2016 University of New Hampshire Combined Research and Extension Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

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 FY2016 achievements are the result of NHAES support and, likewise, some of the achievements and dissemination of NHAES research are facilitated by UNHCE. 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, 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 the primary responsibility of UNHCE.
UNHCE provides a direct link between UNH and people throughout the state. In partnership with local residents and volunteers, Cooperative Extension plans and conducts educational programs responsive to New Hampshire people and the issues they identify that are important to them. In 2016, UNHCE implemented the same regional model for program delivery established four years ago. Area of Expertise (AoE) teams were formed with 2-4 regional field specialists working closely with state specialists to deliver educational programs to focused audiences statewide. This model not only gives UNHCE flexibility in developing new teams when needs of our clientele change, it encourages non-Extension faculty involvement and has been well-accepted by stakeholders and allows field specialists to become truly experts in a given field.
UNHCE state specialists and Extension educators serve as an outreach arm for UNH, providing applied research and practical education primarily in agriculture and natural resources as a well as in family, youth, and community development. This programming not only helps participants but also results in many indirect benefits for non-participant taxpayers. As a University outreach program, we have a network of professional Extension educators (University of New Hampshire staff) located in all ten New Hampshire counties. Our staff work with local volunteers and specialists on the UNH campus to design and conduct educational programs that meet societal, environmental and economic needs.
Further, eXtension has become a more prominent source of information for many of our clientele, particularly in areas we've lost staff capacity. A prominent link to eXtension.org is on our website and all of our staff now have an eXtension ID. Further, many eXtension webinars are cross-posted on our staff development calendar. UNHCE joined the newly formed eXtension organization as a premium member and hopes to continue to promote resources found there. During the fiscal year 2016, UNH Cooperative Extension reaches a significant portion of New Hampshire residents with information or assistance, and recruits, trains and supports over 5,000 trained volunteers in ten counties, who spent over 190,000 hours with staff to conduct educational programs to reach a greater number of New Hampshire citizens (e.g., Master Gardeners, UNHCE Education Center Info Line staff, Lay Lake Monitors, Marine Docents, Wildlife Coverts, Natural Resource Stewards, Coastal Research Volunteers, 4-H Leaders). UNH Cooperative Extension's volunteers' work representing $4.5 million worth of value.
Highlights

- Community and Economic Development (CED)

County residents participated in our programs, which foster resilient communities and build strong local economies. Overall, CED programs helped community leaders engage 1,112 citizens in local decision-making and action. More than 21% of them took on new leadership roles in their communities. More than 1,043 businesses statewide benefited from CED programs focused on developing local strategies for business retention and expansion.

- Food and Agriculture

County residents turned to Cooperative Extension for current, research-based information in the pursuit of profitable and sustainable agriculture. Extension specialists trained food producers, processors and restaurant workers to handle and prepare food safely, resulting in a reduction in food-borne illness. Farmers learned agricultural practices that protect water and soil quality and provide citizens with year-round access to high-quality, locally-grown food.

- Natural Resources

Across the state Cooperative Extension assisted 1,151 landowners with advice on conservation practices and referrals to New Hampshire licensed foresters and certified loggers. Community resource managers, municipal officials, volunteers and natural resource professionals received advice and training on forest and wildlife management, geographical information systems (GIS), the forest industry, invasive species, land and water conservation, and water resources via more than 450 workshops and training sessions. Our work impacted 174,000 acres statewide.

- UNH Professional Development & Training (PD& T)

For over 25 years PD&T has conducted workshops, certificate programs and conferences for New Hampshire's business professionals and educators. Now part of the Cooperative Extension family, PD&T provides its students with access to a wide range of high-quality training sessions in business, teaching, school administration, grant-writing and much more.

- Youth and Family

Our staff and volunteers build resiliency and life skills, develop workforce-ready young leaders, and help families avoid addiction and obesity. In 2016, more than 25,000 citizens participated in our 4-H and nutrition programs. Practical training for educators doubled in attendance to more than 2,300. Because of our community-based work, more than 2,200 students will benefit from improved school health policies. Overall, Extension volunteers from all program areas consistently recognize the value of their work in contributing to the health and well-being of youth, their communities, their own leadership skills, and the environment.

Conveying the significance of different types of NHAES research requires that our reports are accessible to a broad spectrum of stakeholders including producers, consumers, and legislators. This work helps USDA/NIFA make the case for the value of federal investment in the Agricultural Experiment Station system.

NHAES research activities address important questions ranging from basic to applied science, and stakeholder concerns on local, regional or national levels. The problems that NHAES researchers tackle are based on available expertise; multistate and interdisciplinary research enhance the NHAES's ability to deal with a wider range of concerns. NHAES activities span the spectrum from basic research to more applied research. Examples of basic research leading to applied outcomes are organized below by associated planned program and include:

Global hunger and food security

- The Davis research project (NIFA accession 1006924) used marker data marker data from the

IStraw90 array, to construct and publish the first genomic map of the ancestral diploid strawberry species, Fragaria iinumae. The Davis project also contributed to the design of a provisional custom array, the Axiom IStraw35K strawberry array, which incorporates approximately 41,000 SNP loci identified to be most useful by the evaluators of the earlier IStraw90 array. The Axiom IStraw35K will reduce the cost per sample by almost half, from ~$100 to ~$50 per sample. Improved genotyping platforms facilitates wider application of Marker Assisted Breeding (MAB) to the commercially important, octoploid strawberry.

• The Rehan research project (accession 1004515**)** has developed a database of historic records of native bees including 14,000 bee records spanning 150 years in the state to examine former ranges and population numbers for the 200+ species found locally.This is part of a long-term effort to understand the floral requirements and habitat preferences for native bees in efforts to better conserve local populations. Native bees and introduced honeybees are responsible for pollinating an estimated 1/3 of fruit and nut crops consumed by humans.

• Grazing dairy farms feed higher forage diets than confinement dairies and have concerns about how to maximize forage production year-round. The Brito and Smith Research Projects (accessions 1001855, 1006827) are testing whether it is possible to develop resilient alternative forage crops systems (AFC, i.e., warm and cool season grasses, summer annuals, brassicas) for the Northeast, to provide supplemental forage for grazing and/or silage feeding during periods of limited biomass production (e.g., early spring). Preliminary results indicated that AFC have the potential to extend the grazing season and replace traditional forages in dairy farms as AFC pasture production was approximately 20% greater than traditional pasture during the spring. Milk production and milk composition in cows fed AFC or traditional pasture was not statistically different during both spring and summer seasons, suggesting that AFC can replace traditional pasture without penalizing milk output and quality.

• The five-decade, cucurbit breeding program of emeritus professor James Brent Loy continues to roll out new varieties, with improved disease resistance, new colors, and patterns, higher yield, enhanced flavor, higher nutrient density and/or improved taste. From ongoing research (accessions 233554, 233556), six new varieties were released to different seed companies for production. In FY16, licensed varieties of Loy's pumpkin, gourds, squash, and melon brought in $226,172 in royalties to the University. A portion of royalties supports Loy's ongoing breeding programs.

Climate Change and Sustaining Natural Resources:

• The loss of soil organic matter from agricultural soils has severe local regional, and global consequences.The scientific consensus has been that the best way to build soil organic matter is to slow down or inhibit decomposition using plants that soil microbes find difficult to decompose. However, in a recent Nature Communications paper, Grandy and Frey research teams (accessions 1007001, 1003421) have shown that soil organic matter accumulates from inputs of dead microbial cells and microbial byproducts formed when microbes eat plant roots and residues, rather than from the plants themselves. In this potential paradigm-shifting result, Grandy and Frey showed that soil organic matter accumulation is greatest when more-not less-active microbial biomass is formed. This is especially true when that biomass is produced more efficiently, meaning more of the substrate is converted to biomass rather than carbon dioxide.

• The Ollinger research project (accession 1006097) is evaluating the impact of land management (e.g. fertilizing, watering, harvesting) on CO_2, water and heat fluxes in agricultural systems. Preliminary data suggest that there may be a tradeoff between different ecosystem services (e.g. biomass production and net carbon sequestration) provided by these different land cover types. Specifically, the managed cornfield

annually provides the largest amount of usable biomass (1382 g/m^2/yr), followed by the hayfield (860 g/m^2/yr) and mixed forest (wood production is 275 g/m^2/yr), while net carbon sequestration is highest in the mixed forest (909 g C/m^2/yr), followed by the hayfield (234 g C/m^2/yr), and cornfield (-4 g C/m^2/yr).

Food Safety

• The threat of shellfish-borne disease from Vibrio parahaemolyticus (Vp) and Vibrio vulnificus (Vv) is a significant public health concern in the United States. The Jones project (accession 233555) used genetic markers to monitor changes in pathogenic Vibrio populations in the coastal waters of the Northeast United States. Jones' lab has found evidence that sea surface temperatures in regional larger coastal ecosystems, like the Gulf of Maine and Long Island Sound, influence Vibrio species populations in near-shore coastal and estuarine ecosystems. Jones' ongoing surveillance of Vibrio concentrations in water, shellfish, sediments and now plankton suggests that association with plankton are a significant ecosystem factor that enhances Vibrio populations. Some factors conducive to detection by remote sensing may aid tracking and predict risk conditions for pathogen contamination of oyster beds.

Supporting Rural Economies:

• Nursery production of trees and shrubs has shifted largely from field-grown to container systems in the past two decades, but associated root defects may negatively impact plant health and survival. The Neal project (Accession 233734) followed tree growth from production through landscape establishment, focusing on how root mass and morphology responded to three production systems. Severe root defects were formed in plastic containers but were minimal in fabric porous containers, a system that offers producers an economically viable strategy for producing high-quality trees with minimal soil loss. Preventing root injury from sublethal cold exposure is another unique challenge for producers of trees and shrubs in containers. Neal's project improved lab protocols to determining more accurate root cold tolerance (RCT) thresholds and conducted multiple lab tests on ten woody species, determining baseline RCT and testing the effects of cultural factors on RCTs. Producers will use the information in the future to group plants under different protection methods according to their RCT thresholds, reducing costs and losses. A projected ten percent savings represents nearly $1 million to the nursery industry in northern New England.

The NHAES research farms and greenhouses provide many experiential learning opportunities for undergraduates, resulting in better educational outcomes, and ultimately, producing well-qualified employees. More than 60 university courses used the research farms and greenhouses. Kingman Agronomy and Woodman Horticultural Research Farms are run by a farm manager and assistant manager with mutual assistance this year of 19 undergraduate and 15 graduate students, three postdoctoral research associates and several research technicians. The Fairchild Dairy Teaching and Research Center, a conventional dairy, also has two farm managers who are assisted by 29 undergraduate workers plus the 25 students in the two-semester Cooperative Real Education in Agricultural Management (CREAM) course. CREAM students manage 25 cows of the registered Holstein Herd throughout the academic year, as a small business. The Organic Dairy Research Farm (ODRF) has a manager and herdsman and provided work and research experience for 32 undergraduates who help manage animals, milking, feeding, etc. In addition, 11 graduate students, and three postdoctoral associates carry out diverse research projects at ODRF. Finally, the Macfarlane Research Greenhouses are run by two full-time employees and engaged 22 undergraduates; three postdocs and 11 graduate students who carried out research at Macfarlane along with their faculty advisors. Six volunteers maintain the Conservatory at MacFarlane, which is primarily used for teaching. In addition to the undergraduate experiential work at the various agricultural facilities, virtually every NHAES project includes several undergraduates in laboratory and/or field research.

The NH Agricultural Experiment Station endeavors to leverage federal and state capacity funds, including those that support core infrastructure, with external funding through competitive grants and contracts. For Federal FY2016, 32 percent of funding was from federal capacity funds, 30 percent was from state appropriations and 38 percent was from other sources outside the university. With regard to outside funds,

this is a conservative estimate that includes only new grants and contracts initiated in FY2016 and not on-going projects. External funding helps support undergraduate and graduate students, postdocs and technicians, equipment, supplies, and travel. However, without the farm and greenhouse infrastructure provided by capacity funds, most of these research projects would not be feasible.

Evidence of the high-quality of NHAES research is that peer-reviewed manuscripts are published in high impact journals such Nature Communications, Ecology Letters, PloS one, Genome Biology and Evolution, and top disciplinary journals including the J. of Animal Science, Agriculture, Ecosystems & Environment, and The Plant Genome.

Communication Statistics for NHAES

NHAES communications manager Lori Gula Wright continues to enhance the profile of the NHAES in the state and region with news releases, social media engagement, directed email, collaboration with stakeholder agencies, and digital media.

Traditional statewide news media (newspapers, digital, radio, and TV) and trade agricultural media regularly cover NHAES research. Many news releases are picked up by local, regional, national, and international venues (ABC News, Washington Post, NPR, The Atlantic, U.S. News and World Report, Fox News, Boston Globe, Morning Ag Clips, Floral Daily, HortiDaily WMUR, NH1, Union Leader, NHPR, Foster's Daily Democrat, Portsmouth Herald, Concord Monitor). In particular, the Associated Press has picked up the majority of NHAES research stories, resulting in a distribution of NHAES news to hundreds of media outlets and hundreds of thousands of readers. In addition, NHAES research news is regularly publicized by the USDA, Ag is America, UNH, and UNH Cooperative Extension via social media, and the NH Department Agriculture, Markets & Food, NH Farm Bureau, Northeast Organic Farming Association of NH (NOFA NH), and NH Farms Network via newsletters.

The experiment station has experienced a dramatic increase in social media engagement since the previous federal fiscal year. Since Oct. 1, 2015, we have increased engagement on our main NHAES Facebook page (users clicked on a story on our page or engaged with the page in some other way) to nearly 190,000, for an increase of 210 percent over fiscal year 2014-2015. Our NHAES Facebook content in the same period has reached more than 2.1 million Facebook users who either saw it in their news feed or on a friend's page, an increase of 303 percent over the previous period. We expanded our social media content and engagement on Facebook and Twitter this year: we have much more content, including videos, as well as Facebook sites for all of our NHAES facilities. We also have hundreds of thousands of people engage with us on our pages for Fairchild and ODRF Dairies, Woodman and Kingman Farms, Macfarlane Greenhouses, NH Veterinary Diagnostic Laboratory, and COLSA, which are not reflected in these statistics.

Page Engagement: 189,630 (210 percent increase over FY2014-15)

Content Reach: 2,166,649 (303 percent increase over FY2014-15)

In the past year, NHAES also has dramatically increased the use of Twitter to engage with our audiences. We currently have about 550 followers, which include industry leaders such as Stonyfield Farms, Cabot Cheese, and Johnny's Seeds; leaders in the higher education and research agricultural space such as Cornell, University of California, Michigan State, and Hubbard Brook; ag and science media such as AgWeb, HortiDaily, Lancaster Farming, Produce Grower, NHPR Science Journalist Sam Evans-Brown, Concord Monitor ag writer Elodie Reed, Union Leader reporter Kimberly Haas, WMUR, and NH1; federal and national partners such as USDA-NIFA, Ag is America, US Fish and Wildlife, USDA Climate Hubs, Virginia Bueno (communications director for NIFA), Congresswoman Carol Shea-Porter, Congresswoman Annie Kuster, and the National Association of State Foresters; state and regional stakeholders such as the NH Department of Agriculture, Markets & Food, NOFA-NH, Land For Good, Granite State Dairy Promotion, Must Be The Milk, NH Food Alliance, NH Audubon, and Seacoast Growers; UNH constituents such as UNH President Mark Huddleston, UNH, and UNH Extension; and many NH farmers, producers, growers, faculty members, scientists, and community members. By growing our list of Twitter followers who retweet our news, we are able to substantially expand our outreach and engagement efforts.

NHAES research often is featured on high-traffic UNH websites such as the UNH Home Page and UNH Today, which reaches more than 85,000 influencers weekly. Weekly direct email bulletins promoting

NHAES research and events reach more than 900 subscribers, including producers, state and federal legislators and policy makers, SAES leaders, and industry representatives. NHAES also contributes regularly to the Land-Grant Impacts database website.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	84.0	{No Data Entered}	22.0	{No Data Entered}
Actual	109.0	0.0	25.9	0.0

II. Merit Review Process

1. The Merit Review Process that was Employed for this year

- Internal University Panel
- Expert Peer Review
- Other (Peer review of proposals, manuscripts and products)

2. Brief Explanation

UNHCE

New Hampshire state statute identifies county Extension Advisory councils as the legal entity to request county funding on behalf of UNHCE so these councils have a critical role of assessing quality and merit.Members provide feedback on program quality, advise Extension administration on new program staff hires and also provide performance management data on local staff.

NHAES

The New Hampshire Agricultural Experiment Station (NHAES) carries out a formal, competitive, peer review process for proposed research projects. The competition for NHAES 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 NHAES Director or Faculty Fellow. If the prospectus is consistent with NHAES guidelines, the faculty member is encouraged to develop a full proposal for competitive review.
All proposals are evaluated by a review panel comprised of faculty members plus the Faculty Fellow. The review panel is selected from current, highly-productive NHAES project directors who have strong, externally funded research programs. Each proposal is evaluated based on the following criteria:
• Scientific and technical merit.
• Soundness of approach, procedures, and methodology.
• Likelihood of significant outcomes and/or innovation.
• Demonstrates previous accomplishments or potential productivity.
• Probability to leverage NHAES resources.
• Likelihood of significantly enhancing NHAES research capability and competitiveness

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 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.

Merit review for NHAES research outputs (e.g., scientific publications) typically come through scholarly peer review and leveraging of NHAES support to earn highly competitive external funding. These external reviews provide consistent, strong feedback on the quality of our internal review process. In addition, evidence of the value of NHAES activities is seen in the adoption of novel crop varieties, dissemination of new agricultural practices, progress using marker-assisted breeding, and how regional planning bodies use NHAES research outcomes.

III. Stakeholder Input

1. Actions taken to seek stakeholder input that encouraged their participation

- Use of media to announce public meetings and listening sessions
- Targeted invitation to traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Survey of the general public
- Survey of selected individuals from the general public
- Other (County Advisory Councils, comments from research proposals and manuscript reviews.)

Brief explanation.

UNHCE
UNHCE advisory councils in all 10 counties engage with our stakeholders, assess their needs and we develop programs in response to those needs. To facilitate their engagement and facilitation,UNHCE specialists work with stakeholder where they are. In addition, Extension administration meets with each of the stakeholder groups regularly (face-to-face and via video conferencing) to ensure stakeholder input is considered when making broad organizational issues as well.

NHAES
NHAES encourages stakeholder participation using a variety of venues and modalities:
research field days and twilight meetings at NHAES farm facilities, exhibiting at the annual NH Farm and Forest Expo, sending a researcher to present at the NH Northeast Organic Farming Association Winter Meeting, bringing researchers to annual the NE National Farmers Union meeting, using websites, direct communications via emails, social media and via videos on the web.

2(A). A brief statement of the process that was used by the recipient institution to identify individuals and groups stakeholders and to collect input from them

1. Method to identify individuals and groups

- Use Advisory Committees
- Use External Focus Groups
- Needs Assessments
- Use Surveys

Brief explanation.

UNHCE

UNHCE methods for identifying individuals and groups varies according to the situation and needs. Formally, our state field specialists locate individuals and groups whose needs align with our program goals. In addition, other individuals and groups come to us to request information or service required for improving their activities.

NHAES

The NHAES has an external advisory committee that represents different segments of the agricultural and natural resources community in the state. Suggestions for potential members of the advisory committee come from NH Farm Bureau, NH Farmers Union, the NH Department of Agriculture, Market s& Food and meetings across the state. The external advisory committee meets 1-2 times a year, usually in conjunction with a research field day event. In addition, the NHAES director, faculty fellow, or communications manager speak with members of advisory committee throughout the year, for example at meetings of the Farm Bureau, NH Farm and Forest Expo, etc.

2(B). A brief statement of the process that was used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them

1. Methods for collecting Stakeholder Input

- Meeting with traditional Stakeholder groups
- Survey of traditional Stakeholder individuals
- Meeting with the general public (open meeting advertised to all)
- Meeting specifically with non-traditional groups
- Survey specifically with non-traditional individuals

Brief explanation.

UNHCE

UNHCE methods for identifying individuals and groups varies according to the situation and needs. Formally, our state field specialists locate individuals and groups whose needs align with our program goals. In addition, other individuals and groups come to us to request information or service required for improving their activities

NHAES

Multiple NHAES research projects engage directly with stakeholders: For example Halstead and Grizzle research projects (Accessions 233237, 1003387) conduct surveys, interviews and focus groups with stakeholders. Hale and Loy breeding projects (Accessions 233561,233554, 233556) work directly with fruit growers, seed companies, and local farmers. Jones and Whistler (Accessions 233555, 1004199) work with oyster growers, and state seafood safety regulatory agencies throughout the Northeast. Wolheim (Accession 1007001) works directly with the town of Durham to monitor nitrogen flux in College Brook and Oyster River, both of which flow into New Hampshire's Great Bay. All these activities promote two-way communication between researchers and stakeholders.

3. A statement of how the input will be considered

- In the Budget Process
- To Identify Emerging Issues
- Redirect Extension Programs
- Redirect Research Programs

- In the Staff Hiring Process
- To Set Priorities

Brief explanation.

UNHCE
For UNHCE, specific input on staffing, budget and program priorities is solicited through discussion at meetings. Council members are identified based on input from other council members and staff continually look for individuals who might make good council members. Roles for council members include (but not limited to): advocacy on behalf of Extension, hiring/performance review of local staff, budget requests and program priorities.

NHAES
NHAES interacts with stakeholders to identify ongoing and new challenges to the agriculture sector and natural resources sector. Long-term research activities and new directions for NHAES research activities are based on the available resources and expertise, and when possible, opportunities to prioritize for new faculty hires by needs for critical research expertise.

Brief Explanation of what you learned from your Stakeholders

For both NHAES and UNHCE, a priority for our stakeholders in FY16 was to replace open faculty positions in plant pathology and greenhouse crops management. These searches were successfully concluded in FY16.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
1774879	0	1866887	0

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	1194875	0	2120392	0
Actual Matching	1194875	0	1937914	0
Actual All Other	5527932	0	2507662	0
Total Actual Expended	7917682	0	6565968	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	473457	0

V. Planned Program Table of Content

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Childhood Obesity

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
703	Nutrition Education and Behavior	75%		0%	
704	Nutrition and Hunger in the Population	25%		0%	
	Total	100%		0%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	11.0	0.0	0.0	0.0
Actual Paid	12.0	0.0	0.0	0.0
Actual Volunteer	2.2	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Cooperative Extension: Nutrition Connections--educational courses to income eligible NH residents--will be available through the Expanded Food and Nutrition Education Program (EFNEP) and

Supplemental Nutrition Education Program (SNAP-ed).

2. Brief description of the target audience

Limited resource youth, ages 0-18 and young adults (undergraduate and graduate students)

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	482	0	6350	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	0	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of low-income adults participating in Nutrition Connections - educational courses to income eligible New Hampshire residents

Year	Actual

2016	482

Output #2

Output Measure

- Number of youth participating in nutrition programming through Nutrition Connections

Year	Actual
2016	6350

Output #3

Output Measure

- Number of youth participating in 4-H Healthy Living programs

Year	Actual
2016	575

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

Outcome #1

1. Outcome Measures

Number of participants who report an increase in their physical activity

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	674

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Overweight and obesity have greatly increased during recent decades. Contributing factors include physical inactivity, excessive food consumption, and unhealthy food choices. The State of Obesity: Obesity Date Trends and Policy Analysis report shows 26.7% % of adults are obese. Data from a telephone survey of SNAP recipients in 2012 shows, 24% are overweight or obese 35%. Coos, Grafton, Cheshire, Merrimack and Rockingham Counties have higher rates of obesity within NH. The State of NH Obesity Report cites 14.6% of 2-4 year olds and 15.5% of 10-17 year olds in New Hampshire are obese. The NH State Health Improvement Plan 2013-2020 states obesity rates are higher in schools with greater than 50% of the students participating in the free and reduced priced meals program compared to schools with 25% of the students participating. Data show that 71.5% of adults have inadequate fruit and vegetable intake. According to the Youth Risk Behavior Surveillance Survey a considerable percentage of NH teens reported consuming fruits 38.6% and vegetables 31.8% less than once per day. According to the CDC, only 22.3% of adults and 22.9% of youth meet aerobic and muscle strengthening guidelines. Providing nutrition education to adults and youth will help to increase New Hampshire residents? physical activity and intake of fruits, vegetables and whole grain foods closer to recommended levels.

What has been done
UNH Cooperative Extension Nutrition Connections staff implement nutrition and physical activity education for limited income adults and youth. Activities target physical activity, nutrition, community involvement and obesity awareness and prevention. Youth are reached in group settings; families and adults in groups and at home.

Results
Four hundred and eighty-two adults (482) completed a series of lessons. Of those completing a pre/post food recalls and/or pre/post survey questions related to nutrition and physical activity

behaviors, significant impacts included:

16% (77 of 482) of adults reported an increase in physical activity
27% (582 of 2163) of youth reported an increase in physical activity, grades 3-12

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior

Outcome #2

1. Outcome Measures

Number of youth who learn how to choose foods according to the Pyramid and Dietary Guidelines

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1013

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Overweight and obesity have greatly increased during recent decades. Contributing factors include physical inactivity, excessive food consumption, and unhealthy food choices. The State of Obesity: Obesity Date Trends and Policy Analysis report shows 26.7% % of adults are obese. Data from a telephone survey of SNAP recipients in 2012 shows, 24% are overweight or obese 35%. Coos, Grafton, Cheshire, Merrimack and Rockingham Counties have higher rates of obesity within NH. The State of NH Obesity Report cites 14.6% of 2-4-year-olds and 15.5% of 10-17-year-olds in New Hampshire are obese. The NH State Health Improvement Plan 2013-2020 states obesity rates are higher in schools with greater than 50% of the students participating in the free and reduced-priced meals program compared to schools with 25% of the students participating. Data show that 71.5% of adults have inadequate fruit and vegetable intake. According to the Youth Risk Behavior Surveillance Survey a considerable percentage of NH teens reported consuming fruits 38.6% and vegetables 31.8% less than once per day. According to the CDC, only 22.3% of adults and 22.9% of youth meet aerobic and muscle-strengthening guidelines. Providing nutrition education to adults and youth will help to increase New Hampshire residents? physical activity and intake of fruits, vegetables and whole grain foods closer to recommended levels.

What has been done
UNH Cooperative Extension Nutrition Connections staff implement nutrition and physical activity education for limited income adults and youth. Activities target physical activity, nutrition, community involvement and obesity awareness and prevention. Youth are reached in group settings; families and adults in groups and at home.

Results
57.5% (277 of 482) of adults reported an increase in healthier food choices
32.2% (697 of 2163) of youth reported an increase in healthier food choices; grades 3-12
12.9% (306 of 2362) of youth improved their knowledge of healthier foods, grades K-2

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population

Outcome #3

1. Outcome Measures

Number of participants who report eating nearer to the recommended number of cup equivalents from the Fruits and Vegetable Group

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	107

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area

703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Other (None)

Brief Explanation

No known external factors impacted outcomes this year.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Four hundred and eighty-two adults (482) completed a series of lessons. Of those completing a pre/post food recalls and/or pre/post survey questions related to nutrition and physical activity behaviors, significant impacts included:

- 57.5% (277 of 482) of adults reported an increase in healthier food choices
- 16% (77 of 482) of adults reported an increase in physical activity

Six thousand, three hundred and fifty youth (6,350) participated in a series of lessons. Of those completing a pre/post survey related to nutrition and physical activity behaviors, significant impacts included:

- 32.2% (697 of 2163) of youth reported an increase in healthier food choices; grades 3-12
- 12.9% (306 of 2362) of youth improved their knowledge of healthier foods, grades K-2
- 27% (582 of 2163) of youth reported an increase in physical activity, grades 3-12
- 17.4% (154 of 881) of youth reported a decrease in sedentary behavior, grades 6-12

Schools, after-school and other groups participated in training to assess their wellness policies.

- 5 schools assessed their wellness policies and documented changes made affecting over 2200 youth.

Key Items of Evaluation

Pre/post self-report survey revealed impact in participants' knowledge of healthier foods and their ability to make healthier choice in their food consumption.

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Food Safety

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals	0%		33%	
501	New and Improved Food Processing Technologies	0%		10%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	50%		47%	
723	Hazards to Human Health and Safety	50%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	3.0	0.0	2.0	0.0
Actual Paid	2.0	0.0	2.4	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
75483	0	248129	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
75483	0	98421	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
90801	0	427170	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Cooperative Extension food safety programs includes the following:

- SAFE (Safety Awareness in the Food Environment) Programs
- ServSafe®
- Workshops for consumers

Several different NHAES research projects are conducted under this program. Activities include:

- Developing, refining, and applying methods for the detection and enumeration of Vibrio parahaemolyticus
- Using genomic sequencing to identify molecular markers to distinguish between pathogenic and non-pathogenic strains of Vibrio parahaemolyticus and biogeography of the origins of different Vibrio strains.
- Evaluating, through a variety of means, how the neurotoxin **&beta-Methylamino-L-alanine** (BMAA) and the liver toxins microcystins, produced by cyanobacterial blooms on freshwater lakes, are spread across landscapes to animal and human food sources.
- Disseminating research outcomes via scientific, extension, formal and informal venues, and to stakeholder groups and natural resource managers.

2. Brief description of the target audience

Cooperative Extension Food Safety education targets Food handlers at restaurants, schools, health facilities, etc. and the general public

The target audiences for NHAES research activities include both discrete and overlapping groups:

- For Vibrio pathogens in shellfish, the targeted audiences include the shellfish industry and shellfish regulatory agencies, graduate and undergraduate students, high school students, faculty collaborators, and other scientists.
- For microcystins and BMAA from cyanobacterial blooms, the target audiences are students (college and pre-college), scientists, lake shore residents, lake association members, local and regional decision makers, source water protection and watershed managers, surface drinking water suppliers, and public health and environmental agencies throughout New England

3. How was eXtension used?

NHAES did not use eXtension for this planned program, however, dissemination of the results of two of the three projects was achieved by collaboration with UNHCE

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	24884	57642	601	1101

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2016

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	4	9	13

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of people who participate in ServSafe workshops

Year	Actual
2016	261

Output #2

Output Measure

- Number of adults participating in food safety programming through Nutrition Connections - educational courses to income-eligible New Hampshire residents

Year	Actual

2016	247

Output #3

Output Measure

- Number of people who participate in SAFE (Safety Awareness in the Food Environment) programs

Year	Actual
2016	1285

Output #4

Output Measure

- Number of undergraduate students directly involved in the research projects

Year	Actual
2016	39

Output #5

Output Measure

- Number of university courses in which project results have been incorporated

Year	Actual
2016	5

Output #6

Output Measure

- Number of presentations at regional, national, or international scientific meetings

Year	Actual
2016	5

Output #7

Output Measure

- Number of workshops, training sessions, and presentations to non-scientific and regulatory stakeholders

Year	Actual
2016	149

Output #8

Output Measure

- Number of graduate students directly involved in the research.

Year	Actual
2016	6

Output #9

Output Measure

- Number of reviewed, bulletin, popular and other publications

Year	Actual
2016	13

Output #10

Output Measure

- Number of websites in which project results have been incorporated

Year	Actual
2016	2

Output #11

Output Measure

- Number of surveys or other means of gathering information and data from participants

Year	Actual
2016	2

Output #12

Output Measure

- Postdoc and other scientists trained in cutting edge research method

Year	Actual
2016	0

Output #13

Output Measure

- Number of web views: The newly released version of Toxic cyanobacteria of New England: The Dirty Dozen, http://cfb.unh.edu/CyanoKey/indexCayanoQuickGuide.html is extensively used by volunteer lake monitors to identify phytoplankton.

Year	Actual
2016	460000

Output #14

Output Measure

- Dissemination of research findings, related to Vibrios levels in shellfish, to state and federal agencies and oyster farmers and other stakeholders

Year	Actual
2016	20

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of program participants who score 75% or greater on knowledge tests of high risk practices including: * Personal hygiene * Holding/time and temperature * Cooking temperatures * Prevention of contamination
2	Number of food handlers who self-report an intent to adopt recommended hand washing practices,take steps to reduce cross-contamination and/or use proper time and temperature controls after attending a SAFE program.
3	Continued development of improved Vibrio detection methods and post-harvest treatments for reducing Vibrio levels in shellfish to address growing regional concerns.
4	Number of agencies and stakeholder groups involved in research outreach related to Vibrios in shellfish.
5	Knowledge about the changes in Vibrio genomes, which cause transitions to virulence;
6	Understanding of how microcystin toxins spread from lakes to the terrestrial food chain
7	Identify ecosystem factors which influence dynamics of Vibrios in shellfish in the Northeast US estuaries to improve the prediction of risk factors associating with shellfish harvesting and consumption.

Outcome #1

1. Outcome Measures

Number of program participants who score 75% or greater on knowledge tests of high risk practices including: * Personal hygiene * Holding/time and temperature * Cooking temperatures * Prevention of contamination

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1070

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The U.S. Centers for Disease Control and Prevention estimates that each year approximately 1 in 6 Americans or 48 million people get sick from a foodborne illness. Of those people who get sick, 128,000 are hospitalized and 3,000 die from their illness. Demographic and lifestyle changes have increasingly shifted the responsibility for the safety of food from the consumer to other sectors of the food system.

What has been done
The Safety Awareness in the Food Environment program (SAFE) is a two-hour, one-session program targeting food service workers. The program is implemented in all 10 New Hampshire counties.

ServSafe® Manager is a national food safety and sanitation certification program. ServSafe® Manager programs are offered to food service managers/workers throughout the state.

ServSafe® Food Handler Guide is designed for food workers. This program was piloted this year.

Preserving Your Harvest: The Basics of Preserving Food Safely is a two-hour program for consumers.

Food safety programs for food producers and processors including poultry and rabbit producers are designed to meet the needs of these audiences.

Results

A total of 66 SAFE programs reached 1259 food service workers in NH. Results from 910 post-workshop questionnaires indicated that 854 (94%) food service workers scored 75% or greater on the food safety knowledge questions. Of the 910 post-workshop questionnaires received, 724 (80%) food service workers indicated their intent to adopt a recommended food safety practice. The top three response categories were: 221 (31%) food workers intended to improve personal hygiene practices, 158 (22%) food workers intended to make time and temperature changes in their food handling practices and 140 (19%) intended to make changes in sanitation practices. About 81% (588)food workers indicated that it was somewhat to very likely they would make these practice changes to improve food safety.

A total of 261 food service managers/workers participated in a ServSafe® class and/or took the examination. About 76% (198) food managers/workers passed the certification examination with a score of 75% or greater.

Two ServSafe® Food Handler courses were piloted in FY 16 reaching 26 food handlers. Eighteen (69%) participants scored 75% or greater on the post-workshop test. This course is more advanced than our SAFE program but not as in-depth as the ServSafe® food manager course.

Six ServSafe® participants completed an online follow-up survey approximately 2 months after completing the program. Participants reported more frequent use of 11 recommended food handling practices after completing the ServSafe® program as compared to before the program (e.g. using single-use gloves when handling ready-to-eat foods, using a calibrated thermometer to check food temperatures). Three (3) indicators (wash hands using recommended steps; wash hands after visiting the restroom; purchase food from approved, reputable sources) remained the same as all 6 participants indicated they implemented these practices "almost always" before and after the program. Two food safety practices decreased from before to after program (develop procedures for handling food allergens and test sanitizer concentration).

Six Preserving Your Harvest programs were implemented in 5 NH counties. A total of 71 consumers were reached with food preservation and/or food safety information through our Info Line.

Two Food Safety for Poultry and Rabbit Processors programs were implemented reaching 43 processors. Fifteen food safety programs reached 57 growers/producers via farm visits, FSMA presentations to associations or groups, including NOFA, NH Vegetable and Berry Growers Association, milk pricing and policy groups, and the Annual Tree Fruit Growers meeting.

4. Associated Knowledge Areas

KA Code	Knowledge Area
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety

Outcome #2

1. Outcome Measures

Number of food handlers who self-report an intent to adopt recommended hand washing practices,take steps to reduce cross-contamination and/or use proper time and temperature controls after attending a SAFE program.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	724

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety

Outcome #3

1. Outcome Measures

Continued development of improved Vibrio detection methods and post-harvest treatments for reducing Vibrio levels in shellfish to address growing regional concerns.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Accession 1004199 "Changes in pathogenic Vibrio populations in shellfish-borne disease in the coastal waters of the Northeast US are an emerging concern and are likely consequences of changing environmental conditions. Research needs are to develop accurate methods for predicting risk conditions, develop better detection methods for monitoring pathogenic Vibrio strains in harvest areas and in clinical samples, and to develop locale-specific harvest management plans and post-harvest strategies to prevent human illness from shellfish consumption."

What has been done
i)The Whistler lab (accession 1004199) has used genomic sequencing to develop new, precise and accurate molecular markers to monitor changing strains and concentrations of clinical and nonclinical strains of Vibrio parahemolyticus in water, shellfish, sediments, and plankton samples.
ii)A collaboration between Ph.D. student Michael Taylor in the Jones lab (accession 233555) and Mr. Thomas Howell of Spinney Creek Shellfish in Eliot ME have led to the development of a relay method to effectively reduce pathogenic Vibrio in shellfish.

Results
i) "Clinical Vibrio parahaemolyticus strains in MA, NH and ME were locally derived strains through 2011, and thereafter were dominated by a strain (ST36) that appears to have derived from Pacific Northwest populations, and to a lesser extent by strain ST631. A new genetic sequencing approach, diagnostic genes from the ST36 and ST631 type strains were identified, for assays to identify clinical strains and to aid in surveillance of these strains in coastal ecosystems. Overall, Vibrio parahaemolyticus populations in the Great Bay estuary during late 2015-2016 were present at levels comparable at times to those observed during the peak year in 2012, suggesting the bacterial population has adapted to new environmental conditions. This is despite the number of Vibrio parahaemolyticus infections in the Northeast has decreased in the last two years, reflecting cooler Gulf of Maine and Long Island Sound conditions and institution of better harvest management strategies.
ii) Relay of shellfish from an area of high Vibrio levels is a viable strategy for post-harvest treatment to reduce Vibrio concentrations in oysters within 14 days, as long as the site to which shellfish are relayed contains low to undetectable Vibrios. The underlying biological process that reduces Vibrio in the oysters appears to be competitive exclusion. However, success depends on the composition of the microbial community in the relay area."

4. Associated Knowledge Areas

KA Code	Knowledge Area
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety

Outcome #4

1. Outcome Measures

Number of agencies and stakeholder groups involved in research outreach related to Vibrios in shellfish.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	20

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety

Outcome #5

1. Outcome Measures

Knowledge about the changes in Vibrio genomes, which cause transitions to virulence;

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Illnesses caused by Vibrio parahaemolyticus have risen steeply in the region and have been linked to shellfish product harvested from multiple Northeast shellfish growing areas from Long Island Sound and the Gulf of Maine. This trend persists because of inadequate tools for proactive monitoring of pathogens to inform food safety regulation.

What has been done
The Whistler lab (Accession 1004199)continue to refine the genetic maps of pathogen types in the Northeast. Genome sequences are used to differentiate clinical and non-clinical strains and infer the evolutionary relationships between strains.

Results
1.The Whistler lab has determined that, in addition to the invasive ST36 strain that nationally causes the most infections, two new related pathogenic lineages have arisen, presumably from horizontal gene transfer, from the nonpathogen ancestor of pathogenic strain type ST631 endemic to the Northeast. These new pathogenic lineages cause an estimated 17% of infections. Several additional strains contribute infections including ST674, ST34, ST1127, ST636, and ST110.
2. Genomic comparisons on the major pathogen lineages identified unique diagnostic genome content for most of these strains. Nearly every pathogen lineage in the region has acquired the same piece of DNA that confers virulence. This finding enabled the design of detection assays to identify of the pathogenic DNA. Finally, new methods were developed and piloted quantitative methods for the enumeration of ST36 and ST631, which combined may cause up to 70% of all local source infections.

4. Associated Knowledge Areas

KA Code	Knowledge Area
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety

Outcome #6

1. Outcome Measures

Understanding of how microcystin toxins spread from lakes to the terrestrial food chain

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Toxins associated with harmful cyanobacteria blooms are an increasing problem for animal and human health worldwide. These cyanotoxins include known liver toxins (microcystins) and neurotoxins beta-methylamino L-alanine(BMAA). Modes of exposure to these toxins is poorly understood. The overall goal of the research accession is 1007227 is to examine the transfer of cyanobacteria toxins, to crops through irrigation water and lake aerosols. BMAA and MC were measured in these aerosols.

What has been done
1. Cyanobacteria were identified and enumerated in lake aerosols by epifluorescence, from eutrophic and mesotrophic lakes and farm ponds, in comparison to clear, pristine lakes.
2. A controlled experiment was conducted to test for the accumulation of the toxin microcystins in two vegetable crops. Lettuce and radishes were grown hydroponically under four small low-tunnel greenhouses on a specially constructed platform on Lake Attitash, Amesbury, MA.

Results
Samples collected in the summer of 2016 from the lake study and the controlled hydroponic experiment are being analyzed over the fall of 2016 and winter of 2017.

4. Associated Knowledge Areas

KA Code	Knowledge Area
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #7

1. Outcome Measures

Identify ecosystem factors which influence dynamics of Vibrios in shellfish in the Northeast US estuaries to improve the prediction of risk factors associating with shellfish harvesting and consumption.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The threat of shellfish-borne disease from Vibrio parahaemolyticus (Vp) and Vibrio vulnificus (Vv) is a significant public health concern in the US. Changes in pathogenic Vibrio populations in the coastal waters of the Northeast US are an emerging concern and are likely consequences of changing environmental conditions.

What has been done
Significant progress in the application of statistical models that more accurately explain variations in Vibrio populations.

Results
Ecosystem factors influencing Vibrio include water temperature, salinity, pH and chlorophyll a concentration, a surrogate for phytoplankton levels. This work should provide unique new approaches for predicting Vibrio pathogens risk conditions that should be transferable to other areas beyond Great Bay

4. Associated Knowledge Areas

KA Code	Knowledge Area
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

No external factors impacted NHAES research in these planned programs during Federal Fiscal Year 2016 .

V(I). Planned Program (Evaluation Studies)

Evaluation Results

EXTENSION

- Eighty percent (n=724) of food service workers indicated their intent to adopt food safety practices the following areas: improvement of personal hygiene practices, make time and temperature changes in their food handling practices and make changes in sanitation practices.
- About 94% of the 910 of food workers who returned post-workshop questionnaires scored 75% or greater
- In the area of ServSafe®, 18 (69%) of Food Handlers, scored 75% or greater on a post-workshop test and 198 (76%) of the ServSafe® Food Manager scored 75% or greater on the certification exam

NHAES

The discovery research projects covered in this planned program are most often evaluated by ouputs in the form of publication in peer-reviewed journals and successfully defended master's or Ph.D. theses.

Four journal articles and five conference papers were produced by the three research projects in this planned programs

Key Items of Evaluation

EXTENSION

See above (Evaluation results).

NHAES

- The revised website: Toxic Cyanobacteria of New England. The Dirty Dozen. http://cfb.unh.edu/CyanoKey/indexCyanoQuickGuide.html was accessed 460,000 by volunteer lake monitors, and professionals to identify cyanobacteria in freshwater lakes. In eutrophic lakes, cyanobacterial blooms produce microcystins (liver toxins) and beta methylamine alanine, BMAA (neurotoxin); both toxins are hazardous to wildlife and humans.
- Application of statistical models is assisting the Jones lab (accession 233555) to differentially and additively explain variation using some or all of certain ecosystem factors correlated with increased risk of pathogenic Vibrios in shellfish. Vibrio levels are correlated with water temperature, salinity, pH and chlorophyll concentration as a surrogate for phytoplankton; This information will lead improved models to predict Vibrio risk in shellfish over the course of the harvesting season.
- Relay, from a site with high Vibrio levels to a site with low or unmeasurable Vibrio

levels, can be a viable strategy for post- harvest treatment to reduce Vibrio concentrations in oysters within 14 days, The underlying process appears to be competitive exclusion. However, success depends on the composition of the microbial community in the relay area.

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Global Food Security and Hunger

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	5%		0%	
133	Pollution Prevention and Mitigation	0%		5%	
136	Conservation of Biological Diversity	0%		3%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		7%	
202	Plant Genetic Resources	0%		3%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%		3%	
204	Plant Product Quality and Utility (Preharvest)	0%		7%	
205	Plant Management Systems	10%		9%	
206	Basic Plant Biology	0%		2%	
211	Insects, Mites, and Other Arthropods Affecting Plants	10%		2%	
212	Pathogens and Nematodes Affecting Plants	10%		15%	
213	Weeds Affecting Plants	5%		2%	
216	Integrated Pest Management Systems	10%		0%	
301	Reproductive Performance of Animals	10%		7%	
302	Nutrient Utilization in Animals	10%		11%	
305	Animal Physiological Processes	0%		1%	
307	Animal Management Systems	5%		19%	
502	New and Improved Food Products	0%		4%	
601	Economics of Agricultural Production and Farm Management	15%		0%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	10%		0%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	10.0	0.0	12.0	0.0
Actual Paid	25.0	0.0	18.4	0.0
Actual Volunteer	5.1	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
473250	0	1573304	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
473250	0	1497400	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
1032364	0	1118256	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Cooperative Extension

- Workshops/conferences - including single- and multiday conferences, NH Farm and Forest events, and various producer association meetings
- Pasture walks & twilight meetings
- Farm/site visits, including kitchen table meetings and private consultations
- On-farm and university-based applied research projects
- Phone consultations
- Soil and plant tissue diagnostic services
- Publications - newsletters, news releases, fact sheets, publications, web page
- Radio and TV spots

NHAES·

- Conducts applied and discovery research experiments. Specific Activities will be described in conjunction with individual State Defined Outcomes.
- Undertakes engagement with stakeholders in multiple aspects of plant and animal agriculture, related genetics and genomics, and various types of aquaculture. Engagement activities include a variety of venues and modalities: Research field days and twilight meetings at NHAES farms and greenhouses, social media and videos https://www.youtube.com/user/colsaunh

2. Brief description of the target audience

Cooperative Extension and NHAES audiences include:

Farmers/producers, scientists, veterinarians, agricultural researchers, agricultural teachers, graduate and undergraduate students, and the faculty and staff of the region's land land-grant universities and others who work in agriculture-related fields, NH Department of Agriculture, Marketing and Food, NH Farm Bureau, NH Farmer's Union, State Legislators, and the NH Congressional Delegation, as well as taxpayers in the state, region, and nation.

3. How was eXtension used?

Several NHAES researchers have joint appointments with UNH Cooperative Extension. Results from research projects, such as variety trials, are disseminated through Extension bulletins and via eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	39303	66415	1384	1356

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2016
Actual:	1

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	3	53	56

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of farm/site visits, including kitchen table meetings and private consultations

Year **Actual**

2016	805

Output #2

Output Measure

- Number of Pesticide Applicators attending recertification training

Year	Actual
2016	1710

Output #3

Output Measure

- Number of soil and plant analyses conducted by diagnostic labs

Year	Actual
2016	4296

Output #4

Output Measure

- Number of people reached through educational workshops

Year	Actual
2016	11009

Output #5

Output Measure

- Number of undergraduate students directly involved in the research projects

Year	Actual
2016	73

Output #6

Output Measure

- Number of graduate students directly involved in research projects.

Year	Actual
2016	33

Output #7

Output Measure

- Number of university courses in which research project results have been incorporated

Year	Actual
2016	5

Output #8

Output Measure

- Number of research presentations at regional, national, or international scientific meetings

Year	Actual
2016	36

Output #9

Output Measure

- Number of workshops, training sessions and presentations to non-scientific stakeholders

Year	Actual
2016	682

Output #10

Output Measure

- Number of reviewed, bulletin, popular and other publications resulting from research projects

Year	Actual
2016	102

Output #11

Output Measure

- Number of websites in which research project results have been incorporated

Year	Actual
2016	5

Output #12

Output Measure

- Number of surveys or other methods used to collect data from participants conducted for research projects

Year	Actual
2016	48

Output #13

Output Measure

- Number of postdocs and other scientists trained in cutting edge research methods

Year	Actual
2016	5

Output #14

Output Measure

- Arthropods identified for stakeholders

Year	Actual
2016	115

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of NH growers who adopt practices that improve farm productivity, quality of life, environmental conditions, and/or profitability.
2	Number of NH growers that use soil testing recommendations to guide nutrient application
3	Number of NH growers who monitor for pests, use cultural practices to manage pests and/or select reduced-risk (lower EIQ) materials to manage pests.
4	Number of NH growers who increase their knowledge, awareness, and/or skills in crop production practices
5	Number of NH growers who increase their skills, knowledge or awareness in practices or methods related to dairy, livestock or equine production methods.
6	Increase knowledge about plant varieties and production practices suited to the state and region.
7	New knowledge about dairy production, nutrition, animal health and dairy products important to regional producers.
8	New genomic knowledge translated into tools and strategies to facilitate varietal selection through marker-assisted breeding.
9	Knowledge related to how the neuroendocrine system influences reproduction in fin fish aquaculture and other vertebrate animals and in the control of pest species such as lamprey eels.
10	New commercialized varieties of cucurbit vegetables suited to state and region growing conditions, with improved yields,and disease and pest resistance.
11	Increased information on non-Apis bees, their conservation, pathology, susceptibility to pesticides and contribution to crop pollination including economic value.
12	Develop genomic resources for barberries, to assist with taxonomic problems, and as tools to identify the genetic mechanisms(s) of resistance to wheat stem and strip rusts.
13	Improve equipment and deployment methods developed for oyster aquaculture in Northern New England and disseminate to the growing number of NH oyster farmers.
14	Establish a breeding program for hardy kiwifruit (Actinidia spp.) cultivars for New England, by characterizing with genetic and molecule tools, and phenotyping hardy Actinidia germplasm obtained the USDA's National Genetic Resources Program.
15	Number of acres on an Integrated Pest Management Plan
16	Number of producers who report they have taken action that results in better forage quality and yield.
17	Establish dietary guidelines in recirculating aquaculture systems for brown bullhead (catfish).

18	Validate the use of lumpfish as cleaner fish in high current velocity open ocean aquaculture for steel head trout.
19	Produce interspecific squash hybrids intended for the processing industry dealing with pumpkin pie stock, baby puree and frozen food. These new hybrids should be attractive to processors and growers who produce for processors because of its rapid leaf canopy cover, high fresh weight yield, high solids content and improved disease resistance as compared to varieties currently used in the processing industry.
20	Refine agricultural management practices in for resilient forage crop productivity, resilience, and profitability in Northern New England while decreasing the need for external inputs to manage soil fertility and crop pests.
21	Improve the immunoglobulin content of dairy cattle colostrum which is used to transfer maternal immunity to newborn calves after birth.

Outcome #1

1. Outcome Measures

Number of NH growers who adopt practices that improve farm productivity, quality of life, environmental conditions, and/or profitability.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	307

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

More than 4,390 agricultural firms in New Hampshire generate nearly $865 million in annual product value and manage approximately 474,065 acres in farm land. New Hampshire's agricultural industry is principally comprised of small family farms offering a diverse selection of crop, livestock and specialty products. These family businesses are an integral part of the local community maintaining a working landscape and providing citizens with superior products as well as connections to farming and "rural" New Hampshire.

About half of State's farmers consider farming their principal occupation. For these and many of the part-time farms, the family relies on agricultural activities to provide money for an adequate standard of living. New Hampshire's farms need to be profitable if they are to continue to exist. While many sources of outside assistance are available to other types of small businesses, the unique needs of agricultural firms require assistance from organizations and professionals familiar with those needs such as UNH Cooperative Extension.

What has been done
Direct consultations (site visits, phone calls, emails), workshops, conferences, annual meetings of grower and landscape professional associations, field demonstrations, twilight meetings, pasture walks, pruning demonstrations, electronic newsletters, fact sheets, and social media

Results
307 New Hampshire growers/landscapers reported adoption of practices to improve farm productivity, quality of life, environmental conditions, and/or profitability.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems

Outcome #2

1. Outcome Measures

Number of NH growers that use soil testing recommendations to guide nutrient application

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	496

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Over-application of fertilizers can negatively impact water quality and plant growth and it is a waste of money and time. Under-application of fertilizers results in poor plant growth and loss of potential yields and profits. Soil tests and plant tissue tests (for perennial fruit crops) are tools that help growers determine nutrient availability and crop needs.

What has been done
Extension promotes the use of soil and plant tissue testing and implementation of recommendations based on soil test results, educates growers about the effective use of soil and tissue testing as nutrient management tools, and educates growers on how to identify and correct nutrient imbalances in crops.

Results

496 commercial growers reported using UNH Cooperative Extension soil test recommendations to guide their nutrient applications.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems

Outcome #3

1. Outcome Measures

Number of NH growers who monitor for pests, use cultural practices to manage pests and/or select reduced-risk (lower EIQ) materials to manage pests.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	2717

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems

Outcome #4

1. Outcome Measures

Number of NH growers who increase their knowledge, awareness, and/or skills in crop production practices

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	307

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The forage, pasture and silage corn crops that support NH's livestock industry cover more than 100,000 acres, more than 90% of the cropland in the state. In order for these farms to be profitable, producers need information that enables them to adopt practices in raising healthy animals, managing their operations as efficient businesses, and producing crops in a manner that protects soil and water resources.

What has been done
Direct consultations (site visits, phone calls, emails), workshops, conferences, annual meetings of grower and landscape professional associations, field demonstrations, twilight meetings, pasture walks, pruning demonstrations, electronic newsletters, fact sheets, social media.

Results
307 fruit and vegetable growers reported adoption of at least one crop production practices as a result of programming by UNH Cooperative Extension.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems

Outcome #5

1. Outcome Measures

Number of NH growers who increase their skills, knowledge or awareness in practices or methods related to dairy, livestock or equine production methods.

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Increase knowledge about plant varieties and production practices suited to the state and region.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
"Sideman's (accession 1006982)integrated project studies "high-value specialty crop production systems, new varieties, new crops, and methods of extending the growing season... and communicating these results to growers and Extension professionals to increase farm profitability through diversification, improved yields, and improved crop quality." "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."

What has been done
1.Eight hardy table grape cultivars grown in three distinct training systems were evaluated to determine hardiness, disease incidence, yields, and maintenance time required.
2.Onion germplasm was evaluated in an overwintering production system for survival, timing of bulb formation, and potential bulb yield.
3. The third and final year of a variety trial was conducted evaluating spinach cultivars for overwintering in unheated high tunnels.
4. A new project was initiated focused on biological control of cabbage aphid, an insect pest that appears to have become more widespread and abundant in Northern New England and has

stopped some growers from growing brassica crops. Three management techniques (biological control via insectary plantings, organic pesticide treatments, and control) were compared for controlling this pest in Brussels sprouts.

Results
1. For grapes, winter survival, plant vigor, and susceptibility to four diseases were assessed in spring and summer 2016. Some varieties experienced high mortality and high disease susceptibility. A preliminary research report was disseminated for growers.
2. For Onions, varying susceptibility to bolting was detected in different cultivars, and differences in bulb yield and maturity date varied for different cultivars at four different planting dates.
3.Results from three years of spinach cultivar trials, in unheated high tunnels, were published for growers.
4. Preliminary results indicate that organic pesticides were effective in controling cabbage aphids but insectary plantings were not.

4. Associated Knowledge Areas

KA Code	Knowledge Area
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems

Outcome #7

1. Outcome Measures

New knowledge about dairy production, nutrition, animal health and dairy products important to regional producers.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Although organic producers from the Northeastern United States pasture their cows from May to mid-October, they begin to supplement grazing with conserved forage in the fall. As a result, most

organic dairies fed conserved feeds (e.g., silage, haylage, and baleage) for approximately seven months each year, thus raising farm production costs. Research is crucial to help reduce winter feeding costs in organic dairy herds and to improve forage production during the grazing season.

What has been done

1. Winter feeding experiments were conducted with alternative feed sources including flax seed meal, and okara meal (produced from insoluble soybean fiber).
2. Milk production was compared for cows grazing on pasture as compared to various alternative forage crops (warm and cool season grasses, summer annuals, brassicas).

Results

1.Brito's (accession 1001855) preliminary results showed that, overall, the alternative feed sources could replace traditional feed sources such corn and soybean meal without a negative impact on production performance. For instance, okara meal replaced entirely soybean meal in dairy diets and cows produced an average of 20 kg/d of milk across treatments.
2.Preliminary results indicated that alternative forage crops (AFC), have potential to extend the grazing season and replace traditional forages in dairy farms as AFC pasture production was approximately 20% greater than traditional pasture during the spring. Milk production and milk composition in cows fed AFC or traditional pasture was not statistically different during both spring and summer seasons, thus suggesting that AFC can replace traditional pasture without penalizing milk output and quality.

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals
305	Animal Physiological Processes
307	Animal Management Systems

Outcome #8

1. Outcome Measures

New genomic knowledge translated into tools and strategies to facilitate varietal selection through marker-assisted breeding.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Strawberries are an important fruit in New Hampshire and Northern New England, but varieties specifically adapted for this region are limited. Furthermore domesticated strawberry is an octoploid (eight sets of chromosomes) making this fruit very difficult to breed by conventional methods. The availability of detailed molecular maps for strawberries will enable Marker Assisted Breeding (MAB),accelerating breeding for local needs, including organic production and ornamental strawberries.

What has been done

1.The Davis lab (accession 1006924)has contributed to building two commercially available single nucleotide polymorphism (SNP)arrays.
2. Genome mapping of the ancestral diploid strawberry Fragaria iinumae.
3. Advanced strawberry breeding populations through crossing to produce new hybrids, SNP genotyping of progeny populations, phenotyping with respect to multiple traits including verticillium wilt resistance, fruit quality, and flower color,

Results

1.The Istraw90 array and its recent derivative, the Istraw35 array, are available for commercial purchase from Affymetrix, Inc., and are being employed by major strawberry breeding programs throughout the world. The new array has cut costs of genotyping each plant by 50%
2. The first genomic map of the ancestral diploid strawberry species, Fragaria iinumae was constructed. This map will provide an invaluable resource for the anticipated design of a second generation SNP array for strawberry, thereby providing an even more powerful genotyping platform in support of MAB in strawberry.
3. The Davis group identified a set of SNP markers that are absolutely predictive of the presence of colored versus white flowers for an ornamental strawberry breeding sub-program

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources

Outcome #9

1. Outcome Measures

Knowledge related to how the neuroendocrine system influences reproduction in fin fish aquaculture and other vertebrate animals and in the control of pest species such as lamprey eels.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The goal is to identify and perform structure-function activities of key reproductive hypothalamic and pituitary hormones and receptors in lamprey. Specific objectives of work in the Sower lab (accession 1003341) is to determine the effects of thyroxine on the brain concentration of GnRH, the master hormone controlling reproduction in a basal fish lineage, the lamprey eel.

What has been done
1."In an in vivo experiment, thyroxine was injected at 50 µg/kg and 100 µg/kg, along with 10% DMSO (control), into adult female sea lampreys. Lamprey GnRH-I, II and -III were extracted, eluted via chromatography, and brain concentrations were determined by radioimmunoassay."
2."Histological techniques were used to determine the (co)-localization and (co)-expression of the lGpH and thyrostimulin subunits in the lamprey adenohypophysis at different life stages and to identify their synthesizing cell(s)."

Results
1. "There was a demonstrated decrease in l-GnRH-I, - II, and -III concentrations of lampreys treated with thyroxine compared to controls ($p>0.05$. These data provide the first direct evidence of a feedback system between the thyroid and reproductive systems in lamprey."
2.This.. "comprehensive study strongly supports evidence for four definitive adenohypophyseal cell types in the lamprey, including, corticotropes, somatotropes, melanotropes, and the first identification of a novel proto-glycotrope. In addition, Sower lab studies show that there is developmental/region-specific co-localization and co-expression of lGpH and thyrostimulin in the lamprey adenohypophysis."
"..Results from these studies provide key information in the development of novel strategies for improving and controlling reproduction in fish, and that can aid in the development of the scientific basis for a sound fisheries management plan and improving aquaculture."

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
305	Animal Physiological Processes

Outcome #10

1. Outcome Measures

New commercialized varieties of cucurbit vegetables suited to state and region growing conditions, with improved yields,and disease and pest resistance.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Improved variety performance in terms of yield, quality and ease of culture of vegetable cultivars is paramount to successful farming. Loy's long-term project (NIFA accession 233554)seeks to develop gynoecious (highly female) lines as seed parents for reducing production costs for hybrid seed. Another summer squash breeding project targets reduced spines, and powdery mildew resistance. A third project involves improving varieties of winter squash.

What has been done
1.Six gynoecious breeding lines of melon with good appearance and eating quality have been developed and were evaluated in hybrid combinations.
2.NH melon inbreds were released to seed companies for use in hybrid melon combinations.
3. Breeding lines of yellow summer squash with glabrous gene for reduced vines have been evaluated across the Northeast for intermediate powdery mildew resistance. Three hybrids were released to different seed companies for production in 2015-2016.
4. Breeding of winter squash (kabocha, acorn, C. moschata- butternut types) focused on developing bush and vine breeding lines, powdery mildew resistance and improving culinary quality, size, and fruit color.
5. Breeding is ongoing with ornamental pumpkins for complex traits of stripping pattern, and stem strength.

Results
1.Seven of the melon hybrids were given a high rating for appearance, productivity and eating quality, including three with gynoecious (female) flowering.
2. In 2016, three new melon hybrids were introduced, an early season, ribbed melon, Milan, a large, late season ribbed melon, Afterglow, and an early melon for local markets, Cleopatra.
3. One new glabrous summer squash variety, Blonde Beauty, is being marketed by seed

companies in 2016 and 2017.
4. In winter squash, C. moschata, 59 butternut and 43 round-fruited selections were evaluated for fruit characteristics and culinary traits after cooking evaluated, with a focus on high content of dry matter, soluble solids and carotenoid pigments. Thirty-two of the 102 total selections evaluated in cooking tests scored high for both % Dry Weight and carotenoid content, and had soluble solids content above 12%, indicating a high sugar content for good palatability.
5.Three new ornamental pumpkins hybrids developed jointly with a seed company were released in 2016. An attractive, small pumpkin with white rind color was released in 2015 and offered for sale during spring of 2016.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)

Outcome #11

1. Outcome Measures

Increased information on non-Apis bees, their conservation, pathology, susceptibility to pesticides and contribution to crop pollination including economic value.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Bees are important pollinators of food crops and natural ecosystems. The value of pollination to agriculture is estimated at over $200 billion/year worldwide. The abundance of and diversity of pollinators are declining in many agricultural landscapes across the United States. The Rehan project(accession 1004515; the Bee Lab)aims to initiate long-term monitoring of bee biodiversity in New Hampshire and identify species in need of more research. By documenting, what species are abundant, common, and rare to the area they can track species habitat and floral preferences.

What has been done
1.This year the Bee Lab documented the native bees of New Hampshire, plant-pollinator

associations and habitat requirements for bees in the granite state, and are actively archiving historic records to better understand bee declines.
2. The Bee lab has assessed native bee populations across a variety of farm and land use types, also expanding efforts to include foraging behavior across different crop and pasture types.
3. The Bee Lab developed a database of historic records of bees including 14,000 bee records spanning 150 years

Results
"Firstly, the Bee Lab published the first characterization of the native bee community in NH, providing not only species lists but also floral associations (Tucker EM, Rehan SM (2016) Wild bee pollination networks in northern New England. Journal of Insect Conservation.20:325-337). Moreover, this paper documents plant-pollinator phenologies and interactions important for long-term monitoring and habitat assessment. This is part of a long-term effort to understand the floral requirements and habitat preferences for native bees in efforts to better conserve local populations. Second, the Bee Lab assessed native bee populations across a variety of farm and land use types, also expanding efforts to include foraging behavior across different crop and pasture types. This manuscript is now in review for publication. Third, the Bee lab has developed a database of historic records of bees including 14,000 bee records spanning 150 years in the state to examine former ranges and population numbers for the 200+ species found locally. The Bee Lab is now developing online tools to share this information with regional and national as well as international stakeholders through an interactive data archive and image web portal."

4. Associated Knowledge Areas

KA Code	Knowledge Area
136	Conservation of Biological Diversity
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #12

1. Outcome Measures

Develop genomic resources for barberries, to assist with taxonomic problems, and as tools to identify the genetic mechanisms(s) of resistance to wheat stem and strip rusts.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Present throughout New England, barberries are the alternate host to stem rust and stripe rust, two of the most devastating fungal diseases of small grains like wheat and barley. Molecular tools are needed to aid researchers conducting barberry surveillance work in the region and globally, to distinguish over 500 barberry species, and to characterize the genetic mechanism(s)of some barberry species resistance to Puccinia graminis f. sp. tritici (PGT, causal organism of wheat stem rust).

What has been done
1.Activities included the deep (~120x) sequencing of B. thunbergii cv. 'Kobold' via the long-read (>20kb) PacBio platform.
2. The creation and disease scoring of a population of 200 full sibling B. ×ottawensis lines from the controlled intercross of PGT-susceptible B. vulgaris accession 'WH01' and PGT-resistant B. thunbergii accession 'UCONN.'

Results
1.B.thunbergii sequence assembly of Pac reads into a draft genome for that species (Number of contigs: 4,671; Total length of assembly:
1.362 Gb; Contig N50 = 668,984 bp).
2. Over the past 1.5 years SNP-calling pipeline developed in Hale program (accession 233561)for de novo genotyping-by-sequencing (GBS) was completed and published.
3. GBS sequence data for 200 interspecific lines was generated for the purpose of constructing genetic linkage maps for barberry, and mapping of regions of the barberry genome that contribute to PGT resistance/susceptibility.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources

Outcome #13

1. Outcome Measures

Improve equipment and deployment methods developed for oyster aquaculture in Northern New England and disseminate to the growing number of NH oyster farmers.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
This project (accession 1003387) is aimed at enhancing the newly emerging oyster aquaculture industry in New Hampshire by focusing on methods to increase farm production. Oyster farmers are the major group that will benefit, but the research will also be useful to others involved in management and wise use of our coastal and estuarine resources.

What has been done
1.Assess gear types and methods that oyster farmers in the region currently use from the perspective of possible standardization on NH farms.
2. Existing oyster farming manuals and other relevant documents were collected from various locations,

Results
1.Several oyster farmers were interviewed and farms visited during the reporting period in order to determine what methods are currently being used in New Hampshire. A wide range of harvest methods are being used, probably due to the wide range of bottom types (from mud to cobble) on the farm sites. This preliminary information is being used to prepare a survey which gear types are most common, and what are the relative merits and disadvantages different oyster farming gear.
3. Existing iyster farming manuals (for other regions) are being compared to develop a template for a northern New England Oyster growing manual, to be produced in the last year of this project.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems

Outcome #14

1. Outcome Measures

Establish a breeding program for hardy kiwifruit (Actinidia spp.) cultivars for New England, by characterizing with genetic and molecule tools, and phenotyping hardy Actinidia germplasm obtained the USDA's National Genetic Resources Program.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
New England fruit and vegetable agriculture is distinct in both the diversity of its production and its high proportion of direct sales to consumers. Hardy kiwifruits have been recognized by horticulturalists and plant explorers since the early 1800's as possessing great economic potential, particularly in northern climates. Hardy kiwifruits are hairless, grape-sized, kiwi-like berries, that can be eaten whole and have high levels of phytonutrients. Long-term research is needed to develop hardy kiwi cultivars and optimize production practices.

What has been done
1.Continuation of the long-term breeding initiative to develop economic cultivars of cold-hardy kiwiberry(Actinidia arguta, A. kolomikta) for New England and continued efforts to build grower and consumer awareness of the potential of this novel crop in New England.
2. Genome By Sequencing (GBS) has been used to deconvolution of the North American collection of kiwiberry germplasm.

Results
1. The research vineyard has been doubled in size.
2. Genome by Sequencing (GBS) has enabled the successful characterization of population sub-structure, accession redundancy, and genetic diversity in the USDA's large and historic collection of hardy kiwi-berry.
3. GBS has been used to develop and validate a sex-linked molecular marker for both A. arguta and A. kolomikta. The A. arguta sex-linked marker was used in Hale program to screen breeding populations. GBS-identified female vines were transplanted to the breeding vineyard for long-term evaluation and selection, allowing for larger populations fruit producing plants to be evaluated.
4.A consumer survey was deployed at 23 farmers' market across the state in the latter half of September. At each market, members of the Hale lab educated consumers about this novel crop,provided free samples, and requested that response cards be filled out. In all, over 2,000 response cards were completed, capturing consumers' preferences, desire for the product, and price point.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms

202 Plant Genetic Resources

Outcome #15

1. Outcome Measures

Number of acres on an Integrated Pest Management Plan

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	303

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In the farming industry, green practices and reduction of food pollutants are more important than ever. Farmers are looking to make sure their actions are not harmful to the environment and that their crops are safe to human as both a matter of conscious ? and to build trust with consumers. Farmers need to use an Integrated pest management system which treats crop only when needed.

What has been done
monitor for the occurrence of known crop pest around the state during the summer and disseminate the result to farmers. Also, Extension staff provide on-on-one consultations to farmers so they can better implement integrated best management plans.

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems

Outcome #16

1. Outcome Measures

Number of producers who report they have taken action that results in better forage quality and yield.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	24

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
307	Animal Management Systems

Outcome #17

1. Outcome Measures

Establish dietary guidelines in recirculating aquaculture systems for brown bullhead (catfish).

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A significant concern in aquaculture, that will likely limit future growth of the industry, is the use of fishmeal, derived from small, marine fish, primarily harvested from South American waters, as a protein source in finfish diets. Globally, aquaculture consumes two-thirds of the world's fishmeal and three-fourths of the fish oil supply. Alternatives protein sources, (e.g. soy), have been used to replace some or all of the fishmeal in finfish diets, but soy suitability is highly species-dependent. This project seeks to identify new high-value fish for recirculating aquaculture, and sustainable food sources for these systems.

What has been done
1.Juvenile (15-120 g) brown bullhead were captured from the wild, domesticating and feed entrainment was initiated. The fish were fed either a high (50%) or low protein (16%) diets. Adult brown bullhead were captured and placed in containment ponds for natural environmental conditioning.
Hybrid striped bass were produced in NC, transported to NH, genetically tagged and assigned to 5 recirculating systems for growth evaluation. Currently, they have been cultured in their experimental systems for approximately 210 days.
3.Purebred striped bass were produced in NC, transported to NH, PIT tagged, assigned to recirculating systems and undergone stress evaluation.

Results
1. It is too early to consider it a major problem, the brown bullhead have not been feeding as consistently as anticipated. The Berlinsky project (accession 100914) is experimenting with light intensity and fish densities to improve desired environmental conditions for this species.
2&3. Strain comparisons for hybrid and purebred bass for stress responsiveness were compared by measuring plasma cortisol concentrations using a validated enzyme-linked immuno assay for the stress hormone cortisol. Individuals with repetitive high and low cortisol were identified for future studies.

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals
307	Animal Management Systems

Outcome #18

1. Outcome Measures

Validate the use of lumpfish as cleaner fish in high current velocity open ocean aquaculture for steel head trout.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The fledgling steelhead trout aquaculture industry in New England is hampered by infestations of external parasites (salmon lice), with few mechanisms to control them. Lumpfish (Cyclopterus lumpus) may be suitable as a 'cleaner fish' to remove salmon lice, but little is known about the physiology of Lumpfish, and its reproduction.

What has been done
1.A series of incubation tanks, supplied with flowing filtered seawater, were established at the UNH Coastal Marine Lab (CML) for Lumpfish experiments.
2.A single mass of lumpfish eggs was harvested off the coast of Maine; these eggs hatched 24-37 days post collection and were used to conduct physiological experiments of the impact of salinity on the fish.
3. An extensive field study was designed to document the temporal and spatial distribution of juvenile lumpfish.

Results
1. Adult lumpfish were caught in April and May, but failed to produce eggs in captivity.
2. Salinity treatments of juvenile lumpfish was conducted for a total of 70 trials throughout the experiment. There were no significant differences in the standard metabolic rate of fish exposed to the range of salinities, indicating that lumpfish are very efficient osmoregulators. This was further indicated by holding fish, for one week, at each of the test salinities. No signs of stress or mortality occurred at salinities from 5 to 30 ppt. However when presented with a gradient of salinities, the lumpfish preferred high salinity (>20 ppt) water.
4.Juvenile lumpfish began to appear at three of the sampling sites in mid-June, peaked in August, and then began to decline in September. Average seawater temperatures when they first appeared, peaked, and began to decline were 14.6, 19.2 and 17.4 °C, respectively. Results showed that lumpfish were found at all locations, except for the Great Bay site near Jackson

Estuarine Lab (JEL), furthest up the estuary, in all four months.

Thus it has been demonstrated that lumpfish are adaptable to the brackish water of the steelhead trout pens. With increased knowledge about lumpfish physiology and distribution in the Piscataqua River and the Great Bay, it will be feasible to evaluate whether they will be useful cleaner fish in steelhead aquaculture.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
307	Animal Management Systems

Outcome #19

1. Outcome Measures

Produce interspecific squash hybrids intended for the processing industry dealing with pumpkin pie stock, baby puree and frozen food. These new hybrids should be attractive to processors and growers who produce for processors because of its rapid leaf canopy cover, high fresh weight yield, high solids content and improved disease resistance as compared to varieties currently used in the processing industry.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Hybrid varieties of fresh market winter squash and pumpkin have largely supplanted open-pollinated varieties in developed countries because of their uniformity and consistency of yield and fruit quality. Open pollinated varieties, on the other hand, are still the dominate type grown by farmers for the pie and baby food processing industry. Hybrids between two species of squash, Cucurbita maxima (buttercup, Golden Delicious, and Hubbard types) and Cucurbita moschata (butternut, Large Cheese, and Dickinson Field types) are possible and have tremendous potential. Interspecific hybrids are sterile and thereby do not produce seeds, and as such, offer the potential for greater economic yield of the usable flesh or mesocarp tissue of fruit.
The hybrid squash also show promise as rootstocks for melon grafting, to promote blight

resistance and tolerance of colder soil temperatures at transplant.

What has been done

1.Strains of fresh market and processing squash with the bush habit of growth have been developed (Loy, accession 233556). Current breeding efforts are focused on developing strains of Cucurbita moschata fresh market types of squash which flower later and have a higher ratio of male to female flowers such as occurs in some of the processing cultigens. It is expected that such strains in hybrid combination with C. maxima will result in a more acceptable pattern of fruit set.
2. Evaluate new hybrids between a bush C. maxima processing strain (NH. Max65) and several C. moschata cultigens.
3. NH1320 (NH65 to NH.Mo176-29-1) exhibits good seed germination, seedling uniformity, and graft compatibility with melon, and thus, has been used extensively in grafting studies

Results

1."The hybrid NH1310 has a semi-bush growth habit combined with lateral branching from the first 8 to 10 nodes, resulting in rapid leaf canopy development for more efficient photosynthesis and better weed control through shading. The female flowering pattern of NH1310 was shown to be similar to that of a popular processing strain of C. moschata, allowing sufficient vegetative growth prior to fruit set so as to promote a heavy fruit load of fruit uniform in size and flesh consistency. Fresh weight and dry biomass pericarp yields of NH1310 were respectively, 40 and 93% higher than that of the C. moschata processing strain SC936 which is also the male parent of NH1310. Interspecific hybrids are sterile, and thus, photosynthates required for fruit development can be allocated to solely to mesocarp tissue rather than apportioned between mesocarp tissue and seeds. "
2."In 2016, four of the best cross combinations, NH.Max65 and NH Max5-10-1-3 to NH.Mo127-9-6-2 and NH.Mo116-33-7-3, seed yield averaged 189 per fruit. The new hybrids will have to be evaluated for productivity, and flesh quality."
3. "New processing lines have been developed with high dry matter content which is correlated with increased starch which improves the consistency and texture of processed squash. In 2016, the % DW in fruit of three uniform inbred lines, NH.Mo125-1-10-7, NH.Mo116-33-7-3, and NH.Mo127-9-6-2, averaged respectively, 12.7, 13.8, and 11.9%, about double that of two 'Dickinson Field' strains employed in previous studies." Loy's group "has demonstrated a high negative correlation (r2 = -82) between % mesocarp DW and water loss during cooking and processing.
Loy's group has successfully selected for high beta-carotene content, for improved nutritional value.
3." A follow-up grafting study with Halona melon on hybrid squash rootstock resulted in marketable fruit yields of grafted plants at three planting dates, May 11, 20 and 31, were respectively,
91%. 122%, and 147% higher than with non-grafted plants. he plot yield for grafted plants planted

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)

Outcome #20

1. Outcome Measures

Refine agricultural management practices in for resilient forage crop productivity, resilience, and profitability in Northern New England while decreasing the need for external inputs to manage soil fertility and crop pests.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
"Increasing the number of different crop species grown in mixtures may improve the productivity, resiliency, and environmental impacts of feed and forage production systems. This project will explore the agronomic and environmental outcomes of several approaches to forage cropping system diversification including forage crop mixtures, inter-seeding and intercropping. Biologically-based improvements in soil fertility and nutrient cycling, reductions in weed populations and their impacts, and yield buffering against climatic variability would significantly reduce the need for purchased fertilizer inputs and weed control and improve agricultural sustainability."

What has been done
1. The Smith Lab (Accession 10006827) planted three annual forage crop mixtures, along with the component crops grown in monoculture. Each forage crop mixture was intended to fill one of three periods of low forage availability during the grazing seasons: early spring, mid-summer, or late fall.
2. They examined how stand management and seeding approach affect establishment success and soil-health impacts of a forage crop mixture inter-seeded into hayfields.

Results
1.Preliminary forage data suggest that 6-way summer-available mixtures of buckwheat, chickling vetch, millet, oats, sorghum, and teff are as productive as the most productive species grown in monoculture (buckwheat). The 6 way fall-available mixture mixture of canola, forage radish, oats, sunn hemp, triticale, and wheat out-yielded monocultures of canola, forage radish, sunn hemp and had total dry matter yields on par with the highest yielding monocultures (wheat and oats). Analysis of the forage quality data will be necessary to determine if quality parameters are also affected by diversity.

2. Smith lab research found that it is exceedingly difficult to establish forage crop mixtures into standing hayfields without the use of herbicides or significant soil disturbance. Based on their results it would not be appropriate to recommend these treatments to farmers, in order to increase the forage crop diversity of their fields.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems

Outcome #21

1. Outcome Measures

Improve the immunoglobulin content of dairy cattle colostrum which is used to transfer maternal immunity to newborn calves after birth.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Dairy cattle are born with a naive immune system and must receive their immunoglobulins from colostrum (the first maternal secretion from the mammary gland after the cow gives birth). Approximately 60% of the nation's newborn dairy herd fails to achieve adequate immunity (defined as 10g/L immunoglobulin G at 24 hours of age). Some of this failure may be due to dietary deficiencies of pregnant cows in the weeks before birth before they give birth.

What has been done
Improving colostrum quality and uptake of immunoglobulins by the calf is a major component the Erickson's project (Accession 1001283)
Niacin is hypothesized to increase blood flow to the mammary gland. A preliminary experiment was conducted with prepartum cows fed supplemental niacin and IgG of their colostrum was compared to that of control animals.

Results

Feeding prepartum cows 48 grams per day supplemental niacin (beginning 4 weeks before expected day of parturition) improved colostrum quality by about 18% compared to cows receiving 0 grams per day supplemental niacin (P = 0.03) indicating that niacin can increase colostrum quality. Further studies are being conducted to determine whether this improves IgG uptake in newborn calves whose dams have had niacin supplementation.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
307	Animal Management Systems

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)

Brief Explanation

UNHCE
Farmer have reported drought impacting forage crop to feed animals.
NHAES:
Late spring frosts damaged the hardy kiwiberry flowers and reduced yield in the vineyard. California fruit were brought in for a planned marketing study at fall farmer's markets. A prolonged, severe drought during the July and August in NH impacted alternative forage studies.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

UNHCE:
An electronic impact survey was sent to 220 people (30% response rate) in NH with the following results:

- **94%** of our audience **increased knowledge and awareness** of pollinator issues, threats and potential solutions.
- **99%** of respondents followed through by **implementing practices** to protect pollinators

Looking forward, we are well-positioned at the forefront of pollinator habitat education and have established collaborative relationships with many organizations and agencies in the region with shared objectives. Our networking, research and demonstration capabilities position us well to generate new information and deliver educational products to meet identified stakeholder needs.
NHAES:
Publication of peer-reviewed papers and success in obtaining external grants are typical measures of evaluating the quality of basic and applied research. The projects in this associated planned program have been highly productive, with the combined publication of 53 peer-reviewed journal articles during FY 16. The 19 projects associated with this Planned Program have leveraged Hatch and State funds by competing for more than

$1,118,256 additional funding.

Key Items of Evaluation

UNHCE:
Economic impact: 2016 highlights

- Our support to the farmer helped save about $19,000 in cucurbit spray on squash and pumpkin farms.
- As a result of Extension's IPM work, there was half percent reduction of incidence of pest injury on apples (pre-IPM) from 10 to 12% in 2015 to 5.85% in 2016.
- Apple spray savings & fruit quality increase: $170,000

NHAES:
Significant outcomes of the research of this program include:
i. Release of multiple improved varieties of summer and winter squash for both fresh local markets and for food processors;
ii. Development of new tools for Marker Assisted Breeding (MAB);

- hardy kiwiberry (a new fruit crop under development for Northern New England),
- genetic mapping of barberry, the alternative host for the important wheat rust and stem rust pathogens of cereal crops
- for breeding octoploid strawberry.

iii. Evaluation of alternative protein sources for dairy cattle feed, and improving yield and resilience of forage crops for dairy.
iv. Recommendations about best cultivars, season extension management practices for fruit and vegetable production in Northern New England. (This work comes from a NHAES researcher whose primary appointment is in Cooperative Extension: Dr. Becky Sideman)
v. First documentation of the current and changing biodiversity of non-Aphis bees in NH. Native bees are important pollinators critical to successful food production and the health of natural ecosystems.

V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Climate change and sustaining natural resources

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	0%		32%	
112	Watershed Protection and Management	20%		29%	
123	Management and Sustainability of Forest Resources	40%		0%	
124	Urban Forestry	10%		0%	
131	Alternative Uses of Land	10%		0%	
132	Weather and Climate	0%		11%	
206	Basic Plant Biology	0%		14%	
216	Integrated Pest Management Systems	10%		0%	
401	Structures, Facilities, and General Purpose Farm Supplies	0%		4%	
403	Waste Disposal, Recycling, and Reuse	0%		7%	
605	Natural Resource and Environmental Economics	10%		3%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	14.0	0.0	4.0	0.0
Actual Paid	24.0	0.0	4.4	0.0
Actual Volunteer	18.6	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
197183	0	225285	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
197183	0	305305	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1620487	0	962236	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

NHAES researchers:

• Compared new methods for assessing microbial efficiency as it impacts soil C storage and greenhouse gas emissions.
• Investigated the effects of different cropping systems, soil insects, and microbial communities on Soil Organic Matter (SOM) and soil nitrogen cycling.
• Examined climate impact on soil C cycling to improve the Community Land Model, a component of climate change assessments.
• Monitored the flux of N from agricultural, suburban and forested lands, and atmospheric N deposition as these impact the nutrient status of the Great Bay Estuary.
• Refined economic models of on-farm production of animal bedding, static-pile aerobic composting with heat extraction, and uses of the finished compost as soil amendments.

During the fiscal year 2016, Cooperative Extension carried out the following activities:

• Development of educational Information: newsletters (including e-newsletters), fact sheets, trade-magazines, journals, posters, and displays.
• Efforts to promote local seafood awareness, marketing and consumption.
• On-line/web based information: web page updates; blogs, social media (Facebook and Twitter); electronic pest alerts; developing educational visuals/videos; podcasts.
• One-on-one education: Site visits to landowners, fishermen and natural resource professionals; phone, email, video chats and walk-in clients; one-on-one assistance to develop management or business plans.
• Public Relations/marketing/communications.
• Technical Assistance to state agencies/organizations.
• Workshops, conferences, statewide Speaker's Bureau State-wide and multistate (regional) public forums, demonstrations Invited presentations.
• Write and respond to news media.

2. Brief description of the target audience

Audiences for **NHAES researchers** include agricultural producers, natural resource managers and consumers, land managers, climate change scientists, soil scientists; undergraduate and K-12 students, public policymakers, regional planners, local communities, and decision makers concerned with the magnitude of different pollution sources that impact local water quality.

Additional target audiences for UNHCE include nonindustrial private forest owners (NIPF), municipal and other forest landowners, natural resource professionals, communities, volunteers, NH forest-based industries, and the public, land owners and recreational users of New Hampshire's lakes, estuaries, rivers, and ocean beaches.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	70292	141145	4219	95

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	3	44	47

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects.

Year	Actual
2016	16

Output #2

Output Measure

- Number of graduate students directly involved in the projects.

Year	Actual
2016	9

Output #3

Output Measure

- Number of university courses in which the project results have been incorporated.

Year	Actual
2016	6

Output #4

Output Measure

- Number of presentations at regional, national, or international scientific meetings

Year	Actual
2016	45

Output #5

Output Measure

- Number of workshops, training sessions and presentations to non-scientific stakeholders

Year	Actual
2016	604

Output #6

Output Measure

- Number of websites in which research project results have been incorporated.

Year	Actual
2016	7

Output #7

Output Measure

- Number of one-on-one consultations (woodlot exams, phone calls, emails, office visits, cost share programs, forester referrals, etc.)

Year	Actual
2016	2115

Output #8

Output Measure

- Number of volunteers trained and supported: Coverts, Natural Resource Stewards, Stewardship Network volunteers and other community volunteers such as conservation commissions, etc.

Year	Actual
2016	2840

Output #9

Output Measure

- Number of annual lake reports and coastal reports published on water quality assessments from volunteer monitoring efforts

Year	Actual
2016	49

Output #10

Output Measure

- Number of towns and conservation groups provided with direct assistance regarding land and water conservation

Year	Actual
2016	57

Output #11

Output Measure

- People reached through media: press releases, newsletters, radio, TV, web, direct mailing
  Not reporting on this Output for this Annual Report

Output #12

Output Measure

- Number of postdocs trained in cutting edge research.

Year	Actual
2016	5

Output #13

Output Measure

- Research Websites views of UNH Static-pile aerobic composting facility at the Organic Dairy Research Farm https://www.youtube.com/watch?v=YNTX5vqN2Fs&feature=youtu.be and Phenology web camera data (phenocam network) for tracking changes in vegetation and other

surface properties for all four research sites:
https://phenocam.sr.unh.edu/webcam/sites/kingmanfarm/
https://phenocam.sr.unh.edu/webcam/sites/moorefields/,
https://phenocam.sr.unh.edu/webcam/sites/thompsonfarm2N/
https://phenocam.sr.unh.edu/webcam/sites/westedge/ and

Year	Actual
2016	314

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of acres of forest management plans meet or exceed NH forest stewardship standards
2	Number of volunteers in conservation work in NH communities as a result of training and continued work by UNHCE primarily in the Coverts, Stewardship Network and Natural Resource Stewards programs
3	Number of acres on which landowners develop conservation easements on in New Hampshire each year
4	Number of communities to develop action plans that include a variety of approaches for making progress in community-based natural resource protection projects.
5	Design and validate new methods for analyzing plant and microbial lipids in soil organic matter.
6	Further understanding of how global change factors impact microbial efficiency, a key determinate of soil C storage and greenhouse gas emissions.
7	Increase understanding of landscape configuration in determining the effectiveness of natural ecosystem services to attenuate N loading from agricultural versus suburban landscapes
8	Refine an integrated system for providing animal bedding using on-farm forest resources; evaluate a experimental static pile aerobic composting system for energy extraction from animal bedding and manure.Estimate costs and payback timeline for the various components of the composting system.
9	Number of Extension participants who engage with a licensed forester and/or a certified logger.
10	Number of people who report using a forest stewardship best management practice.
11	Validate the Community Land Model (CLM) for CO2 and water flux, radiation, and albedo, across agricultural, forested and suburban landscapes comparing eddy flux data to remote sensing data and modeling.
12	Identify small molecules used to establish symbiosis from various nitrogen fixing Frankia bacteria and their actinorhizal plant hosts.
13	Improving accumulation of soil organic matter
14	Evaluate the potential impacts of integrated multitrophic aquaculture (IMTA) on native seaweed vegetation.
15	Number of acres affected by best management practices adopted by landowners, natural resources, professional and communities through land management and stewardship and concervation efforts.

Outcome #1

1. Outcome Measures

Number of acres of forest management plans meet or exceed NH forest stewardship standards

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	173973

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
NH is over 80% forested with more than 2/3 of that area owned by private landowners. Having these landowners follow management plans answers long-term sustainability of the forest lands that contributes to economics and quality of life.

What has been done
Extension county field specialists meet one-on-one with landowners to discuss stewardship approaches and refer landowners to licensed forester to develop management plans.

Results
In 2016, Extension Specialists contribute to the management of 173973 acres of forest management plans that meet or exceed Hew Hampshire forest stewardship standards.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
605	Natural Resource and Environmental Economics

Outcome #2

1. Outcome Measures

Number of volunteers in conservation work in NH communities as a result of training and continued work by UNHCE primarily in the Coverts, Stewardship Network and Natural Resource Stewards programs

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1039

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Monitoring stewardship and educating people on the condition and practices for standing our important Natural Resources is a challenging task and Extension Natural Resource volunteers increase our capacity to deliver impacts accross the state.

What has been done
Lakes Lay monitoring, Natural resource steward, coverts, coastal research, volunteers and specialists for wildlife volunteers are trained by Extension to build natural resources stewardship capacity of New Hampshire communities.

Results
1039 volunteers in conservation work in NH communities as a result of training and continued work by UNHCE primarily in the Coverts, Stewardship Network and Natural Resource Stewards programs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
124	Urban Forestry
131	Alternative Uses of Land

Outcome #3

1. Outcome Measures

Number of acres on which landowners develop conservation easements on in New Hampshire each year

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Number of communities to develop action plans that include a variety of approaches for making progress in community-based natural resource protection projects.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	11

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
131	Alternative Uses of Land
605	Natural Resource and Environmental Economics

Outcome #5

1. Outcome Measures

Design and validate new methods for analyzing plant and microbial lipids in soil organic matter.

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Further understanding of how global change factors impact microbial efficiency, a key determinate of soil C storage and greenhouse gas emissions.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Soil organic matter is very important to soil health. Enormous amounts of carbon are stored in soils; carbon dioxide and methane are released from soil by microbial activity which may exacerbated by climate change and human activities.
Microbial Carbon Use Efficiency (CUE) is a critical regulator of soil organic matter dynamics and terrestrial carbon fluxes, with strong implications for soil biogeochemistry models. While ecologists increasingly appreciate the importance of CUE, its core concepts remain ambiguous: terminology is inconsistent and confusing, methods capture variable temporal and spatial scales, and the significance of many fundamental drivers remains inconclusive.

What has been done
The first activity of the Frey and Grandy labs (accessions 1003421, 1007001) was to conduct a synthesis of existing information on microbial CUE. This result is a major review paper described below.

Results
Geyer, K.M., E. Kyker-Snowman, A.S. Grandy, and S.D. Frey. 2016. Microbial carbon use efficiency: Accounting for population, community, and ecosystem-scale controls over the fate of

metabolized organic matter. Biogeochemistry DOI 10.1007/s10533-016-0191-y).
In this paper, the authors "outline the processes underlying microbial efficiency and propose a conceptual framework that structures the definition of CUE according to increasingly broad temporal and spatial drivers where (1) CUEP reflects population-scale carbon use efficiency of microbes governed by species-specific metabolic and thermodynamic constraints, (2) CUEC defines community-scale microbial efficiency as gross biomass production per unit substrate taken up over short time scales, largely excluding recycling of microbial necromass and exudates, and (3) CUEE reflects the ecosystem-scale efficiency of net microbial biomass production (growth) per unit substrate taken up as iterative breakdown and recycling of microbial products occurs. CUEE integrates all internal and extracellular constraints on CUE and hence embodies an ecosystem perspective that fully captures all drivers of microbial biomass synthesis and decay. These three definitions are distinct yet complementary, capturing the capacity for carbon storage in microbial biomass across different ecological scales. By unifying the existing concepts and terminology underlying microbial efficiency, our framework enhances data interpretation and theoretical advances."

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
131	Alternative Uses of Land

Outcome #7

1. Outcome Measures

Increase understanding of landscape configuration in determining the effectiveness of natural ecosystem services to attenuate N loading from agricultural versus suburban landscapes

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Non-point nitrogen (N) pollution is one of the factors contributing to elevated watershed N inputs and the degradation of New Hampshire's Great Bay, resulting in the Bay's classification by EPA as negatively impacted. The Wollheim project (Accession 1003833) seeks " to understand how the location of agricultural and suburban land use, in the watershed, influences the delivery of N

to surface waters and ultimately to New Hampshire's Great Bay".

What has been done

1.Members of the Wollheim lab measured nutrient concentration and water quality at 10 sites throughout the Oyster River watershed on a monthly basis and with continuous high-frequency monitoring of the Oyster River at Mill Pond.
2. E.coli concentration was measured throughout the Oyster River watershed, including headwaters with various land use types, across flow.
3."Storm event sampling took place at an agricultural site, an urban site, a forested site, and the Oyster River at Mill Pond, which integrates all three land use types, plus any transformations that occur as water flows through the river network."

Results

1. "The best way to improve estimates of annual nutrient loads in headwater catchments is not through deployment of high-frequency in situ sensors but through improved estimates of headwater discharge. However, high-frequency sensors are still invaluable for understanding differences in storm patterns and storm-scale fluxes among
different catchment types. Nutrient concentrations entering the estuary at the mouth of the river are much lower than expected based on inputs in the headwaters because of instream removal."
2. "E.coli concentration was highest in the most land use-impacted stream, College Brook, which flows into the Oyster River near Mill Pond." "E. coli flux is highly correlated with storm runoff. The loading function with land use, precipitation, and air temperature explain much of the variability in terrestrial E. coli loading."
3."During most precipitation events all headwater sites show patterns of dilution. In contrast, the mainstem of the Oyster River tends to show increases in concentrations during storms." This is attributed "to lower nitrogen removal by the river network during storm events. Total nutrient and chloride flux across individual storms was strongly correlated with total storm runoff across all land uses. However, the slope of the relationship was much steeper in the more urban sites than in the forested sites, with the mainstem of the Oyster River being intermediate.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management

Outcome #8

1. Outcome Measures

Refine an integrated system for providing animal bedding using on-farm forest resources; evaluate a experimental static pile aerobic composting system for energy extraction from animal bedding and manure.Estimate costs and payback timeline for the various components of the composting system.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Composting is a growth industry in the Northeast. As states and municipalities increase restrictions on the disposal of organic wastes in landfills, alternative methods for treating and disposing of wastes are being developed and applied. Aerated Static Pile (ASP) composting with Heat Recovery (HR) is a recently developed technology for accomplishing these goals.

What has been done
Since the initiation of operations for the UNH Aerated Static Pile/Heat Recovery Composting facility in 2013, 23 batches of manure, bedded pack and other materials generated at the farm, totaling about 3,500 cubic yards, have been processed through the facility.
The Aber lab (Accession 233560) manages the ASP composting center with Heat recovery at the Organic Dairy Research Farm.
1."In FY16 a series of energy capture studies were performed. Temperatures in the vapor streams produced by the different batches of compost were monitored continuously and heat capture from vapor streams was determined."
2."Concentrations of four gasses (CO2, Ammonia, Methane, and Oxygen) in the exhaust air was measured over the composting cycle."

Results
1. "The rate of useful heat capture (Kjoules/min) is a direct function of the difference in temperature between the vapor generated and the temperature of the water in the heat storage tank. Results provide a clearer method for estimating actual heat capture for composting systems."
2. "At initial stages of composting CO2 concentrations are greatly elevated above ambient, and range as high as 15% in the early stages of composting. After 4-5 days, the concentration stabilizes around 3% of the exhaust air stream. Ammonia concentrations are very high initially; sometimes exceeding 3000 parts per million (ppm). After the initial 4-5 day period, concentrations tend to stabilize around 300 ppm, still much above ambient. As the system remains aerobic throughout the composting process, Oxygen levels vary little from ambient, and methane levels are nearly undetectable." Therefore Static Pile Aerobic Composting of manure significantly decreases the production of the potent greenhouse gas methane.

4. Associated Knowledge Areas

KA Code	Knowledge Area
401	Structures, Facilities, and General Purpose Farm Supplies

403 Waste Disposal, Recycling, and Reuse

Outcome #9

1. Outcome Measures

Number of Extension participants who engage with a licensed forester and/or a certified logger.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	260

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
131	Alternative Uses of Land

Outcome #10

1. Outcome Measures

Number of people who report using a forest stewardship best management practice.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	391

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
216	Integrated Pest Management Systems
605	Natural Resource and Environmental Economics

Outcome #11

1. Outcome Measures

Validate the Community Land Model (CLM) for CO2 and water flux, radiation, and albedo, across agricultural, forested and suburban landscapes comparing eddy flux data to remote sensing data and modeling.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2016 0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
"Ecosystems can have a large effect on climate as they "breathe," "sweat," reflect light, and exchange heat throughout the day and night"
The overall goal of the Ollinger project (Accession 1006997) "is to measure how different landscapes in New Hampshire affect climate. Better understanding of how variation in vegetation impacts climate will improve computer models for local-scale patterns of weather."

What has been done
The impact of land management (e.g. fertilizing, watering, harvesting) was evaluated for its impact on CO2, water and heat fluxes in agricultural systems.

Results
"By combining measurements from the flux towers with biomass production and management (fertilization and harvest data) (the Ollinger project) has been able to quantify both net carbon sequestration as well as rates of usable biomass production. At the managed (cornfield and hayfield) sites, quantifying carbon added via fertilization and removed by harvest is critical for determining net ecosystem carbon exchange. Our preliminary data suggest that there may be a tradeoff between different ecosystem services (e.g. biomass production and net carbon sequestration) provided by these different land cover types. Specifically, the managed cornfield annually provides the largest amount of usable biomass (1382 g/m2/yr), followed by the hayfield (860 g/m2/yr) and mixed forest (wood production is 275 g/m2/yr), while net carbon sequestration is highest in the mixed forest (909 g C/m2/yr), followed by the hayfield (234 g C/m2/yr), and cornfield (-4 g C/m2/yr).

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
131	Alternative Uses of Land
132	Weather and Climate

Outcome #12

1. Outcome Measures

Identify small molecules used to establish symbiosis from various nitrogen fixing Frankia bacteria and their actinorhizal plant hosts.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Nitrogen fixation is the biological conversion of the gaseous dinitrogen to ammonia required for the growth of all biological organisms. Nitrogen fixation by actinorhizal plants is an important part of the nitrogen budget of the planet. Actinorhizal plants are also salt tolerant. Frankia, the primary bacterial partner of the actinorhizal symbiosis, produce many bioactive molecules. Actinorhizal symbioses also include nonFrankia bacteria. The first step to identifying small molecules used to establish actinorhizal symbioses is to develop bioassays that measure interactions between Frankia, nonFrankia actinobacteria and actinorhizal plants.

What has been done
1. To study the plant-microbe interaction between actinorhizal plants and nonFrankia actinobacteria, the Tisa lab (accession 1006507) has tested the effects of plant root exudates on the physiology of other Frankia strains. Differences in hyphal curling in these other Frankia strains differentiate various host compatibility group.
2.Two Nocardia strains BMG51109 and BMG111209 were isolated from surface sterilized root nodule of Casuarina glauca collected in Tunisia.

Results
1.The hyphal curling response was dependent on host plant root exudates and these strains were not responsive to non-host plant exudates
2.The Norcardia strains are able to decrease the time-course in nodulating the actinorhizal host plant by Frankia and to promote significantly the growth of Casuarina plants. Co-infection experiments with Nocardia and Frankia show an early onset of plant nodulation timeline compared to plants infected with Frankia alone. Co-infection also caused an increase the number of nodules present on the plants. These results indicate that the Nocardia bacteria serve as "helper" bacteria to increase plant nodulation and provide other benefits to plant health.
These new bioassays are essential to validate the isolation of small molecules that trigger interactions the establishment actinorhizal symbioses and subsequent nitrogen fixation.

4. Associated Knowledge Areas

KA Code	Knowledge Area
206	Basic Plant Biology

Outcome #13

1. Outcome Measures

Improving accumulation of soil organic matter

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Soil organic matter is intricately linked with soil health, drives nitrogen and other nutrient cycling and plant productivity, and contains twice as much carbon as the atmosphere. Restoring soil organic matter in agricultural systems is thus an essential component of sustainability, but the processes by which this is done remain uncertain.

What has been done
The Grandy lab (Accession 1007001) measured plant versus microbial contribution to the formation soil organic matter (SOM). Respective contributions to SOM were tweezed apart using stable isotope labeling and mass spectrometry.

Results
1. Soil organic matter accumulates from inputs of dead microbial cells and microbial byproducts formed when microbes eat plant roots and residues, rather than from the plants themselves. Soil organic matter accumulation is greatest when more-not less-active microbial biomass is formed. This is especially true when that biomass is produced more efficiently, meaning more of the substrate is converted to biomass rather than carbon dioxide.
2.Challenging another long-held view, this research showed that the characteristics of the microbial community are even more important for soil organic matter formation than soil type. The new research provides promise for designing agricultural systems that promote microbial communities that optimize soil organic matter formation.
3. Using field and lab experiments, the Grandy lab showed that as crop diversity increases, distinctive soil microbial communities are related to increases in soil aggregation, organic carbon and total nitrogen stocks, microbial activity, accelerated rates of nutrient cycling, and the ratio of carbon to nitrogen acquiring enzyme activities. By increasing the quantity, quality and complexity of crop residues, high diversity rotations can sustain soil biological communities, with positive effects on soil organic matter accrual, soil fertility, and crop yield.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships

Outcome #14

1. Outcome Measures

Evaluate the potential impacts of integrated multitrophic aquaculture (IMTA) on native seaweed vegetation.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
By 2012, over 50% of the fish consumed by humans are produced by aquaculture. However, fish aquaculture pens are point sources of nitrogen and phosphorous. The goal of Integrated Multitrophic Aquaculture (IMTA) is to produce fish and other seafood as in a sustainable fashion, by growing filter feeders (shellfish) and algae (which absorb nitrogen and phosphorous around fish pens. The research by Mathieson (accession 1007230) investigates how IMTA impacts native seaweed vegetation in New Hampshire.

What has been done
1.The occurrence of non-native and opportunistic seaweeds at multiple IMTA sites and contiguous "control" locations were assessed by random collections and line transect/quadrat evaluations.
2.Mathieson assisted Meegan Glenn, a graduate student of NHAES oyster researcher Grizzle, in preparing a detailed seasonal synopsis of macroalgal populations in an oyster aquaculture site.

Results
1.Four Asiatic seaweeds have recently been found abundantly near oyster aquaculture sites within the Great Bay Estuary System (i.e. within Little Bay proper), while they are less abundant at non-aquaculture sites. The four taxa include the brown alga Colpomenia peregrina plus three red algae, Dasysiphonia japonica, Gracilaria vermiculophylla, and Grateloupia turuturu). The North Pacific rhodophyte Agardhiella subulata is also a conspicuous introduced-species within these same habitats.

Initial biomass documentations confirm that D.japonica and G. vermiculophylla are the two dominant introduced taxa within the Great Bay Estuary System, while A. subulata and G. turuturu are perhaps the two most recent introductions?
2. A synopsis of algal/oyster interactions published, and will the first study of this kind for Northern New England.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management

Outcome #15

1. Outcome Measures

Number of acres affected by best management practices adopted by landowners, natural resources, professional and communities through land management and stewardship and concervation efforts.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	173973

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
605	Natural Resource and Environmental Economics

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Public Policy changes
- Government Regulations

Brief Explanation

Economy: drop in value in low grade wood market had implication typical recommended woodlot management practices.
Government regulations: Brown bat classification to endangered species impacted ability to harvest lumber during the summer months,
A severe drought in New Hampshire during the summer of 2016 broadly impacted multiple research projects.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

UNHCE
Through the Communities and Natural Resources Area of Expertise of UNH Cooperative Extension, natural resource professionals are equipped and prepared
to use appropriate and effective practices when managing natural resource based projects.
Results of the previous year's efforts include:

- 198 professionals reported an increase in capacity for climate and/or natural resource protection.
- 155 professionals reported an intention to promote or adopt a new service or practice.

NHAES:
Publication of peer-reviewed papers and success in obtaining external grants are typical measures of evaluating the quality of basic and applied research. The projects in this associated planned program have been exceptionally productive, with the combined publication of 44 peer-reviewed journal articles during FY 16. These seven projects have leveraged Hatch and State funds by competing for more than $962,236 in additional funding.

Key Items of Evaluation

A publication from Grandy's project and Frey's projects(accessions 1007001, 1003421) in FY15, Kallenbach, C.M.*, A.S. Grandy, S.D. Frey, and A. F. Diefendorf. Microbial physiology and necromass regulate agricultural soil carbon accumulation. 2015. Soil Biology & Biochemistry (SBB), 9:279-290 was featured in Our Changing Planet, US Global change Research Program annual report to Congress; It was the Top-ranked Soil Biology and Biochemistry paper for social media; top-ten most downloaded paper. This paper reports potential paradigm-changing of the means by which Soil Organic Matter accumulates.

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Supporting a Rural Economy

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
205	Plant Management Systems	0%		34%	
403	Waste Disposal, Recycling, and Reuse	0%		13%	
601	Economics of Agricultural Production and Farm Management	0%		13%	
602	Business Management, Finance, and Taxation	20%		0%	
605	Natural Resource and Environmental Economics	40%		0%	
608	Community Resource Planning and Development	40%		7%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	0%		33%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	11.0	0.0	1.9	0.0
Actual Paid	8.0	0.0	0.7	0.0
Actual Volunteer	1.1	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
136316	0	73674	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
136316	0	36788	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
311299	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

UNHCE conducted:

- Workshops and seminars
- One-on-one business consultations and technical assistance
- Twilight meetings
- Development and dissemination of business resources and publications (web and print)
- Media releases (news and radio)
- Economic development technical assistance.
- Economic development planning.
- Community planning forums/charettes.

NHAES scientists

- Conducted experiments to develop improved over-wintering techniques for large, container-grown trees and shrubs that will save labor and enhance profitability for Northeast producers.
- Documented recent demographic trends in both rural and urban areas before and during the Great Recession and compare New Hampshire demographic trends to those in the region and nation. Disseminate this knowledge to local, regional, and national policymakers.
- Used focus groups and surveys to determine consumer willingness to pay, for local and/or organic foods.
- Evaluated attitudes towards new policies to reduce municipal expenditures.
- Tested the effects that social capital infrastructure has on different measures of environmental quality. Apply the results to improve communications for local policy agencies and with the public.

2. Brief description of the target audience

NHAES research target audiences include:

Local farmers, agricultural and resource Economists, undergraduate and graduate students, citizens, urban foresters, extension educators, nursery growers, landscapers, arborists, land use professionals, homeowners, legislators, contractors, firms and rural residents, demographers, social and natural scientists as well as state and federal planners and policy-makers and the media.

UNHCE target audiences include Community leaders, municipal board/committees, community volunteers, professional community development practitioners, active community members, municipalities, regional economic development corporations, regional planning commissions, and chambers of commerce.

Farmers, fishermen, food processors, forest products businesses, tourism businesses, industry sectors, potential entrepreneurs, business service providers, greenhouse and landscape professionals.

3. How was eXtension used?

NHAES does not use eXtension directly
eXtension is an important resource base of UNHCE

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1755	116793	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	6	6	12

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of one-on-one consultations with greenhouse growers and landscape professionals

Year	Actual

2016	15

Output #2

Output Measure

- Number of communities provided with technical assistance to enhance their decision making with regard to tourism and economic development plans, projects and activities

Year	Actual
2016	36

Output #3

Output Measure

- Number of people reached through risk management and farm management workshops
  Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Number of people reached through site/farm visits related to farm and forest management

Year	Actual
2016	2500

Output #5

Output Measure

- Number of Community Profiles (community-level strategic planning program, facilitated by UNHCE professionals)

Year	Actual
2016	14

Output #6

Output Measure

- Number of presentations at regional, national, or international scientific meetings

Year	Actual
2016	9

Output #7

Output Measure

- Number of workshops, training sessions and presentations to non-scientific stakeholders

Year	Actual

2016	463

Output #8

Output Measure

- Number of reviewed, bulletin, popular, news and other publications

Year	Actual
2016	23

Output #9

Output Measure

- Number of surveys or other means of gathering information and data from participants

Year	Actual
2016	18

Output #10

Output Measure

- Number of graduate students directly involved in research project.

Year	Actual
2016	6

Output #11

Output Measure

- Number of websites in which research project results have been incorporated

Year	Actual
2016	10

Output #12

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2016	2

Output #13

Output Measure

- Number of people participating in Extension's Economic Development Academy

Year	Actual
2016	16

Output #14

Output Measure

- Number of people attending workshops/twilight meetings

Year	Actual
2016	350

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of community members who report new skills (e.g. leadership, group process, identifying resources, managing change, etc.)
2	Number of people that implement tools and resources in their communities (data anlaysis, engagement process and action plans)
3	Number of community leaders who develop a new understanding of the issues facing their community.
4	Number of NH growers who make informed decisions on production practices that result in business sustainability
5	Number of new businesses started
6	Number of presentations to civic and government entities to increase knowledge of demographics and migration in the region and nation.
7	Availability of modified production systems for woody nursery crops in northern nurseries.
8	Disseminate results from greenhouse growth trials on ornamental and alternative crops
9	Number of NH farms that develop and implement a business plan
10	Provide local producers with survey outcomes on price increments that consumer show willingness to pay for local and/or organic foods. This information will enable farmers and greenhouse producers to better target their production practices and outputs for local markets in a shifting local and regional food system.
11	Disseminate results from 1) evaluations of attitudes towards new policies to reduce municipal expenditures and 2) testing the effects that social capital infrastructure has on different measures of environmental quality.

Outcome #1

1. Outcome Measures

Number of community members who report new skills (e.g. leadership, group process, identifying resources, managing change, etc.)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	325

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
EXTENSION

Economic development has become a key theme throughout New Hampshire. Of those communities who completed Master Plans within the last 10 years across the state, all identified economic development as a priority. As New Hampshire works to regain some of the economic prosperity that it enjoyed before the great recession, many communities, like the ones in Grafton County, struggle to figure out where and how to start their economic development efforts. UNH Cooperative Extension created a program call the Business Retention and Expansion (BR&E) program to assist communities to better understanding their existing economies, connect the community with the needs of its existing business sector and to jump start their economic development efforts.

What has been done
EXTENSION

1. Organized over 60 residents into leadership Teams and task forces and educate them about the makeup of their economy and how it working.

2. Trained over 200 local residents, community and business leaders on the BR&E program and how to conduct business visits

3. Identified over 700 businesses to survey which resulted in, of three of the four communities, around 300 surveys completed.

4. Developed nine economic development projects targeted for implementation in three communities that are at the project phase (e.g. improvement of local broadband infrastructure, better signage for parking, better use of web resources to market local businesses, streamlined permitting and one-stop-shop for regulatory assistance, etc).

5. The Economic Development Academy engaged 20 professional practitioners in an intensive 8-day training with the goal of building their knowledge and skill in the use of effective economic development tools and strategies.

Results
EXTENSION

The 8-day Economic Development Academy course enhanced the skills and capacity of economic development practitioners to implement economic development programs/projects in their respective communities and regions.
Economic Impacts:
1. One participant used the information gleaned to develop a new economic development program to support communities in their regional planning district. They have provided
2. George Reagan from the NH Housing Finance Authority is using course content to engage stakeholders around the issue of affordable/workforce housing and find ways to better message the importance of workforce housing to the vitality of communities.
3. A municipal planning director embarked upon a process to institute a business retention and expansion program.
4. A municipal economic development director has streamlined permitting applications and regulatory review to be more flexible and adaptable to business needs.

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4. Associated Knowledge Areas

KA Code	Knowledge Area
602	Business Management, Finance, and Taxation
608	Community Resource Planning and Development
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #2

1. Outcome Measures

Number of people that implement tools and resources in their communities (data anlaysis, engagement process and action plans)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	222

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
605	Natural Resource and Environmental Economics
608	Community Resource Planning and Development
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #3

1. Outcome Measures

Number of community leaders who develop a new understanding of the issues facing their community.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	207

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Community leaders need accurate data in order to make sound decisions about important issues facing the community, whether they are looking to attract or retain a business, or if they are facing the sudden loss of a key employer. However, community decisions are often not grounded in good information, often resulting in financial losses, lost opportunities, negative employment impacts, and inefficient use of tax dollars, not to mention other possible human and environmental impacts.

What has been done
UNH Cooperative Extension has developed program options to help communities identify issues and needs, and understand the trends and data that speak to the issues and inform possible options for addressing them. For instance, Extension has an economic impact analysis program that helps communities explore economic and other data to identify potential economic opportunities in the community (e.g. retail trade or market potential analysis). Another program, entitled emergency economic impact analysis, helps communities explore how a sudden economic change could impact the economy, local industries, and households. These are just two programs that help to raise local leaders awareness of issues and trends.

Results
In each of the communities that Extension has worked, the Extension support always leads to the incorporation of new information into a plan. Such plans include economic development plans, Master (land use) plans, project plans, and/or strategic plans. Further, Extension supports communities in implementing these plans by working with local boards, committees, and bodies to implement the plans. In four communities Extension worked in last year, data and information on the issues resulted in streamlined regulations to allow for things like workforce housing, context-sensitive building design, and more effective permitting. In one other communities, action groups worked on projects that led to the creation of 4 new businesses, 5 jobs, and the development of 44 units of workforce housing. In yet another community, Extension?s work to raise decision-makers awareness of issues resulted in the form of a coalition to improve access to healthy food and options for active living. Outcomes include the development of ?pop-up? farm stands in low-income communities, demonstrations on how to prepare and use healthy produce, creation of a community garden, and development of a peer mentoring program. All of these projects were catalyzed as a result of local decision-makers becoming more aware of local issues and Extension resources available to help address the issues.

4. Associated Knowledge Areas

KA Code	Knowledge Area
605	Natural Resource and Environmental Economics
608	Community Resource Planning and Development

Outcome #4

1. Outcome Measures

Number of NH growers who make informed decisions on production practices that result in business sustainability

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation
605	Natural Resource and Environmental Economics

Outcome #5

1. Outcome Measures

Number of new businesses started

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation
605	Natural Resource and Environmental Economics
608	Community Resource Planning and Development

Outcome #6

1. Outcome Measures

Number of presentations to civic and government entities to increase knowledge of demographics and migration in the region and nation.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A critical goal of multi-state project, W3001 The Great Recession, its Aftermath, and Patterns of Rural and Small Town Demographics, is to analyze and disseminate information about demographic trends in the recession and post-recession period to critical policy audiences and stakeholders.

What has been done
NHAES researcher Ken Johnson (accession #231220) 1) spoke about rural and urban demographic trends in New Hampshire to NH State House-Senate Ways and Means and Finance Committees Joint Meeting in Concord, NH. The meeting was attended by approximately 100 people including the chairs of both committees, numerous committee members from both the House and Senate and policy staff and media; 2)presented a paper on delineating the rural-urban continuum that continued work I presented last year at the National Academy of Science on classifying rural areas; and 3) presented research results on Demographic Transformations in the Forested Regions of Nonmetropolitan America to USDA Forest Service staff. This presentation informs US Forest Service planners as they develop future plans for managing the national forests; 4) presented research on demographic trends in New Hampshire and New England to New Hampshire NGO Funders Meeting attended by the leaders and senior staff of most of the major non-profits in New Hampshire.

Results
1) The Great Recession reduced fertility rates in the U.S. by 8% and fertility rates have not recovered. Nearly 500,000 fewer babies are being born annually now compared to the number that would have been born had pre-recession fertility trends continued. This has serious implications for rural America which depends on natural increase(births-deaths) for much of its population increase.
2) The impact of the Great Recession had the effect of "freezing people in place". This had the effect of reducing migration and diminishing fertility gains in rural areas. The demographic implications this had for specific rural areas differed.
3) In regions with histories of rapid population increase through migration (recreational, retirement and metro fringe counties), the rate of population increase slowed because the recession reduced migration.
4) In rural areas with histories of population loss or slow growth (farm areas), the Recession slowed the rate of population loss because migration losses diminished.
5) Detailed analysis of age-specific net migration patterns in rural counties document distinct migration signatures for different types of rural counties with the sharpest contrast between rural farm counties and rural recreational counties.
6) Rural America is becoming more racially and ethnically diverse. Though the Great Recession slowed this process due to reduced migration and diminished fertility, the process is continuing. The growth of the Hispanic population has been particularly important to rural demographic change. Hispanics represented just 7.6% of the rural population in 2010, but they produced 63% of the entire rural population gain between 2000 and 2010.

4. Associated Knowledge Areas

KA Code	Knowledge Area
803	Sociological and Technological Change Affecting Individuals, Families, and

Communities

Outcome #7

1. Outcome Measures

Availability of modified production systems for woody nursery crops in northern nurseries.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Container-grown nursery crop production is on the increase, since these plants are more easily harvested, handled and sold to consumers than traditional balled-and-burlapped stock. Associated root defects in container-grown plants may negatively impact plant health and survival. Overwintering container crops is labor intensive and result in high losses. Further work is needed to better understand root cold tolerance and how it is affected by cultural and environmental factors in container-grown plants.

What has been done
NHAES researcher Cathy Neal followed tree growth from production through landscape establishment, focusing on root mass and morphology (accession #233734).
i) Her research improved lab protocols using programmed freeze tests and electrolyte leakage assays for determining more accurate root cold tolerance (RCT) thresholds.
ii) Neal and coworkers compared tree root growth and morphology, during landscape establishment as affected by pot-in-pot (PiP), fabric container (FC) and field production (F) systems, comparing transplants during establishment stages.

Results
i)Baseline RCT values were determined for ten species using excised root assays. Varieties within a species can differ significantly in root cold tolerance levels. This information can inform both breeders and producers when developing or choosing varieties.
There was no evidence that late fertilizer application made roots more susceptible to cold injury. In fact, low fertilizer status in late fall may delay root cold acclimation without changing mid-winter RCT levels.
ii)Good marketable trees were produced by each method, but field-grown trees were largest and PiP smallest at harvest.The strong radial distribution of structural roots observed in field-grown

trees is purported to be the best structure for long-term tree health.The defective PiP roots continued to enlarge, forming a solid wall of circling roots at the original container interface which would be expected to limit growth and, eventually, survival. Root pruning of PiP trees was successful and no additional defects were observed during the transplant study.Improved cultural method lead to a projected ten percent savings represents nearly $1 million to the nursery industry in northern New England,
ii)The results of outreach to landscape contractors, arborists, and producers lead to 85% reported increased in knowledge and skills in tree selection and transplanting to optimize root structure and tree health.
This will add value to ecosystem services from landscaping and reduce costs to property owners and municipalities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems

Outcome #8

1. Outcome Measures

Disseminate results from greenhouse growth trials on ornamental and alternative crops

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

Number of NH farms that develop and implement a business plan

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	22

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Only 30% of New Hampshire farmers report net income from their operations. This suggests that the majority of farms operate at a loss. While many of these net loss growers are hobby farmers, others are simply growers struggling to make sustain their operation. It is important that farm operations are working from a business plan that lays out their products, strategies, markets, marketing channels, etc.

What has been done
UNH Cooperative Extension instituted the annual Agriculture and Natural Resource Business Institute to provide agriculture and natural resource business owners/managers with the skills to manage their business. A key component of the intensive course is business planning.

Results
Each year, 15-30 people participate in the agriculture and Natural Resource Business Institute. The participants at the last institute each presented their final business plan/strategy that they plan to carry forward into their existing or future operation. While not all participants of this institute end up starting a business, those with existing businesses commit to implementing best practices learned through the institute in their operations. And a few new businesses have been developed by course participants. Skills gained from the institute include increased efficiency of operations, new products, change in their product, enhanced marketing, and greater profitability.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation

Outcome #10

1. Outcome Measures

Provide local producers with survey outcomes on price increments that consumer show willingness to pay for local and/or organic foods. This information will enable farmers and greenhouse producers to better target their production practices and outputs for local markets in a shifting local and regional food system.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Many local government and development agencies in Northern New England have been searching for industries which provide the right "fit" for their regions to replace lost jobs and stem out-migration from rural areas. Of particular interest is the potential for increased "local" food production, which has been touted by advocates as reducing economic leakages via import substitution, promoting environmental quality, and facilitating the accumulation of social capital. Specific objectives include i) measuring the premium consumers were willing to pay for organic, or local produce compared to convention produce. ii)evaluate the role of intermediate distributors of locally grown produce.

What has been done
i)NHAES researchers (accession 233237) and their collaborators have completed in-depth preliminary tests of the larger survey in New Hampshire and Massachusetts (Pyburn et al. 2016; Shi et al. 2016). These results indicate that even in relatively similar and geographically proximate states, demand functions may differ considerably.
ii).Preliminary work on intermediate distributors of locally grown produce began in summer of 2016. NHAES researchers and their collaborators conducted several dozen, in- person surveys in a pilot study, as well as site visits to several of the major operations that collect and consolidate locally grown produce and ship them to regional markets.

Results
i)The price premiums that New Hampshire residents are willing to pay for locally grown and other produce characteristics differ considerably from survey results in Massachusetts.
ii) Through these on-site interviews, NHAES researchers elicited feedback on the types of information grower's and distributors would like to have from restaurateurs and grocery stores. Combining this information with previously developed survey instruments, researchers conducted a series of face-to-face interviews with restaurateurs and grocery store managers in the seacoast area of New Hampshire.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
608	Community Resource Planning and Development

Outcome #11

1. Outcome Measures

Disseminate results from 1) evaluations of attitudes towards new policies to reduce municipal expenditures and 2) testing the effects that social capital infrastructure has on different measures of environmental quality.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A detailed examination of new means of provision of municipal services (specifically, waste management) will provide policy-makers at the state and local level with information as to whether the "single stream" method of recycling being widely publicized is more efficient than current methods.

What has been done
i)Regarding solid waste, this year NHAES researchers (accession 233237) have focused on one particularly troublesome item, single use (grocery) plastic bags. Information was collected on a variety of strategies which have been used nationwide to deal with this single use (grocery) plastic bags.
ii)a follow-up study on the potential for social capital development at local levels was initiated with colleagues in Wisconsin and the National Institute of Ireland Galway.

Results
i)Information collected on various strategies on dealing with single-use plastic bags will be distributed to local communities considering bans, deposits and other measures to control plastic waste.
ii)The follow-up study on social capital development at local levels is being analyzed.

4. Associated Knowledge Areas

KA Code	Knowledge Area
403	Waste Disposal, Recycling, and Reuse
608	Community Resource Planning and Development

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Competing Programmatic Challenges
- Other (personnel loss)

Brief Explanation

UNHCE:
Our inventory workforce development programs was challenged to find a plan to better attract the competing Canadian market

NHAES: Greenhouse specialist Brian Krug left UNH for an industrial job in spring of 2015; putting work on improving greenhouse ornamentals and alternative crops on hold until Krug's replacement was hired (in the fall of 2017).

V(I). Planned Program (Evaluation Studies)

Evaluation Results

EXTENSION
We have provided leadership, engagement, and action planning to a wide-range of community volunteers throughout New Hampshire. Our evaluation (using surveys, interviews and observations) showed that community members took early action on the economy and important community issues. We are training facilitators to broaden that impact.

NHAES:
The outcomes of research activities were evaluated via rigorous peer review of manuscripts and conference presentations, book chapters, etc.

Key Items of Evaluation

EXTENSION

- Increased in the number of community volunteers we work with from 129 to 142.
- The community volunteers we worked with donated 2478 hours of their time to improve their community.
- We worked to train volunteers who are participating on one of the 22 Action Groups we oversaw throughout the state.
- We worked with 104 community volunteers participate on a steering committee, task force or action group.
- Volunteer community leaders reported learning new skills from our staff such as facilitation, leadership, community engagement, meeting management, action planning, downtown assessment, data analysis, conducting key informant interviews and needs assessment.

NHAES: Research covered under this planned program resulted in detailed profiles for root cold thresholds for trees and woody ornamentals, for ten species and multiple cultivars. Comparisons were made for three cultural methods: pot in pot (PiP), fabric container and field production methods, on root morphology, and then tree growth following transplant (Neal accession # 2333734). New recommendations for improved cultural methods for trees and shrubs are projected to lead to ten percent savings represents nearly $1 million to the nursery industry in northern New England,

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Youth and Family

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
724	Healthy Lifestyle	25%		0%	
801	Individual and Family Resource Management	10%		0%	
802	Human Development and Family Well-Being	25%		0%	
806	Youth Development	40%		0%	
	Total	100%		0%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	20.0	0.0	0.0	0.0
Actual Paid	41.0	0.0	0.0	0.0
Actual Volunteer	60.5	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
312643	0	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
312643	0	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
2472981	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

- 4-H Youth Development staff and volunteer training (both in person and on-line)
- 4-H Youth Development projects, clubs, events, and camp (including NH Teen Council & Conference, National Congress & Conference, Barry Conservation Camp, healthy living and science projects)
- 4-H Youth Development staff and volunteer training (both in person and on-line)
- Afterschool Staff trainings - including N.H. Afterschool Professional Development Career System and Certification Process
- Marine Docent educational work with schools and groups
- Science Literacy statewide community of practice for agencies/organizations involved in this work
- Seacoast SeaPerch

2. Brief description of the target audience

Youth, ages 5-18, 4-H members and volunteers, limited resource families and children, after school program staff, health practitioners

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	225832	220	73911	267

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	0	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of volunteers supported and recognized

Year	Actual
2016	1345

Output #2

Output Measure

- Number of youth enrolled in 4-H as a 4-H club, after school or special interest group member

Year	Actual
2016	4047

Output #3

Output Measure

- Number of youth attending Barry Conservation Camp

Year	Actual
2016	270

Output #4

Output Measure

- Number of volunteers providing science literacy programming as a result of increased science literacy training.

Year	Actual
2016	140

Output #5

Output Measure

- Number of WORKSHOPS OR TRAINING FOR EDUCATORS, PROFESSIONALS, AND/OR VOLUNTEERS (includes in person or on-line program development, promotion, implementation, and evaluation.

Year	Actual
2016	376

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of enrolled 4-H members participating in STEM projects/events who show an increase in their knowledge about STEM and an increase their STEM skills
2	Number of volunteers who increase their science literacy in discreet STEM programming (pre/post survey)
3	Number of youth (4-H members or others) who show an increase in their universal life skills (e.g. teamwork & communication)
4	Number of youth attending Barry Conservation Camp who demonstrate effective practicing of life skills (e.g. teamwork & communication)
5	Number of parents and caregivers who gain knowledge of strategies and skills to promote positive parent child interactions
6	Number of organizations/collaborations who report increased awareness, knowledge or skills needed to implement effective actions and initiatives to address community needs of youth and families of vulnerable children, youth and families
7	Proportion of participants completing the Youth Mental Health First Aid course who report increased confidence in their ability to address youth mental health issues

Outcome #1

1. Outcome Measures

Number of enrolled 4-H members participating in STEM projects/events who show an increase in their knowledge about STEM and an increase their STEM skills

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	7065

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
As the world becomes more technologically advanced and scientifically complex, a science-literate citizenry and workforce 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.

What has been done
Work by Science Literacy UNHCE staff focuses on 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 during school or during out-of-school time. They feature a range of topics, including coding, sustainability, marine science, ecology, robotics, engineering, and computer science.

Results
Overall a total of 22,764 youth participated in UNH branded STEM education programs offered by UNHCE throughout the state, including life science (e.g., forestry & ecology), physical science (e.g., rocketry), engineering, and computer science.

Approximately 9,950 youth participated in STEM programs offered by Extension's Science Literacy and 4-H teams.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #2

1. Outcome Measures

Number of volunteers who increase their science literacy in discreet STEM programming (pre/post survey)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	107

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
As the world becomes more technologically advanced and scientifically complex, science-literate citizenry and work force are 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.

What has been done
Overall a total of 22,764 youth participated in UNH branded STEM education programs offered by UNHCE throughout the state, including life science (e.g., forestry & ecology), physical science (e.

g., rocketry), engineering, and computer science.

Approximately 9,950 youth participated in STEM programs offered by Extension?s Science Literacy and 4-H teams.

Results
64% of participating youth surveyed report an ability to explain scientific phenomena using evidence.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #3

1. Outcome Measures

Number of youth (4-H members or others) who show an increase in their universal life skills (e.g. teamwork & communication)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	262

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being
806	Youth Development

Outcome #4

1. Outcome Measures

Number of youth attending Barry Conservation Camp who demonstrate effective practicing of life skills (e.g. teamwork & communication)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	227

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Recent research indicates that youth are spending less time outside than ever before. A growing body of research also indicates that direct exposure to nature is essential for healthy childhood development and for the physical and emotional health of children. Barry Conservation 4-H Camp (BCC) gets kids unplugged and outdoors. It provides a non-threatening environment for youth to be active, to develop competence in life skills, to learn about and enhance their own abilities and to benefit from meaningful participation in a community designed just for them. In New Hampshire there are many youth residential camps which are American Camp Association accredited, but few focus on the combination of environmental education and positive youth development.

What has been done
UNH Cooperative Extension, 4-H youth development partners with New Hampshire Fish and Game to provide the residential environmental educational camp in the White Mountain of New Hampshire, Barry Conservation 4-H Camp. Trained and certified staff and volunteers provide week-long experiences for youth 10-17 years of age. Program focuses include fishing, shooting sports, hunter certification, basic environmental education and wilderness survival skills, plus a mini-camp experience for young campers age 8-12. Camp provides children with a community of caring adults, who nurture experiential education that results in self-respect and appreciation for human value. All of the outcomes - self-identity, self-worth, self-esteem, leadership, and self-respect - build personal competencies. These personal competencies are reflected in the four "C's" of the camp community: compassion, contribution, commitment, and character. These "Cs" of personal development mirror the positive youth development that happens in other 4 H experiences.

Results

At least 70% of the survey takers reported positive gains on each of the 15 indicators assessing program's impact.

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being
806	Youth Development

Outcome #5

1. Outcome Measures

Number of parents and caregivers who gain knowledge of strategies and skills to promote positive parent child interactions

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	283

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Parents, children, and families face an increasing variety of challenges and stressors in our times. Social/Emotional competency is crucial to a child?s success. Skills learned in early childhood impact a child's future success and increase a child's resilience, the ability to rebound from challenging circumstances. Parents and caregivers are in the position to promote social-emotional learning through everyday interactions with the children in their lives.

When a parent goes to jail or prison, there is a disruption in the family and in the life of a child. Parental separation due to incarceration has been shown to have profound impacts on children's psychological, developmental and financial well-being. Without support and services for these children, they are at risk of repeating the behavior of their parents or becoming incarcerated themselves. (Child Protection Best Practices Bulletin)

What has been done
UNH Cooperative Extension (UNHCE) collaborated with the Sullivan County Community Corrections Center (CCC) to offer parenting education programming to incarcerated parents. The Transitional Re-Entry and Inmate Life Skills (TRAILS) program of the CCC is a residential minimum security treatment center for men and women. In order to promote the skills needed for

incarcerated parents to succeed after release UNH-CE augmented the TRAILS program by offering the Parenting Inside Out (PIO) Jail edition program, created by the Oregon Social Learning Center. It is an evidence-based, cognitive-behavioral parent management skills training program created for incarcerated parents. Three, ten-week, 20-hour series were held for the Sullivan County Dept. Of corrections. Two series were run for the males and one for the females with 35 inmates participating.

Results
Of participants completing the evaluation:

64% said they increased their ability to listen to the adults in their life

79% said they increased their understanding of the child job and parent job at different stages of development

71% said they increased their ability to use emotion regulation to remain calm and in charge

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being

Outcome #6

1. Outcome Measures

Number of organizations/collaborations who report increased awareness, knowledge or skills needed to implement effective actions and initiatives to address community needs of youth and families of vulnerable children, youth and families

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Proportion of participants completing the Youth Mental Health First Aid course who report increased confidence in their ability to address youth mental health issues

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2016 9651

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Youth in our culture are experiencing an ever increasing variety of stresses and challenges related to navigating the expanse between childhood and adult life. Stressors include the social pressures of puberty, navigating high school, and for many young people and their families the struggles associated with poverty, maintaining adequate housing, and having enough to eat. These stresses are intensified by modern screen life, where the everyday experience of being a teenager plays out on the public stage of social media. In addition, adolescence is a time in a person?s life where they may experience the first indications of mental illness. In our society, there remains ambivalence and confusion about the nature of mental illness and a stigma around seeking help, support and treatment. Even when family and friends of a teen know that something is amiss, they may not know what to do or where to turn.

Mental Health First Aid was created by a nurse and a mental health scholar in Australia. It emerged from the observation that many of us when faced with a person in distress with a physical ailment such as choking in a restaurant or bleeding from a cut, know what to do because we have taken a first aid course. However, when faced with a person in distress due to a mental health concern, we are uncertain how to respond. There was a need for a course that paralleled physical first aid, but provided a framework for a layperson to respond to a mental health concern. The result was ?Mental Health First Aid? which was created and first taught in Australia. Mental Health First Aid training was brought to the United States in 2008 by the National Council for Behavioral Health. A separate course addressing the particular needs of youth experiencing a mental health concern or in crisis was created in 2011.

A goal of Youth Mental Health First Aid (YMHFA) is to reduce the negative attitudes and discrimination towards people with mental health problems.

What has been done
UNH Cooperative Extension developed a team of three trained YMHFA instructors. With an explicit focus on programs and volunteers serving out of school time, youth and those connected to UNH. The instructor team has completed 8 training sessions certifying approximately 139 YMHF Aiders. Training sessions were cosponsored by Wilton Public & Gregg Free Library, Franklin Middle School Project AWARE, COOS County 4H Youth Development Program, Grafton County 4H Youth Development Program, Belknap and Carroll County Youth Development Programs.

Results
Of the participants who completed the survey

96% stated that they were more confident that they could recognize the signs that a young person may be dealing with a mental illness

98% stated that they were more confident that they could reach out to a young person experiencing a mental illness

98% stated that they were more able to actively and compassionately listen to a young person in distress

97% stated that they Increased their ability to assist a young person who may be dealing with a mental health problem seek professional help

97% stated that they increased their ability to assist a young person who may be dealing with a mental health problem connect to appropriate community, peer, and personal supports

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Other (Data issues)

Brief Explanation

The team encountered issues in collecting data from teenagers. After sending the survey to program participants, very few were returned the evaluation document to the program team. In the future, our evaluation team will address this issue by using alternative methods to gather data to assess impact.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

"Due to difficulties reaching youth participants, we were not able to survey a meaningful proportion of participants to assess program impact. However, we assumed representativeness of the sample of youth surveyed. Then we extrapolated the number and the proportion of individuals impacted from the result of the survey. We envision new strategies to correct our data collection this year."
Youth and adult participants report satisfaction with the program or demonstrate increased knowledge in the concepts embedded in UNHCE programming for Youth and Family.

Key Items of Evaluation

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
0	Number of children and youth who reported eating more of healthy foods.
Climate Change (Outcome 1, Indicator 4)	
0	Number of new crop varieties, animal breeds, and genotypes whit climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
143	Number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources.
Global Food Security and Hunger (Outcome 2, Indicator 1)	
11	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
3	Number of viable technologies developed or modified for the detection and
Sustainable Energy (Outcome 3, Indicator 2)	
0	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
0	Tons of feedstocks delivered.