2015 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 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 FY2015 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, family, or supporting rural economies, which are widely applied by producers and citizens. Disseminating best practice, without the discovery research component, is the primary responsibility of UNHCE.
University of New Hampshire Cooperative Extension (UNHCE) has a proud history of serving the people of New Hampshire for more than a century. UNHCE provides a direct link between university resources and the people who live and work in the state. In partnership with local residents and volunteers, UNHCE plans and conducts educational programs in response to needs identified and prioritized by clientele, stakeholders, partners, UNH faculty and UNHCE staff. More than 4,000 trained volunteers including Master Gardeners, UNHCE Education Center Volunteers, Lay Lake Monitors, Marine Docents, Wildlife Coverts, Natural Resource Stewards, Coastal Research Volunteers, and 4-H Leaders. These volunteers work in their communities to extend university outreach and participate in citizen-based research and monitoring programs.
UNHCE's four program teams include Food and Agriculture, Natural Resources, Community and Economic Development and Youth and Family. In 2012, UNHCE implemented a regional model for program delivery. The four program teams are further divided into Area of Expertise (AoE) teams consisting of 4 to 7 field and state specialists who deliver educational programs to various audiences throughout the state. This model based on the regional use of specialized program staff gives UNHCE flexibility in developing new teams when needs of our clientele change, encourages non-Extension faculty involvement and has resulted in substantially greater economic, environmental and social impacts.
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 biological 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 facilities the 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 include:

- Research by the Sower (#1003341) and Berlinsky (#226010) labs has led to the isolation of genes for two Gonadotropin-releasing peptide hormones from Black Sea Bass (Centropristis striata). These hormones play an important role in reproductive sex change in the protogynous (female to male) fish.

Black Sea Bass are high-value fish, and thus targets for raising in recirculating aquaculture systems. The ability to control sexual development in Black Sea Bass will eventually contribute to management advances in this commercially important fish.

• Genomic research lead by Whistler (#1004199) has identified differences between benign and pathogenic of Vibrio parahaemolyticus. These bacteria are common members of the marine environment; the pathogenic strains are thought to be responsible to for more than 45,000 foodborne infections each year. The Whistler lab has identified five pathogenic strains of Vibrio parahaemolyticus, from clinical isolates provided by Health Departments in Massachusetts. Based whole genome comparisons, the Whistler lab now knows which strain types have caused regional infections. Whistler and her colleagues have developed the capacity for not only identification/ trace-back of these pathogenic strains but rapid enumeration from environmental samples using quantitative polymerase chain reaction (PCR) and Most Probable Number (MPN) methods approved by the Food and Drug Agency (FDA).

• Barberries (Berberis spp.) have been shown to function as the alternate host to stem rust and stripe rust, two of the most devastating fungal diseases of small grains like wheat and barley. Barberries (B. vulgaris) are naturalized in New England, and Japanese barberry (B. thunbergii) has been introduced as an ornamental. These barberries now pose an unknown threat in facilitating wheat rust evolution as momentum builds for reviving small grain production in New England region. The Hale lab (#233561) has used genome by sequencing (GBS) and has improved a bioinformatic "pipeline" to identify molecular markers for genetic mapping in Berberis spp. for "orphan" species (e.g. without a reference genome.) Using a hybrid population of B. x ottawensis (B. vulgaris X B. thunbergii, from Lime Connecticut), the Hale lab has identified a gene region in Japanese barberry highly associated with resistance to wheat rust (Puccinia graminis f. sp. tritici, Pgt). These genetic tools will speed the understanding of the molecular basis of barberry resistance to Pgt and potentially lead the way to new approaches to breeding rust-resistant wheat.

Dairy and nursery/floriculture account for the two largest farm sectors in New Hampshire. NHAES supports these agricultural sectors with research to improve forage and cow nutrition, calf health and development, dairy cow fertility, overwintering of nursery stock, energy efficiency for greenhouses, and winter greens production in greenhouses during the shoulder seasons for the floriculture industry. Examples of these research activities include:

• The Erickson lab (#1001283) developed a more accurate to estimate neonatal calf blood plasma volume, which is essential to determine the amount of antibodies absorbed from colostrum. These antibodies (IgGs) serve as the calf's initial immune system. Recent studies estimate 60% of the United States newborn dairy herd fails to take up adequate antibodies, leaving developing calves to susceptible to infection and resulting in slower growth rates and ultimately less milk production. The new method from Erickson's lab to measure plasma volume will be valuable to researchers who are seeking to improve calf IgG absorption from colostrum.

• A pilot study by Krug (#1004331) and Ben Luce from Lyndon State College Vermont, demonstrated that heat pump reduced the oil consumption of a warm greenhouse in New Hampshire by nearly 45% during February through April. If the redelivery of heat is accomplished in a passive, low energy manner such as bed heating, this approach should be an effective mean to significantly reduce heating fuel consumption in cold season greenhouses, especially during the sunnier shoulder seasons.

• Root cold tolerance (RCT) studies conducted by Neal (#233734) were used to compare the sensitivity of eight different nursery shrubs and trees, maintained under different overwintering conditions. The information generated can be adopted by nurseries by segregating more tolerant versus less tolerant species which may require different overwinter conditions.

Since the Great Recession, the number of farms in New Hampshire has held steady at about 4,400,

bucking the continued loss of farm numbers and acreage. The vast majority of New Hampshire farms are small diversified family farms with women representing more than 30% of the operators. NHAES conducts research to support the financial bottom line of small diversified farms. Examples include:

• Halstead (#233237) is part of Hatch Multistate project to assess consumer attitudes about local produce, particularly their willingness to pay a premium for local/organically grown products. Results of focus group/survey efforts demonstrating the premium consumers are willing to pay for produce characteristics such as locally grown, organically grown, and appearance. For example, consumers in the study were found to be willing to pay 55% more for a locally grown cucumber than a non-local cucumber. The local premium appears much more important than the organic premium.

• Vegetable and berry growers in New Hampshire face several unique challenges. The humid climate favors disease and insect pressures. The short growing season creates a small window of opportunity to grow crops each season. High land values and labor costs pose economic challenges. Despite this, **direct markets** such as roadside farm stands, farmers' markets and community-supported-agriculture (CSA) sales models **account for the overwhelming majority of fresh produce sales in New Hampshire**. Sideman(#228522) and her students evaluate horticultural characteristics of Brussel sprout cultivars and topping (removing the apical meristem); they found that topping can improve marketable yield and that cultivars vary in characteristics impacting production success. Detailed recommendations have been prepared for growers.https://extension.unh.edu/resources/files/Resource003914_Rep5563.pdf

• Sideman and her students also have developed an innovative overwinter production method for onions, planted in the fall, and grown with a single layer of rowcover. This system permits the harvest of onions in late May, several weeks earlier than would be possible with traditional spring planting.

• J.Brent Loy (# 233554, #23556) building on a five-decade breeding program for cucurbits, has released nine new varieties of melons, squash, snack seed pumpkins and ornamental pumpkins. Some of his hybrid squash proved to be excellent rootstock for grafted melons, by growing under cooler soil temperatures and providing resistance to late-season wilt. Loy's cucurbit varieties continue as one of the top royalty earners for the University of New Hampshire.

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 75 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 19 undergraduate and 8 graduate students. The Fairchild Dairy Teaching and Research Center, a conventional dairy, also has two farm managers who are assisted by 29 undergraduates workers plus the 25 students in 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 has a manager and herdsman, and 32 undergraduates who help manage animals, milking, feeding, etc. Finally, the Macfarlane Research Greenhouses are run by two full-time employees and 22 undergraduates. In addition to the agricultural facilities, virtually every NHAES project includes undergraduates in laboratory 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 FY2015, 20 percent of funding was from federal capacity funds, 23 percent was from state appropriations and 57 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 FY2015 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 Ecology Letters, PLoS one, and top disciplinary journals including the J. of Animal

Science, Endocrinology, and The Plant Genome.

The NHAES communications and information coordinator, Lori Gula Wright, has substantially improved the profile of the NHAES in the state, and region with press releases and weekly direct email bulletins promoting NHAES research and events reach more than 700 subscribers, including producers, policy makers, and industry representatives. Traditional statewide news media (newspapers, radio, and TV) and trade agricultural media regularly cover NHAES research.Many of her press releases are picked up by local, regional, national and international venues (ABC News, Washington Post, WMUR, NHPR, Portsmouth Herald, Morning Ag Clip, The Atlantic, Floral Daily, HortiDaily).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. I In addition, NHAES research news is regularly publicized by the USDA,Ag is America and UNH Cooperative Extension via social media, and the NH Department Agriculture, Markets & Food and the NH Farm Bureau via newsletters. In the reporting period, NHAES saw a 70 percent increase in page likes (people who follow our Facebook page and want to receive our research news). Nearly 61,000 people engaged with our NHAES Facebook page in this period, meaning they clicked on a story on our page or engaged with the page in some other way. NHAES Facebook content reached more than half a million Facebook users (537,000) during this period, meaning they saw it in their news feed or on a friend's page.
NHAES also has seen a dramatic increase traffic to its website. In the current reporting period, the NHAES website logged nearly 51,500 page views, compared with about 33,000 the prior year, and about 23,000 two years ago. This represents a 56 percent increase in web engagement from FY2014 to FY2015 and a 125 percent increase from FY2013 to FY2015. NHAES research often is featured on high-traffic UNH websites such as the UNH Home Page and direct email releases, including UNH Today, which reaches 80,000 influencers weekly. The NHAES office contributes regularly to "America is Ag" and to the Land-Grant Impacts database website.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	75.0	{No Data Entered}	22.0	{No Data Entered}
Actual	107.0	0.0	27.4	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

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.

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 Director or NHAES 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 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 non-traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals
- Targeted invitation to selected individuals from general public
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- 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 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 sought stakeholder input on activities and priorities using a variety of activities.
NHAES sponsored several public presentations and meetings, with traditional and nontraditional stakeholders, both as individuals and groups. These provide opportunities for direct interactions between stakeholders, researchers, and NHAES administrators. This year events included a tripartite research field day at the Woodman Horticultural Research Farm (sponsored jointly with UNHCE) which included activities for the general public to celebrate pollinator appreciation day, research presentations, and a twilight workshop on landscaping for pollinators. There was a research field day at the Organic Dairy Research Farm, which showcased innovations in dairy forage and supplement rations, reproductive cell biology of dairy cows and research on the agricultural ecosystem on topics including controlling nitrogen run-off and using aerobic composting to capture energy used to preheat water for dairy parlor sanitation. Research Field days are advertised to appropriate agricultural sectors, both by direct email, press releases and through the NH Weekly Market Bulletin, published by Department of Agriculture, Markets and Food, and the NH Farm Bureau weekly newsletter. .
There were annual popular open house events at several facilities: the Poinsettia Trials in December at the Macfarlane Research Greenhouses and the April Greenhouse Open House, attracting 2800 members of the public each year. Granite State Dairy Open Barn Days are popular events at the Fairchild Dairy, attracting more than 600 visitors in June.
The NHAES also holds an education session at the New Hampshire Farm and Forest Expo and hosts a booth in the Exhibition Hall. Farm managers, graduate students, and faculty help with the booth and are able to respond to directly to stakeholders. The NHAES Director attends meetings of the New Hampshire Farm Bureau, Stakeholders who contact the NHAES office with questions, or comments receive quick responses.

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 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 has an external advisory committee whose members represent various sectors of the agricultural community in the state. The advisory committee meets annually on campus, usually in conjunction with research field day. The NHAES Director, Faculty Fellow and Communications Coordinator meet members of the advisory committee at various events across the state, over the year.

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.

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.
The NHAES Director and members of the NHAES administrative office identify individuals and groups from state and regional agricultural sector organizations. Input is collected from one on one conversations at a variety of state-wide and regional events and, with individual growers groups events,

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.

The UNHCE uses input from council members and staff to identify important community members who can support our effort as new council members. The roles for council members include but are not limited to the following: advocacy on behalf of Extension, hiring/performance review of local staff, budget requests and program priorities.
NHAES interacts with stakeholders to identify ongoing and new challenges to the agriculture 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

In 2014 as well as 2015, UNHCE stakeholders also include county and state decision makers request that we provide evidence of impact, often as economic impact.
There are regional, national and international concerns about pollinator health and pollinators critical role in agricultural productivity. It has been very timely that the College of Life Science and Agriculture, and NHAES were able to recruit an expert in bee taxonomy, and ecology two years ago.This new expertise has resulted in the first characterization of the status of native bee

populations in the state and region.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
1765047	0	1872820	0

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	1400479	0	1921333	0
Actual Matching	1400479	0	2224571	0
Actual All Other	5322097	0	483	0
Total Actual Expended	8123055	0	4146387	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	521970	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	50%		0%	
704	Nutrition and Hunger in the Population	50%		0%	
	Total	100%		0%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	11.0	0.0	0.3	0.0
Actual Paid	16.0	0.0	0.0	0.0
Actual Volunteer	2.7	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.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1225	0	7140	0

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

Patent Applications Submitted

Year: 2015

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	0	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects
  Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Number of university courses in which project results have been incorporated
  Not reporting on this Output for this Annual Report

Output #3

Output Measure

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

Year	Actual
2015	0

Output #4

Output Measure

- Number of surveys or other means of gathering information and data from participants
  Not reporting on this Output for this Annual Report

Output #5

Output Measure

- Number of reviewed, bulletin, popular and other publications
  Not reporting on this Output for this Annual Report

Output #6

Output Measure

- Number of websites in which project results have been incorporated

Year	Actual
2015	0

Output #7

Output Measure

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

Year	Actual
2015	1225

Output #8

Output Measure

- Number of youth participating in nutrition programming through Nutrition Connections

Year	Actual
2015	0

Output #9

Output Measure

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

Year	Actual
2015	200

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	In collaboration with other SAES, develop a Healthy Campus Index and assess participating institutions.
2	Number of graduate students involved and trained in engagement research.
3	Number of participants who report an increase in their physical activity
4	Number of youth who learn how to choose foods according to the Pyramid and Dietary Guidelines
5	Number of participants who report eating nearer to the recommended number of cup equivalents from the Fruits and Vegetable Group

Outcome #1

1. Outcome Measures

In collaboration with other SAES, develop a Healthy Campus Index and assess participating institutions.

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Number of graduate students involved and trained in engagement research.

Not Reporting on this Outcome Measure

Outcome #3

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
2015	621

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. Myths and unreliable sources of information abound. New Hampshire's (NH) 2012 Behavioral Risk Factor Surveillance Survey (BRFSS) shows 34.8 % adults are overweight and 27.3 % are obese. (1) Data from a telephone survey of SNAP recipients in 2012 shows, 24% are overweight or obese (35%). (2) Coos, Grafton, Cheshire, Merrimack and Rockingham Counties have higher rates of obesity within NH. (3) A survey of third graders in NH showed that 33.4% of third graders were overweight or obese. (4) BRFSS data from 2009 show that 27.9% of NH residents eat fruits and

vegetables five or more times per day and 72.1% do not. (5) Data reveal that for SNAP recipients, 16% ate five or more servings of fruits and vegetables each day and 18% do not eat any daily servings. Cost is the most frequently cited reason among all recipients (40%) as the primary barrier preventing them from eating a more nutritious diet. (2) Data for intake of whole grains is very limited, however, a study in 2005 found only 7% of adults met the 2005 recommendations for whole grains. (6) BRFSS data for 2011 show 56.1% of adults engage in 150 minutes or more aerobic activity per week and 43.9% do not. Providing 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

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior

Outcome #4

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
2015	541

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

Outcome #5

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
2015	763

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

- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)
- Other (Certain research projects were dropped from the portfolio, hence we did not track some of the outcomes and output originally planned.)

Brief Explanation

Certain NHAES researchers changed their research activities and were no longer involved in the Childhood Obesity Planned program.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Five hundred and eighty-one adults (581) 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:

- 69% (180 of 261) of adults reported an increase in healthier food choices
- 42.6% (58 of 136) of adults reported an increase in physical activity

Seven thousand, one hundred and forty youth (7,140) participated in a series of lessons. Of those completing a pre/post survey related to nutrition and physical activity behaviors, significant impacts included:

- 29.6% (763 of 2579) of youth reported an increase in healthier food choices; grades 3-8
- 23.8% (541 of 2273) of youth improved their knowledge of healthier foods, grades K-2
- 27% (621 of 2287) of youth reported an increase in physical activity, grades 3-12
- 20.3% (482 of 2380) of youth reported a decrease in sedentary behavior, grades 3-12

Key Items of Evaluation

- To respond to the educational needs of silage corn growers, Cooperative Extension specialists conducted field meetings, workshops, and a forage trial sponsored by a NRCS Conservation Innovation Grant. As a result of these efforts, the number of farms who use cover crops has increased. According to NRCS there were 3,400 acres signed up for their aerial seeding program for establishing cover crops in 2015, more than three times the 1100 acres signed up in 2014 and most of it on field corn.

- A multi-disciplinary team of Cooperative Extension state and field specialists designed programming to assist farmers in meeting Food Safety Modernization Act rules. This

programming will be launched in 2016.

• In 2015, the Youth and Family program trained 1142 educators across the state in youth mental health first aid, STEM education, mindful in education and youth development.

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
133	Pollution Prevention and Mitigation	0%		4%	
135	Aquatic and Terrestrial Wildlife	0%		21%	
212	Pathogens and Nematodes Affecting Plants	0%		8%	
215	Biological Control of Pests Affecting Plants	0%		7%	
311	Animal Diseases	0%		10%	
501	New and Improved Food Processing Technologies	20%		7%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources	40%		0%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	40%		35%	
723	Hazards to Human Health and Safety	0%		8%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	3.0	0.0	3.2	0.0
Actual Paid	3.1	0.0	2.7	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**
115542	0	165535	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
115542	0	154874	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
67741	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Cooperative Extension food safety programs:

- SAFE (Safety Awareness in the Food Environment)
- Programs ServSafe® Preserving Your Harvest - The Basics of Safe Food Preservation
- Food Safety from Farm and Garden to Preschool Food Safety for Poultry and Rabbit Processors
- Serving It Safe - Food Safety for School Foodservice Employees
- Food Safety Modernization Act - NH Task Force Meetings
- Food Preservation workshops
- Training Master Gardeners to answer food safety/food preservation questions
- Single session food safety programs
- Food safety and food preservation displays and pressure gauge testing
- Nutrition Connection food safety education
- Regional foodservice programs

----------NHAES ----------

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

- Using experimental evolution to identify the suites of adaptations that occur as Pseudomonas sp. to form symbiotic or pathogenic biofilms;
- Developing, refining, and applying methods for the detection and enumeration of Vibrio parahaemolyticus and Vibrio vulnificus;
- Design new methods to distinguish between benign and pathogenic strains of Vibrio parahaemolyticus and Vibrio vulnificus;
- Evaluating, through a variety of means, how microcystins 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: Food handlers at restaurants, schools, health facilities and farms and the general public.

----------NHAES----------

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

• For bacterial biofilms, the targeted audience is peer researchers, students, and ultimately agricultural producers concerned with the role of Pseudomonas in crop or animal productivity and disease.
• For Vibrio pathogens in shellfish, the targeted audience includes the shellfish industry and shellfish regulatory agencies, graduate and undergraduate students, high school students, faculty collaborators, and other scientists.
• For microcystins from cyanobacterial blooms, the target audience is students (college and pre-college), scientists, lake shore residents, lake association members, local and regional decision makers, source water protection and watershed managers, suppliers of surface drinking water , and public health and environmental agencies.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	525	1100	1	0

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

Patent Applications Submitted

Year:	2015
Actual:	1

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	0	10	10

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

● Number of people who participate in ServSafe workshops

Year	Actual
2015	239

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
2015	425

Output #3

Output Measure

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

Year	Actual
2015	1189

Output #4

Output Measure

- Number of undergraduate students directly involved in the research projects

Year	Actual
2015	18

Output #5

Output Measure

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

Year	Actual
2015	4

Output #6

Output Measure

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

Year	Actual
2015	23

Output #7

Output Measure

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

stakeholders

Year	Actual
2015	99

Output #8

Output Measure

- Number of graduate students directly involved in the research.

Year	Actual
2015	5

Output #9

Output Measure

- Number of reviewed, bulletin, popular and other publications

Year	Actual
2015	14

Output #10

Output Measure

- Number of websites in which project results have been incorporated

Year	Actual
2015	12

Output #11

Output Measure

- Number of surveys or other means of gathering information and data from participants
  Not reporting on this Output for this Annual Report

Output #12

Output Measure

- Postdoc and other scientists trained in cutting edge research method

Year	Actual
2015	1

Output #13

Output Measure

- Number of times research advances were covered in the popular or scientific press or on news programs

Year	Actual
2015	10

Output #14

Output Measure

- A simple, web-based identification guide was developed for common species of toxic cyanobacteria in New England. http://cfb.unh.edu/CyanoKe/indexCyanoQuickGuide.html This taxonomic key is being used to train state agencies and citizens interested in confirming the presence of toxic cyanobacteria in lakes, irrigation ponds, and water supplies

Year	Actual
2015	2796

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	Increased knowledge about mechanisms of biofilm adaptation and diversification in pathogens and symbionts.
6	Knowledge about the changes in Vibrio genomes, which cause transitions to virulence;
7	Understanding of how microcystin toxins spread from lakes to the terrestrial food chain

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
2015	201

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 out of 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
UNH Cooperative Extension's (UNH CE) food safety programming targets each sector of the food system: producers, processors, food service, and consumers. Extension Field Specialists implement ServSafe programming statewide.

Results
239 food managers/workers were administered the ServSafe® examination and/or participated in ServSafe® programs. 201 participants (84%) passed the examination with a score of 75% or greater.

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
2015	953

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 out of 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
76 SAFE programs were conducted reaching 1189 food workers in NH. Two Serving It Safe programs for school food service workers reached 64 employees.

Results
1027 post-workshop questionnaires were received. 953 participants (93%) scored 75% or greater on the post-workshop knowledge questionnaire.

SAFE program participants were asked to identify at least one change they planned to make in their food handling practices as a result of attending the program. The most frequently cited food handling practices category was personal hygiene, for example, washing hands and wearing gloves. The second most frequently cited category was time and temperature practices followed by preventing cross contamination. When asked to describe the strength of their intention to implement these practices, 96% answered that it was somewhat to very likely that they would make the change.

For Serving It Safe, 54/60 (90%) completing the post-workshop questionnaire scored 75% or greater.

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Contamination of local shellfish by Vibrio parahaemolyticus is increasingly becoming a problem for growers and consumers. Even a few reported cases can have a cumulative and devastating effect on this growing industry. Effective shellfish management requires a better ability to detect and predict pathogen populations in growing areas.

What has been done
1. Advanced genomic methods were used to analyze the pathogens causing infections in the region and identify the unique genetic attributes of these strains. PCR-based assays were developed for each of the five major pathogen types known to occur in local shellfish. These genetic attributes were further utilized for development of a sensitive and quantitative detection assay.
2. Post-harvest relay was refined reduce Vibrio contamination of shellfish. Trends in Vibrio and non-Vibrio bacterial taxa in oysters during the relay process have been tracked using metagenomic analysis through the high-throughput DNA sequencing.
3. Post-harvest relay methods have been refined to reduce Vibrio levels in oysters. Trends in Vibrio and non-Vibrio bacterial taxa in oysters during the relay process have been tracked using metagenomic analysis through the Illumina platform. The bacterial sequence data were analyzed using high throughput sequence analysis software to show which bacteria taxa increase when pathogenic Vibrio species decrease, and thus may be involved in competitive exclusion of

pathogenic Vibrio species during the relay process.

Results
1.Through the 2015 summer oyster harvest season, these detection assays were applied to samples harvested from several commercial oyster growing areas, and aided in the trace-back of contaminated shellfish during an outbreak and harvest closure. These assays improved the timely response of shellfish managers in reducing infections.
2.The overall results suggest that relay can be 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. Various bacteria were identified from oyster and estuarine water samples which were shown to interact to either impede the growth of Vibrio parahaemolyticus or enhance the growth of the pathogen.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
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
2015	7

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Commercial shellfish harvesting and public health are being threatened by the emerging incidence of illness caused by Vibrio, a group or potentially pathogenic bacterial species, in consumers of shellfish from the Northeastern United States. Where New England states with colder coastal ecosystems had rare disease occurrence in the past, recent increases in disease incidence has triggered increased harvest management and monitoring efforts for industry and

public health agencies that have increased costs to both groups.

What has been done

The Jones' laboratory (#233555) has worked directly with shellfish industry, conducting research with Spinney Creek Shellfish Inc. of Eliot ME, Island Creek Oysters of Duxbury MA, and several other NH and CT oyster farmers. The Jones' lab has also engaged industry, often in collaboration with extension specialists, indirectly through small meetings with CT, MA, ME and NH growers and other industry groups, and in larger joint meetings with regulatory agencies and at science-industry-regulatory agency seminars and conferences, including the International Conference on Molluscan Shellfish Sanitation (ICMSS) in Puerto Varas Chile in March 2015 and the Northeast Aquaculture Conference and Exposition (NACE) in Portland, ME in January 2015, the Regional Vibrio Forecasting Workshop in CT in November 2015, NH Shellfish growers and regulators annual meeting in January 2016, the Milford Aquaculture Seminar in CT in January 2016, and the tri-annual World Aquaculture Society/National Shellfisheries Association meeting in NV in February 2016. We have also forged successful collaborations with public health and resource state agencies in NH, MA, ME and CT.

Results

The Jones' lab interactions include small group and medium-size seminar meetings with agency personnel interested in our approaches for detection of total populations and pathogenic strains of Vibrio species, our strategies for post-harvest treatment to reduce Vibrio levels, and working together to design effective monitoring and research studies to develop the capacity for forecasting risk conditions related to pathogenic Vibrio populations for shellfish harvest management.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
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

Increased knowledge about mechanisms of biofilm adaptation and diversification in pathogens and symbionts.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Microbes form biofilms, aggregates of cells in extracellular matrixes, interacting with diverse hosts in natural environments. The goals of this research are to better understand the evolutionary adaptations in the formation of biofilms of bacteria: Pseudomonas aeruginosa that are ubiquitous opportunistic pathogens and Pseudomonas fluorescens, a biological control agent of fungal pathogens of crop plants.

What has been done
Genome sequencing of both clones and populations to identify the mutations under selection in the lifecycle of biofilms. These include mechanisms affecting bacterial motility, attachment, metabolism of the stick-or-swim switch, cyclic-di-GMP, and polysaccharide production.

Results
These mutations were shared between both pathogenic and beneficial Pseudomonads. Future work will be required to link these mutations to ecological function more precisely.

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Pathogens and Nematodes Affecting Plants
215	Biological Control of Pests Affecting Plants
311	Animal Diseases

Outcome #6

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 Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual

2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Contamination of local shellfish by Vibrio parahaemolyticus is increasingly becoming a problem for growers and consumers. Benign and virulent strains of Vibrio coexist in marine habitats although the relative proportions of strains vary throughout the summer. Rapid detection methods are critically needed to improve shellfish management and protect consumers.

What has been done
This research analyzed the pathogens causing infections in the region and identified the unique genetic attributes of these strains. We then developed PCR-based detection assays for each of the five major pathogen types known to occur in local shellfish. These genetic attributes were further utilized for development of a sensitive and quantitative detection assay.

Results
Through the summer of 2015 oyster harvest season, these detection assays were applied to samples harvested from several commercial oyster growing areas, and aided in the trace-back of contaminated shellfish during an outbreak and harvest closure. These assays improved the timely response of shellfish managers in reducing 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 #7

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Recent evidence indicates toxins produced by aquatic cyanobacteria from harmful agal blooms (HCBs) are linked deaths of domestic animals and to a wide array of human diseases including liver tumors and amyotrophic lateral sclerosis (ALS) or Lou Gehrig's disease.The primary objective of this study was to examine the transfer of microcystins, toxins produced by most HCBs, both within the lakes and ponds and their potential routes of exposure to humans, domestic animals and wildlife. The focus is on microcystins(MCs) since these liver toxins are widely regarded as some of the most serious and widespread group of cyanobacteria toxins.

What has been done
Levels of microcystins were measured in: lake sediments, the water column, phytoplankton, fresh-water mussels, fish, waterfowl, aerosols and in crops irrigated with water from a lake that frequently experiences blooms of cyanobacteria.
A new method was developed for measuring cyanobacteria and their toxins in aerosols released by lakes.

Results
1.MC levels in the lake sediments were generally more than an order of magnitude greater than in the water column, suggesting that cyanotoxins are a concern for NH lakes.
2.High concentrations of MCs were measured in both the phytoplankton and zooplankton, indicating the potential for biomagnification at higher levels in the lake food chain, such as in fish, thereby representing a potential source of toxins for humans and animals.
3. There is significant bioaccumulation of MC in filter feeding freshwater mussels, and in fish and loons. MC may be contributing to the recent disappearance of the Common Loon from lakes.
4. Lakes subject to HCBs produce aerosols containing MC and cyanobacteria. This work also indicates aerosols are a potentially important novel pathway for toxins to move from water bodies to crops, an area of research.
5. MCs were detected in lettuce that was irrigated with water from a lake that frequently experiences blooms of cyanobacteria. Similarly, moderate to high levels of MCs were found in blueberries grown near a lake with persistent cyanobacteria blooms. These findings indicate that growers need to be informed about the importance of monitoring cyanobacteria levels grown near contaminated lakes or irrigated with pond water.
6. New methods for detecting cyanobacteria have been disseminated via US EPA workshops to enhance a citizen monitoring program in New England.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Other (One of the project directors in this planned program moved to another institution early in the summer of 201

Brief Explanation

The progress in studies of how plant pathogenic microbes evolve and adapt as they develop biofilms was halted when by the departure of a key research group (# 226672).

V(I). Planned Program (Evaluation Studies)

Evaluation Results

After implementation of the statewide ServSafe® program, our assessment showed that 84% of the participants passed the examination with a score of 75% or greater.
The progress of NHAES research was deemed to be successful from the a strong record of peer-reviewed publication and leveraging of NHAES funding with competitive external funding.

Key Items of Evaluation

.NHAES:

- Patent application 62/128,764 Methods and compositions for identifying pathogenic Vibrio parahaemolyticus.
- Demonstration that in lake with harmful cyanobacterial blooms, microcystin toxins (MCs) bioaccumulate in lake sediments, in filter feeders, in fish and water foul and in nearby terrestrial habitats including in irrigated fruits and vegetables.

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%		1%	
133	Pollution Prevention and Mitigation	0%		4%	
136	Conservation of Biological Diversity	0%		3%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		7%	
202	Plant Genetic Resources	0%		6%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%		7%	
204	Plant Product Quality and Utility (Preharvest)	0%		6%	
205	Plant Management Systems	10%		4%	
211	Insects, Mites, and Other Arthropods Affecting Plants	10%		0%	
212	Pathogens and Nematodes Affecting Plants	15%		9%	
213	Weeds Affecting Plants	5%		5%	
216	Integrated Pest Management Systems	15%		0%	
301	Reproductive Performance of Animals	15%		15%	
302	Nutrient Utilization in Animals	15%		9%	
304	Animal Genome	0%		2%	
305	Animal Physiological Processes	0%		9%	
307	Animal Management Systems	5%		9%	
315	Animal Welfare/Well-Being and Protection	5%		0%	
502	New and Improved Food Products	0%		3%	
503	Quality Maintenance in Storing and Marketing Food Products	0%		1%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	10.0	0.0	12.0	0.0
Actual Paid	22.5	0.0	19.7	0.0
Actual Volunteer	259.0	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**
577217	0	1272081	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
577217	0	1564572	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
940386	0	483	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

UNHCE
Research activities

- Applied research
- Fields trials
- Publication of research

Educational Information

- Newsletters Fact sheets NE Vegetable & Small Fruit, Greenhouse Guides Public awareness activity/materials Pictorial "field manuals" for teaching Trade-magazines, journals, posters, displays Books
- Web based information: blogs, social media Fruit Pest Update/Hotline Electronic pest alerts NH Grower Listserv Developing educational visuals/videos; podcasts Developing web tools - grower calculators, mobile apps, ebooks
- One-on-one education
- Site visits Phone, email, video chats and walk-in clients One-on-one assistance to develop management or business plans
- Diagnostic/ID services

Workshops and Conferences Attendance

- Workshop series
- Annual Grower Association meetings
- Statewide Speaker's Bureau
- State-wide and multistate
- Public forums Demonstrations
- Invited presentations

Support Activities

• Series of workshops and/or webinars, individual consultations and resource referrals for food entrepreneurs, including sessions on Hazard Analysis Critical Control Point (HACCP)
• Good Agricultural Practices (GAP) Workshops
• Volunteer Training
• support and management Master Gardener Natural Resource Stewards
Monitoring/scouting and sharing pest data with stakeholders and other NE states

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Cooperative Extension

• Newsletters, fact sheets NE Vegetable Pest Management Guide, Greenhouse Pest Management Guide
• Public awareness activities/displays, trade-magazines and newsletters
• Web-based information including electronic newsletters, news releases, social media, Fruit Pest Phone Line, vegetable and fruit pest alerts emailed to NH Grower Listserv, educational videos, apps for greenhouse growers (fertilizer, plant growth regular and pesticide calculations), hybrid course (online and in-person), UNH Cooperative Extension website extension.unh.edu
• One-on-one education through site visits, phone, email, video chats and walk-in clients on topics including farm business plan development, integrated pest management, plant nutrition, livestock nutrition, animal handling, dairy management, forage crop production, soil health management, cover cropping and more.
• Workshops (single and multi-day), twilight meetings at farms, day-long seminars, regional grower conferences, farmer-to-farmer sessions, pasture walks
• Annual Grower Association meetings, NH Farm and Forest Exposition, NH Farm Bureau Annual Meeting
• Statewide Speaker's Bureau
• Invited presentations On-farm demonstrations and field trials
• Plant and animal diagnostic services, soil testing and recommendations, arthropod identification
• Volunteer training - Master Gardener training course and continuing education
• TV appearances, radio interviews

NHAES·

• Conduct applied and discovery research
• Undertake engagement with stakeholders in multiple aspects of plant and animal agriculture, related genetics and genomics, and various types of aquaculture.

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-grant universities and others who work in agriculture-related fields, and taxpayers in the state, region and nation.

3. How was eXtension used?

UNH Cooperative Extension's Education Center provides research-based information to NH citizens through a toll-free hotline and email service. eXtension is a resource used by volunteers answering calls and emails.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	48523	194434	774	463

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

Patent Applications Submitted

Year: 2015

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	0	59	59

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
2015	2351

Output #2

Output Measure

- Number of people reached with agriculture information via radio and TV spots

Year	Actual
2015	122900

Output #3

Output Measure

- Number of Pesticide Applicators attending recertification training

Year	Actual
2015	0

Output #4

Output Measure

- Number of soil and plant analyses conducted by diagnostic labs

Year	Actual
2015	3176

Output #5

Output Measure

- Number of people reached through educational workshops

Year	Actual
2015	10204

Output #6

Output Measure

- Number of undergraduate students directly involved in the research projects

Year	Actual
2015	55

Output #7

Output Measure

- Number of graduate students directly involved in research projects.

Year	Actual
2015	35

Output #8

Output Measure

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

Year	Actual
2015	14

Output #9

Output Measure

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

Year	Actual
2015	48

Output #10

Output Measure

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

Year	Actual
2015	672

Output #11

Output Measure

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

Year	Actual
2015	8

Output #12

Output Measure

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

Year	Actual
2015	16

Output #13

Output Measure

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

Year	Actual
2015	12

Output #14

Output Measure

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

Year	Actual
2015	4

Output #15

Output Measure

- New mapping populations created by crossing or mutagenesis for hardy kiwi for crop domestication and breeding.

Year	Actual
2015	2

Output #16

Output Measure

- New mapping population generated to identify genes for wheat rust resistance in barberry

Year	Actual
2015	1

Output #17

Output Measure

- The Rehan lab (1004515) organized the first annual NH Bee Bioblitz was conducted in the White Mountains National Forest. Participants included naturalists and citizen scientists from three states who helped to document the diversity and status of native bees in NH for the first time.

Year	Actual
2015	30

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 who submit soil and/or tissue tests to determine crop nutrient needs
3	Number of NH growers who formulate plans to guide their crop production, pest management, nutrient allocation, or farm management decisions
4	Number of NH growers who increase knowledge, awareness, and/or skills in pest management practices and technologies.
5	Number of NH growers who increase their knowledge, awareness, and/or skills in crop production practices
6	Number of NH growers who increase their skills, knowledge or awareness in practices or methods related to dairy, livestock or equine production methods.
7	Increased knowledge about plant varieties and production practices suited to the state and region.
8	New knowledge about dairy production, nutrition, animal health and dairy products important to regional producers.
9	New genomic knowledge translated into tools and strategies to facilitate varietal selection through marker assisted breeding.
10	Improved range of weed management options available for sustainable and organic growers.
11	Develop regionally appropriate management systems to suppress soil borne pathogens for both organic and conventional farms
12	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.
13	New commercialized varieties of cucurbit vegetables suited to state and region growing conditions, with improved yields,and disease and pest resistance.
14	Increased information on non-Apis bees, their conservation, pathology, susceptibility to pesticides and contribution to crop pollination including economic value.
15	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.
16	Improved equipment and deployment methods developed for oyster aquaculture in Northern New England and disseminated to the growing number of oyster farmers in NH.
17	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.

18	A new bioinformatic pipeline was developed for Genome By Sequencing for Single Nucleotide Polymorphism Calling Reference Optional Pipeline (GBS-SNP-CROP) in the absence of a reference genome.
19	Genistein from soybean meal and concentrate in finfish feeds act as an oestrogen disrupter in summer flounder and southern flounder.
20	Develop an improved method to estimate the apparent efficiency of immunoglobulin absorption in neonatal cows.
21	Modify genomic methods to directly investigate the potential for complex community interactions between some important plant-parasitic eukaryotic taxa (nematodes) and their associated bacterial communities.
22	Evaluate how agricultural weed populations are changing across Northern New England.

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
2015	281

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

Farm management efforts enhance farm profitability by providing programs in agricultural finance, record keeping, enterprise analysis, business and estate planning, direct marketing and merchandising, and risk management.

Each of these program areas address the unique needs of farmers in order to keep their operations viable. 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

281 NH 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
102	Soil, Plant, Water, Nutrient Relationships
205	Plant Management Systems
315	Animal Welfare/Well-Being and Protection

Outcome #2

1. Outcome Measures

Number of NH growers who submit soil and/or tissue tests to determine crop nutrient needs

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2882

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
410 corn, forage and pasture samples 194 fruit crop samples 184 vegetable crop samples 124 high tunnel vegetable crop samples 1,553 home grounds and gardens samples

515 commercial growers reported using UNH Cooperative Extension soil test recommendations to guide their nutrient applications. Home grounds and garden clients were not surveyed in 2015.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
205	Plant Management Systems

Outcome #3

1. Outcome Measures

Number of NH growers who formulate plans to guide their crop production, pest management, nutrient allocation, or farm management decisions

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	152

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Local farmers needed support and information for farm management and Integrated Pest Management plan.

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
One hundred fifty two agricultural business owners/operators reported creation of a farm management plan or Integrated Pest Management plan in 2015.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Number of NH growers who increase knowledge, awareness, and/or skills in pest management practices and technologies.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2037

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Growers and producers need continual education and recertification in best practices for pest management.

What has been done

In 2015, there were 49 recertification training opportunities related to pest management through UNH Cooperative Extension-sponsored workshops, twilight meetings, and conferences.

Results
1,336 individuals received training and 672 applicators received re-certification credits from UNH Cooperative Extension efforts. An additional 29 people earned credits via UNHCE online training.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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 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
2015	142

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.

Fruit and vegetable production in a northern climate is challenged by a short growing season, variable soils, plant disease that favors humid conditions, and a myriad of newly arriving invasive insect pests.

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
102 fruit and vegetable growers and 40 forage crop producers 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
102	Soil, Plant, Water, Nutrient Relationships
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems

Outcome #6

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.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	33

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Livestock and dairy businesses operate on a thin profit margin, often unable to reinvest into the business. Good quality farm land is scarce and expensive, and the prices of inputs like labor, fuel, feed, and licensed slaughter are high, making it difficult for locally-raised meats and dairy products to compete in the marketplace.

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

33 dairy and livestock producers reported adoption of a production practice as a result of UNH Cooperative Extension programming in 2015.

4. Associated Knowledge Areas

KA Code	Knowledge Area
315	Animal Welfare/Well-Being and Protection

Outcome #7

1. Outcome Measures

Increased 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 Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Vegetable and berry growers in New Hampshire face several unique challenges. The humid climate favors disease and insect pressures. Pests (weeds, insects and diseases) limit farm profitability through reduced yields. The short growing season and extremely variable weather patterns create a short window of opportunity to grow crops each season. The strong relationship between producer and consumer encourages growers to market innovative crops and products that are unique to their farm or to the region, thereby differentiating themselves from other farms and from supermarkets. Many of the high-value crops grown in New England are grown using production systems that are different from the growing methods used in major production areas and warmer climates.

What has been done
Integrated research and extension activities are is in the area of high-value specialty crop production systems and methods of extending the growing season (e.g. season extension). These included:
1. Cultivar and topping (removing the apical meristem) impact on Brussel sprout production.
2. Overwinter production of spinach in unheated high tunnels (2nd of three years).
3. In replicated experiments over several years, several types of covering materials were compared with respect to temperature and light during winter months and on the survival of a

marginally hardy test crop. This system was used for overwintering production trials of multiple cultivars of onions.

Results
1.Topping can improve marketable yield and cultivars vary for several characteristics that are important to growers. Detailed recommendations about topping and cultivar choice were prepared for growers and have been communicated in the form of presentations, direct communication, and easy-to- access web-based reports.
2. Two years (of a three-year study) on winter spinach production in unheated high tunnels have been completed.
3. A single most protective option for winter rowcover was identified (1.25 oz. per square yard rowcover, plus 6 mil polyethylene), and this was used for subsequent experiments with overwintering onions. This innovative system permits the harvest of onions in late May, several weeks earlier than possible with traditional spring planting.Cultivar selection and fall planting date both had a significant effect on yield potential; formation of large spring bulbs required early fall planting and the use of cultivars highly resistant to bolting (flower production). Several yellow and red cultivars adapted to this system that produced high-quality bulbs. (http://extension.unh.edu/resources/files/Resource005477_Rep7652.pdf)

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems

Outcome #8

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 Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Purchase fee including forages and grains constitute the highest expenses for organic and conventional dairy farms in the Northeast. opportunities exist to develop
resilient AFC systems (e.g., warm and cool season grasses, summer annuals, brassicas) that provide supplemental forage for grazing and/or silage feeding during periods of limited biomass production (e.g., early spring, the "summer slump", and late fall). Opportunities also exist to better understand how alternative feed sources such as field peas, liquid molasses, flaxseed meal, okara (a byproduct of the soy milk and tofu industry), and kelp meal impact nutrient utilization and health in lactating dairy cows.

What has been done
1. The Brito lab (#1001855) and Smith lab (#229253) conducted preliminary studies of alternative forage crops (AFC) production to extend the grazing seasons and replace traditional forages.

2. The Brito lab (#1001855)conducted preliminary feeding studies with dairy cattle have been conducted with alternative feed sources, such as okara meal, a byproduct of tofu production.

Results
1. Alternative forage crops (AFC) 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.
2.Preliminary results also 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. Results from our project are helping organic and conventional dairy farmers in the Northeast make informed decisions about the use of AFC and alternative feed sources in their family enterprises.

4. Associated Knowledge Areas

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

Outcome #9

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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Population growth, climate change, and interest in local food all contribute to the expanding need for rapid development of locally adapted crop varieties that serve consumer demands for high quality, locally grown produce, and value-added horticultural products. The pace of varietal development will increase through genomics-enabled "marker-assisted breeding."

What has been done
NHAES sponsored research by Davis lab (#229267) has developed a suite of molecular markers predictive of strawberry flower color was developed and is being used in an ongoing breeding program. The lab contributed to the development of a microarray for single nucleotide polymorphisms (the Axiom IStraw90 strawberry SNP array).

Results
Axiom IStraw90 strawberry SNP array was demonstrated to be an effective tool for high throughput marker genotyping in multiple strawberry populations, including ancestral diploid strawberry, pentaploid plants and the more genetically complex octoploid domesticated strawberry. Approximately 40 new F1 hybrid strawberry plants and more than ten segregating progeny populations have been produced, and approximately 800 previously generated hybrids and progeny plants have been maintained and further characterized in the field and greenhouse.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems

Outcome #10

1. Outcome Measures

Improved range of weed management options available for sustainable and organic growers.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Inorganic fertilizers and pesticides have both monetary and environmental costs and therefore many farmers are looking for ways to reduce their reliance on these inputs. Alternative approaches to managing crop fertility and pests, including intercropping and the use of cover crops as green manures and smother crops, have the potential to reduce the need for costly external inputs while at the same time improving soil quality and environmental outcomes; however, their effectiveness and utilization in cropping systems and environmental conditions typical of the Northern New England (NNE) region have not been adequately explored.

What has been done
1.Cover crop field trials were used to quantified biomass production, weed suppressive potential, and rotational benefits for over 15 different species of cover crops that could replace bare fallow periods in NNE's vegetable and row crop production systems.

2.The effects of an Italian ryegrass-white clover intercrop in broccoli. production were tested along with simultaneous variation in nitrogen fertilizer.

Results
1.Of 15 different species of cover crops, buckwheat and annual ryegrass appear to provide the greatest biomass and weed suppression benefits (often twice that of other spring- and fall-sown cover crops, respectively) early in the growing season, while forage radish was consistently a top performer in the fall, providing excellent late season biomass production and weed suppression (89-97% weed suppression over four site-years). In addition, forage radish improved soil fertility for a subsequent spring-sown crop at levels that were comparable to that provided by a legume cover crop. Cover crop "cocktails" did not suppress weeds as well as the most weed-suppressive cover crop monoculture (buckwheat) and that cover crop biomass was more important than

species identity in determining which weed species were suppressed.

2. Broccoli yields were unaffected by the presence of the intercrop in one year but were reduced in intercropped treatments the following year. This is consistent with growers' observations and confirmed the presence of trade-offs involved with using intercrops, which can provide useful ecosystem services to agricultural production systems. Warren, N, RG Smith, and RG Sideman. 2015. Effects of living mulch and fertilizer on the performance of broccoli in plasticulture. HortScience 50(2):218-224.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
213	Weeds Affecting Plants

Outcome #11

1. Outcome Measures

Develop regionally appropriate management systems to suppress soil borne pathogens for both organic and conventional farms

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Soil borne diseases, including seed disease, seedling damping-off, and pod and root rots, continue to be one of the most persistent yield limiting factors in crop production. Management of many soil borne plant pathogens has relied heavily on fungicides seed treatments or soil fumigation with methyl bromide (MeBr). Methyl bromide phase-out has encouraged the development of alternative chemical and non-chemical management strategies, strongly grounded on a better understanding of plant pathogen diversity and the complex interactions among soil microbial communities.

What has been done
The Broder lab (#233236)
1. Developed a method to screened commercial strawberry and one of its wild ancestors for

resistance to Verticillium dahliae using a strain modified to express Green Fluorescent Protein (GFP).
2. Sequenced the genomes of three strains of V. dahliae, tow of which infect strawberry and one of which infects mint.
3. The microbiome of dry bean was sampled from wild and domesticated beans in the center of domestication in Central Mexico. (The Hale lab #233561 also contributed to this effort).

Results
1. The protocol has been standardized to use GFP-expressing strains V.dahliae to measure colonization of susceptible, tolerant and resistant strawberries. This is the first step to screening strawberry breeding populations, which are segregating for the trait of resistance to V. dahliae.

2. Preliminary results indicate that one V.dahliae strain affecting strawberry is more closely related to a strain recovered from lettuce, rather than the other V. dahliae strain recovered from infected strawberries. This may indicate that virulence to strawberry is present in several lineages of V. dahliae.
3.Microbes were recovered from wild and domesticated beans in the center of domestication are being screened for their ability to buffer commercial bean cultivars from drought and nutrient stress.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
212	Pathogens and Nematodes Affecting Plants

Outcome #12

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Controlling reproduction either by improving commercially valuable fisheries (black sea bass) or preventing population increases in invasive or unwanted species (lamprey eels), respectively, is of critical importance to aquaculture, commercial fisheries, and to wildlife biologists. To control reproduction, it is essential to understand the underlying mechanisms of neuroendocrine control. In all vertebrates, gonadotropin-releasing hormone (GnRH) is the "master or central control" of reproduction.

What has been done
The Sower lab (#1003341)has used genomic analysis, immunohistochemistry and in-situ hybridization to conduct comparative studies of the neuroendocrine systems in Lamprey eel (ancient jawless fish) and Black Sea Bass. The Sea Bass are protogynous hermaphrodites--females change to males between 2 and 5 years of age.

Results
Two copy DNAs (cDNAs) were cloned for the Black Sea Bass GnRH2, and GnRH3 but no GnRH1 cDNA was identified. Each Black Sea Bass peptide hormone is produced as a single propeptide, which is processed to release the GnRH peptide hormone. The expression of these proteins and brain aromatase were examined in the brain and endocrine system was examined as sea bass morphed from female to male. Although sex change in black sea bass is not associated with dramatic changes in GnRH or aromatase gene expression among brain regions, these genes may mediate processes at other levels, such as within individual hypothalamic nuclei, or through changes in neuron size, that warrant further research.

A nonclassical pituitary heterodimeric glycoprotein (GpH) was cloned and characterized, consisting of thyrostimulin A2 subunit with the classical beta subunit in the sea lamprey, a jawless basal vertebrate. Recombinant GpH was demonstrated activate the lamprey glycoprotein receptor I. These data suggest an intermediate stage of the structure-function of the gonadotropin/thyroid-stimulating hormone in a basal vertebrate, leading to the emergence of the highly specialized gonadotropin hormones and thyroid stimulating hormones in gnathostomes (jawed fish).

4. Associated Knowledge Areas

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

Outcome #13

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
2015	9

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Plant breeding is a continuous process producing new varieties of cucurbit vegetables (squash, pumpkins, melon, cucumbers) with improved flavor, disease resistance, decreased production costs, and other traits valued by producers and consumers. The Loy cucurbit breeding program (#233554, #233556), which is more than 40 years old and is supported by the NH Agricultural Experiment Station, continues to provide new and improved strains of cucurbits which are marketed by seed companies worldwide.

What has been done
1.Use of genetically female parents can markedly lower seed production costs of hybrid melon. The gynoecious trait was first introduced into New Hampshire melon lines in the early 1970s by utilizing genes derived from plant introduction accessions obtained through the USDA. Numerous backcrosses have been required to eliminate undesirable genes which were transferred from the original plant sources of genes for female flowering, a phenomenon called linkage drag.
2.Several hull-less seeded breeding lines have been developed at the University of New Hampshire during the past 30 years which exhibit high seed yields and powdery mildew resistance. A plant introduction accession from Poland was instrumental in breeding for larger seed size and improved seed fill.
3.Several color and pattern traits were introgressed into egg and spoon gourds, along with the bush habit of growth and earlier maturity. Genes for different color and stripping patterns are currently being tr3. One new white pumpkin variety has been developed in a cooperative effort with a seed company, and additional white hybrids are slated for future release tansferred from egg gourd lines into ornamental pumpkin

Results
1.The Loy breeding program has produced two green-fleshed lines and two orange-fleshed melon lines with good eating quality, appearance, and resistance to powdery mildew and fusarium wilt. These lines can be used directly for making hybrids or can be further improved for specific melon types with minimal additional breeding input. Development of traditional hybrids has continued, and three new varieties were introduced commercially in 2015, First Kiss, an early cantaloupe with medium size fruit, True Love, an early Athena-type melon, and Shockwave, a long shelf-life cantaloupe with higher sugar content than most varieties.
2.A new high-yielding hybrid , Naked Bear, for hull-less pumpkin seed was introduced and offered in commercial catalogs in 2015. Another variety, Camillo, jointly developed with a seed company, has been introduced into Europe and is being evaluated for introduction in North America.
3. One new white pumpkin variety has been developed in a cooperative effort with a seed

company, and additional white hybrids are slated for future release.
4.In acorn squash, Loy and coworkers have developed and released three varieties with higher starch content and improved eating quality as compared to standard varieties. The objectives of current breeding work are to develop varieties with larger fruit and which retain color better during storage.

4. Associated Knowledge Areas

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

Outcome #14

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
2015	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 more than
$200 billion/year worldwide. The abundance of and diversity of pollinators are declining in many agricultural landscapes across the United States.

What has been done
The Rehan lab, (#1004515), has initiated long-term monitoring of bee biodiversity in New Hampshire and identify species in need of more research. By documenting which species are abundant, common, and rare to the area it is possible to track species habitat and floral preferences. By further developing long-term monitoring, it will be possible to identify bee species at risk and changes in pollinator communities.

Results

1.The native bee community in NH has been characterized for the first time and this species list has been submitted for publication.
2. Documentation of bee and floral phenology have been initiated to understand plant-pollinator interaction.
3. A database of historic bee records for the state of NH has been created to examine former ranges and populations for 120+ species found locally to determine the status of bees in the state in terms of endemic species stability and the introduction of new species through range expansion and anthropogenic introductions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
136	Conservation of Biological Diversity
304	Animal Genome

Outcome #15

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Present throughout New England, barberries (Berberis vulgaris) have been shown to function as the alternate host to stem rust and stripe rust, two of the most devastating fungal diseases of small grains like wheat and barley. Barberry now poses an unknown threat, as momentum builds for reviving small grains production in New England. Molecular tools are needed to assist with global surveillance efforts for Berberis spp. in wheat-growing regions,including New England.

What has been done
Recent research has revealed that some barberry species (including Japanese barberry, which is resistant to stem rust) are in fact susceptible alternate hosts to wheat stripe rust, thus prompting the wheat rust research on Japanese barberry, Berberis thunbergii.
The Hale lab (#233561) activities included phenotyping, sampling, and propagating approximately

200 individuals from a Berberis ×ottawensis population (a hybrid between B. thunbergii and B. vulgaris) in Lime Kiln, CT. Additionally, a genotyping-by-sequencing (GBS) pilot run was performed on four barberry accessions, confirming the viability of that approach for Berberis vulgaris.

Results
Using a pipeline developed for calling single nucleotide polymorphisms (SNPs) using GBS data in species with no reference genome, the Hale lab was able to find a locus in B. thunbergii with a highly significant association with Puccinia graminis f. sp. tritici (Pgt, the causative agent of wheat rust) resistance.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
212	Pathogens and Nematodes Affecting Plants

Outcome #16

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There is a need to make improved information on oyster aquaculture in the region more accessible to existing and potential oyster farmers as the nascent industry expands in New Hampshire's estuaries. 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.Quantify the effects of variations in major gear types and deployment methods on oyster

growth.

2.Assess gear types and methods that oyster farmers in the region currently use from the perspective of possible standardization on NH farms.

Results
1.One experiment on 'wet storage' methods was conducted with the objective of characterizing the effects of winter storage under laboratory conditions that mimic the estuary on oyster condition. The major intent was to determine if the seawater facilities at Jackson Estuarine Laboratory would be suitable for such experiments without major modifications. The expected level of oyster condition deterioration was observed, and no problems were found with the facilities.
2.Several oyster farmers were interviewed during the reporting period in order to determine what methods are currently being used in New Hampshire, focusing on the harvesting of 'bottom seeded' oysters, because bottom seeding has become the preferred method in the state for final grow-out. 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.

4. Associated Knowledge Areas

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

Outcome #17

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Hardy kiwiberry is a novel horticultural crop of potential economic importance to New England growers. Aside from casual selection by individual growers, Actinidia germplasm has not be domesticated to improve fruit production, plant habit, or disease resistance.

What has been done
NHAES sponsored research by Hale (#233561)continued the establishment of a hardy kiwiberry research vineyard. The lab developed a novel bioinformatic pipeline for genome by sequencing (GBS)for species lacking a reference genome. Collaborative research has been established with two farms in northern New Hampshire.

Results
1.Breeding hardy kiwiberries has been advanced by the generation of several hybrid breeding populations and the identification of large numbers of single nucleotide polymorphisms, using GBS, for 144 Actinidia genotypes.

2. The NHAES vineyard came into production in 2015, allowing preliminary pre- and post-harvest assessment of fruit to begin.

3. Breeding program activities and results were communicated to regional stakeholders via a field day, held at the NHAES Woodman Farm during harvest in September.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
502	New and Improved Food Products

Outcome #18

1. Outcome Measures

A new bioinformatic pipeline was developed for Genome By Sequencing for Single Nucleotide Polymorphism Calling Reference Optional Pipeline (GBS-SNP-CROP) in the absence of a reference genome.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual

2015	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Genome by sequencing(GBS) approaches to identify DNA polymorphisms for mapping and crop improvement has largely been limited to major crop plants which have had extensive investments to develop reference genomes. However for resource limited, underutilized plant breeding programs, reference genomes are not yet available, even with the rapidly dropping cost DNA sequencing prices.

What has been done
An open source pipeline was created in an open-source format that can maximize GBS data usage and perform high-density SNP genotyping in the absence of a reference.

Results
The new pipeline was applied to pair-end, next generation DNA sequences for 48 accessions of tetraploid kiwiberry. GBS-SNP-CROP yielded on average three times as many SNPs as previous pipelines e.g. TASSEL-GBS analyses (32 and 64 bp tag lengths) and more than 18 times as many as TASSEL-UNEAK, with fewer genotyping errors in all cases, as evidenced by comparing the genotypic characterizations of biological replicates. This pipeline will be valuable for many crop species with limited genetic and bioinformatic resources.

4. Associated Knowledge Areas

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

Outcome #19

1. Outcome Measures

Genistein from soybean meal and concentrate in finfish feeds act as an oestrogen disrupter in summer flounder and southern flounder.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Some species of teleost fish change sex during development. The inclusion of soybean meal and soy concentrates, which are used to replace fishmeal in finfish feeds, will introduce phytoestrogens in aquaculture fish and some of these phytoestrogens may have endocrine disrupting activity. Understanding how these factors impact sex determination will have a significant impact on the economic success of aquaculture of these species.

What has been done
Several environmental factors affecting sex determination in Paralichyd flounder (summer and southern) were elucidated. Genistein is a phytoestrogen found in soybean meal and concentrate. Two different doses of genistein were used as treatments, and compared to controls, to determine masculinizing and feminizing effects of the phytoestrogen on two species of flounder.

Results
Greater numbers of female fish resulted from the low and high dose genistein treatments (98 ± 2% and 78 ± 12% respectively), as compared to the control group (21 ± 10%). Reduced growth at 153 days post hatching (DPH) and poor survival (28%) at 285 DPH were also observed for the high dose genistein treatment. Collectively, these results demonstrate the feminizing effects of genistein in southern flounder and show reduced growth and survival with high-level dietary administration of the phytoestrogen. (http://onlinelibrary.wiley.com/doi/10.1111) The research has important implications for rearing monosex (all female) populations of flounder to achieve enhanced growth and attain economic benefits for aquaculture.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
307	Animal Management Systems

Outcome #20

1. Outcome Measures

Develop an improved method to estimate the apparent efficiency of immunoglobulin absorption in neonatal cows.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In dairy cattle, the antibodies the newborn absorbs from colostrum in the first few hours of life are essential to protect the calf from disease until its own immune system becomes active. Accurate determination of blood plasma volume during the first day of life is important to measure the quantity of immunoglobulin G (IgG) that is absorbed from feeding colostrum. There are discrepancies in current method (Quigley et al. J. Dairy Sci.81: 1308-1312, 1998) used to estimate calf blood plasma volume; furthermore, current practice for colostrum feeding is different from what was used in the 1990s. Plasma volume estimates are essential to measure the efficiency of IgG absorption influences the calf's growth rate and later how much milk the animal will produce.

What has been done
The Erickson lab (#1001283)used two different colostrum replacer feeding regimens combined with Evans Blue Dye procedure for determining the blood plasma volume using (Cabral et al. Can. J. Anim. Sci 95:293-298,2015) to more accurately determine plasma blood volume and IgG uptake in neonatal calves.

Results
Feeding colostrum replacer in either one or split into two feedings did
not affect blood plasma volume or hematocrit measurements. An initial precolostral blood sample along with body weight can accurately predict hematocrit at 12, and 24 h. Those values, along with an adjustment for
sex of the calf, can accurately predict hematocrit at 6 and
18 h after birth. Researchers evaluating colostrum replacer can utilize these data to accurately determine the apparent efficiency of absorption and pinpoint when IgG absorption is maximized.

4. Associated Knowledge Areas

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

Outcome #21

1. Outcome Measures

Modify genomic methods to directly investigate the potential for complex community interactions between some important plant-parasitic eukaryotic taxa (nematodes) and their associated bacterial communities.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In order to directly investigate the potential for complex community interactions between important plant-parasitic eukaryotic taxa (nematodes) and their associated microbiomes, new methods are needed to examine complex biological populations. The parasitic nematode Anguina tritici induces the formation of wheat galls. The Anguina genus represents an important group of agricultural parasites that are resistant to long periods of desiccation.

What has been done
The Thomas lab adapted molecular methods isolate small amounts of DNA from dried Anguina trictici wheat galls for high-through put DNA sequencing. Nematodes and microbiomes were sequenced and are in the early state of genomic analysis.

Results
A draft genome sequence for the nematode Anguina tritici has been produced and a refined protocol for sample preparation from desiccated galls has been developed. These data and methods will add to the toolbox of researchers studying plant parasitic nematodes. Specifically for the metagenomics analysis, the new sample preparation protocol will enable better estimates of the abundance of associated microbes in a way that makes it possible to estimate representation in a way that can differentiate between amplification bias versus actual counts of bacterial genomes represented in the sample pool. Preliminary analyzes have indicated the presence of genes involved in trehalose expression (important in the desiccation resistance pathways).

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Pathogens and Nematodes Affecting Plants
304	Animal Genome

Outcome #22

1. Outcome Measures

Evaluate how agricultural weed populations are changing across Northern New England.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Climate change and new agricultural practices have resulted in changes in weed populations which farmers deal with during crop production.

What has been done
A detailed inventory was carried out on the abundance and distribution of agricultural weeds on organically managed vegetable farms in Northern New England through collaborative activities of SAES researchers and cooperative extension specialists. The composition and abundance of weed communities were correlated with soil and climatic variables. DNA methods were used to investigate the taxonomic complexity of lambsquarters.

Results
1. Investigators have new insights on the relative importance of climate variables and change in determining weed abundance at the farm level. They have identified weeds which are more likely to be more widely distributed in northern New England as temperatures warm. Weed scientists will apply this data to develop more effective chemical, mechanical, and cultural weed control practices.
2. Molecular taxonomy confirmed that lambsquarters (Chenopodium album) should be considered a species complex. A new, aggressive weed, clammy goosefoot, was identified in Vermont.
3. An offshoot of this study was a brief growing trial for cultivated quinoa (Chenopodium quinoa); despite late planting (July) this trial indicates quinoa has potential as a new, valuable crop for Northern New England.

4. Associated Knowledge Areas

KA Code	Knowledge Area
213	Weeds Affecting Plants

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Other (Loss of key research staff member)

Brief Explanation

Broder, the NHAES's research plant pathologist, Kirk Broders, left the NHAES in 2015, for a position at another Land Grant University. His departure has slowed progress in several projects where Broders and his students were key collaborators.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

UNHCE: Growers, livestock producers, and landscapers reported adoption of new practices for better production and environment protection.
NHAES: Research activity, outputs and outcomes have particularly strong for this, the largest planned program, as measured by :

- 59 peer-reviewed publications,
- the development of a new bioinformatic pipeline for genome by sequencing (GBS) which produced molecular markers for species without reference genomes.
- commercial the release of 9 new cucurbit varieties (melons, snack seed pumpkin, ornamental pumpkin, etc.) developed at UNH.
- rapid progress in marker-assisted breeding in strawberries, hardy kiwi, and barberry.
- knowledge about how phytoestrogens influence gender determination in commercially valuable species of flounder used in aquaculture.
- characterization of the native bee pollination in NH for the first time, as part of a new effort to evaluate the status of pollinators in the state.
- demonstration of the efficacy of producing onion through the winter in low-cost low tunnels and spinach in unheated high tunnels.
- An innovative system using rowcover was developed for overwinter production of onions (early fall planting), which are harvested in late May, several weeks earlier than traditional for spring onion planting.

Key Items of Evaluation

Further investigation is been planned to assess the actual impact of UNHCE's support on Growers, livestock producers and landscapers activities.
NHAES researchers have made significant contributions

- in advances in molecular breeding of strawberries and hardy kiwi,
- evaluating the status of native bees in NH essential pollination for agricultural productivity,
- tomato, onion, and Brussel sprout cultivar trials and new, season-extending production methods for vegetable growers
- the release of nine new cucurbit varieties for commercial production.

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
101	Appraisal of Soil Resources	0%		10%	
102	Soil, Plant, Water, Nutrient Relationships	0%		38%	
112	Watershed Protection and Management	25%		23%	
123	Management and Sustainability of Forest Resources	45%		0%	
124	Urban Forestry	10%		0%	
131	Alternative Uses of Land	10%		0%	
133	Pollution Prevention and Mitigation	0%		2%	
216	Integrated Pest Management Systems	10%		0%	
401	Structures, Facilities, and General Purpose Farm Supplies	0%		6%	
403	Waste Disposal, Recycling, and Reuse	0%		13%	
511	New and Improved Non-Food Products and Processes	0%		2%	
605	Natural Resource and Environmental Economics	0%		4%	
903	Communication, Education, and Information Delivery	0%		2%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	14.0	0.0	2.3	0.0
Actual Paid	16.0	0.0	4.2	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**
125896	0	409127	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
125896	0	444873	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1787584	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

UNHCE

Cooperative Extension will carry out applied research, field trials and publishing research reports including:

- 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

Applied research

- Fields trials
- Publication of research to science community
- Incorporate research results into outreach materials/programs for the public stakeholders

UNHCE Outreach events/Activities

- Development of Educational Information: Newsletters (including e-newsletters) Fact sheets Trade magazine articles, journals, posters, displays Books
- Communication with news media (Web ,radio, TV, newspapers)
- On-line/web based information: Web page updates; blogs, social media (Facebook and Twitter) Electronic pest alerts Developing educational visuals/videos; podcasts
- Outreach to new clientele
- Call before you Cut Campaign

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 stewardship management or business plans

Workshops and Conferences Attendance

- Workshop series
- Statewide Speaker's Bureau (ie: Speaking for Wildlife)
- State-wide and multistate (regional)
- Public forums Demonstrations/Information and Feedback Sessions Demonstrations/ Demonstration Projects
- Invited presentations

Technical Assistance to state agencies/organizations

- Tree Farm Program
- Quabbin to Cardigan outreach/marketing campaign
- Small & Beginner Farmers
- Women in the Woods
- Land trusts, town officials, municipalities, parks, town forests
- Connect professionals to partners, projects, and information

SUPPORT ACTIVITIES Volunteer Training, Management, and Support

- Wildlife Coverts
- Natural Resource Stewards
- Marine Docents
- Lakes Lay Monitoring Program (LLMP)
- Stewardship Network of New England

External Partnerships

- ongoing work with partners and collaborators
- outreach agreements/contracts with state agencies (NH Fish and Game, NH Division of Forests and Lands, NH Department of Environmental Services

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NHAES research activities included

- Comparison new methods for assessing microbial efficiency as it impacts soil C storage and greenhouse gas emissions.
- Investigation of the effects of different cropping systems, soil insects, and microbial communities on Soil Organic Matter (SOM) and soil nitrogen cycling.
- Evaluaton of climate impact on soil C cycling to improve the Community Land Model, a component of climate change assessments.
- Monitoring 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.
- Refining 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.
- Dissemination of information about these new practices to various stakeholder groups across the state, region, and nation.

2. Brief description of the target audience

UNHCE Target audiences for this program area include partner agencies, forest landowners, licensed foresters, certified professional loggers, conservation volunteers and citizen scientists including, Coverts volunteers Lakes Lay Monitoring participants, and Natural Resource Stewards, land/water/wildlife conservation and stewardship organizations, conservation commissions and other town volunteers, New

Hampshire forest-based industries, community decision-makers and the public.

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

3. How was eXtension used?

eXtension was used to refer inquiries regarding well water testing and treatment, pond management and some of our staff participated in or lead a number of communities of practice.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	50750	542710	295	2024

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

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	0	19	19

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects.

Year	Actual
2015	37

Output #2

Output Measure

- Number of graduate students directly involved in the projects.

Year	Actual
2015	22

Output #3

Output Measure

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

Year	Actual
2015	22

Output #4

Output Measure

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

Year	Actual
2015	46

Output #5

Output Measure

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

Year	Actual
2015	829

Output #6

Output Measure

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

Year	Actual
2015	14

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
2015	3973

Output #8

Output Measure

- Number of volunteers trained and supported: Coverts, Community Tree Stewards, and other community volunteers such as conservation commissions, etc.

Year	Actual
2015	145

Output #9

Output Measure

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

Year	Actual
2015	44

Output #10

Output Measure

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

Year	Actual
2015	21

Output #11

Output Measure

- People reached through media: press releases, newsletters, radio, TV, web, direct mailing

Year	Actual
2015	542710

Output #12

Output Measure

- Number of postdocs trained in cutting edge research.

Year	Actual
2015	3

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 and Community Tree Stewards programs
3	Number of people who influence the forest environment in NH with increased working knowledge about forest resource management through workshops, seminars, or educational events annually
4	Number of NH communities engage in natural resource inventories or natural heritage assessments to identify natural assets
5	Number of acres landowners develop conservation easements on in NH acres each year
6	Number of communities to develop action plans that include a variety of approaches for making progress in community-based natural resource protection projects.
7	Number of community decision makers, conservation groups or development professionals who report gaining knowledge about preventing degradation from storm water runoff.
8	Understanding the impact of atmospheric deposition on water quality in order to develop management strategies that stakeholders can use to improve water quality.
9	Address microbial contributions to soil organic matter (SOM) accumulation, and also to the timing and extent of SOM breakdown and N mineralization in various cropping systems.
10	Further understanding of how global change factors impact microbial efficiency, a key determinate of soil C storage and greenhouse gas emissions.
11	Increase understanding of landscape configuration in determining the effectiveness of natural ecosystem services to attenuate N loading from agricultural versus suburban landscapes
12	Develop and 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.

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
2015	95034

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
New Hampshire is 83% forested and that lends itself to a strong forest, recreation, and tourism economy. More than two-thirds of the forested lands is in private ownership so having these landowners understand their management option is critical to the state's quality of life and its economy.

What has been done
11 staff forest stewardship professionals assisted 872 large forest woodlot owners (10 acres or greater) and additionally inspected 385 woodlands.

Results
10,633 new acres were put under forest management plans and an additional 14,614 acres were referred to NH Foresters to or update initiate plans with an additional 69,787 acres of tree farms inspected to comply with or exceed NH stewardship standards. 27% of New Hampshire's private forest land is managed according to an integrated forest stewardship plan.

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 and Community Tree Stewards programs

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	1202

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Extension staff alone can only reach a small fraction of the public, can collect only a limited amount of data on our natural resources and have to prioritize and qualify their efforts to ensure they are putting their time into the more complicated and demanding programming activities. Volunteers help extend the reach and audience throughout the stage as well as are available to coordinate local based natural resource stewardship and monitoring efforts. In addition, these trained volunteers also contribute their natural resources knowledge to their communities by reporting to and serving on conservation commissions and planning boards.

What has been done
There were over 1202 active trained volunteers from the Wildlife Coverts, Natural Resources Stewards, Lakes Lay Monitoring, Speaking for Wildlife, and Coastal Research Volunteer programs that contributed over 39,573 hours of service in 2015 doing nature walks, giving presentations, monitoring lakes and coastal waters, replanting primary dune vegetation, creating demonstration projects, managing county Big Tree programs and assisting in many other aspects of our Extension programming. In addition through the Stewardship Network of New England 705 volunteers donated 2,213 hours of service to clean beaches, pull invasive vegetation, perform trail maintenance and collect samples to investigate New England Cottontail abundance.

Results
Over 73,718 acres were actively managed for wildlife habitat, over 350 lake and stream sites were monitored, provided extensive community engagement and service. Volunteers reached out to over 20,000 people with a message of sound forest stewardship and wildlife conservation.

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 people who influence the forest environment in NH with increased working knowledge about forest resource management through workshops, seminars, or educational events annually

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	646

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Forests are critical to sustaining New Hampshire's forest products industry and forest-related tourism and recreation which contribute more than $2 billion to the economy. New Hampshire's forests also provide habitat for wildlife, protect water quality, and help to define the character of our communities. Increasing population, fragmentation of the resource base and changes in land ownership all affect the ability of New Hampshire's forests to meet the diverse needs of the people.

What has been done
244 workshops were offered to landowners, decision-makers and the natural resources professionals that work with them with a combined total of 7,341 people attending.

Results
Approximately 80% of the 290 New Hampshire licensed foresters attended at least one workshop to maintain their certification. 346 loggers obtained or maintained their certification by attending Professional Logger program Workshops.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources

124	Urban Forestry
131	Alternative Uses of Land
216	Integrated Pest Management Systems

Outcome #4

1. Outcome Measures

Number of NH communities engage in natural resource inventories or natural heritage assessments to identify natural assets

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
New Hampshire is currently experiencing a wide range of issues such as sprawling development, loss of natural areas and wildlife habitats, water quality issues, an increase in extreme weather events (such as flooding), climate change, and declining rates of community engagement. over the next 20 years, forests and agricultural lands will continue to decline, only about one third of the state will be rural (compared with two thirds in 1950) with most of that land in the northern half of the state, and only 22% of drinking water resources (aquifers) are protected.

What has been done
The Communities & Natural Resources team worked to build the capacity of community leaders to engage in actions for natural resource management and conservation to maintain clean water, diverse natural areas, connected wildlife habitats and resilient communities.

Results
Through the Taking Action for Wildlife Community Assistance Program, Chester (Rockingham County) and Moultonborough (Carroll County) started work on their natural resources inventories, Pembroke (Merrimack County) and Jefferson (Coos County) completed their NRI, Littleton (Grafton County) planned and conducted a public outreach session, attended by 40 participants. Project partners: NH Fish and Game Department

4. Associated Knowledge Areas

KA Code	Knowledge Area

112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
131	Alternative Uses of Land

Outcome #5

1. Outcome Measures

Number of acres landowners develop conservation easements on in NH acres each year

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	713

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Note: We have moved away from assisting with transactional details with landowners and land trusts since the land trusts have developed this capacity over time. Our new approach is in helping to train volunteers to perform easement monitoring for the land trusts, doing train the trainer programs on how to lead a volunteer field day (invasive weed pulling, trail maintenance, wildlife habitat improvement etc.)

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 #6

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
2015	101

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
New Hampshire is currently experiencing a wide range of issues such as sprawling development, loss of natural areas and wildlife habitats, water quality issues, an increase in extreme weather events (such as flooding), climate change, and declining rates of community engagement. Over the next 20 years, forests and agricultural lands will continue to decline, only about one-third of the state will be rural (compared with two thirds in 1950) with most of that land in the northern half of the state, and only 22% of drinking water resources (aquifers) are protected.

What has been done
1. 300 community leaders from 98 communities and conservation groups in all 10 counties and Maine, Massachusetts, Vermont and New York, increased their knowledge of a variety of land conservation, wildlife, forestry, farmland, conservation funding and stewardship issues at the 2015 Saving Special Places Conference.
2. 166 participants from 89 communities in all 10 counties attended five public input sessions for the 2015 Wildlife Action Plan. 1,142 people responded to the online survey intended to garner additional input and 123 people submitted comments on the draft plan during the public comment period.
3. 56 people from 33 communities in all 10 New Hampshire counties plus Maine and Massachusetts attended a series of 3 conservation workshops organized through our partnership with the NH Association of Conservation Commissions. Topics included: How to Lead an Invasive Plants Workday, Conservation Easement Monitoring for Volunteers and Outdoor Skills for Conservation.

Results
93% of participants attending workshops at the annual Saving Special Places Land Conservation Conference reported that they planned to use the new tools, lessons and understandings they

learned about in their land conservation and natural resources planning efforts including performing natural resources inventories and incorporating NH Wildlife Action Plan habitat data.
In an evaluation of community leaders and others involved in the 2014-2015 NH Method Wetland Evaluation training, 60% of workshop participants submitted evaluations (30) which yielded the following results:
100% of respondents increased their understanding of wetland evaluation using the NH Method and their ability to conduct a field wetland assessment
95% of respondents learned new information they plan to apply in their work and future decisions about wetlands.
80% of respondents improved their ability to locate wetland information

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 #7

1. Outcome Measures

Number of community decision makers, conservation groups or development professionals who report gaining knowledge about preventing degradation from storm water runoff.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	931

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Coastal and inland municipalities are experiencing an increased urgency to address storm water management issues in the context of increasing amounts of impervious surfaces, sea level rise, and climate change. With increased storm water runoff comes increased pollutant delivery to critical receiving waters: lakes, streams, wetlands, estuaries and the sea.

What has been done

115 participants from six counties (Belknap, Carroll, Hillsborough, Merrimack, Rockingham and Strafford counties, Maine and Massachusetts) learned about current climate research and local adaptation strategies at the 3rd annual Climate Summit held in Greenland in April 2014. Project partners: Great Bay National Estuarine Research Reserve, NH Coastal Adaptation Workgroup

129 participants from 20 communities in Belknap, Carroll, Hillsborough, Merrimack, Rockingham and Strafford counties, Maine and Massachusetts learned about climate adaptation strategies they can use through two workshops in the Water, Weather, Climate and Community workshop series: Keeping NH's History Above Water; Protecting Seacoast Heritage from Climate Change and Coastal Hazards and Preparing our Coastal Communities; Using Climate Science to Guide NH Decisions for Today and Tomorrow. Project partners: NH Coastal Adaptation Workgroup

108 people attended Preparing for Climate Change programs in three communities (Hampton, Hampton Falls and Seabrook) in Rockingham County and one community (Dover) in Strafford County. Participants attended a series of up to five monthly meetings in their community to learn how their communities can adapt to a changing climate, and to discuss local strategies to address sea level rise, storm surge and coastal flooding in their communities.

Results

- In an evaluation of community leaders participating in the Preparing for Climate Change program in Dover, Hampton, Hampton Falls and Seabrook, 23 participants submitted evaluations:
. 78% of respondents increased their knowledge of climate change and adaptation strategies
. 91% of respondents would recommend the program to other communities
. 65% of respondents agreed the program helped their community to make progress to prepare for climate change.

- Post session questionnaires from the two workshops (93 participants; 53 evaluations returned) in the Water, Weather, Climate and Community workshop series indicate that:
. 90% of the respondents reported increased knowledge about various climate adaptation
. 66% are reporting improved capacity to address climate change impacts.
. 60% of respondents are planning to apply what they learned
. Coastal watershed municipalities are experiencing an increased urgency to address storm water management issues in the context of increasing amounts of impervious surfaces, sea level rise, and climate change 50% intend to change a plan, policy, regulation or practice based on what they learned.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
403	Waste Disposal, Recycling, and Reuse

Outcome #8

1. Outcome Measures

Understanding the impact of atmospheric deposition on water quality in order to develop management strategies that stakeholders can use to improve water quality.

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

Address microbial contributions to soil organic matter (SOM) accumulation, and also to the timing and extent of SOM breakdown and N mineralization in various cropping systems.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The loss of soil organic matter (SOM) from agricultural soils has severe local regional, and global consequences. Restoring soil organic matter in agricultural systems is has focused on the impact of tillage, but its effects on soil organic matter are inconsistent, and no-till cropping systems do not always build soil organic matter. This project has investigated the impact of crop diversity, an essential element of organic management practices compared to conventional agricultural management practices.

What has been done
Principles from biodiversity-ecosystem function theory were used to test whether changes in plant diversity over time (e.g., through crop rotation) affect soil communities and function in an agroecosystem. Field and lab experiments and meta-analyses were used to examine the effects of crop biodiversity on soil microbial communities diversity, soil aggregation, organic carbon and total nitrogen stocks, microbial activity, rates of nutrient cycling, and the ratio of carbon to nitrogen acquiring enzyme activities. Microbial physiology was measured as an alternate mechanism of SOM accumulation under organic (ORG) compared to conventional (CT) agricultural management practices, where ORG is accumulating C despite fewer total C inputs and greater soil tillage.

Results
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. ORG management practices had 50% higher carbon use efficiency (±8 se) and 56% higher growth rates (± 22 se) relative to conventional ($p < 0.05$).

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships

Outcome #10

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Agricultural productivity is dependent on soil nutrient cycling processes which are mediated by soil microorganisms. Microbial
activity in turn is controlled to a large degree by temperature, moisture, substrate quality, and nutrient availability. Human-
induced environmental change (e.g., climate warming, land-use change) may alter the microbial community and the nutrient
cycling processes it mediates.

What has been done
1. A synthesis of existing information on microbial carbon utilization efficiency was completed and a comparison of available methods for measuring microbial efficiency was initiated.
2. Collaboration was initiated with an Earth System modeler to incorporate our results into the Community Land Model, the terrestrial component of the Community Earth System Model used

for climate change assessments.

Results
1. One manuscript has been accepted for publication about comparing methods for measuring microbial efficiency.
2. The Community Land Model, used for climate change assessments is being improved based on the results of these empirical experiments.

4. Associated Knowledge Areas

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

Outcome #11

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
2015	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. Environmental Protection Agency has classified the Bay classification by as negatively impacted and is requiring towns within the watershed to implement expensive remediation. Understanding how
location of agricultural and suburban land use in the watershed influences the delivery of N to surface waters and ultimately to
the Bay. Findings will inform management options for reducing N pollution as land use change continues and agriculture re-intensifies.

What has been done
1. Nutrient concentrations were quantified across a range of small agricultural and suburban catchments that contain differing configurations of land use during low and high flow.
2. Hotspots of nitrogen loading were identified during low and high flow along near river land use

activities.
3. Landscape heterogeneity was characterized for N sources, flowpaths, and the intersection with ecosystem patches, that have elevated N removal capacity.

Results
1, Nitrogen export concentrations across all sites were greatest in the most land use impacted stream, College Brook, after it flows through campus. While N is high in the upper College Brook, downstream of Fairchild Dairy, it is not as high as further downstream, indicating that the athletic fields and other campus sources may be a bigger contributor to N exports than agricultural activity.
2. UNH campus is a hot spot for nitrogen and chloride loading, and College Brook is one of the most impaired streams in Seacoast of New Hampshire. Despite dilution of nutrient concentrations during storms in more impacted headwater streams,most nutrient loading occurs during storm events because flow increases at a faster rate than concentrations decline. In the Oyster River mainstem where it enters Great Bay, nutrient concentrations actually increase during storm flow events, indicating a disproportionate increase in loading to Great Bay during storms. Analysis of nitrate sources using stable isotopes suggests that atmospheric nitrate sources (as opposed to soil, fertilizer, or animal waste sources) increase considerably during storm events in watersheds with impervious surfaces.
3. Small reservoirs in the region are strong nitrate sinks during low flow summer periods, indicating that they mitigate nitrogen exports from watersheds. However, some of the nitrate is converted to dissolved organic nitrogen, which is then exported, reducing the impact in terms of total N retention. Nevertheless, in terms of total dissolved nitrogen, smaller reservoirs remain a significant net sink. This has implications for dam removal considerations in the region.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management

Outcome #12

1. Outcome Measures

Develop and 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.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual

2015 0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The financial stability of organic dairies in the Northeast are challenged by the high cost of animal bedding, and energy sanitation for the milking parlor. Woodlots, associated with NE dairies, could provide a source of raw materials to produce wood shavings to bedding and heat captured from static pile aerobic composting of bedding and manure could be used to preheat water for milking parlor. Furthermore, aerobic com composting would reduce the amount of methane, a potent greenhouse gas, released from dairy forms.

What has been done
1. A major renovation and upgrade of the composting and heat capture system were conducted in 2015.
2. Three experiments were conducted relating to improving the system's BTU (British thermal units) generation.
3. Five composting replicates were conducted using all the manure and bedded material from the Organic Dairy Research Farm.
4. Measurements were initiated of the composting output of carbon dioxide, methane, oxygen and ammonia generated.

Results
Experiments continue to optimize conditions for static pile aerobic composting, in order to maximize BTU captured, while balancing the outputs of oxygen and greenhouse gasses.

4. Associated Knowledge Areas

KA Code	Knowledge Area
401	Structures, Facilities, and General Purpose Farm Supplies
403	Waste Disposal, Recycling, and Reuse
605	Natural Resource and Environmental Economics

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Other ()

Brief Explanation

No external factors influenced outcomes in this planned program for 2015

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Participants of Preparing for Climate Change program (UNHCE) reported satisfaction with the program and plan to use the skill and knowledge learned at their respective workplace.
Several of the NHAES research projects covered in the planned program have been very

productive as measured by numbers of peer-reviewed publications, invited presentations at conferences and the ability to leverage NHAES funding with external competitive grants.

Key Items of Evaluation

- 10,633 new acres were put under forest management plans and an additional 14,614 acres were referred to NH Foresters to or update initiate plans with an additional 69,787 acres of tree farms inspected to comply with or exceed NH stewardship standards. (UNHCE)
- Approximately 80% of the 290 New Hampshire licensed foresters attended at least one workshop to maintain their certification.(UNHCE)
- NHAES sponsored laboratory and field experiments and meta-analyses were used to compare the impact of conventional agricultural management practices (CT) and organic practices (ORG): ORG had 50% (±8 se) higher carbon use efficiency and 56% higher growth rate (± 22 se) relative to CT ($p < 0.05$).

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%		37%	
402	Engineering Systems and Equipment	0%		13%	
403	Waste Disposal, Recycling, and Reuse	0%		10%	
601	Economics of Agricultural Production and Farm Management	10%		10%	
602	Business Management, Finance, and Taxation	20%		0%	
605	Natural Resource and Environmental Economics	20%		0%	
608	Community Resource Planning and Development	50%		5%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	0%		25%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	11.0	0.0	1.9	0.0
Actual Paid	12.0	0.0	0.8	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**
169976	0	74590	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
169976	0	60252	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
344379	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

UNHCE activities
Forums

- Community Profiles
- Master Plan, visioning
- action planning, focus groups
- Other targeted community forums (charrettes, etc.)

One-on-one education/consultation:

- Site visits Phone
- Email
- video chats
- walk-in clients
- One-on-one assistance to businesses and municipalities

Collaboration

- Technical Assistance to state agencies/organizations
- Working with boards/town committees
- Community collaborations/boards

Workshops

- Practitioner trainings and Institutes

Cooperative Extension will conduct:

- 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 Research

- A multi-year project was initiated to examine problems faced by farmers in Northern New England and

to assess consumer attitudes about local produce, especially for their willingness to pay a premium for locally/organically grown produce.

- Research was conducted on managing plastic film (e.g. grocery bags) at the state/local level.
- The demographic impact of the great recession and post-recession period in rural Northern New England was assessed, and results were disseminated

2. Brief description of the target audience

NHAES research and Cooperative Extension target audiences included: Scientists, undergraduate and graduate students, citizens, land use professionals, homeowners, legislators, contractors, rural business, rural residents, demographers, social and natural scientists as well as policy-makers and the media. Other stakeholders are 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. Finally target audiences include 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?

eXtension resources from the Entrepreneurs and their Communities Community of Practice were utilized and some fact sheets were developed by UNH Cooperative Extension for eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	3225	1670	50	18

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

Patent Applications Submitted

Year: 2015

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	2	7	9

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of people attending workshops/twighlight meetings

Year	Actual
2015	1550

Output #2

Output Measure

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

Year	Actual
2015	13

Output #3

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
2015	60

Output #4

Output Measure

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

Output #5

Output Measure

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

Year	Actual
2015	1124

Output #6

Output Measure

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

Year	Actual

2015	7

Output #7

Output Measure

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

Year	Actual
2015	26

Output #8

Output Measure

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

Year	Actual
2015	74

Output #9

Output Measure

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

Year	Actual
2015	53

Output #10

Output Measure

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

Year	Actual
2015	8

Output #11

Output Measure

- Number of graduate students directly involved in research project.

Year	Actual
2015	7

Output #12

Output Measure

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

Year	Actual
2015	6

Output #13

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2015	47

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of groups around the state to implement participatory decision-making processes as a result of Civic Participation and Leadership Team activities (i.e. Master Plan Visioning Session, Community Profile Action Planning, strategic planning)
2	Number of communities that build a knowledge base of resources for building civic engagement and leadership
3	Number of communities that work with Extension to implement mechanisms/tools to analyze the current situation and identify emerging issues to be addressed.
4	Number of community leaders who develop a new understanding of the issues facing their community.
5	Number of NH growers who increase their skills, knowledge, and/or awareness of farm management techniques, risk management programs, or marketing practices
6	Number of new businesses started
7	Number of NH growers who formulate plans to guide their crop production pest management, nutrient allocation and business management decisions
8	Number of presentations to civic and government entities to increase knowledge of demographics and migration in the region and nation.
9	Availability of modified production systems for woody nursery crops in northern nurseries.
10	Improved methods to facilitate two-way communications between public and decision makers, and survey instruments associated with natural resource and agriculture management
11	Disseminate results from economic feasibility experiments to heat pumps for greenhouse climate control greens production in Northern New England.
12	Disseminate results of hydroponically-grown, salad green and herbs variety trials.
13	Assessment of the economic feasibility of growing salad greens in minimally heated greenhouses.

Outcome #1

1. Outcome Measures

Number of groups around the state to implement participatory decision-making processes as a result of Civic Participation and Leadership Team activities (i.e. Master Plan Visioning Session, Community Profile Action Planning, strategic planning)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	15

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Public participation on community boards, committees, and events communities has steadily declined over the past four decades. One result is that local economic development and land use decisions, plans, and policies increasingly lack public input and support. Municipal leaders have asked for Extension's help in catalyzing new leadership and volunteerism in communities to reweave the civic fabric that has eroded over the past four decades.

What has been done
Successful Community visioning processes were held in 7 communities, engaging over 700 community residents in local decision-making.

Results
Out of those 700 engaged, 157 took on formal leadership roles in their communities. They led action committees: that resulted in cleaning up of downtown parks, filled vacant downtown buildings with four new businesses, took roles on planning boards and conservation commissions, and developed new community communication channels.

4. Associated Knowledge Areas

KA Code	Knowledge Area
602	Business Management, Finance, and Taxation
608	Community Resource Planning and Development

Outcome #2

1. Outcome Measures

Number of communities that build a knowledge base of resources for building civic engagement and leadership

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	7

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Public participation on community boards, committees, and events communities has steadily declined over the past four decades.

What has been done
Through workshops and hands-on training, UNHCE builds communities? capacity to address issues of public concern by helping them cultivate effective local leadership, foster collaboration, and engage the public in community decision-making and action.

Results
157 local volunteers received training to implement projects and activities in their own communities.

4. Associated Knowledge Areas

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

Outcome #3

1. Outcome Measures

Number of communities that work with Extension to implement mechanisms/tools to analyze the current situation and identify emerging issues to be addressed.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done
Cooperative Extension conducted community needs assessments in three communities focusing on different topics. Needs assessment are an important tool in community development and our model is to engage a local partner and teach community volunteers to do the work. This allows them to get a greater understanding of the needs and to develop community connections which serve them well when they are moving to program development.

Results
The needs assessment in one town, for example, identified a need for expanded funding to address energy efficiency and a committee was formed, which is now implementing actions that conserve energy by the residential, governmental, and commercial venues.

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 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
2015	207

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Communities often make decisions that do not reflect local residents? perceptions. As a result, such decisions often do not get buy-in or local support.

What has been done
Through multiple community engagement processes, extension has helped over 7 communities and a dozen organizations to engage constituents in developing shared values/ vision, and commitment towards action.

Results
207 leaders helped to implement public engagement processes in their respective communities, which have resulted in the formation of 23 action committees that are pursuing community-based projects and actions.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

Number of NH growers who increase their skills, knowledge, and/or awareness of farm management techniques, risk management programs, or marketing practices

Not Reporting on this Outcome Measure

Outcome #6

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
2015	4

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Rural towns are struggling to keep small businesses, which keep downtowns vital, provide employment, and contribute to tax revenues.

What has been done
Extension's economic development visioning process focuses on catalyzing local projects, which may include the development of new businesses.

Results
The visioning process in just one town that Extension worked in Franklin, NH resulted in the creation of 4 new businesses. Those include a coffee shop, bike shop, art space, and property management.

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 #7

1. Outcome Measures

Number of NH growers who formulate plans to guide their crop production pest management, nutrient allocation and business management decisions

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	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
205	Plant Management Systems
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation

Outcome #8

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
2015	15

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A critical goal of this project is to evaluate demographic trends in the recessionary and post-recession period in rural America and to disseminate this to state, regional and national policy audiences and stakeholders through policy-oriented presentations

What has been done
Demographic analysis has been carried out based on census and other surveys.

Presentations on the demographic analysis were disseminated to
1. A National Academy of Science Panel on classifying rural areas, sponsored by the Economic Research Service of the USDA (including policy makers, planners, USDA officials and academics).
2. Senior staff of the US Forest Service for the Regional Planning Act 10 year.
3) NH State House Ways and Means Committee (demographic trends in NH)
4) NH Task force on Demographic Change

Results
1) The impact of the Great recession had the effect of "freezing people in place". This included the effect of reducing migration and diminishing fertility gains in rural areas. The demographic implications this had for specific rural areas differed.

2) 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.

3) In rural areas with histories of population loss or slow growth (farm areas), the Great Recession slowed the rate of population loss because migration losses diminished.

4) Detailed analysis of age-specific net migration patterns in rural counties documents distinct migration signatures for different types of rural counties with the sharpest contrast between rural farm counties and rural recreational counties.

5) Rural America is becoming more racially and ethnically diverse. Though the Great Recession slowed this process due to reduced migration and diminished fertility rates, 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.

5) The complex patterns of demographic change in rural America underscore the continuing need to develop methods to delineate and differentiate the rural landscape both so researchers can continue to track the population changes there and to inform rural policy-makers.

4. Associated Knowledge Areas

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

Outcome #9

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Understanding root cold tolerance levels of common woody species grown in containers allows growers more options for overwintering that will reduce labor and costs. This research and outreach supports the regional economy and provides environmental benefits from ecosystem services provided by healthy plants, including soil and water quality protection, carbon sequestration, wildlife habitat and preservation of local biodiversity.

What has been done

Laboratory experiments using a recirculating glycol bath and measuring electrolyte leakage from excised roots to measure root cold tolerance (RCT). Experiments were conducted for eight species over the course of the winter to determine how RCT varies as a result of the different container types and other environmental manipulations used for overwintering. Exposed plants of whole plants were cooled to the same temperatures, and then the potted plants were observed in a cold greenhouse for examination of growth and recovery.

Results
Root cold tolerance thresholds were determined for Itea virginica, Magnolia stellata, and Stephenandra incisa. The theoretical 50% RCT calculated from excised roots was compared to the whole plant response. The information generated can be adopted by nurseries by segregating more cold tolerant versus less tolerant species which may require different overwintering conditions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems

Outcome #10

1. Outcome Measures

Improved methods to facilitate two-way communications between public and decision makers, and survey instruments associated with natural resource and agriculture management

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
As the industrial base of New Hampshire and the northeastern United States has changed over recent decades, many local government and development agencies have been searching for industries which provide the right "fit" for their regions to replace lost jobs and stem out-migration from rural areas. Strategies are needed to identify and attract firms and industries which can replace some of this lost employment, as well as strategies to enhance human and social capital in these areas. One topic of particular interest in urban/rural fringe areas 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.

What has been done
A multi-disciplinary group of scientists working on social capital was formed to try to tie together the various disciplinary threads (sociology, economics, political science, etc.) that provide resources for the public and decision makers in rural communities.

Results
1. A journal article was published which presents results of focus group/survey efforts demonstrating the premium consumers are willing to pay for produce characteristics such as locally grown, organically grown, and appearance. For example, consumers in the study were found to be willing to pay 55% more for a locally grown cucumber than a non-local cucumber. The local premium appears much more important than the organic premium.
2.This multi-state working group published an edited textbook dealing with the role of social capital in strengthening communities' ability to respond to natural disasters, economic downturns, migration, and other issues. This text was authored by a multidisciplinary group of economists, sociologists, political scientists, planners, and engineers.

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 economic feasibility experiments to heat pumps for greenhouse climate control greens production in Northern New England.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Cold Season greenhouses maintained at warm temperatures generally consume large quantities of heating fuel, but also often require ventilation on sunnier days to release excess solar heat. NHAES funded research explored the use of some current air-to-water heat pump technology and thermal energy storage to capture and store excess solar heat for use at night to reduce fuel consumption.

What has been done

A heat pump was installed in one of paired greenhouses at the NHAES Woodman Horticulture farm. The heat pump was used to supplement a propane heater. Extensive measurements of the system performance were taken, and energy flows were characterized in detail by collaborator Ben Luce of Lyndon State College in Vermont. Predictive computer simulations were developed and used to analyze the results.

Results
The system studied reduced the oil consumption of a warm greenhouse in New Hampshire by nearly 45% during February through April. Actual performance was found to be consistent with simulation predictions based on Typical Meteorological Year data. Predictions of best possible results in all months and for a range of thermal storage capacities are provided. If the redelivery of heat is accomplished in a passive, low energy manner such as bed heating, this approach should be an effective mean to significantly reduce heating fuel consumption in cold season greenhouses, especially during the sunnier shoulder seasons. Results were disseminated at the Green Sys Conference in Evora Portugal in July 2015 and will be published this year: Krug, B.A. and B. Luce. 2016. Reduction in cold season greenhouse heating fuel via recovery of excess solar heat with heat pumps. Acta Hort. in press

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems

Outcome #12

1. Outcome Measures

Disseminate results of hydroponically-grown, salad green and herbs variety trials.

Not Reporting on this Outcome Measure

Outcome #13

1. Outcome Measures

Assessment of the economic feasibility of growing salad greens in minimally heated greenhouses.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual

2015 0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Strong consumer interest in locally produced vegetables is prompting growers (including large ornamental producers) to explore winter production of greens and herbs. A collaborative project at the NHAES evaluated the economic feasibility of growing salad greens in NH in the winter.

What has been done
A wide array of species grown for salad greens was evaluated in terms of growth characteristics and yield potential. Using representative species from three general groups (slow growth but high-yielding [spinach], moderate growth and high-yielding [lettuce], and fast growth but low-yielding [mizuna]), several experiments were conducted evaluating rate of growth compared with sowing date and greenhouse temperature.

Results
1. The productivity of various winter greens was summarized after three trials (November through April) of growth in greenhouses minimally heated to 40 degrees F with no supplemental light. The growth rate slowed from November to January. Growth responses are summarized in https://extension.unh.edu/resources/files/Resource003798_Rep5413.pdf
2. An enterprise budget was created for growing winter salad greens in minimally heated greenhouses (https://extension.unh.edu/resources//files/Resource003798_Rep5413.pdf, and several extension publications on winter greens production were released.

Winter salad greens production continues to expand in New Hampshire.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Other (The NHAES/UNHCE Greenhouse specialist left UNH in the spring on 2015, to take a job in industry.)

Brief Explanation

With the loss of the Greenhouse specialist in the spring of 2015, trails to evaluate greens and herbs varieties for hydroponics, and then disseminate results to growers, were put on hold.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

UNHCE

- Out of those 700 engaged, 157 took on formal leadership roles in their communities.

They led action committees that resulted in cleaning up of downtown parks, they filled vacant downtown buildings with four new businesses, they took roles on planning boards and conservation commissions, and they developed new community communication channels.

- 157 local volunteers received training to implement projects and activities in their own communities.
- 207 leaders helped to implement public engagement processes in their respective communities, which have resulted in the formation of 23 action committees that are pursuing community-based projects and actions.

NHAES:

Researchers associated with this planned were very productive, as measured by publications in peer-reviewed journals or as conference papers, and in giving testimony to state and federal agencies.

Key Items of Evaluation

For UNHCE, see the previous section

An NHAES researcher and a second member of the Hatch multi-state research project NE1049 edited a new book on Social Capital.

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
802	Human Development and Family Well-Being	25%		0%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	15%		0%	
805	Community Institutions, Health, and Social Services	20%		0%	
806	Youth Development	40%		0%	
	Total	100%		0%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	22.0	0.0	0.0	0.0
Actual Paid	22.0	0.0	0.0	0.0
Actual Volunteer	35.0	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**
411848	0	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
411848	0	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
2182007	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

UNHCE Applied research
Educational programs or events for youth, adults and/or families:

- Development,
- promotion,
- implementation
- evaluation (could be in person or on-line)

Private resource development:

- fundraising activities (includes managing/assisting a 4-H Foundation or Leaders Association)

Public relations/marketing/communications:

- general social media,
- newsletter,
- event and webpage development (i.e., not connected specifically to one program)

Technical assistance to programs, coalitions or organizations
Volunteer management (Recruitment, support, supervision and recognition)
Workshops or trainings for educators, professionals, and/or volunteers:

- program development,
- promotion,
- implementation,
- and evaluation (could be in person or on-line)

- 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 0-18, 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

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	27259	881	20343	304

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

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	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
2015	945

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
2015	5875

Output #3

Output Measure

- Number of youth attending Barry Conservation Camp

Year	Actual

2015	275

Output #4

Output Measure

- Number of adults participating in financial literacy programs

Year	Actual
2015	39

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 citizenship projects/events who show an increase in their knowledge about citizenship and an increase in their actual citizenship skills
2	Number of 4-H Volunteers, 4-H Staff, Afterschool Staff and other Youth Development practitioners receiving training and/or technical assistance who report providing environments for youth with essential positive youth development elements present (e.g., sense of belonging, mastery, independence, & generosity)
3	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
4	Number of program participants who document an increase in their financial literacy
5	Number of youth taking on leadership roles

Outcome #1

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2223

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Research would suggest that while structured out of school-time programs can result in the development of a wide range of life skills but for these activities to be successful as venues for substantial positive youth development, they need to be integrated into a broader community or context. Organized out of school activities and programs can have downstream benefits for communities as well, for example, in the late 1990s, it was estimated that Manchester NH saved over $72,000 in educational expenses through the implementation of effective after-school programming that helped youth avoid repeating grades or additional special education interventions and a 2002 report from the New Hampshire Charitable Foundation suggested that service learning is a useful method for helping youth to develop social capital within their communities. To this end, YRBS data suggests that in 2013 47% of NH youth feel like they matter to their communities (an increase since 2003) and there is there is evidence to suggest that youth in the NH north country who are involved in activities are more likely to feel this connection to their communities, and have mentors that give them greater hope for the future

What has been done
In 2015, all ten NH counties enrolled youth as part of the 4-H Positive Youth Development Program. Enrollment records suggest that over 2400 youth enrolled as 4-H members. These youth partnered with caring adults, both volunteers and staff, and participated in community-based programs designed upon the essential element of research-based positive youth development. Youth development groups included clubs and programs in out-of-school-time and home-school environments as well as events and activities at the local, county, state and national levels. All clubs perform citizenship/community service projects and multiple participants attended 4-H National Conference and Congress' premier citizenship events.

Results

1. 91% of surveyed 4 - H members said they agree or strongly agree that "I learned things that helped me make a difference in my community."
2. 66% of surveyed 4 - H members said they agree or strongly agree that "I led a project that made a difference in my community."
3. 4-H Clubs across the state completed over 404 community service projects. Individual members completed an additional 318. Volunteer leaders estimated youth spent over 18,000 hours engaging in these citizenship projects and activities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
805	Community Institutions, Health, and Social Services
806	Youth Development

Outcome #2

1. Outcome Measures

Number of 4-H Volunteers, 4-H Staff, Afterschool Staff and other Youth Development practitioners receiving training and/or technical assistance who report providing environments for youth with essential positive youth development elements present (e.g., sense of belonging, mastery, independence, & generosity)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	170

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
While NH youth on average may benefit from a prosperous state with a nationally admired standard of living, not all NH youth will not automatically thrive due to this. For example, 2014 Kids Count data suggests that NH was experiencing negative trends in four key economic well-being indicators. Additionally, Youth Risk Behavior Surveillance System (YRBS) surveys indicate that 20% of NH youth feel that they had been bullied at school at some point over the past 12 months and as much as 18% of youth at some point last year felt so sad or hopeless almost every day for two weeks or more in a row that they stopped doing some usual activities. Focus groups held across the state in 2013 by UNHCE corroborate this data as participants expressed concern for families in poverty, mental health issues, and job skill development.

Research would suggest that while structured out of school-time programs can result in the development of a wide range of life skills, but for these activities to be successful as venues for substantial positive youth development, they need to be integrated into a broader community or context.

What has been done

Through various professional development offerings UNH cooperative Extension staff trained over 1140 community teachers and educators in best practices in youth development, STEM Education, and Social Emotional Learning.

The 4-H Program utilized Volunteers to deliver programs to youth in community-based clubs, 4-H afterschool clubs, short-term special interest /short term programs, overnight camps, day camps, school enrichment programs. County and State staff provided support to nine hundred forty-five volunteers (945) who supported these delivery methods.
Utilizing different training methods, staff provided face to face volunteer orientation training for new volunteers, online and virtual training opportunities, state regional leader trainings, technical assistance and resources support. Volunteers of 4-H groups were surveyed documenting volunteer hours for club roles including, organization, project, resource and non-enrolled volunteer support (community volunteers) to groups.

Results

Belonging: Over 90% of 4-H Volunteers surveyed about their clubs or programs report that:
1. Youth feel safe in this program.
2. Youth try to help others to feel a part of the group.
3. Youth are kind to one another.

Mastery: Over 90% of 4-H Volunteers surveyed about their clubs or programs report that:
1. Youth learn something important in this program.
2. Youth learn from activities that are challenging but appropriate to their developmental level.
3. Youth have opportunities to share what they have learned.
4. Youth are recognized for their accomplishments.

Independence: Over 90% of 4-H Volunteers surveyed about their clubs or programs report that
1. Youth and adults work together to plan activities.
2. Youth are listened to by adults in this program.
3. This program helps youth feel better about themselves.
4. Feedback is encouraged and gathered from youth about their experience in this program.

Generosity: Over 90% of 4-H Volunteers surveyed about their clubs or programs report that
1. Youth help other (youth or adults) in some way in this program.
2. Youth participate in a variety of service activities.
3. The program reaches out to new youth who have not been involved in these kinds of programs

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being
805	Community Institutions, Health, and Social Services

Outcome #3

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
2015	128

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 adults and school age youth is more important than ever.

What has been done
Work by Science Literacy staff focuses on STEM programs for youth and adults. 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 as well as adults. 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, and computer science.

UNH Cooperative Extension 4-H staff implement venues for volunteers to teach 4-H members about Animal Science. 4-H'ers learn about Animal Husbandry and practice those skills through activities such as: quiz bowls, judging events, communication events, and hippology contests. Youth are reached in club settings, and after school groups

Results
UNHCE STEM Literacy Projects:
Over 90% of youth surveyed reported:
" I like to see how things are made or invented."
" I like experimenting and testing ideas."

4-H Animal Science Projects:
93% of the members reported that they think about the advantages and disadvantages of choices when making decisions pertaining to their animals.
100% of the members reported they make decisions about their animals based on what is best for their animal
86% reported that they keep records and know the actual costs of keeping an animal.
86% of the members reported that they can evaluate their animals based on the ideal animal for their species.
100% of the members reported that they know how to act safely around animals.

4. Associated Knowledge Areas

KA Code	Knowledge Area
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
806	Youth Development

Outcome #4

1. Outcome Measures

Number of program participants who document an increase in their financial literacy

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	39

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Financial literacy is the backbone of a healthy economy. Families challenged by risk factors are less likely to be able to manage their limited incomes than families with more time and resources

to apply money management.

What has been done
In 2015, UNHCE was at the tail end of phasing out its work in financial literacy programming. However, we did run one On-line course through the More Than Wheel program (focused on helping low-income people acquire car loans) and multiple face to face courses in a county jail for inmates

Results
All participants reported an increase in their financial literacy.

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #5

1. Outcome Measures

Number of youth taking on leadership roles

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	710

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
While NH youth on average may benefit from a prosperous state with a nationally admired standard of living, not all NH youth will not automatically thrive due to this. For example, 2014 Kids Count data suggests that NH was experiencing negative trends in four key economic well-being indicators. Additionally,Youth Risk Behavior Surveillance System (YRBS) surveys indicate that 20% of NH youth feel that they had been bullied at school at some point over the past 12 months and as much as 18% of youth at some point last year felt so sad or hopeless almost every day for two weeks or more in a row that they stopped doing some usual activities. Focus groups held across the state in 2013 by UNHCE corroborate this data as participants expressed

concern for families in poverty, mental health issues, and job skill development.
Research would suggest that while structured out of school-time programs can result in the development of a wide range of life skills, but for these activities to be successful as venues for substantial positive youth development, they need to be integrated into a broader community or context.

What has been done

In 2015, all ten NH counties enrolled youth as part of the 4-H Positive Youth Development Program. Enrollment records suggest that over 2400 youth enrolled as 4-H members. These youth partnered with caring adults, both volunteers and staff, and participated in community-based programs designed upon the essential element of research-based positive youth development. Youth development groups included clubs and programs in out-of-school-time and home-school environments as well as events and activities at the local, county, state and national levels. These programs provide multiple opportunities for youth to take on developmentally appropriate leadership roles.

Results

710 youth served in a leadership role for their club or group
424 youth served in a leadership role at the community, county or state level

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Other (none)

Brief Explanation

UNHCE is phasing out financial literacy programming and another state agency is taking over this work.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

1. Over 18,000 hours of youth engagement in citizenship projects and activities
2. 66% of surveyed 4 - H participants, reported that they led a project that made a difference in their community as a result of their participation in the 4-H program
3. 5875 youth were enrolled in 4-H as a 4-H club, after school or special interest group member

Key Items of Evaluation

The Youth and Family program trained 1142 educators across the state in youth mental health first AID, STEM education, mind fullness in education and youth development.

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)	
110	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)	
7	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
6	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.