li>• Internal University Panel</li> <li>• Expert Peer Review</li> <li>• Other (Peer review of proposals, manuscripts, and products)</li> </ul> <p><b><u>UNHCE</u></b></p> <p>UNHCE has a county advisory council in each of the state’s 10 counties. Councils consist of twelve citizen volunteers, one county commissioner and one state legislator. Councils meet monthly 8-10 times per year. NH state statute identifies county Extension advisory councils as the legal entity to request county funding on behalf of UNHCE, therefore, councils have a critical role in Extension operations. Council members advise staff on the educational needs of the region and provide input in</p> |

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|  | <p>searches for new staff. Additionally, a state advisory council consisting of two members from each county council meets with Extension administration twice per year to provide advice on educational needs throughout the state. Extension program team leaders meet regularly with county advisory councils.</p> <p><b><u>NHAES</u></b></p> <ul style="list-style-type: none"> <li>• Internal University Review panel of proposals</li> <li>• Expert peer review of output</li> </ul> <p>The New Hampshire Agricultural Experiment Station (NHAES) carries out a formal, competitive, internal peer-review process for proposed research projects. The competition for NHAES research support is announced to eligible faculty via email at the beginning of the academic year. Faculty are encouraged to submit a one-page prospectus and discuss this prospectus with the director or NHAES faculty fellow. If the prospectus is consistent with NHAES guidelines, the faculty member is asked to develop a full proposal for competitive review.</p> <p>One approach for evaluating initial success of basic and applied research are publication in peer reviewed journals and approval of graduate dissertations: In federal fiscal years 38 research projects supported by the NHAES produced seven graduate dissertations and 79 peer reviewed papers. In addition, these 85 conference papers were presented on ongoing research. These publication and conference presentation records and the ability of a large number of PD to leverage their research to secure additional external research funding, are metrics of a successful research program by NHAES researchers.</p> |
| <p><b>2. The <u>Scientific Peer Review Process</u></b></p> | <p><b>NHAES:</b> All proposals are evaluated by a review panel comprised of faculty members plus the faculty fellow and NHAES director. The review panel is selected from current, highly productive NHAES project directors who have externally funded research programs. Each proposal is evaluated based on the following criteria:</p> <ul style="list-style-type: none"> <li>• Scientific and technical merit.</li> </ul>   |

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|  | <ul style="list-style-type: none"> <li>• Soundness of approach, procedures, and methodology.</li> <li>• Likelihood of significant outcomes and/or innovation.</li> <li>• Demonstrates previous accomplishments or potential productivity.</li> <li>• Probability to leverage NHAES resources.</li> <li>• Likelihood of significantly enhancing NHAES research capability and competitiveness</li> </ul> <p>Evaluations are discussed by the review panel, the members of which rank each proposal's funding priority. The director and faculty fellow use the panel evaluation, along with their own evaluations with respect to NHAES priorities and resources, to make recommendations on which projects to fund. Project directors, whose proposal have been recommended for funding by the NHAES, are guided in how to use REEport's Project Initiation module. Each project initiation is reviewed by the faculty fellow before submission to NIFA for final approval.</p> |
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**III. Stakeholder Input**

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

| Stakeholder Input Aspects   | Updates  |
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| <p><b>1. Actions taken to seek stakeholder input that encouraged their participation with a brief explanation</b></p> | <p><u>Actions taken to seek stakeholder input</u></p> <ul style="list-style-type: none"> <li>• Use of media to announce public meetings and listening sessions</li> <li>• Targeted invitation to traditional stakeholder groups</li> <li>• Targeted invitation to traditional stakeholder individuals</li> <li>• Targeted invitation to non-traditional stakeholder individuals</li> <li>• Survey of traditional stakeholder groups</li> <li>• Survey of traditional stakeholder individuals</li> <li>• Other (County Advisory Councils, comments from research proposals and manuscript reviews.)</li> </ul> <p><b><u>UNHCE</u></b></p> |

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|  | <p>UNHCE strives to connect with all towns and cities in New Hampshire and in 2019, 95% of communities were served by UNHCE. To do so, UNHCE staff, volunteers and county advisory councils engage with stakeholders and develop programs in response to educational needs. In addition, Extension administration meets with state and regional partners regularly to ensure stakeholder input is considered when making organizational decisions.</p> <p><b><u>NHAES</u></b></p> <p>NHAES has an external advisory committee represents different segments of the agricultural and natural resources community in the state. In October 2018, the external advisory committee meet with AES director Jon Wraith, the Faculty Fellow Anita Klein, and communications manager Lori Wright and the incoming Department Chair of the Agriculture Nutrition and Food Systems, agroecologist Prof. Dave Mortensen, on Kingman farm. The committee also met with cucurbit breeder emeritus Prof. J. Brent Loy, and toured new greenhouses built to support Asst. Prof. Todd Guerdat aquaponics research. The committee enjoyed updates on Dr. Loy’s 50+ years of innovating breeding. Other discussion included how the advisory board might reach out to incoming UNH President James Dean, who had not previously served at a land-grant university. Their goal was to emphasize the importance of agriculture in the NH economy.</p> <p>In addition, the NHAES director, faculty fellow, or communications manager speak with members of the advisory committee throughout the year, for example at meetings of the Farm Bureau, and at the annual NH Farm and Forest Expo. In addition, members of the advisory board contact the NHAES director by email about issues of concern.</p> <p>The NHAES director is also in close contact the NH Commissioner of Agriculture and Program Leaders in the NH Department of Agriculture, Markets, and Food and leadership in the NH State Legislature Committee on Environment and Agriculture, officers of the NH Farm Bureau and New England Farmers Union, and large commercial growers in the state.</p> |
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| <p><b>2. Methods to identify individuals and groups and brief explanation.</b></p> | <p><u>Methods to identify individuals and groups</u></p> <ul style="list-style-type: none"> <li>• Use Advisory Committees</li> <li>• Use External Focus Groups</li> <li>• Needs Assessments</li> <li>• Use Surveys</li> </ul> <p><b><u>UNHCE</u></b></p> <p>UNHCE specialists and volunteers have established relationships with stakeholders including individuals, NGO's, state and regional associations, and state departments. Specialists interact with stakeholders on an ongoing basis throughout each program year. Input is collected informally through discussions and formally through program evaluations and surveys. Extension administration meets with state department commissioners and directors on a regular basis.</p> <p><b><u>NHAES</u></b></p> <p>In addition to meeting with external advisory group (see part 1), the Dean or Faculty fellow meet with members of the NH Farm Bureau the NE Farmers Union, State Agriculture, Wildlife and Department of Environmental Safety, and with local conservation and agricultural committees. The Communications manager coordinate a booth for the NHAES at NH Farm and Forest Expo each February and solicits questions and comments.</p> <p>Individual research projects reach out to target stakeholder groups in a variety of ways appropriate to ongoing research. (see progress/final reports #1004515, #1006928, #1010499, #1010738, #1011028,#1013351, #1017760)</p> |
| <p><b>3. Methods for collecting stakeholder input and brief explanation.</b></p>   | <p><u>Methods for collecting Stakeholder Input</u></p> <ul style="list-style-type: none"> <li>• Meeting with traditional Stakeholder groups</li> <li>• Survey of traditional Stakeholder individuals</li> <li>• Meeting with the general public (open meeting advertised to all)</li> </ul>   |

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|  | <ul style="list-style-type: none"> <li>• Meeting specifically with non-Survey specifically with non-traditional individuals -traditional groups</li> </ul> <p><b><u>UNHCE</u></b></p> <p>Stakeholder input is solicited through county and state advisory councils. One hundred twenty citizen volunteers participate in county and state-wide advisory councils. These councils advise local Extension staff on the priorities of people living in the county and participate in hiring new staff. In addition, UNHCE administration meets with each of these groups regularly to ensure stakeholder input is considered when making organizational issues. Further, specific groups (after school providers, volunteers, landowners, decision makers, etc.) are asked for input on program quality, impact and direction.</p> <p><b><u>NHAES</u></b></p> <p>Individual project directors offered specialized field day events on campus, including the annual Under the Vines meeting at Woodman farm, and individualized visits from seed company collaborators to the cucurbit breeding program at Kingman farm in the fall.</p> <p>NHAES Research Faculty and UNHCE Extension Prof. Becky Sideman also presented her diverse research at a variety of venues:</p> <ul style="list-style-type: none"> <li>• Winter production research at UNH. July 2019. Frozen Ground III Conference. Fairlee, VT. (35 growers)</li> <li>• Season extension &amp; specialty crop research at UNH. May 2019. Tour for master gardeners. Durham, NH. (25 master gardeners)</li> <li>• Facilitated vineyard-to-vineyard discussion about cold-climate grapes &amp; winemaking. Sideman, B. and G. Hamilton. NH</li> <li>• Winery Association Annual Educational Workshop. Jan 2019. Lee, NH. (20 farmers)</li> </ul> |
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|  | <ul style="list-style-type: none"> <li>• Low tunnels for strawberry production: structures, management &amp; outcomes. Orde, KM and B Sideman. Mid-Atlantic Vegetable &amp; Fruit Growers' Convention. Jan 2019. Hershey, PA. (90 farmers)</li> <li>• Day-neutral variety performance in NH and PA under open field and protected culture conditions. Orde, KM, K Demchak and B Sideman. Mid-Atlantic Vegetable &amp; Fruit Growers' Convention. Jan 2019. Hershey, PA. (110 farmers) Good bugs, bad bugs: Using insectary strips to promote Biocontrol on farms. Aug 2019. Scooter's Farm of Woodmont, Hollis, NH. E. Venturini, M. Birchler, M. Madden, A. Harris. (20 attendees)</li> <li>• USDA-NRCS and Xerces Society staff training focused on insectary plantings. Jul 2019. A. Harris, Woodman Horticultural Farm, UNH Durham, Tuckaway Farm, Lee, NH, and Mildred's Drumlin Farm, Lee, NH. (15 attendees)</li> <li>• Using insectary plants to promote biological control of pests on Brussels sprouts. A. Harris. 4H Farm Day Tour. Aug 2019. Woodman Horticultural Farm, UNH, Durham. (15 attendees)</li> <li>• Using insectary plants to promote biological control of pests on Brussels sprouts and implications for high tunnel use. A. Harris. Rimol Greenhouses Systems staff. Sept 2019. Woodman Horticultural Farm, UNH, Durham. (3 attendees)</li> <li>• High tunnel tomato nutrient management: lessons learned. Sideman, B., B. Hoskins, M. Hutton, H. Bryant, and E. Sideman. January 2019. Connecticut Vegetable &amp; Small Fruit Growers' Conference. S. Windsor, CT. (250 farmers)</li> </ul> <p>#1010499 PD Steve Jones presented research results on Ecosystem factors affecting <i>Vibrio parahaemolyticus</i> populations and potential impacts on shellfish safety to government and public stakeholders groups</p> <ul style="list-style-type: none"> <li>• UNH Ocean Discovery Day, October 6, 2018</li> <li>• Panel called "Public health issues on the farm" at the Northeast Aquaculture Conference and Exposition. January 11, 2019. Boston, MA</li> <li>• The annual NH Aquaculturists Meeting. February 14, 2019. Portsmouth, NH</li> <li>• Shellfish safety at the Coastal Pollution Research and Management Workshop. February 15-16, 2019. Darling Marine Center, Walpole, Maine.</li> <li>• "Microbial Hazards Associated with Pre-harvest Culture Practices" at the Northeast Shellfish Sanitation Association annual meeting. April 9-10, 2019. Plymouth, MA</li> </ul> |
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|   | <ul style="list-style-type: none"> <li>• "Who's Polluting the Water? Pointing the Finger in the Right Direction" at the 2019 Beaches Conference. June 14, 2019. Kittery, Maine.</li> <li>• "APPLYING ENVIRONMENTAL SURVEILLANCE AND EPIDEMIOLOGY TO MANAGE <i>Vibrio parahaemolyticus</i> RISKS ASSOCIATED WITH SHELLFISH CONSUMPTION" at the 12th International Conference on Molluscan Shellfish Safety. September 9-13, 2019. Ensenada, Mexico</li> <li>• "Managing Oyster Aquaculture Practices to Reduce <i>Vibrio parahaemolyticus</i> Risks in the Northeast United States" at the 12th International Conference on Molluscan Shellfish Safety. September 9-13, 2019. Ensenada, Mexico</li> <li>• served as an expert on shellfish safety at the Maine Shellfish Learning Network workshop. September 20, 2019. Milbridge, Maine.</li> </ul> <p><b>#1013433_PD Wil Wollheim</b> Major local and regional stakeholder meetings</p> <ul style="list-style-type: none"> <li>• the Lamprey River Symposium (January 2019, Durham NH),</li> <li>• Piscataqua Region Estuarine Partnership Technical Advisory Committee (meets regularly). Members of the group have also met with several partners and stakeholders throughout the year including the Town of Durham, NH</li> <li>• NRCS, NH DES, the City of Portsmouth, and oyster aquaculture farmers in Great Bay.</li> <li>• An additional target audience includes primary and secondary students through events such as Ocean Discovery Day (UNH), Little Harbour School's STEAM Day (Portsmouth NH), class presentations (Durham NH) and Skype a Scientist (global network).</li> </ul> <p><b>#1013434_PD Ken Johnson</b> W4001 "Social, Economic and Environmental Causes and Consequences of Demographic Change in Rural America</p> <p>Presentations to government stakeholder groups</p> <ul style="list-style-type: none"> <li>• "Recent New Hampshire Demographic Trends." Invited Presentation to New Hampshire State House Ways and Means Committee and Finance Committee Joint Economic and Fiscal Orientation. Concord, N.H. January, 2019.</li> <li>• Johnson, K.M. 2019. "Recent New Hampshire Demographic Trends." Invited Presentation to New Hampshire Commission on Demographic Trends. New Hampshire State Legislature. Concord, N.H. June, 2019.</li> </ul> |
| <p><b>4. A Statement of how the input will be considered and brief explanation of</b></p> | <p><u>How the input will be considered</u></p> <ul style="list-style-type: none"> <li>• In the Budget Process</li> <li>• To Identify Emerging Issues</li> </ul>   |

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| <p><b>what you learned from your stakeholders.</b></p> | <ul style="list-style-type: none"><li>• Redirect Extension Programs</li><li>• Redirect Research Programs</li><li>• In the Staff Hiring Process</li><li>• To Set Priorities</li></ul> <p><b><u>UNHCE</u></b></p> <p>Specific input on the budget and programmatic priorities are solicited from stakeholders on an ongoing basis. Advisory council members, stakeholders and staff make recommendations for new council members. Staff and volunteers make a concerted effort to build diversity among councils. Extension administration and a standing committee are providing professional development for staff on topics related to cultural proficiency.</p> <p><b><u>NHAES</u></b></p> <p>Within the limitations of UNH budgets, stakeholder input contributes in decision making for new faculty hires. Given the importance of the greenhouse and nursery industry, the priority for FY2019 was to refill the split position between UNHCE and NHAES for a greenhouse and nursery specialist. That search was completed at the end of Federal Fiscal Year 19 with the hiring of Dr. Muhammad Shahid.</p> |
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**IV. Planned Program Table of Contents**

| <b>No.</b> | <b>Program Name in order of appearance</b>      |
|------------|---|
| 1.         | Childhood Obesity                               |
| 2.         | Food Safety                                     |
| 3.         | Global Food Security and Hunger                 |
| 4.         | Climate change and sustaining natural resources |
| 5.         | Supporting a Rural Economy                      |
| 6.         | Youth and Family                                |

**V. Planned Program Activities and Accomplishments**

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

| No. | Title or Activity Description                            | Outcome/Impact Statement  | Planned Program Name/No.        |
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| 1.  | <p><b>UNHCE:</b></p> <p>Healthy Living and Nutrition</p> | <p><b>Issue:</b></p> <p>Overweight Americans and the rate of obesity have greatly increased during recent decades. Contributing factors include physical inactivity, excessive food consumption and unhealthy food choices. Many health-related conditions exist in the NH SNAP eligible population including obesity, overweight, diabetes, pre-diabetes, and heart disease. The SNAP eligible population in NH also has higher rates of sugar sweetened beverage consumption, time spent in sedentary activities, inadequate consumption of fruits and vegetables and physical inactivity. Health related conditions could improve if people followed the US Dietary Guideline recommendations, which are the guiding principles for this work at individual, community and policy levels. Modifiable risks for heart disease are achievable through direct education. In addition, increasing fruit and vegetable consumption through efforts at farmers markets, food pantries and schools; working with community agencies, childcare centers and schools to improve nutrition and physical activity supports; and working with community agencies and coalitions to make it easier for SNAP eligible to eat healthier and be more physically active can reduce health related conditions over the long term.</p> <p><b>What has been done:</b></p> <p>UNH Cooperative Extension Healthy Living and Nutrition staff implement nutrition and physical activity education for limited income adults and youth and general audiences. Activities target physical activity, nutrition, community involvement and obesity awareness and prevention. Youth</p> | <p><b>CHILDHOOD OBESITY</b></p> |

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|  |  | <p>receive education in group settings; families and adults receive education in groups and at home. Sustained behavior changes through interventions that can reach individuals through multiple avenues is most effective. Longer lasting change can be achieved through ‘collective impact strategies.’ With this in mind, we seek to leverage our relationships by finding common outcomes shared with partners, volunteers and coalition members. We then hope to facilitate the pursuit of these outcomes in order to more efficiently focus on collaborative efforts.</p> <p>Our model places an emphasis on food and nutrition efforts that focus on the Dietary Guidelines and MyPlate, specifically, increasing fruits and vegetables and increasing physical activity. Our model also places an emphasis on opportunities to reach larger numbers of people through community and volunteer efforts.</p> <p><b>Target Audience:</b> Youth grades 3-12</p> <p><b>Results:</b><br/> <i>Seven hundred and thirty-four adults (734) enrolled in a series of lessons and four hundred and sixty-seven (467) completed the series. Of those completing a pre/post food recalls and/or pre/post survey questions related to nutrition and physical activity behaviors, significant impacts included:</i></p> <ul style="list-style-type: none"> <li>• <i>37.9% (173 of 457) of adults reported an increase in healthier food choices, by eating vegetables more often</i></li> <li>• <i>41% (188 of 457) of adults reported an increase in physical activity</i></li> </ul> <p><i>Five thousand, eight hundred sixty-eight youth (5,868) participated in a series of lessons. Of those completing a pre/post survey related to nutrition and physical activity behaviors, significant impacts included:</i></p> <ul style="list-style-type: none"> <li>• <i>34.8% (567 of 1629) of youth reported an increase in how often they eat vegetables; grades 3-12</i></li> <li>• <i>33.5% (535 of 1598) of youth reported an increase in how often they are active, grades 3-12</i></li> </ul> |  |
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|           |  | <ul style="list-style-type: none"> <li>• 29.3% (449 of 1532) of youth decreased sedentary activities</li> </ul> <p>Youth participating in 4H Healthy Living projects improved knowledge and behaviors:</p> <ul style="list-style-type: none"> <li>• 16.8% (16 of 95) of youth increased their choices of healthier foods</li> <li>• 21.4% (18 of 24) of youth increased their knowledge of healthier food choices</li> <li>• 68.4% (13 of 19) of youth increased how often they were active</li> <li>• 36.8% (7 of 19) of youth decreased sedentary activities</li> </ul> <p>Several schools and school districts assessed policies and documented changes.</p>   |  |
| <p>1.</p> | <p>NHAES # 1010738</p> <p>Using Behavioral and Environmental Tools to Identify Weight Related Factors Associated with Health in Communities of Young Adults</p> <p>Dr. Jesse Stabile-Morrell, Roland O'Neil Professor</p> <p>Hatch Multistate NC1193</p> | <p><b>Issue:</b><br/>         “Young adults, especially college students, have a high risk of weight gain. Rapid changes in the physical and social environments influence their eating and exercise habits.”</p> <p><b>What was done:</b><br/>         “To improve the understanding of the individual and environmental factors associated with weight gain in young adulthood, as well as improve the reach and sustainability of community programming, the NC1193 multistate group is developing tools to assess the healthfulness of college campuses and effectively disseminate information that can be used by campus administrators and stakeholders to make changes that support and sustain healthier environments for their students.”... “Three manuscripts related to the Healthy Campus Environmental Audit were published and describe the PACES, POINTS, and VEND tools of this audit.”</p> <p><b>Target Audience:</b> “The following target audiences were served:</p> <ul style="list-style-type: none"> <li>• Young adults, 18-24, attending the University of New Hampshire</li> <li>• Undergraduate students and dietetic interns</li> </ul> |  |

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|    |  | <ul style="list-style-type: none"> <li>• Community leaders and campus administrators</li> <li>• Research scientists and professional organizations”</li> </ul> <p><b>Results: (Change of Knowledge)</b> “In all, the seven components of the Healthy Campus Environmental Audit (vending, restaurant/dining hall, small stores, recreation services, policies, and demographics) contribute to the development of a Healthy Campus Index that will be used by higher education institutions to evaluate the healthfulness of their campuses.”</p> <p><b>(Change of Knowledge)</b> “Data from the College Health and Nutrition Assessment Survey at UNH showed gender differences: in the prevalence of weight misperception and its relationship to life satisfaction, perceived stress, and relationship with healthy behaviors, prevalence and frequency of binge drinking, and level of eating competence. Collectively, this work continues to build our understanding of the impact of the environmental and behavioral factors on perceptions and weight-related parameters among young adults. Data to date support sex-specific, target interventions may be important in the promotion of healthy weight.”</p> |   |
| 1. | <p><b>UNHCE:</b><br/>Dairy, Forage Crop, and Livestock</p> | <p><b>Issue:</b><br/>With a growing demand for local, farm-to-table/ farm-to-restaurant products, NH meat producers are beginning to expand their market reach by selling their products to restaurants who support the local food vision. In particular, having local poultry and rabbit on the menu was growing in popularity for restaurants in the state. For producers, raising poultry and rabbit can have a great return on investment and can provide high yields with low infrastructure or input, especially for beginners. Prior to 2014, New Hampshire poultry and rabbit producers could only sell to restaurants if their product was processed at a USDA inspected facility. With no USDA facilities to process poultry in the state of New Hampshire and rabbits falling under voluntary inspection as a non-amenable species, selling these products to restaurants was challenging and unfeasible for producers. In 2014 HB 608 was passed through NH state legislation,</p>  | <p style="text-align: center;"><b>FOOD SAFETY</b></p> |

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|  |  | <p>allowing producers to sell up to 20,000 poultry and 1,000 rabbits per year directly to New Hampshire restaurants without USDA inspection. Included in the bill was a training requirement pertaining to food safety and animal husbandry that must be met by the producers.</p> <p><b>Target Audience:</b><br/>Food producers, restaurants, Schools, students, public citizens, extension specialists</p> <p><b>What has been done:</b><br/>The need of a training requirement for HB 608 was met with the development of the course “Food Safety for Rabbit and Poultry Producers”. This course has been offered in the fall and spring by the Dairy, Livestock, and Forage Crop team and Food Safety Team since 2015. To date, the course has been held in the southern, central, eastern, and northern parts of the state. For programming year 2018-2019 two courses were offered, one in Portsmouth, NH and one in North Haverhill, NH. The course covers HB 608 and the regulations surrounding it in detail, presented by Department of Health and Human Services. Following discussion, topics covered in the course include carcass condemnation, required facilities and equipment, basic sanitary standards, worker health and hygiene, cleaning and sanitation, cold chain and temperature control, required and recommended record keeping, and labeling requirements.</p> <p><b>Results:</b><br/>The result of HB 608 has created an avenue for producers to market their products at a potentially higher sale value and access a new market they hadn’t been able to in previous years. Twenty-five producers participated in either the Portsmouth or North Haverhill workshop in the 2018-2019 programming year. Of the producers who filled out evaluations, there was a 60% increase in knowledge on the topics covered to market and sell products through this avenue. After completion of the course, producers are then required to register with the New Hampshire Department of</p> |  |
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|           |  | <p>Agriculture, Markets and Food as an approved food source to sell to restaurants. As of May 2019, 81 producers total registered their farm with the NH Department of Agriculture Markets and Food after completion of the workshop. Nine of those producers registered after taking the Food Safety for Rabbit and Poultry Producers within the 2018-2019 programming year. In a survey to producers who have completed the training over the past five years, total sales to restaurants has been \$600-\$54,000 in additional farm revenue. Overall, this effort has allowed poultry and rabbit producers to diversify their markets and generate another stream of income that contributes to the sustainability of their business.</p>   |  |
| <p>2.</p> | <p>NHAES #1010499<br/>                 Ecosystem Factors Affecting <i>Vibrio parahaemolyticus</i> Populations and Potential Impacts on Shellfish<br/>                 PD Assoc. Prof. Stephen Jones<br/>                 Co-PD Professor Cheryl Whistler</p> | <p><b>Issue:</b><br/>                 “Oyster aquaculture in northern New England has realized incredible increases in the number of producers and overall production in the past 10 years, yet the associated economic benefits are threatened by the northward emergence and increased incidence of pathogenic bacteria, specifically <i>Vibrio</i> species, that are becoming more prevalent as conditions change in our region. <i>V. parahaemolyticus</i>-borne illnesses are by far the most important <i>Vibrio</i> species, causing a significant number of illnesses in consumers of oysters from New England states...”</p> <p><b>Target Audience:</b><br/>                 included the shellfish industry, regulatory agencies, environmental groups, students, public citizens, extension specialists and fellow scientists interested in shellfish safety. We have applied our research in work directly with the shellfish industry.</p> <p><b>What has been done:</b><br/>                 “We have successfully developed risk forecasting capacity at a harvest-area scale that can be used anywhere in New England. Our continuous refinement of methods for both monitoring pathogenic <i>Vibrio</i> species in NH coastal waters and evaluating pre and post-harvest practices to</p> |  |

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|                  |   | <p>minimize health risks also have served as models for other states to adopt. Our latest methods for detecting the strains of <i>V. parahaemolyticus</i> that actually cause disease are also being used at varying scales to help NH and our partner states to better track and confirm that these strains remain problematic and in need of management.”</p> <p><b>Results and impact: Change of knowledge</b> “These results have provided valuable, region-specific knowledge about conditions that can be used to forecast total <i>Vibrio parahaemolyticus</i> concentrations and the models and overall approach are being considered for adoption by regional shellfish program managers, public health agencies, and the shellfish industry.</p> <p><b>Change of action:</b> The major impact of this project is providing information to shellfish growers and regulators that allows them in near real-time to adjust culture and harvest practices that protect the health of shellfish consumers while minimizing costs to the industry.</p>   |   |
| <p><b>2.</b></p> | <p><b>UNHCE:</b><br/>Agricultural Business Management</p> | <p><b>Issue:</b><br/>Succession planning is an important area to build agricultural business owners’ skills to preserve working farms, provide opportunity for the next generation of farmers, and to provide secure retirement for the generation transitioning off the farm. Furthermore, it is critical to have a succession plan implemented help prevent farm assets from being used to cover medical expenses. This requires planning and transferring assets at least five years before medical services are needed.<br/>As a result of our close relationships with the agricultural community, agricultural business owners have long turned to UNH Cooperative Extension for assistance with farm succession planning and farm transfer. This topic is complex, it involves working with people to discern their goals, conflicts, relationships, retirement plans and a host of other topics very personal subjects. Succession planning also involves a financial assessment of the business to see if it can support all it needs to and to</p> | <p><b>GLOBAL FOOD SECURITY AND HUNGER</b></p> |

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|  |  | <p>assess how much a sale likely will garner its owners. Asset transfer mechanisms, tax planning, business structures, and legal topics further round out this complex subject area. Many NH agricultural business owners have reached an age where business transfer is a short-term goal. As such, UNH Cooperative Extension requests for assistance and education on this topic has been increasing over the past two years.</p> <p><b>Target Audience:</b><br/>This program targeted specifically, agricultural business owners and regulatory agencies</p> <p><b>What has been done:</b><br/>Our Agricultural business team has worked one-on-one with 12 farms in Coos, Belknap, Grafton, Rockingham, and Sullivan Counties. We further provided a web-based educational series that consisted of three one-hour meetings held on Zoom and from these meetings, produced three educational videos to increase agricultural business owners’ understanding of the process. The videos include: Gifting vs. Selling the Farm, Inheriting the Farm, and Estate Planning: Wills vs. Trusts, Long-term Healthcare Planning.<br/>A member of our team also worked collaboratively with a regional organization to teach at one of their multi-state workshops. Another member of our team helped an organization develop a grant that was funded to meet the needs of regional producers. This same member served on a regional committee looking at how to meet the needs of farmers seeking assistance with succession planning.<br/>Finally, members of our Area of Expertise served as a resource to help agricultural business owners find lawyers, tax accounts, and when needed, mediators, to assist them. Our work impacted 59 farmers/producers.</p> |  |
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|  |  | <p><b>Results:</b></p> <ul style="list-style-type: none"> <li>• <i>As a direct result of our work, two farms, comprising 650 acres of farmland with assets valued over \$6.5 million, had implemented a succession plan approved by lawyers and tax accountants.</i></li> <li>• <i>An additional five farms have made significant advancement through the succession planning process, forging written goals, working with UNHCE to develop and/or explore financial statements to learn farm and person assets' net worth, have met with tax accountants or lawyers to begin formalizing their plans. These farms comprise over 1,600 acres and have a value exceeding \$7.6 million in asset values.</i></li> <li>• <i>Another six farms are in the beginning stages of developing a succession plan. They have increased their knowledge about the process and steps and have begun plan development.</i></li> <li>• <i>All the farms above will continue to be commercial farms, preserving open space, producing local agricultural goods, employing NH workers, and keeping all the family members involved in agricultural work. Furthermore, their farm family legacy will continue for at least another generation!</i></li> <li>• <i>Our educational efforts increased the knowledge of our participants in the different aspects of succession planning. The videos developed and posted on YouTube further impacted state and regional farmers. The videos received the following number of views:</i> <ul style="list-style-type: none"> <li>○ <i>Gifted vs. Selling the Farm 40 views</i></li> <li>○ <i>Inheriting the Farm: 26 views</i></li> <li>○ <i>Estate Planning: Wills vs. Trusts, Long-term Healthcare Planning 95 views</i></li> </ul> </li> <li>• <i>Our assistance to Land for Good helped them procure a \$ 101,021.00 grant to build succession planning skills for agricultural service providers throughout the northeast.</i></li> </ul> |  |
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| <p><b>3.</b></p> | <p><b>UNHCE:</b><br/>Legal Impact Narrative</p> | <p><b>Issue:</b><br/>Ignorance is never bliss when it comes to the law. Not complying with labor laws, not having written legal documents, not understanding legal obligations with respect to finances, and a host of other legal topics creates significant risk for agricultural businesses. As owners fail labor audits, as farmers learn that volunteers are not a legal employee classification and incur significant financial losses, and as non-written leases are broken and producers are left with no legal recourse, agricultural business owners seek help.<br/>Producers have been increasingly requesting assistance with legal compliance. A needs assessment completed by 131 farmers in Maine, Vermont and New Hampshire in September of 2017 showed that 101 of these farmers rated their confidence level below 60% in their ability to comply with legal regulations. One hundred and five (105) farmers expressed a desired to learn how to reduce legal risks on their farms. Respondents communicated a desire to have on-line education. Another needs assessment found the top legal concerns to be: land use/ property rights (55%), business liability (54%), labor and employment laws (35%) and food safety (32%).</p> <p><b>Target Audience:</b><br/>This program targeted farmers, agricultural business owners, Agricultural producers and agricultural service providers food producers and, regulatory agencies</p> <p><b>What has been done:</b><br/>A multi-state grant was funded to develop an on-line learning experience to build the knowledge and skills for agricultural producers and agricultural service providers to reduce legal risks. Five modules were developed: labor law, insurance and liability mitigation, business structures, leasing and financing, and value added and Agritourism topics.</p> |  |
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|  |  | <p>Tools were developed for participants to identify and learn about topics to mitigate their current risks. Participants utilized narrated PowerPoint presentations, engaged in interactive activities, read written resources housed on the site, and participated in three, 90-minute educational sessions.</p> <p>One hundred and ninety people registered for the program and 165 participants utilized the educational program’s resources to increase their skills and knowledge. The participants were from five states, NH, ME, VT, MD, and DE.</p> <p>Legal resources were created and updated for each of these five states.</p> <p><b>Results</b></p> <p><i>Action Outcomes</i></p> <ul style="list-style-type: none"> <li>• 31 participants made a change in how they classified their employees, reducing their legal risks and complying with labor laws.</li> <li>• 151 purchased workers’ compensation insurance.</li> <li>• 67 participants purchased new insurance or made changes to their insurance policies protect their business.</li> <li>• 139 participants analyzed their operating agreements, partnership agreements, or bylaws and 38 decided whether a new or different business structure will best manage their legal risks with 31 making changes.</li> <li>• 42 participants analyzed local zoning obligations to see if it allowed for Agritourism activities.</li> <li>• 42 participants implemented a written lease agreement.</li> <li>• 37 participants went back and analyzed contract clauses, production agreements and sales agreements.</li> <li>• 22 participants wrote a sales agreement.</li> </ul> |  |
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| <p><b>3.</b></p> | <p><b>UNHCE:</b><br/>Sweet potato Production</p> | <p><b>Issue:</b><br/>New growing practices (including new varieties, new crops, season extension, and more) can increase farm profitability through diversification, improved yields, and improved crop quality. Prior to 2005, sweet potato (<i>Ipomoea batatas</i>) was considered a tropical crop that could not be grown in the Northeastern U.S.; preliminary research investigating sweet potato production in New England had inconsistent results. Thus, we did not know whether this crop could be grown in the region, and which production techniques were likely to be successful.</p> <p><b>Target Audience:</b><br/>Sweet potato producers, commercial growers and homeowners</p> <p><b>What has been done:</b><br/>Between 2006 and 2012, supported by the NH Agricultural Experiment Station and the NH Vegetable &amp; Berry Growers' Association, we conducted extensive research on sweet potato production in New Hampshire and participated in the National Sweet potato Collaborators' Group, which provided access to new varieties and knowledge from major sweet potato production regions. Using research results, we developed guidelines and recommendations for variety selection, production strategies and postharvest curing and storage practices for New England. We conducted a concerted extension/outreach campaign that included written publications for commercial growers and homeowners and presentations at grower conferences throughout the Northeastern U.S, in addition to peer-reviewed scientific publications. On an annual basis, we have also provided feedback and advice to many growers (at various production scales) from throughout New England to help refine their sweet potato production, harvest, and storage practices.</p> |  |
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|                  |   | <p><b>Results:</b><br/>                 The recently published 2017 Agricultural Census reported that 110 acres of sweet potatoes were grown on nearly 200 farms in New England (compared with 33 acres in 2012, only 4 acres in 2007, and 0 acres in 2002). Assuming a very conservative price per pound of \$1, and a conservative yield of 10 tons/acre, the annual economic value of this crop would be approximately \$2.2 million. We know that yields far in excess of 10 tons/acre are possible, and that many producers obtain very high direct-market prices exceeding \$3/lb, further increasing potential impacts. Prior to our work done at UNH, this market did not exist, and our integrated research and extension work enabled its' development, expanding availability of a high quality locally grown product for consumers and a new high value crop for producers.</p>  |  |
| <p><b>3.</b></p> | <p><b>NHAES # 1006914</b><br/><br/>                 Improving Finfish Production in Recirculating Systems<br/><br/>                 Prof. David Berlinsky<br/><br/>                 Hatch</p> | <p><b>Issue:</b><br/>                 “The United States is a major consumer of seafood but imports the vast majority (&gt;90%) of the seafood consumed. To increase U.S. food production through aquaculture, it is necessary to evaluate candidate species for desirable attributes such as rapid growth, stress tolerance and disease resistance. The results of this research will inform the public about the strengths and challenges associated with culturing three species of food finfish (striped bass, hybrid striped bass, and brown bullhead) in recirculating aquaculture systems.”</p> <p><b>Target audience:</b><br/>                 “Aquaculture and aquaponics researchers and students, as well as current and potential fish farmers.</p> <p><b>What was done: “</b><br/> <b>1)</b> “Previously reported on the feeding behavior and protein requirements of brown bullhead in captivity and initiated broodstock conditioning for captive spawning. The conditioning experiment was</p> |  |

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|  |  | <p>conducted as follows: Nine adult female and six male fish were stocked into five tanks of a six tank RAS, and thirteen females and eight males were stocked into the sixth. This system was comprised of 1750 L tanks and a 450 L sump with photo-thermal control and illuminated with indirect lighting on a simulated ambient photoperiod for New Hampshire. The temperature was lowered to 4C during the Autumn months and raised to 18C in the following spring.”</p> <p>2) In a series of experiments, purebred and hybrid striped bass were grown to marketable sizes in different environments applicable to commercial production. Pure striped bass juveniles (n= ~2000) were produced using wild-caught broodstock from rivers in Nova Scotia, Delaware, Virginia, North and South Carolina, Florida, Texas and a selected, domesticated strain. Fish were reared in triplicate fresh (0 ppt), brackish (5 ppt) and saltwater recirculating (30 ppt) recirculating systems for up to two years of age until production and morphometric parameters (growth, feed conversion, body shape) were compared among strains and salinities. Similarly, hybrid striped bass juveniles (n= ~900) produced using the mature male striped bass from the study described above, were stocked into identical replicated systems and grown until fish attained standard industry market size (680 g; 1.5 lb).</p> <p><b>Results (Change of Knowledge):</b></p> <p>1) “Spawning substrates were provided to promote volitional spawning however volitional spawning did not occur. Upon dissection it was found that neither females nor males attained final stages of reproductive maturation (final oocyte maturation and spermiogenesis, respectively). Considering the feeding inconsistency, slow growth and susceptibility to fungal outbreaks, that we encountered previously, we must conclude that <b>brown bullhead are likely not a good candidate</b></p> |  |
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|                  |   | <p><b>for recirculating aquaculture.</b> Future research with the species should focus on alternative culture systems (e.g. ponds).”</p> <p><b>2) (Purebred and Hybrid Stripped Bass)</b> “Parental broodstock and cultured offspring were fin-clipped and genotyped to identify juvenile family origin in both experiments. Final weights of pure striped bass after one and two years averaged approximately 0.5 and 2.5 kg, respectively and did not differ by water salinity. Final weights (~ 500g) and body shape of hybrid striped bass at one year of age were comparable to their purebred parents when cultured in the same recirculating systems.”</p>   |  |
| <p><b>3.</b></p> | <p><b>NHAES #1016574</b></p> <p>Management Systems to Improve the Economic and Environmental Sustainability of Dairy Enterprises.</p> <p>Prof. Peter Erickson</p> <p>Hatch Multi-State<br/>NC2042</p> | <p><b>Issue:</b></p> <p>Three studies are designed to investigate ways to improve the health and growth of calves and heifers and decrease the costs of raising the next generation of dairy cows that are an integral part of sustainable dairy farming.</p> <p><b>1)</b> “Improving calf health requires antibody uptake by calves from colostrum immediately after birth.”</p> <p><b>2)</b> A second study examines “if sodium butyrate, fed to calves postweaning, could be used as a growth promoter resulting in similar outcomes to antibiotic feed additives. This experiment could result in less antibiotic supplementation to cattle.”</p> <p><b>3)</b> “Wet brewer's grains are a common by-product of the brewing industry and could provide an alternative to corn and soybean meal as energy and protein supplements to growing dairy heifers. Currently, there are no data indicating the value of this feed to dairy heifers.”</p> <p><b>Target Audience:</b> “Ruminant nutritionists, veterinarians, and dairy producers along with undergraduate and graduate students.”</p> |  |

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|  |  | <p><b>What was done:</b></p> <ol style="list-style-type: none"> <li>1) “Meloxicam (a non-steroidal anti-inflammatory drug) was supplemented at birth to newborn calves to determine if it would reduce stress as determined by an improved uptake of the antibody-immunoglobulin G (a measure of immunity).”</li> <li>2) “Regarding calf nutrition and management, we found that heifers fed the feed additive sodium butyrate grew at a faster rate than heifers fed no sodium butyrate and that they were healthier in regards to the protozoal disease - coccidiosis. This was repeated and confirmed in a follow-up experiment where sodium butyrate (0.75 g/kg body weight) was compared to the commonly fed feed additive - monensin (1 mg/kg body weight).”</li> <li>3) “In a study with yearling dairy heifers, wet brewer's grains can substitute adequately for corn and soybean meal thus substantially reducing the cost to feed heifers without any observable adverse effects.”</li> </ol> <p><b>Results:</b></p> <ol style="list-style-type: none"> <li>1) <b>(Change of Knowledge):</b> “Results indicated that meloxicam was not beneficial to feed to newborn calves at or before colostrum feeding.”</li> <li>2) <b>(Change of Knowledge):</b> “Sodium butyrate performed almost as well as (the antibiotic) monensin regarding the efficiency of growth (gain/feed). Sodium butyrate supplemented heifers were similar to monensin fed heifers in regards to body weight and skeletal growth. Naturally occurring incidence of coccidian oocyst shedding was similar in heifers fed either monensin or sodium butyrate but better than control heifers.</li> </ol> |  |
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|                  |  | <p><b>3) (Change of Knowledge):</b> “Sodium butyrate fed at this rate is a suitable replacement for monensin in growing heifer diets. ”</p> <p><b>4)</b> “The cost savings by replacing the corn-based energy mix and the soybean meal-based protein mix with wet brewer's grain is \$0.20/head/day. <b>Impact:</b> For a typical NH dairy farm, raising 100 head of heifers, substituting wet brewer's grain for corn and soybean meal, would result in an estimated savings of \$7,300 per year.”</p>   |  |
| <p><b>3.</b></p> | <p><b>NHAES # 1010110</b><br/>         Applying engineering principles to the design of recirculating aquaponic systems<br/><br/>         Asst. Prof. Todd Guerdat</p> | <p><b>Issue:</b><br/>         “Aquaponics, the integration of aquaculture and hydroponics ... offers the opportunity for sustainable, local, efficient production of healthy foods (fish and vegetables). The hydroponic growing of plant and vegetables utilizes the nutrient-rich water from finfish aquaculture systems to create a value-added product to commercial fish culture. Indoor aquaponic production offers the opportunity for controlled environmental and biosecure growing conditions and provides for the safety, supply and quality for year-round production. While aquaponics has been vetted heuristically, few sound systems engineering principles have been applied to existing designs.”</p> <p><b>Target audience:</b><br/>         “General public, new and experienced growers, academic researchers, extension professionals, university students.”</p> <p><b>What was done:</b><br/>         “Rainbow trout have been shown to experience toxic effects from potassium in recirculating aquaculture systems, and the manipulation of the fish rearing environment to suit plant requirements included potassium supplementation. Thus, nutrient production from trout was studied in the solid waste stream, and deleterious effects of potassium was conducted to understand lethal and sublethal concentrations.”</p> |  |

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|                  |   | <p><b>Results (Change of Knowledge):</b></p> <p>“Data from the rainbow trout and tilapia nutrient production research show that all nutrients required for hydroponic production are present in both waste streams, however, each waste stream is characteristically different in nutrient quantities and organic carbon. The nutrient profile from tilapia is different from rainbow trout, due in part to the feed nutrient profiles and the gut physiology of the fish. ... The results to date from the research have been used by engineering students to develop a comprehensive nutrient, water, and energy balance spreadsheet model complete with a break-even economic analysis... The model will be used by extension professionals and growers to estimate revenue and determine crop production estimates.”</p>  |  |
| <p><b>3.</b></p> | <p><b>NHAES #1017760</b><br/>                 Conservation and Utilization of Plant Genetic Resources<br/><br/>                 Assoc. Prof. Iago Hale<br/>                 Hatch Multi-state</p> | <p><b>Issue:</b></p> <p><b>1)</b> “The kiwiberry is a novel horticultural crop of potential economic importance to New England growers. This project systematically evaluates, for the first time under New England's growing conditions, the North American collection of cold-hardy kiwifruit germplasm.”</p> <p><b>2)</b> “Present throughout New England, barberries have been shown to function as the alternate host to the two most devastating fungal diseases of wheat, stem rust and stripe rust. This project will assemble a collection of diverse barberry germplasm from around the world and develop needed molecular tools to aid researchers conducting barberry surveillance work in the region and globally.”</p> <p><b>Target audience:</b></p> <p><b>1)</b> “Kiwiberry producers, processors, home gardeners, researchers, and those involved in related industries (e.g. nurseries).”</p> <p><b>2)</b> “Current and prospective small grain producers in the U.S. Northeast; international wheat rust community of researchers, with focus on</p> |  |

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|  |  | <p>breeding and genetics; and international barberry community of researchers, with focus on Berberis taxonomy and genomics.”</p> <p><b>What was done:</b></p> <p>1) <b>a)</b> Released a comprehensive, online kiwiberry production guide and enterprise analysis for the Northeast. <b>b)</b> Ongoing: Develop improved germplasm through strategic crosses and optimize production practices; develop genomic resources to increase breeding efficiency; educate stakeholders about this new horticultural product; and work to establish a viable kiwiberry (<a href="http://www.noreastkiwiberries.com">www.noreastkiwiberries.com</a>). <b>c)</b> Genetic work revealed widespread misidentification within the USDA collection and among nurseries, leaving interested producers unsure as to where to source plants.</p> <p>2) “The purpose of this research is to develop the genomics tools needed to support this research, as well as global barberry surveillance more generally, assess the risk posed by New England barberries to small grains production in and beyond the region, educate regional growers about this potential risk ... as momentum builds for revitalizing small grains production for local consumption.”</p> <p><b>Results:</b></p> <p>1) <b>Change in Action:</b> a) An “online kiwiberry production guide and enterprise analysis for the Northeast. Reception has been excellent, with &gt;2,000 users from 39 different countries in the first seven months. b) The sex-linked molecular marker developed in our program was converted to a high-throughput Kompetitive allele specific PCR Marker with LGC Genomics. We now have a standard marker for use in the breeding program, the only example of a routine Marker Aided Selection protocol for kiwiberry.” This marker allows producers to plant vineyards with balanced numbers of male and female kiwiberry vines for optimum production. c) We have partnered with Hartmann's Plant Company (MI), genotyping its inventory to certify varieties</p> |  |
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|                  |  | <p>relative to the program's variety recommendations for the region. Hartmann's provided leaf samples of its inventory, which we subjected to genetic sequencing. The data are now available and being analyzed using the bioinformatics pipeline developed in our program.”</p> <p><b>2) Change of Knowledge:</b> Barberry. The reference genome and assembled transcriptome of <i>B. thunbergii</i> cv. 'Kobold'; genetic linkage maps for both <i>B. vulgaris</i> and <i>B. thunbergii</i>; and the results of the first Quantitative Trait Loci (QTL) analysis of non-host resistance to Pg in barberry, revealing a single, well-defined resistance locus in <i>B. thunbergii</i>. Bartaula R, Melo ATO, Kingan S, Jin Y, Hale I (2019) Mapping non-host resistance to the stem rust pathogen in an interspecific barberry hybrid. BMC plant biology, 19(1), 319 <a href="https://doi.org/10.1186/s12870-019-1893-9">https://doi.org/10.1186/s12870-019-1893-9</a> “</p>  |  |
| <p><b>3.</b></p> | <p><b>NHAES # 1017757</b></p> <p>Conservation and Utilization of Plant Genetic Resources</p> <p>Professor Emeritus J. Brent Loy</p> <p>Hatch Multi-State NE9</p> | <p><b>Issue:</b></p> <p>“There is an increasing emphasis on enhancing local production of fruits and vegetables as a means of sustaining food security in North America. As a result of this pursuit, local farm markets have greatly expanded in New England over the past 10 to 15 years. The breeding efforts with squash, pumpkins and melons at the University of New Hampshire are aligned with this vision, that of increasing the diversity of squash, pumpkin and melon varieties adapted to growing conditions in New England and much of the Northeast, and developing varieties of squash and melon with better eating quality and nutrition.”</p> <p><b>Target audience:</b></p> <p>Personnel at seed companies responsible for producing and releasing new varieties developed at the University of New Hampshire, growers and home gardeners who purchase seeds and grow the varieties, produce managers responsible for displaying and promoting fresh vegetables, and consumers who purchase fruits and vegetables.</p> |  |

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|  |  | <p><b>What was done:</b></p> <p>1) “Melon breeding for the Northeastern United States: A new race of powdery mildew is now prevalent in the Northeast and infects many varieties developed for this region, including three important NH breeding lines previously conveying resistance to races 1 and 2. Efforts are underway to transfer a dominant gene with resistant to the new race into susceptible lines.”</p> <p>2) “Yellow summer squash with reduced spines: A glabrous mutant (gl-2) which largely eliminates the large, prickly spines (compound trichomes) on stems and leaf petioles of yellow summer squash was discovered in 1992, and through extensive breeding efforts this trait has been incorporated into improved inbred lines for developing hybrids of yellow straightneck (YSN) and crookneck (YCN) summer squash.”</p> <p>3) “Kabocha/buttercup (<i>Cucurbita maxima</i>) breeding: The major objective of the UNH breeding program has been to develop bush breeding lines for producing semi-bush hybrids with good eating quality.”</p> <p>4) “Breeding acorn squash (<i>Cucurbita pepo</i> ssp. <i>ovifera</i>): We have developed inbred lines with large, attractive fruit that hold color well in storage, have high dry matter contents between 18 to 25% at maturity, and intermediate Powdery Mildew Resistance (PMR). During the past three years, several experimental hybrids developed from these breeding lines have been evaluated at the Kingman Research Farm in Madbury, NH and by seed companies in the Northeast.”</p> <p>5) Ornamental pumpkins (<i>Cucurbita pepo</i> ssp. <i>pepo</i>): “To better serve growers and consumers with more pumpkin diversity, our pumpkin breeding program has expanded to develop more hybrid varieties with white fruit, and also hybrids with a bicolor pigmentation (yellow/green or orange/green), combined with striping patterns. In</p> |  |
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|  |  | <p>2019, 36 white hybrids, representing different size classes, were evaluated at the Kingman Research Farm for color retention, productivity and stem integrity. Many of these hybrids were also evaluated by cooperating seed companies. Forty bicolor, striped hybrids were also evaluated for productivity, degree of bicolor expression, and retention of pigmentation.”</p> <p><b>Results (Change in Action):</b></p> <p><b>1)</b> “Over 25 melon hybrids, comprised of either one or two inbred lines developed at the University of New Hampshire, are currently being marketed, with most hybrids being offered by several major catalog seed companies in the Northeastern United States. A new variety utilizing a NH breeding line, 'Sugar Rush', was added to this list in 2018. It follows the recent introduction of Sugar Cube, a popular variety with one parent contributed by NH breeding efforts. Gynoecious (highly female) melon breeding lines with good external appearance and culinary traits have been developed for use as seed parents for reducing production costs for hybrid seed production.”</p> <p><b>2)</b> Yellow summer squash with reduced spines. “Three YSN glabrous varieties were previously introduced, and a fourth YSN glabrous hybrid, Smooth Criminal, with a desirable single-stem growth habit, early maturity, high productivity, uniform fruit shape, and intermediate resistance to powdery mildew disease (PMR), was introduced into the seed trade in 2018/2019.”</p> <p><b>3)</b> Kabocha/buttercup (<i>Cucurbita maxima</i>) breeding: “Several bush breeding lines with both green and orange fruit have now been developed, and five semi-bush hybrids have been introduced into the seed trade.”</p> <p><b>4)</b> Breeding acorn squash (<i>Cucurbita pepo</i> ssp. <i>ovifera</i>):</p> |  |
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|           |   | <p>“Hybrids are evaluated for growth habit, pattern and timing of fruit set, fruit size, fruit yield, soluble solids content (SSC), flesh dry weight (% DW), shelf life, and cooked culinary traits. Currently, one new hybrid, NH2632, is being produced by a seed company for introduction in the near future.”</p> <p>5) Ornamental pumpkins (<i>Cucurbita pepo</i> ssp. <i>pepo</i>): “It is anticipated that five or six new white hybrids will be released in the near future. Two of these are tentatively scheduled for production in 2020. Two new pumpkin hybrids with orange fruit in the 14 to 22-pound size range, Carbonada Gold and Renegade, were introduced by the seed industry in 2018/2019, and also as a result of cooperative efforts with a seed company, an attractive and unique pumpkin, Grizzly Bear, with brown pigmentation and warty skin, was introduced.”</p> <p>6) “Hull-less seeded pumpkin (<i>Cucurbita pepo</i> ssp. <i>pepo</i>). The NH-bred hybrid variety, 'Naked Bear', is the major, high yielding variety available to most vegetable growers. An additional hybrid for use both as an ornamental pumpkin and for hull-less seeds, 'Pie-Pita', is now available to organic growers. Another NH hybrid, NH2020, is being produced by a food company in the Midwest for organic production and utilization for various snack-food products.”</p> |  |
| <p>3.</p> | <p><b>NHAES #1010298</b></p> <p>Developing Interspecific Hybrids in Squash for Processing, Fresh Markets, and Grafting Rootstocks</p> <p>Professor Emeritus J. Brent Loy</p> <p>Hatch</p> | <p><b>Issue:</b></p> <p>“Winter squash is an important crop throughout the Northeast, but continued viability of this crop depends upon the continued improvement of varieties in terms of productivity, eating quality, and disease resistance. A new and exciting approach initiated at the NH Agricultural Experiment Station has been to develop interspecific hybrids between two species of squash, <i>Cucurbita maxima</i> (buttercup and Golden Delicious types) and <i>C. moschata</i> (butternut, and Dickinson Field types).”</p>   |  |

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|  |  | <p><b>Target Audience:</b><br/>         “We are working closely with two companies interested in processing squash, one of which is also interested in production of rootstock hybrids for melon production. We will try to assist interested growers in New England on grafting techniques and on trialing some of our interspecific hybrid rootstocks. Vegetable growers who may use interspecific hybrids either for grafting or for production of squash are the ultimate target of our research.”</p> <p><b>What has been done:</b></p> <ol style="list-style-type: none"> <li>1) “Increasing the diversity of <i>C. moschata</i> and <i>C. maxima</i> breeding lines for making compatible interspecific crosses.”</li> <li>2) “Evaluate disease resistance, productivity, and culinary characteristics (of hybrid crosses).”</li> </ol> <p><b>Results (Change of Knowledge)</b></p> <ol style="list-style-type: none"> <li>1) “Several more <i>C. moschata</i> lines have recently been developed from an Australian accession with good powdery mildew resistance crossed to a breeding line, NH.Mo125-1-10. Fruit in these new lines are either tan or mottled green/tan at maturity, weight 2 to 4.5 kg, with 12 to 17% DW and high <math>\beta</math>-carotene content.”</li> <li>2) “Open-pollinated, Dickinson Field strains account for over 90% of canned pie stock, and we have not generated interest from processing companies in utilizing interspecific F1 hybrids. As such, our research in 2018 and 2019 focused more on achieving greater seed productivity in interspecific crosses, evaluating rootstocks for grafting to different melon varieties, and using interspecific hybridization to transfer useful traits between <i>C. moschata</i> and <i>C. pepo</i>. In 2019, we evaluated the effects of grafting in three melon varieties, 'True Love', 'Sugar Cube' and 'Sugar Rush'. Average FW plot yields for grafted plants of 'Sugar Cube', 'Sugar Rush', and 'True Love' were, respectively, 61.1, 73.7, and</li> </ol> |  |
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|                  |  | <p>60.1 kg, as compared to 46.2, 33.0 and 46.2 kg for non-grafted plants. Mean soluble solids contents were significantly higher in NG plants of 'Sugar Cube' (15.0%) and 'Sugar Rush' (13.6%), than that of GR plants (12.8%); however, soluble solids contents in both NG and GR treatments was well above the USDA fancy grade of 11%.”</p>   |  |
| <p><b>3.</b></p> | <p><b>NHAES #1010449</b><br/>Sustainable Solutions to Problems Affecting Bee Health<br/><br/>Cathy Neal, UNHCE Extension specialist and NHAES researcher<br/><br/>Hatch Multi-state NC1173_old</p> | <p><b>Issue:</b><br/>“Lack of good quality habitat is a major factor contributing to widespread pollinator declines in recent years. Pollinators need a diversity of wildflowers and other plants that provide a continuous sequence of bloom on which they can feed throughout the season. Establishing and maintaining bee forage (on farms) or wildflower meadows (in the landscape) is difficult, costly and time-consuming for land managers, however, and often results in failure.” Prior research identified appropriate species selection, site preparation and weed management as the biggest challenges to successfully planting wildflower meadows.</p> <p><b>Target Audience:</b><br/>Landowners and land managers (public and private lands), Municipal and government agencies and boards, environmental, community and conservation groups, gardeners, farmers scientists, extension specialists, undergraduates. In 2019, research was disseminated at five events held the NHAES Woodman Farm; the largest, Connecting the Dots, drew 160 participants.</p> <p><b>What was done:</b><br/><b>1)</b> Determine whether yield benefits can be correlated with distance from pollinator hubs. Two experiments were completed with squash and blueberries, respectively, placed at five distances from an established wildflower meadow. Several pairs of flowers on each plant were tagged, one open to pollination and one covered with pollinator exclusion netting.</p> |  |

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|                  |                               | <p><b>2)</b> Investigate the relative attractiveness of native perennial species and their cultivars to key pollinators. Cultivars of purple coneflower (<i>Echinacea purpurea</i>) were grown to maturity in containers, then arranged in randomized complete block designs in two growing seasons. Pollinator visitation rates were quantified during peak bloom periods, using timed pollinator counts repeated over several days each year.</p> <p><b>Results:</b></p> <p><b>1)</b> Pollinator visitation rates, fruit yield, and seed set from tagged fruit failed to support the hypothesized linear relationship with distance from the pollinator hub. Outcome (increase in knowledge): While the additional pollinator resources no doubt increased abundance of pollinators, they did not increase crop yields because pollinator populations supported by the surrounding landscape (primarily woodland edges) were apparently adequate. “A thorough habitat assessment should be conducted on farms before investing in supplemental pollinator plantings (that) may or may not be economically justified.”</p> <p><b>2)</b> Outcome (increase in knowledge): “Within a species, there may be large differences in pollinator attractiveness by cultivar. In general, those selected for highly modified form, color and size were less valuable to pollinators than the original species or similar selections, however, each cultivar needs to be tested. Honeybees exhibited different preferences than bumble bees or solitary bees. Lists of pollinator-friendly plants should reflect differences at the cultivar level in order to be useful to people choosing plants for their pollinator gardens.”</p> |  |
| <p><b>3.</b></p> | <p><b>NHAES # 1016530</b></p> | <p><b>Issue:</b><br/>         “The success of sustainable agriculture in the United States will increasingly rely on the integration of biologically based tools with traditional agricultural practices. One strategy is to harness the power of</p>  |  |

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|  | <p>Managing Plant Microbe Interactions in Soil to Promote Sustainable Agriculture</p> <p>Asst. Prof. Anissa Poleatewich<br/>Hatch Multi-state W4147</p> | <p>naturally occurring beneficial microbes as biopesticides. Inconsistent field performance of biopesticides, however, has been a barrier to grower uptake. This project will elucidate how different agricultural practices (cultivars grown, fertilizers, growing substrates) influence performance and activity of the different types of biopesticides to develop best practices tailored to specific greenhouse production systems.”</p> <p><b>Target Audiences:</b></p> <ul style="list-style-type: none"> <li>• Commercial growers</li> <li>• Extension specialists, Scientists</li> <li>• Undergraduate and graduate students</li> <li>• Companies/producers and retailers of microbial and fungal Biocontrol agents</li> <li>• Companies that produce substrates for Plant Growth</li> </ul> <p><b>What was done:</b></p> <p>“Evaluate the effect of propagation substrates on biocontrol efficacy. Two experiments were conducted using a vegetable crop (cucumber) and a floriculture crop (calibrachoa). We wanted to determine if root rot disease suppression by biopesticides is influenced by the growing media type. The floriculture and vegetable systems were used as a model to determine if similar effects occur in different production systems. Three growing substrates commonly used in greenhouse propagation made from inorganic (Oasis foam) and organic (peat and coconut coir) materials were compared. Three commercially available biopesticides were tested on each of the three substrates and compared to a water control.”</p> <p><b>Results (Change in Knowledge):</b> “We found that the substrate influenced Pythium root rot severity. Generally, plants grown in coconut coir had higher levels of disease. We also found that the substrate had an effect on biopesticide efficacy, in which disease suppression tended to be greatest in coconut coir.”</p> |  |
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| <p><b>3.</b></p> | <p><b>NHAES # 1004515</b><br/>                 Sustainable Solutions to Problems Affecting Bee Health<br/><br/>                 Asst. Prof. Sandra Rehan<br/>                 Hatch Multi-state NC1173_old</p> | <p><b>Issue:</b><br/>                 “Widespread declines in pollinator diversity have led to concern about a global pollinator crisis. The National Research Council has called for regional, national and international monitoring programs to allow tracking the status and trends of pollinators. This study will establish the first complete diversity assessment of native bees in the region and will also provide a better understanding of pollinator diversity and ecology.”</p> <p><b>Target audience:</b><br/>                 This project targeted stakeholders in the farmers, forestry, landowners, landscapers, school groups, citizen scientists, naturalists, and conservation authorities.</p> <p><b>What was done:</b><br/> <b>a)</b> “We conducted long term biomonitoring of wild bees across forest and clear-cut habitats as well as organic and conventional farms to determine the brood productivity, survival, and body size of wild bees.”<br/><br/> <b>b)</b> “We also examined bee abundance, diversity and functional traits across landscapes to determine suitable habitat for wild bees.”</p> <p><b>Results:</b><br/> <b>a)</b> “We can directly attribute bee body size and survival to nutritional state and maternal investment and thus learned, that increasingly managed landscapes including clear cut forests and conventional farms harbor small and fewer bees suggested compromised nutrition in these landscapes.”<br/> <b>b)</b> “Taken together, over five years and six landscapes, we determined indicator species for suitable wild bee habitat that can be used for long term pollinator health and sustainability monitoring. Indicator species include bumblebees, carpenter bees, and sweat bees in un-grazed landscapes. Interestingly, we found that grazing pressure negatively</p> |  |
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|                  |  | influences bee abundance, species richness, and functional trait diversity while management intensity has little effect.”   |  |
| <p><b>3.</b></p> | <p><b>NHAES #1006928</b><br/>                 Varieties and cultural practices for vegetable and small fruit production in New Hampshire</p> <p>Dr. Rebecca Sideman<br/>                 Extension Specialist and NHAES researcher</p> | <p><b>Issue:</b><br/>                 Vegetable and berry growers in New Hampshire and the rest of Northern New England are challenged by a short growing season, variable weather patterns, high land values and labor costs. Despite these challenges, the opportunities for local vegetable and berry production are vast, with very strong direct marketing channels. Many of the high value crops grown in New England are grown using production systems that are different from those used in major U.S. producing areas. Use of the most effective growing practices for our region (including new varieties, new crops, and season extension strategies) can increase farm profitability through diversification, improved yields, and improved crop quality.</p> <p><b>Targeted audience:</b><br/>                 “Commercial farmers, home gardeners, extension educators and researchers. Efforts to reach these audiences will include educational workshops, field days and on-farm twilight meetings, undergraduate teaching, and educational in-services.”</p> <p><b>What was done:</b></p> <ol style="list-style-type: none"> <li><b>1)</b> In a project done in collaboration with Pennsylvania State University and the University of Minnesota, as part of USDA-AFRI SCRI project optimized protected culture environments for berry crop.</li> <li><b>2)</b> Validated soil-testing methods and generate regionally appropriate recommendations for nutrient management for high tunnel tomato production.</li> <li><b>3)</b> Introduction of sweet potato cultivation to NH (long term). Prior to 2005, sweet potato (<i>Ipomoea batatas</i>) was considered a tropical crop that could not be grown in the Northeastern United States;</li> </ol> |  |

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|  |  | <p>preliminary research investigating sweet potato production in New England had inconsistent results. Between 2006 and 2012, supported by the NH Agricultural Experiment Station and the NH Vegetable &amp; Berry Growers' Association, we conducted extensive research on sweet potato production in New Hampshire and participated in the National Sweet potato Collaborators' Group, which provided access to new varieties and knowledge from major sweet potato production regions.</p> <p><b>Results</b></p> <p><b>1) Change of Knowledge:</b><br/>         “Characterized the effects of low tunnels covered with standard polyethylene, polyethylene with reduced infrared radiation, and two experimental coverings on soil and air temperature and light levels during spring, summer, and fall. Characterized the effects of the low tunnel coverings described above in a factorial experiment using both black and white polyethylene mulches, on strawberry growth, fruit production, and insect pest pressure, using day-neutral strawberry cv. Albion. Developed several practical tools to provide relevant information to growers seeking to extend their growing season using this low-cost method.”</p> <p><b>2) Change of Knowledge</b><br/>         In this multi-year experiment, we found that <b>a)</b> even extremely high levels of applied K were depleted quickly from high tunnel soils, and <b>b)</b> in general, soil K levels were positively correlated with marketable fruit weight, and negatively correlated with incidence and severity of yellow shoulder (YS) and percentage of cull fruit. Thus, increased soil testing and an improved understanding of how to better manage soil K can increase fruit quality and yields. We have communicated the results of this work in a variety of ways, including presentations at grower conferences, presentations at scientific conferences, and</p> |  |
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|                  |  | <p>adjusting our New England soil testing recommendations to reduce the likelihood of K deficiencies in high tunnel soils.</p> <p><b>3)</b> Sweet Potato cultivation – long-term impact. “The recently published 2017 Agricultural Census reported that 110 acres of sweet potatoes were grown on nearly 200 farms in New England (compared with 33 acres in 2012, only 4 acres in 2007, and 0 acres in 2002). Assuming a very conservative price per pound of \$1, and a conservative yield of 10 tons/acre, the annual economic value of this crop would be approximately \$2.2 million. We know that yields far more than 10 tons/acre are possible, and that many producers obtain very high direct-market prices exceeding \$3/lb., further increasing potential impacts. Prior to our work done at UNH, this market did not exist, and our integrated research and extension work enabled its' development, expanding the availability of high quality locally grown product for consumers and a new high-value crop for producers.”</p> |  |
| <p><b>3.</b></p> | <p><b>NHAES #1016232</b></p> <p>Quantifying the mechanistic drivers of weed community assembly across diverse forage production systems</p> <p>Assoc. Prof. Richard Smith</p> <p>Hatch</p> | <p><b>Issue:</b></p> <p>“Weeds are a serious threat to the economic and environmental sustainability of agriculture. Applications of herbicide and tillage are the most common practices used to reduce weed abundance; however, these practices have both economic and environmental costs. Improving the understanding of the biotic factors that contribute to weed mortality in cropping systems could lead to new ecologically-based strategies for managing weeds that reduce the need for herbicides and other costly control practices.”</p> <p><b>Target audience:</b></p> <p>Farmers, students, extension personnel, and other agriculture professionals interested in management strategies for improving ecologically-based weed suppression.”</p>   |  |

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|                  |  | <p><b>What was done:</b><br/>                 “We measured weed seed predation rates over the 2018 and 2019 growing season in a grain-crop rotation with different levels of soil disturbance (tillage, strip-till, and no-till) and pesticide input (insecticide and fungicide seed treatments vs no seed treatment).”</p> <p><b>Results:</b><br/>                 “Our preliminary analysis of these data indicate that seed predators (i.e., ground beetles, crickets, and field mice-biotic sources of seed mortality) are a significant source of natural weed control, with rates of seed removal approaching over 90% of seeds offered during a 48-hour period. Both tillage and pesticides appear to influence seed predation rates and these effects differ depending on the nature of the seed predator (insects vs small mammals).”</p>   |  |
| <p><b>3.</b></p> | <p><b>NHAES #1013437</b><br/>                 Biomarkers for metagenomics analysis of plant parasitic nematode communities</p> <p>Professor W. Kelley Thomas Hatch</p> | <p><b>Issue:</b><br/>                 “Nematode parasites of plants are a major cause of crop loss and a global threat to agriculture. Evaluating the existence of plant parasites in agricultural soils is critical to the proper application of mitigation strategies like crop rotation, and pesticide application. Our scientific premise is that the pathogenicity phenotype of plant parasitic communities is poorly predicted by markers of taxonomy. As a result, the accurate markers for pathogenicity must be closely genetically linked to the gene or genes involved in the mechanisms of pathogenesis.”</p> <p><b>Target Audience:</b> “Nematologists and/or other plant parasite research groups developing molecular methods to detect plant parasites. For example, we have shared our recently developed mitochondrial DNA capture protocol with two scientists, Drs. Dorota Porazinska and Tom Powers, who...will apply our methods to monitor several important plant parasitic nematode species in agricultural soils. This proposal was recommended for funding as of December 2019.”</p> <p><b>What was done:</b></p> |  |

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|                  |  | <p>“A solution to the core issue of effective identification of plant pathogenic nematodes will require both fine genetic resolution below the species-level and high sensitivity to allow management to identify emerging pests. Toward those goals, the Thomas lab has developed an approach focused on cost-effective DNA sequencing of target genes including the entire mitochondrial genomes and an array of single copy nuclear genes of nematodes based on environmental DNA extracted from soil sample.”</p> <p><b>Results (Change of Knowledge):</b><br/>                 “We have successfully developed a hybrid capture method to enrich for mitochondrial DNA sequences from environmental DNA samples. To do this, scientists collected all known animal mitochondrial genomes and with Kapa/Roche, designed a set of DNA probes that can match every known animal mitochondrial DNA sequence. We tested these probes through two design phases, improving the enrichment to 3 orders of magnitude. It is now possible to efficiently assay animal mitochondrial diversity from metagenomics DNA and identify species- and strain-level variation among not only nematodes but any metazoan animal in the sample.”</p> |   |
| <p><b>4.</b></p> | <p><b>UNHCE:</b><br/>                 Natural Resources Professional Training and Forester Referrals</p> | <p><b>Issue:</b><br/>                 The health of New Hampshire’s natural resources depends on sound land use, strong conservation organizations, and citizens engaged in natural resource management and conservation to maintain working forestlands, clean water, diverse natural areas, and connected wildlife habitats. NH is currently experiencing a wide range of issues such as forest fragmentation, sprawling development, loss of natural areas, climate change, invasive species, and increasing extreme storm events. The continued development and human use of the state’s natural resources results in significant ecosystem impacts, including habitat loss, water</p>  | <p><b>CLIMATE CHANGE AND SUSTAINING NATURAL RESOURCES</b></p> |

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|  |  | <p>quality impairment, colonization of invasive species, and increased stormwater runoff. These impacts can critically affect the economy, public health and quality of life.</p> <p>Professionals working in environmental fields have a tremendous opportunity and responsibility to use best practices to protect natural resources while advising landowners, in land use planning and conducting their activities. Training programs from UNH Extension using emerging technologies and research-based best practices provide natural resources professionals with tools and approaches they can use to advise private landowners, land trusts, communities agency staff, educators, and decision-makers how to sustain productive forest lands, abundant clean water, diverse natural areas, and connected wildlife habitats in New Hampshire.</p> <p><b>Target Audience:</b><br/>New Hampshire volunteers, landowners, natural resources professionals, land trusts, community agency staffs, educators, and decision-makers.</p> <p><b>What was done:</b><br/>This year, Extension state specialists in forestry, wildlife, land conservation, water quality, stormwater management, and geospatial technologies provided advice and technical support to private landowners and natural resources professionals by phone, email, and in person. Public events consisted of (1) NH Land Trust Coalition Workshop which helped 48 land trust and professionals to understand tax responsibilities related to land trusts, (2) Stormwater Best Management Practices workshop for 200 participants focused on minimizing the impacts of excess runoff, (3) six facilitated meetings to support NH regional National Pollutant Discharge Elimination System Stormwater Permits which helped 141</p> |  |
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|  |  | <p>participants to address new permit requirements in their communities, and (4) 18 geospatial technologies workshops which provided information and training to 119 participants on technology-based mapping approaches to be used to map, analyze, and communicate about natural resources. In total, the Area of Expertise (AoE) reached 508 professional participants from more than 70 NH communities and 5 other states (MA, ME, NY, OK, VT). (5) Over 200 forestry and wildlife workshops focused on laws, regulations, sustainable forestry, forest health and wildlife habitat enhancement were offered to over 500 natural resources professionals (consulting foresters, loggers, natural resources scientists).</p> <p><b>Results:</b></p> <ul style="list-style-type: none"> <li>• <i>After attending Untangling Knotty Issues Surrounding IRS Tax Deductions: Land Trust Responsibilities with Appraisals &amp; Form 8283's, 100% of land trust staff and other natural resources professionals reported that the workshop increased their knowledge about IRS tax deductions and Form 8283 and 94% reporting the workshop gave them new tools and understanding they can use in their organization.</i></li> <li>• <i>Of the 119 attendees of geospatial technology workshops including GIS/GPS Boot Camp, Introduction to ArcGIS, and Telling Your Story with Maps, 100% better understood how GIS could be used in their work, 100% said they could use GIS more effectively to share information with others, and 100% said they planned to use what they learned in the workshops.</i></li> <li>• <i>Through facilitated support for NH regional National Pollutant Discharge Elimination System Stormwater Permits, professionals from 47 New Hampshire communities became better informed of</i></li> </ul> |  |
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|           |   | <p><i>the practices necessary to limit the effects of stormwater on their infrastructure and natural resources.</i></p> <ul style="list-style-type: none"> <li>• <i>Over 500 natural resources professionals (consulting foresters, loggers, natural resources scientists) secured or maintained their licenses and/or certifications to conduct business by attending one or more of our forestry and wildlife workshops and trainings.</i></li> </ul>   |  |
| <p>4.</p> | <p>NHAES #1016142<br/>The Genomic Basis of Soil Microbial Growth and Efficiency<br/>Prof. Serita Frey<br/>Hatch</p> | <p><b>Issue:</b><br/>“Agricultural productivity is dependent on nutrient cycling processes, which are mediated by soil microorganisms. Microbial activity, in turn, is controlled to a large degree by temperature, moisture, substrate quality, and nutrient availability. Human-induced environmental change (e.g., climate warming, land-use change) may alter the microbial community and the nutrient cycling processes it mediates, thus impacting crop productivity. Growth rate and metabolic efficiency are key microbial traits controlling soil carbon storage. The goal of this project is to define the genomic basis of soil microbial physiology (i.e., growth and efficiency) and use this new knowledge to develop more realistic models of soil organic matter decomposition.”</p> <p><b>Target Audience:</b> “The scientific community, university students, professional soil scientists and natural resource managers, and the general public.”</p> <p><b>What was done:</b> “We investigated the temperature response and genomic markers predictive of these parameters in ten saprotrophic fungi representing a broad phylogeny.”</p> <p><b>Results (Change of Knowledge):</b> “Temperature responses were species-specific, and growth rates and efficiency were not correlated, contradicting the predicted evolutionary tradeoff between resource consumption rates and growth efficiency. The fungal taxa studied</p> |  |

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|           |  | <p>clustered into three distinct ecological groups based on where they fall along an r/K continuum, their genetic potential for decomposition, and their intrinsic metabolic efficiencies. (R-Selection refers to species with high growth rates while K selection refers to stable populations near the carrying capacity of the environment that tend to favor the slow-growing long-lived populations.) Hence, binning microbial taxa into a few trait-based groups based on genomic information is a viable way to predict physiological attributes relevant to soil carbon cycling.”</p>   |  |
| <p>4.</p> | <p>NHAES #1007001<br/>                 Measuring and Predicting Soil Organic Matter Formation and Nitrogen Mineralization<br/>                 Assoc. Prof. A. Stuart Grandy<br/><br/>                 Hatch</p> | <p><b>Issue:</b><br/>                 “Soil organic matter (SOM) influences most key soil processes including water holding capacity, soil aggregation, porosity, and erosion potential. Soil organic matter also influences several ecosystem-scale processes, including trace gas emissions and net primary productivity and plays a central role in the global carbon cycle, although the processes underlying the formation of SOM remain poorly defined, as well as relationships between the soil carbon (C) and nitrogen (N) cycles.”</p> <p><b>Target Audience:</b><br/>                 “Other scientists and land managers interested in soil organic matter formation and nitrogen mineralization.”</p> <p><b>What was done:</b><br/>                 “We are interested in how changes in soil N cycling could lead to a greater capacity of soil to supply N. We collected soil from a long-term diversity experiment at the Eastern Nebraska Research and Extension Center in Mead, NE.” We conducted a novel, isotopic pool dilution assay that measures gross rates of amino acid production, consumption, and net rates of proteolysis. In addition, gross rates of N mineralization were measured along with microbial biomass, carbon use efficiency, respiration, enzyme activity, and total C and N.”</p> <p><b>Results: (Change of Knowledge)</b></p> |  |

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|           |   | <p>“Crop rotation influences net rates of proteolysis for total amino acids but there was not a significant effect of fertilizer. Total amino acid consumption by microbes was approximately 1.5x greater than gross amino acid production, resulting in negative rates of net proteolysis between all treatments. Diverse rotations have higher net rates of proteolysis than corn-soy and continuous-corn rotations. Which together with other results suggests that agricultural management strategies play an important role in influencing bioavailable N cycling... Diversified crop rotations positively impact ecosystem processes in temperate agroecosystems by increasing yield resilience, crop productivity, and soil quality.”</p>  |  |
| <p>4.</p> | <p>NHAES #1010114<br/>                 Understanding how wind turbine-induced vibrational noise influences subsoil-breeding beneficial insects; a test of the sensory pollution hypothesis</p> <p>Asst. Prof. Dan Howard</p> <p>Hatch</p> | <p><b>Issue:</b><br/>                 “Wind energy is increasingly promoted and viewed as a sustainable compliment to traditional land uses such as agriculture and grazing, although we lack a clear understanding of the ecological effects of wind turbine vibration on soil-living organisms. Subterranean invertebrates occupy an important niche in the ecological community associated with the decomposition of organic matter, the aeration of soils, and soil nutrient cycling, and insect such as burying beetles that feed and/or breed on carrion represent one important group of decomposers in this community. Burying beetles exhibit complex parental care behavior, including the use of sound and likely vibration in communication, and thus soil vibrations produced by wind turbines may pose a challenge to the successful burial of a carcass and the rearing of offspring.”</p> <p><b>Target audience:</b><br/>                 Behavioral Ecologists, Conservation Managers, undergraduates, and K-12 students. NHPR feature: The Secret, Bizarre World of Insect Vibration Language, April 2017 <a href="http://nhpr.org/post/secret-bizarre-world-insect-vibration-language">http://nhpr.org/post/secret-bizarre-world-insect-vibration-language</a></p> |  |

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|  |  | <p><b>What was done:</b><br/>         “This project integrated both laboratory and field investigations that tested predictions of the sensory pollution hypothesis as it relates to beneficial insect ecology, behavior, and physiology. The broader aim of the research was to generate hypotheses regarding how edaphic (subsoil) invertebrate communities respond under conditions of vibrational disturbance, and how these responses might produce secondary effects related to community assemblage dynamics, soil nutrient structure, and ultimately agroecosystem and rangeland productivity. Additional experiments are testing whether seismic noise influences stridulatory (communicative sound production) in an attempt to understand the mechanisms underlying these effects.”</p> <p><b>Results (Change of Knowledge)</b><br/>         “We were able to rigorously examine the effect of soil vibrational noise on Nicrophorus beetle reproductive behavior, including its effect on carcass handling time, direct parental care behaviors, and resulting brood demographics. We found that these subsoil-breeding insects, when reproducing in conditions of seismic (soil-borne) noise took 38% longer to bury the carcass on which they breed, and produced 23% fewer offspring, leading to a 12% reduction in overall brood mass. These measured impacts, depending upon the intensity of ambient vibrational noise in the environment, could potentially contribute to a decline in beneficial subsoil-dwelling arthropods that exhibit neural sensitivity to surface waves. Findings show that the sensory systems of these beneficial insects can easily detect seismic vibration in the range of frequencies (peak sensitivity 25-300 Hz) produced by anthropogenic sources such as wind turbines....We documented declines in Nicrophorus burying beetle</p> |  |
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|                  |   | <p>populations at a site proximate to wind energy developments in Oklahoma.”</p>   |  |
| <p><b>4.</b></p> | <p>NHAES #1006507<br/>                 Functional Genomic Approaches toward Understanding the Frankia-Actinorhizal Plant Association and their Responses to Harsh Environments<br/>                 Prof. Louis Tisa<br/>                 Hatch</p> | <p><b>Issue:</b><br/>                 “Nitrogen fixation by (bacteria symbiont Frankia) of actinorhizal plants is an important part of the nitrogen budget of the planet. The ability of Frankia to bind and sequester several toxic heavy metals suggests potential for bioremediation and phytoremediation applications especially on heavy-metal-contaminated-land. Frankia are metabolically versatile degrading polyaromatic hydrocarbon suggesting further bioremediation capabilities.... A major hindrance in the application of this system is the lack of genetic tools for Frankia, the bacterial partner of the symbiosis.”</p> <p><b>Target audience:</b><br/>                 “The diversity of outcomes and impacts suggest that groups working on plant-microbe interactions (beneficial and pathogenic), agricultural and biotechnology industries, land restoration groups, environmental restoration and protection groups, farmers are projected target” audiences.”</p> <p><b>What was done:</b></p> <ol style="list-style-type: none"> <li>1. “To study the plant-microbe interaction between actinorhizal plants and nonFrankia actinobacteria, we have initiated studies on the microbiome of local actinorhizal plants. We have also begun to elucidate the microbiome of actinorhizal plants growing under harsh environmental conditions.”</li> <li>2. "We have made significant progress in the development of genetic tools for Frankia: stable introduction of plasmids, gene transfer between metabolically distinct strains of Frankia, and modification of the gene editing tool CRISPR/Cas9 that it will function Frankia.”</li> </ol> |  |

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|                  |  | <p><b>Results:</b></p> <ol style="list-style-type: none"> <li><b>Change of Knowledge:</b> “Actinorhizal plants co-inoculated with both Frankia and a non-Frankia bacterium were healthier and survived harsh test conditions. These results suggest that these other bacteria may be aiding the plants' ability to survive under these harsh conditions.”</li> <li><b>Change of Action:</b> “As a proof of concept, a salt tolerance candidate gene (Ccl6_RS22605) from the highly salt-tolerant Frankia sp. strain Ccl6 was cloned into pBBR1MCS-3, and introduced into the salt-sensitive <i>Frankia casuarinae</i> strain Ccl3. The gene was expressed in the transformants and results in increased level of salt tolerance. Together these results represent stable plasmid transfer and exogenous gene expression in <i>Frankia</i> spp., overcoming a major hurdle in the field.”</li> </ol>                            |  |
| <p><b>4.</b></p> | <p>NHAES #1013433<br/> A framework for understanding water quality at river network scales</p> <p>Assoc. Prof. Wil Wollheim<br/> Hatch</p> | <p><b>Issue:</b><br/> “Water quality problems are known to result from a variety of human activities such as agriculture and urbanization, distributed throughout the landscape. However, many water quality problems are reduced because of processes in water bodies themselves. As pollutants travel through river systems, the probability that pollutant loads are at least somewhat reduced by freshwater ecosystems increases. The major issues being addressed by this research include how water quality is impacted by agriculture and urbanization, how climate variability interacts with land use to affect water quality, and to what extent surface waters help clean up non-point pollution inputs. Findings will help to prioritize management activities that are cost effective.”</p> <p><b>Target audience:</b><br/> Policy makers and land managers who are trying to address water quality problems.</p> |  |

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|  |  | <p><b>What was done:</b><br/>         “This project provides a framework for understanding (river) ecosystem service in New England, with an emphasis on non-point sources, including both agriculture and urban sources. Our approach is to isolate the amount of non-point pollutants entering into water bodies through sampling of headwater streams draining different land uses, while simultaneously sampling large rivers to quantify how these pollutants have declined. Models will be used to make these connections.”</p> <p><b>Results (Change of Knowledge):</b><br/>         Key findings and implications include:</p> <ol style="list-style-type: none"> <li>1) “As watersheds increase in size (as water flows downslope), the cumulative function of the river network can increase at a faster rate than does the rate of input, indicating the importance of larger rivers as a key component determining the role of river systems in regulating water quality (Wollheim et al. In prep). An implication is that large rivers should be managed to maintain their functionality. “</li> <li>2) “Reservoirs may at times be nitrogen sources, not just nitrogen sinks. When algal blooms occur, all inorganic N is assimilated or denitrified, allowing N fixing algae to become abundant, introducing more N to the system (Phillips URC 2019). This has implications as to whether the removal of dams in New England is likely to lead to increases or decreases in nitrogen fluxes to the coast.”</li> <li>3) “Based on modeling results, river networks have a greater capacity to improve bacterial contamination (<i>E. coli</i>) than previously thought due to the filtration by stream bottom sediments, through which surface water continuously exchanges. Previous models of <i>E. coli</i> attenuation only considered die-off in the water column (Huang et al. In Review). Managers of landscape sources of pathogen bacterial should incorporate the role of this natural ecosystem service. Based on the</li> </ol> |  |
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|           |   | <p>model applications described above, we have identified key factors that contribute to a smaller imbalance between network supply and demand, representing times and places when downstream fluxes of pollutants are effectively regulated by surface water. These conditions include low stream flow periods, large watersheds, river systems with significant interactions with subsurface benthic sediments (filtration), presence of ponded waters like beaver ponds, lakes, and reservoirs, and disproportionate distribution of pollutant sources in the headwaters of a watershed rather than closer to the basin mouth. Each of these factors should be considered when prioritizing management activities, such as where to emphasize cover crops, fertilizer reductions, septic system upgrades, and installing stormwater management.”</p>   |  |
| <p>5.</p> | <p><b>UNHCE:</b><br/>Community and Economic Development (CED)</p> | <p><b>Issue:</b><br/>Strong communities have engaged citizenry and local leaders who participate in decision-making that strengthens the local economy and addresses community-identified priorities.</p> <p><b>Target Audience:</b><br/>Local leaders, New Hampshire volunteers, Business owners</p> <p><b>What has been done:</b><br/>The Community Economic Development AoE seeks to work with civic leaders, municipal officials, and community volunteers—as well as regional and state-wide partner organizations—to build their knowledge, skills and capacity to engage the public in decision-making and in implementing local action. Our core programs are focused on business retention, Main Street revitalization, tourism development, and entrepreneurship development, as follows:</p> <p><u>Business Retention:</u> Via the Business Retention Program and the Economic Development Visioning Program, community volunteers are trained to engage local businesses through round table discussions,</p> | <p><b>SUPPORTING A RURAL ECONOMY</b></p> |

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|  |  | <p>interviews, and surveys in order to understand their needs. The goal is to help communities develop and implement strategies and actions that address business needs.</p> <p><u>Entrepreneurship</u>: Through 1 Million Cups, Twin State Innovation and youth entrepreneurship curriculum, Extension cultivates networks among entrepreneurs, provides core entrepreneurship skills, and facilitates an entrepreneurial ecosystem that enhances entrepreneurship opportunities in communities.</p> <p><u>Main Street Revitalization</u>: Through the First Impressions Program, Extension builds community capacity to develop and implement strategies to revitalize the Main Street. And through the Main Street Academy, an intensive, multi-day training, local leaders learn to address vacant buildings and implement strategies that create vibrancy. Such strategies include development of pop up shops, events, flex office space, workforce housing using underutilized spaces, and arts to draw people to the downtown.</p> <p><u>Tourism</u>: Extension helps communities assess their natural, cultural, and recreational assets. Using this information, communities learn to leverage those assets attract visitors that shop in the downtown and support the local and regional economy.</p> <p><b>Results:</b><br/>         The Community and Economic Development program helps cultivate civic leaders, revitalize downtowns and grow the local and regional economy. With Extension’s support, in 2019:</p> <ul style="list-style-type: none"> <li>• <i>200 entrepreneurs connected at business networking events</i></li> <li>• <i>\$1.5 million in financial support was generated for projects in ten communities</i></li> </ul> |  |
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|           |  | <ul style="list-style-type: none"> <li>• <i>51 graduates of the Main Street Academy worked on local projects/efforts</i></li> <li>• <i>30 towns and two counties engaged in efforts to strengthen local economies</i></li> <li>• <i>5 communities engaged over 150 businesses to identify and address needs</i></li> <li>• <i>1 Maker Space was launched to support local entrepreneurs</i></li> </ul> <p>These examples demonstrate how Extension has helped communities strengthen their economic base. This includes investment in buildings, incubators and maker spaces, public parks, trails and other recreational opportunities. As well, Extension’s work helps to build a network of engaged citizens and increases social capital networks among and between communities. Were it not for Extension’s skill-building programs, networking, needs assessment, and strategy development work, communities would not have the knowledge to make decisions, nor would they have the community support to implement positive change. We are the only NH resource that provides early support to communities the change process to build the leadership and capacity prior to implementing strategies that strengthen the community. Our regional and state partners rely on us to do set the stage for economic development so that communities have tangible plans and capacity to access technical assistance and grant funding. Skilled leaders ultimately forge strong local economies.</p> |  |
| <p>5.</p> | <p><b>NHAES #1015411<br/>Enhancing Rural Economic Opportunities, Community Resilience, and Entrepreneurship<br/>Hatch Multistate NE1749<br/>PD Prof. John Halstead</b></p> | <p><b>Issues:</b><br/>“Rural communities face a wide range of economic growth and development issues ranging from changing economic structure to public service provision. Rural communities need to take advantage of market opportunities (e.g. local/regional/organic food systems). This project will provide an economic and policy assessment of specific topics related to</p>   |  |

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|  |  | <p>these problems in the areas of local foods and sustainable small-scale agriculture.”</p> <p><b>What was done:</b><br/>         “Our project on the economics of local agriculture, partially funded by USDA/NIFA, has been completed, and we are disseminating the results via peer-reviewed publication to academic professionals and regional policymakers, legislators, and department commissioner (e.g. the NH Agriculture, Markets, and Food), as well as Cooperative Extension (which played a key role in the research).”</p> <p><b>Target Audience:</b><br/>         “Farmers and policy makers involved with the economic effects of local agriculture in northern New England; consumer groups involved in local agriculture in northern New England; local governments involved in waste management and recycling in New Hampshire;”</p> <p><b>Results:</b><br/> <b>1)</b> “We have compiled a wealth of information on unmet demands for produce (currently filled from out of region sources), constraints to local farmers in expanding their current operations, and consumers' preferences and willingness to pay for a variety of local fruits and vegetables. Our results show that the region (NH, VT, ME) supplies less than a quarter of the produce which it consumes, and that two of the major constraints to expanding local production are affordable land and dependable labor.”</p> <p><b>Results:</b><br/>         “KEY OUTCOME/CHANGE IN KNOWLEDGE: We have expanded substantially the knowledge base of the northern New England agricultural community with respect to why consumers and producers do (or don't) purchase local produce, and identified avenues for expanding local production.”</p> |  |
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| <p>5.</p> | <p><b>NHAES # 1015411 Enhancing Rural Economic Opportunities, Community Resilience, and Entrepreneurship Hatch Multistate NE1749</b><br/> <b>PD Prof. John Halstead</b></p> | <p><b>Issue:</b><br/>                 +We were asked by the New Hampshire Department of Environmental Services to provide an economic analysis of the benefits and costs of lowering the standard for arsenic in NH drinking water; this was a prime issue of debate for the state legislature over the past year.”</p> <p><b>Target audience:</b><br/>                 “legislators and policy makers involved in setting standards for arsenic levels in New Hampshire drinking water.”</p> <p><b>What was done:</b><br/>                 “Our research this year was benefit-cost analyses conducted jointly by the UNH College of Life Science and Agriculture, the UNH Paul School, and the NH Department of Environmental Services on the net benefits of lowering the NH standard for arsenic in drinking water from 10 to 5 ppb (parts per billion).”</p> <p><b>Results:</b><br/>                 “KEY OUTCOME/CHANGE IN CONDITION: Our research led to the conclusion that the benefits of reduced mortality/morbidity from the reduction in the incidence of e.g. bladder and lung cancers far outweighed the costs of additional water treatment to remove arsenic. The report we compiled was distributed to the New Hampshire state legislature for consideration; subsequently, this body approved the reduction to 5 ppb, and the new standard was signed into law by New Hampshire's governor.”</p> <p><b>Dissemination:</b><br/>                 UNH Research Leads to New Drinking Water Standard in Granite State<br/> <a href="https://colsa.unh.edu/nhaes/article/2020/04/drinkingwater">https://colsa.unh.edu/nhaes/article/2020/04/drinkingwater</a></p> |  |

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| <p>5.</p> | <p><b>NHAES #1013434 Social, Economic and Environmental Causes and Consequences of Demographic Change in Rural America</b><br/> <b>Hatch Multistate W4001</b><br/> <b>PD Professor Ken Johnson</b></p> | <p><b>Issue:</b><br/> “Rural populations are changing in both size and structure. Such changes in population size and characteristics affect a wide range of social and economic outcomes. Thus, it is imperative that we examine the causes and consequences of recent rural demographic change and the demographic processes, such as migration and fertility, which account for changing patterns of population redistribution both in New Hampshire and throughout the United States.”</p> <p><b>What was done: “</b><br/> A critical goal of this project is to document nonmetropolitan demographic change and disseminate information about these demographic trends in rural America to critical academic and policy audiences.”</p> <p><b>Results:</b><br/> CHANGE OF KNOWLEDGE: “The Great Recession ‘froze people in place’. This had the effect of reducing migration in rural areas. The demographic implications this had for specific rural areas differed in regions with histories of rapid population increase through migration (recreational, retirement and metro fringe counties), here the rate of population increased slowed because of the economic situation reduced migration. There is increasing evidence that migration is pickings up again, at least in these rural areas. In rural areas with histories of population loss or slow growth (farm areas), there is no evidence of population gains and nearly 80% of the farm counties are depopulating.”</p> <p><b>Dissemination:</b></p> |  |
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|           |  | <p>“Presented results about rural and urban demographic trends in New Hampshire to N.H. State House-Senate Ways and Means and Finance Committees Joint Meeting in Concord, NH, and to numerous governmental and nongovernmental organizations over the past year in New Hampshire.”</p> <p>U.S. Population Growth Shrinks to Lowest Level in 100 Years<br/> <a href="https://colsa.unh.edu/nhaes/article/2020/03/census">https://colsa.unh.edu/nhaes/article/2020/03/census</a></p> <p>American Population Shrinking in More Than a Third of Rural Counties<br/> <a href="https://colsa.unh.edu/nhaes/article/2019/04/rural">https://colsa.unh.edu/nhaes/article/2019/04/rural</a></p> <p>Migration is Biggest Driver of Population Change in New Hampshire<br/> <a href="https://colsa.unh.edu/nhaes/article/2019/11/migration">https://colsa.unh.edu/nhaes/article/2019/11/migration</a></p> <p>UNH Research: Younger People Moving to New Hampshire on Rise<br/> <a href="https://colsa.unh.edu/nhaes/article/2018/12/NHmigration">https://colsa.unh.edu/nhaes/article/2018/12/NHmigration</a></p> |  |
| <p>5.</p> | <p><b>NHAES #1013736</b><br/> <b>Harnessing Chemical Ecology to Address Agricultural Pest and Pollinator Priorities</b><br/> <b>Hatch Multistate NE1501</b></p> <p><b>PD Asst. Prof. Shadi Atallah</b></p> | <p><b>Issue:</b><br/>         “Apple is the major fruit crop in New Hampshire with 1,400 to 1,600 acres harvested on 146 farms, and a farm gate value fluctuating between \$7 and 10 million (USDA 2015). Fruit pests and diseases have the potential to cause significant economic losses in apple production. There are currently no commercial varieties that are resistant to insect pests, which are increasingly problematic for Northeast growers. This project assesses the (potential) economic value of apple pest resistance through the intercropping of domesticated and heirloom/cider varieties that vary in their susceptibility but also in their market values.”</p> <p><b>What was done:</b></p>   |  |

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|  |  | <p>“Two (computer) models for intercropping were developed: Model 1 simulates an apple orchard under codling moth infestations. Given cider and commercial apple prices, production costs, and codling moth damage information, the model solves for the proportion of mixing commercial vs. cider apple trees that minimize infestations (through the natural defenses of cider varieties) while maximizing profits. In <b>Model 2</b>, we determine the threshold number of insects that should trigger sprays, given an infested multi-variety orchard consisting of the optimal proportion of cider varieties, arranged in a random spatial configuration. We use historical degree day (DD) data and associated established DD threshold-based spray recommendations to add pesticide application features to our Model 1. This is then used it as a simulator to generate data on infestation and damage level over time. Reinforcement Learning (RL) is employed to find the robust optimal pesticide application threshold.”</p> <p><b>Results:</b><br/> CHANGE OF KNOWLEDGE Model 1: “This optimum is 20% cider variety and 80% commercial variety. However, this optimum changes as the market price difference of the two apple varieties changes: the optimal proportion of cider decreases to zero when the price difference is greater than \$0.3/lb. We consider eight different spatial configurations for the intercropping, in addition to the baseline random spatial intercropping and find that the diagonal configuration yields the highest profits and requires the lowest amount of cider intercropping (4%). Random spatial intercropping, in contrast, ranks seventh and has the second-highest optimal proportion of cider (30%). Model 2: The term ‘robust’ refers to thresholds that are not too sensitive to data uncertainty. The model solution shows a greater degree of sensitivity to uncertainty in pesticide costs compared to the uncertainty in the pest growth rate.”</p> |  |
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| <p>6.</p> | <p><b>UNHCE:</b><br/>STEM Programs for Youth/<br/>Science Literacy</p> | <p><b>Issue:</b><br/>As the world becomes more technologically advanced and scientifically complex, a science literate citizenry and work force is vital. The Congressional report, Rising Above the Gathering Storm, states that building a workforce literate in science, technology, engineering and mathematics (STEM) is crucial to maintaining America’s competitiveness in a rapidly changing global economy. In fact, national and state statistics show an increased demand for a more science literate workforce. One way to address this national need has been the development of new science and engineering K-12 education standards, the Next Generation Science Standards (NGSS). As New Hampshire STEM programs look to meet 21st century needs, both in-school and out-of-school programs are working to shift science curriculum to align with the new vision of NGSS. This new shift to the NGSS is a challenge for many STEM programs. There is a need for high-quality, K-12 STEM programs that are grounded in the NGSS framework and that support the development of a more science literate citizenry in NH and beyond. The need to provide impactful STEM programs for school age youth is more important than ever.</p> <p><b>Target Audience:</b><br/>School age youth, New Hampshire volunteers</p> <p><b>What has been done:</b><br/>Science Literacy UNHCE staff and faculty design and deliver STEM programs for youth. These engaging programs address the need for STEM enrichment, supporting the NGSS expectations and providing deeper understanding of science content. The Science Literacy STEM programs target school age youth. These STEM programs are offered statewide either in school or during out-of-school time. They feature a range of topics, including marine science, ecology, robotics, engineering, and computer science.</p> <p><b>Results:</b></p> | <p><b>YOUTH AND FAMILY</b></p> |
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|  |  | <p><i>Overall a total of 3,460 youth participated in STEM education programs and events offered by Science Literacy UNHCE throughout the state, including life science (e.g., marine science &amp; ecology), physical science (e.g., Mousetrap Powered Cars), engineering (e.g., Seacoast SeaPerch), and computer science (e.g., Creative Computing Challenge).</i></p> <ul style="list-style-type: none"> <li>• <i>Youth report or demonstrate engagement in STEM activities (i.e., the first step towards pursuing further study in this area).</i></li> <li>• <i>Youth report or demonstrate knowledge about STEM concepts embedded in programs.</i></li> <li>• <i>Overall, the majority of participating K-12 STEM educators report an increase in their science literacy in discrete STEM programming or content as a result of UNHCE Science literacy professional development workshops.</i></li> <li>• <i>Overall, the majority of participating (94%) K-12 STEM educators (n=36) report an increase in their capacity to apply best practices pedagogical approaches a result of UNHCE Science literacy professional development workshops.</i></li> </ul> |  |
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