2014 University of New Hampshire Research 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). It covers federal Hatch and corresponding matching and nonmatching funds. For FY2014, the University of New Hampshire Cooperative Extension (UNHCE), will report separately to NIFA. 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 FY2014 achievements are the result of NHAES support and, likewise, some of the achievements of NHAES 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.

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 activities spans the spectrum from basic research in modeling drivers in climate change, sources of Vibriosis threatening New England oyster farming, to applying genomic knowledge in marker assisted breeding, to more applied research. Examples of basic research include:

Several NHAES projects (Wollheim, McDowell, Ollinger) monitor nonpoint source nutrient flow into the Great Bay Estuary; the results of these studies are essential as New Hampshire and Maine communities work to reverse nitrogen and phosphorous impairment of the Great Bay, a national recognized estuary.

• Research conducted by Grandy (#230340) demonstrated a more efficient C cycling in organic cropping systems than conventional. New carbon inputs were more rapidly incorporated into biomass in the organic systems, which was related to 20 percent higher microbial growth rate, 15 percent higher biomass, and 20 percent higher growth efficiency. These differences in microbial physiology appear related to greater stabilization of new carbon inputs. Microbial communities in diverse organic cropping systems have microbial physiological characteristics that enhance the efficiency of new carbon input conversion to soil organic matter. (Plant Soil, 386:223-236, 2015)

• Findings from Ollinger (# 223368) suggest that at both short and long-term time horizons, biophysical factors such as albedo and surface heat fluxes may influence climate forcing more than biological processes such as carbon storage and greenhouse gas emissions. As a result, the current policy focus on carbon sequestration in soils and plant biomass may be too narrow for developing a comprehensive approach for mitigating climate change across a mixed-land use landscape. (Remote Sens Environ 158, 465-477. 2015).

• Research lead by Haney (#227004) demonstrated that microcystins toxins produced by cyanobacteria in lakes are transferred by irrigation and aerosols to food crops. Microcystins are hepatotoxins, and are also suspected as factors contributing the onset of Amyotrophic Lateral Sclerosis (ALS or Lou Gehrig's disease).

• Metagenomic studies led by Jones (#233555) demonstrated how Vibrio populations in oysters changed during relay to higher saline environments. These results point to the mechanism by which relay is effective for post-harvest treatment of oysters to reduce Vibrio concentrations before sale.

• Collaboration with two other New England land-grants allows NHAES to effectively leverage its resources to address regional agricultural priorities related to climate change. Invasive cropland weeds have a serious impact on crop production, and ongoing climate changes are likely to impact the current distribution of species (# 222761). The Maine Agricultural and Forest Experiment Station (MAFES), Vermont Agricultural Experiment Station (VTAES) and Cooperative Extension (VTCE), and the NHAES examined the changing diversity of weed species and their seed banks within Northern New England. Surveys were conducted on 77 organic vegetable farms across the three states. More than weed 52,000 seedlings were identified and enumerated, providing a broad picture of weed distribution in the three-state region. Species differed markedly with respect to morphological diversity, ranging from a lack of evident diversity among samples of hairy galinsoga (Galinsoga ciliata) to remarkable ranges of diversity in pigweed (Amaranthus spp.) and yellow wood sorrel (Oxalis stricta), the latter including variations in flower color and size, the extent of stem and petiole "hairiness," leaf color, and others.

NHAES provides many opportunities for experiential learning for undergraduates, resulting in better educational outcomes and, ultimately, producing well-qualified employees. Best College Reviews (http://www.bestcollegereviews.org/best-university-farms/) has ranked the UNH research farms in the top 20 nationwide, in part because of the variety of facilities (horticulture and agronomy, organic and conventional dairy, and greenhouses) and as farming at the University of New Hampshire is "more academically centered than at many institutions on our list." These 'UNH' facilities are in fact those of the NHAES.

Since the Great Recession, the number of farms in New Hampshire held steady at 4,400, bucking the continued loss of farm numbers and acreage across much of the country (2015 Ag Census.) Seventy per cent of New Hampshire farms are small and serve local markets. New Hampshire is second nationally in the percentage of farms with direct sales, with two counties, Hillsborough and Rockingham, in the top 40 of U.S. counties in direct market sales. Some of the research activities of the NHAES complement the renewed public interest in regional agriculture in New England and the growing local food movement.

Dairy research, vegetable trials, and season extension strategies all have direct value for the productivity of these small farms. With both conventional and organic research dairies, NHAES researchers have a unique opportunity to conduct comparative studies, which are of value to both conventional and organic dairy farmers and consumers of dairy products. Likewise, parts of the Woodman Horticulture Farm are maintained under organic practices, providing opportunities to support the diverse producers in the region.

NHAES research tests new ideas and technologies for regional agricultural operations and the nascent aquaculture industry, averting financial risk for regional producers while working to improve their operational bottom lines and sustainability. Specific examples of research outcomes in FY2014 include:

• Field peas, an alternative forage crop, have been shown to replace corn meal and soybean meal in dairy diets without negative impact on milk production and quality. These will reduce feed costs for dairy farmers in the Northeast.

market value of yields from a single 10x32m high tunnel by $10,000 or even more.

• Producers have greatly expanded production of sweet potatoes following NHAES field trials. UNHCE disseminated results to regional producers. The crop value for sweet potatoes has grown from $33,000 to $660,000 over a five year period.

A large segment of NH Agriculture includes production of bedding plants, and landscaping. Results from Krug's research (#226175) demonstrated that applying controlled release fertilizer to production of greenhouse bedding plants reduces fertilizer cost by 70 percent, while decreasing the release of nutrients in runoff by approximately ten fold compared to liquid fertilizer. These new recommendations for improved bedding plant fertilizers have been widely disseminated to growers and greenhouse managers.

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 FY2014, 18 percent of funding was from federal capacity funds, 24 percent was from state appropriations and 58 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 FY2014 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.

Licenses on plant varieties, especially summer squash, melon, pumpkin and winter squash, derived from J. Brent Loy's long-term breeding programs (#233554, #233556) represent the greatest proportion of royalties earned for the whole of the University of New Hampshire.

Research conducted by NHAES scientists is of the highest quality. This year, results of NHAES-funded science were published in high-impact journals such as PlosOne as well as in other leading journals for individual disciplines. NHAES scientists were invited to speak at national and international conferences and at scientific society meetings.

The NHAES administrative office added a communications and information coordinator in April 2014, thereby greatly augmenting our efforts to communicate research outcomes to all stakeholder groups. Page hits to the NHAES website have increased by 45% over FY2013 to ~33,000 per year. NHAES educational sessions offered at the annual New Hampshire Farm and Forest Expo are recorded and made available to broader audience on YouTube; there have been more than 550 viewings of the 2014 videos. Research results and agricultural practice recommendations are regularly communicated to regional producers through field days, workshops, email, websites, traditional and niche media, social media and newsletters. Weekly direct email bulletins promoting NHAES research and events reach more than 900 subscribers, including producers, policy makers, and industry representatives. Traditional statewide news media (newspapers, radio, and TV) and niche agricultural media regularly cover NHAES research. 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: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	28.3	0.0
Actual	0.0	0.0	38.3	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

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, high-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 competitivenes

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. 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, the impact of educational interventions on health measures of college age students, and how regional planning bodies use NHAES research outcomes. For example, the town of Durham and the University of NH have initiated a long term study of non-point N sources along the Oyster River, one of the seven rivers flowing into the N-impaired Great Bay Estuary. The design of the Oyster River study resulted from an on-going NHAES study of the nearby Lamprey River.

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 selected individuals from the general public
- Other (Comments from proposal and manuscript reveiwers,)

Brief explanation.

NHAES sought stakeholder input on activities and priorities using a variety of approaches: NHAES sponsored several public presentations and meetings, with traditional and nontraditional Stakeholders, both as individuals and groups. These included a twilight meeting at the Kingman Agronomy Farm (sponsored jointly with cooperative extension), a research field day the Organic Dairy Research Farm, and at an education session at NH Farm and Forest Expo (the largest gathering of agricultural and forestry industry in New Hampshire).

Other less formal events draw members of the general public. During FY14 these included: Granite State Dairies Open Barn Day (Fairchild Dairy); Durham Farm Days (Fairchild Dairy, Woodman Farm); Poinsettia Trials and Spring Greenhouse Open House (Macfarlane Research Greenhouses); and Employee Training Day for Stonyfield Yogurt Company (Organic Dairy Research Farm). Over the year, more than 3,861 members of the public visited the Fairchild Dairy, including NH Ag in the Classroom tour groups, summer camps, and various school groups. There were 3,520 visitors at Macfarlane Research Greenhouses who participated in open houses, a Farm Bureau members tour, Future Farmers of America events, various tours of regional school groups. The Organic Dairy Research Farm hosted 178 visitors. There were 550 visitors at the Woodman Horticultural Research Farm and 190 visitors to Kingman Farm. The farms, dairies, and greenhouses provide important venues for experiential learning for the University of New Hampshire serving a total of 65 courses from the College of Life Science and Agriculture, the Thompson School of Applied Science, and study arts classes from the College of Liberal Arts.
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Our researchers' value stakeholder input and participation, and we work to demonstrate to stakeholders how their input is incorporated in NHAES activities to encourage continued broad public engagement. Input by stakeholders for individual NHAES projects was encouraged in a variety of ways, appropriate to each project, through the use of:
Surveys (by phone, in person or web-based).
Presentations at scientific and/or general conferences (e.g., meeting with fisheries communities).
Focus groups.
Meetings for multistate projects.
Publications, mass media, and a new presence on social media (Facebook, Tumblr, Twitter).
Bringing NHAES to the university classroom and to K-12 students and teachers.

The NHAES director, the faculty fellow, and the new communications and information coordinator, Lori Wright, who joined the experiment station in April 2014, are exploring new ways to engage stakeholders. Weekly direct email bulletins promoting NHAES research and events reach more than 900 subscribers, including policy makers, industry representatives, and those with an interest in NHAES research. Traditional statewide news media (newspapers, radio, and TV) and niche agricultural media regularly cover NHAES research. NHAES research often is featured on high-traffic UNH websites such as the UNH Home Page and direct emailings, including UNH Today, which reaches 80,000 influencers weekly..

The NHAES website experienced a 45 percent increase in traffic compared with the previous year, accessed more than 33,000 times. It underwent a reorganization this year and is updated almost daily as part of our effort to make the experiment station and agriculture more prominent and accessible via the web. There has been a four-fold increase in "likes" on the NHAES Facebook page in the last year.
Through these activities, we are working to better target outreach to identify and engage nontraditional stakeholders, especially those who may be unaware of NHAES research outcomes.

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 Internal Focus Groups
- Use External Focus Groups
- Open Listening Sessions
- Use Surveys
- Other (UNH Cooperative Extension)

Brief explanation.

To identify both individual stakeholders and groups we partner with UNH Cooperative Extension; the NH Department of Agriculture, Markets andFood; the College of Life Science and Agriculture; the NHAES External (producer) Advisory Committee; and faculty and staff. The director, faculty fellow and communications coordinator are members of the NH Farm Bureau and the New England Farmers Union. The NHAES Director, the faculty fellow, and /or faculty participated in statewide initiatives and on state and regional committees (e.g., NH Current Use Board, NH State Conservation Committee) and the agenda meeting of the NH Farm Bureau.

The NHAES participates annually in the NH Farm and Forest Expo, which draws several thousand visitors each year. All together, these gatherings and meetings facilitate direct identification and communication with very large and diverse groups of stakeholders. Meeting with, and speaking to, participants at the Expo, research field days, the annual COLSA greenhouse open house, Granite State Dairy Open Barn, and extension conferences and workshops provides insights from grower groups, lakes monitoring associations, industry groups, professionals, home gardeners and state and federal government agencies. Other important opportunities to identify stakeholders and collect input include the liaisons with NH Department of Environmental Services; Piscataqua Region Estuaries Partnership (PREP), and town planning boards in the Great Bay Estuary. NHAES partners with the UNH Diversity and Affirmative Action & Equity Offices as well as Cooperative Extension to identify underrepresented or underserved constituents.

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 groups
- Meeting with traditional Stakeholder individuals
- Survey of traditional Stakeholder individuals
- Meeting specifically with non-traditional groups
- Meeting specifically with non-traditional individuals
- Meeting with invited selected individuals from the general public
- Other (peer review on manuscripts submitted for publication)

Brief explanation.

For strategic planning and the development of NHAES programs and priorities, we collected input primarily through the NHAES External Advisory Committee comprised of 20 members representing a broad spectrum of regional agriculture and conservation interests, as well as meetings with stakeholder groups and individuals, including:

- growers
- farmers
- citizens
- agricultural organizations and councils
- members of various watershed groups and lake associations
- representatives of state and federal agencies
- regional AES and Cooperative Extension administrators
- extension educations
- project directors of ongoing research projects and their graduate and undergraduate students

• members of the State Agricultural and Environment Committee of the State Legislature

The NHAES Director, faculty fellow, and research scientists participate in cooperative extension workshops to provide a way of transferring knowledge while taking a pulse of the concerns of major stakeholder groups.

NHAES projects obtained direct and indirect stakeholder input in various ways. Projects with social science components used interviews, questionnaires, and some online surveys. Basic science projects received input in the form of reviewer comments to proposals and manuscripts. Additional inputs were obtained during discussions at regional, national, and international meetings. For other projects, end users were able to ask questions of, and provide comments to, researchers during workshops and training sessions.

3. A statement of how the input will be considered

- In the Budget Process
- To Identify Emerging Issues
- Redirect Research Programs
- In the Staff Hiring Process
- In the Action Plans
- To Set Priorities
- Other (Strategic Initiatives Development)

Brief explanation.

Stakeholder input was incorporated into ongoing activities and in strategic planning. Then NHAES Advisory External Advisory Committee told us that many members of the producer community were not aware of research studies, so in 2014 the NHAES office was reconfigured to add a communications specialist.

We continue to look at both ongoing needs and anticipated changes in demands for NHAES activities as the agricultural landscape changes on a state and regional basis. For example, we are responding to requests to support research, training, and outreach for integrated activities that benefit diversified small farms as well as traditional interests in dairy and ornamental horticultural production. Ongoing field days at research farms and greenhouses are aimed at engaging stakeholders and communicating NHAES research activities. Owners of small dairy farms told it us it was hard to for them to travel to research field days or NH Farm and Forest Expo, so we have made video recordings of NHAES education presentations available via YouTube.

Brief Explanation of what you learned from your Stakeholders

• NHAES studies in the production of alternative forage crops for dairy cattle followed survey and focus groups results for priorities from region producers.

• Focus groups and surveys are being used to assess the potential to expand local agriculture in Northern New England. Survey respondents have changed their primary source of fresh produce from the grocery store to farmers markets or directly from producer. The top reasons respondents purchase local fresh produce are concern for healthy eating, quality of the produce, and to support local farms. This is true across all age, education, income, and gender levels.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	1887485	0

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	0	0	1365514	0
Actual Matching	0	0	1774495	0
Actual All Other	0	0	2474	0
Total Actual Expended	0	0	3142483	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	0	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
305	Animal Physiological Processes			20%	
701	Nutrient Composition of Food			5%	
702	Requirements and Function of Nutrients and Other Food Components			52%	
704	Nutrition and Hunger in the Population			13%	
723	Hazards to Human Health and Safety			10%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.6	0.0
Actual Paid	0.0	0.0	0.6	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**
0	0	46438	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	41382	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

NHAES researchers will:

• Use mass spectrometry data to quantify changes epigenetic changes in chromatin (modification of protein and DNA) of cultured mouse fat cells, and compare these changes in different nutritional states;
• Examine the effects of inflammatory omega-6 fatty acids and non-inflammatory omega-3 fatty acids, from dairy fats, on the development of respiratory allergy in an animal model;
• Compare dairy fats of milk from conventional total mixed ration-fed cows, which are known to be higher in omega-6 fatty acids, with that of pasture-fed organic dairy cows, which are known to be higher in omega-3 fatty acids;
• Develop community-based education programs to improve diet and activity in older adults, which can be refined and evaluated in future projects.

2. Brief description of the target audience

This project is intended to benefit the health of people across New Hampshire and the region, while making the conduct of scientific research more transparent to community partners, stakeholders, and the public.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1857	656	0	0

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

Patent Applications Submitted

Year:	2014
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	5	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2014	10

Output #2

Output Measure

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

Year	Actual
2014	4

Output #3

Output Measure

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

Year	Actual
2014	8

Output #4

Output Measure

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

Year	Actual
2014	2

Output #5

Output Measure

- Number of reviewed, bulletin, popular and other publications

Year	Actual
2014	5

Output #6

Output Measure

- Number of graduate students directly involved in the research.

Year	Actual
2014	3

Output #7

Output Measure

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

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of graduate students trained and ready to enter the workforce.
2	Number of undergraduate students involved and trained in engagement research.
3	Evaluate the hypothesis: Milk fat consumption of pasture-fed cows will have a more protective effect against development of allergy development than milk fat cows fed a total mixed ration diet.
4	Enhanced understanding of epigenetic processes in cultured fat cells that may influence fat accumulation
5	Measurable improvement in dietary consumption of whole grains by older adults participating in whole grains foods education training
6	Evaluate whether the increased in prevalence of respiratory allergy and asthma is a correlated with changes in the ratio dietary of omega 6 and omega 3 fatty acids
7	Evaluate whether the fire retardant polybromal biphenylethers (PDPE) disrupt glucose and fatty acid metabolism in a way that may contribute to the growing obesity epidemic in the developed world.

Outcome #1

1. Outcome Measures

Number of graduate students trained and ready to enter the workforce.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
702	Requirements and Function of Nutrients and Other Food Components
704	Nutrition and Hunger in the Population
723	Hazards to Human Health and Safety

Outcome #2

1. Outcome Measures

Number of undergraduate students involved and trained in engagement research.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	10

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
702	Requirements and Function of Nutrients and Other Food Components
704	Nutrition and Hunger in the Population
723	Hazards to Human Health and Safety

Outcome #3

1. Outcome Measures

Evaluate the hypothesis: Milk fat consumption of pasture-fed cows will have a more protective effect against development of allergy development than milk fat cows fed a total mixed ration diet.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The trend in respiratory disease has been paralleled by a rise in obesity and change in composition of U.S. diets characteristically high in energy density and imbalanced in omega-6 and omega-3 fatty acids (fa). Arachidonic acid (AA) is an omega-6-fa and is a substrate for prostagladin E2 (PGE2), which stimulates increased antigen sensitivity. Is the evidence that increased dietary AA correlates with biological markers for allergens, PGE2, antibody IgE and cytokines?

What has been done
Animal studies: Mice were fed diets that varied in ratio of omega-6/omega-3 fa, and then sensitized to chicken ovalbumin. Diet effects on lung macrophage cells (AVM) release of allergy markers, and gene expression were studied. Additional cell culture studies examined the relationship between AA and PGE2.

Results
Animal studies:PGE2 production of AVM of mice fed 6:1 and 15:1 fa diets were more than two times higher than from AVM of mice fed 1:1 diet for six weeks ($p < 0.01$)

Cell culture studies:Release of PGE 2 increased linearly to doses of AA and decreased linearly to omega-3 fa ($p<0.05$). atty acid analysis of AVM showed close correspondence between fatty acid content of cells and fatty acid treatments.

Together, these results are consistent with the working hypothesis that the changing composition of omega-6 and omega-3 fatty acids in human diets leads to increased sensitivity to respiratory disease.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components

Outcome #4

1. Outcome Measures

Enhanced understanding of epigenetic processes in cultured fat cells that may influence fat accumulation

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Metabolic disease has become a substantial medical and economic burden to the modern society. Though manifested through multiple complications, disturbance in adipose tissue homeostasis lies in the center of the metabolic syndrome. This study examines how development of adipose cells (adipogenesis) is influenced by epigenetic changes, specifically chromatin remodeling.

What has been done
DNA is wrapped around histone proteins in chromatin. Post-translational modifications to histone proteins influence how tightly the bind DNA, and hence what genes are expressed. This project developed very precise quantitative methods to identify chemical modifications in histones in preadipocytes during differentiation and investigated how nutritional factors impact those histone modifications.

Results
Using a systematic approach enabled by quantitative mass spectrometric approach, substantial changes in multiple histone modifications were quantified. The most prominent change takes place on histone H4 Lys16. This study reveals complex changes in methylation on K27/K36, suggesting multiple chromatin subdomains that respond differently during preadipocyte differentiation. In summary, our study, for the first time, describes the transformation of global histone modification landscape during adipocyte differentiation. Key chromatin factors that regulate these changes in histone modifications can serve as molecular targets to modulate adipogenesis and alleviate metabolic syndrome. Results indicate the histone actyltransferase, MYST1, is a novel chromatin factor in fat cell development. Conceivably, inhibitors that disrupt either its enzymatic activities or its interactions with MLL/SET complex have the potential to treat metabolic syndrome. The high-density, quantitative profiles of histone modifications generated from our study provide useful resources to other researchers, aiming to understand molecular details of adipogenesis and to develop pharmacological agents for the management of metabolic syndrome.

4. Associated Knowledge Areas

KA Code	Knowledge Area
702	Requirements and Function of Nutrients and Other Food Components

Outcome #5

1. Outcome Measures

Measurable improvement in dietary consumption of whole grains by older adults participating in whole grains foods education training

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Eating whole grains is know to reduce some of chronic disease risks in older adults. The average adult in America eats less than one serving of the recommended three serving minimum of whole grains each day. Consumption of whole grains in older adults is particularly low.

of our collaborative research project to investigate barriers to fruit, vegetable and whole grains in older adults, this pilot study investigated the effectiveness of a three-session nutrition education program, entitled Is It Whole Grain? to improve older adults knowledge, identification and consumption of whole grains.There is a need to test the efficacy of educational interventions for older adults to increase whole grain consumption.

What has been done
As part of collaborative research project to investigate barriers to fruit, vegetable and whole grains in older adults, a pilot study investigated the effectiveness of a three-session nutrition education program, titled "Is It Whole Grain? to improve older adults knowledge, identification and consumption of whole grains.

Results
Based on the analysis of pre- and post-intervention whole grain questionnaire responses from 157 older adults, aged 60 or older, residing in New Hampshire and Iowa, significant improvements in older adults' knowledge and intake frequency of whole grains were shown. Participants' mean pre- to post- whole grain knowledge scores increased significantly from 15.46 ± 0.38 to 21.96 ± 0.31 ($p < 0.001$). Participants' median frequency of whole grains consumed increased significantly from eight to ten times a week ($p=0.009$).

4. Associated Knowledge Areas

KA Code	Knowledge Area
702	Requirements and Function of Nutrients and Other Food Components
704	Nutrition and Hunger in the Population

Outcome #6

1. Outcome Measures

Evaluate whether the increased in prevalence of respiratory allergy and asthma is a correlated with changes in the ratio dietary of omega 6 and omega 3 fatty acids

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In the US has been a steady increase in prevalence of respiratory allergy and asthma. This is paralleled by a rise in obesity and change in composition of diet. Animal meat protein has become an important dietary source of Arachidonic acid. This omega 6 fa is precursor to a prostoglandin E2 (PGE2), which contributes to stimulating immune cell functions toward development of increased antigen-sensitization and allergy development. Do the ratio of dietary omega6:3 fa influence respiratory allergy and asthma biomarkers?

What has been done
Human studies: The relationship between diet and allergy sensitization, levels of specific-Ig E antibodies to common respiratory allergens were studied in 60 young adult obese and non-obese women, with and without asthma.

Results
Sensitization, sp IgE. antibodies and intake of AA were higher among obese vs. non obese; and between women with asthma than no asthma ($p<0.05$). Dietary AA correlated significantly with intake of animal protein ($r = .8; p<0.01$)) and with sensitization and antibody levels ($p<0.01$).

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components

Outcome #7

1. Outcome Measures

Evaluate whether the fire retardant polybromal biphenylethers (PDPE) disrupt glucose and fatty acid metabolism in a way that may contribute to the growing obesity epidemic in the developed world.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
One class of flame retardants ? polybrominated diphenyl ethers, or PBDEs ? associated with childrens' pajamas affect has been shown to be persistent in the environment. Previous work has shown this chemical can be found in the plasma serum of young adults. Research carried out this year was to test whether PDPE disrupts glucose and lipid metabolism in a rat model, consistent with the hypothesis that PDPE acts as 'obesogen'.

or PEPCK, could be the source of this disruption. We've learned that PBDEs suppress liver PEPCK activity by about 40%, reduce the amount of PEPCK protein by about 25% and reduce the activity of a specialized liver metabolic pathway by about

40%.

What has been done
Several experiments were carried out with male rats, whose diet was supplemented either with low levels of PDPE in corn oil (treatment) or corn oil alone (control).The first project looked at whether PDPE disrupted glucose and fatty acid metabolism. The second project examined where PDPE caused changes in the level of a key regulatory enzyme in glucose and fatty acid

metabolism: Phosphoenolpyruvate carboxykinase (PEPCK).

Results
1. After 28 days and a 48-hour fast, blood from PBDE-treated rats had significantly higher ketones, but lower glucose and triglycerides, compared to controls. This suggested that livers of PBDE-treated rats were unable to maintain glucose and lipid homeostasis.
2.Both PEPCK protein and glyceroneogeneis rates were reduced by 25 percent and 42 percent respectively in PDPE treated rates compared to controls, suggesting that a suppression in PEPCK protein reduces PEPCK activity, which reduces metabolic flow through glyceroneogenesis.
are consistent with the hypothesis that the environmentally persistent organic chemical PDPE may act to promote weight gain in humans.

4. Associated Knowledge Areas

KA Code	Knowledge Area
305	Animal Physiological Processes
723	Hazards to Human Health and Safety

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Other (Change in Experimental design)

Brief Explanation

Focus of research on the effects of balance of n-6/n-3 fatty acids from conventional versus organic pasture feed dairy on propensity of animals/humans to be sensitized to respiratory allergens was shifted from milk to meat products for two reasons. First, the results of the human study indicated that the consumption of meat products and intake of arachadonic fatty acid (AA) in meat products and not dairy correlated strongly with increased sensitization and elevated specific antibodies to respiratory allergens. Secondly, the wide variation in fat content of dairy products consumed made assessing the effects of milk more complicated, logistically.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The principal means of evaluation of activities in this planned program were acceptance of manuscripts for publication in peer-reviewed journals, invited presentations and participation in professional meetings. In FY 2014, five peer-reviewed papers were submitted or published from research projects in this planned program FY2014. Five presentations were presented in professional meetings. By these criteria, all research projects in this planned program continue to be effective.

Key Items of Evaluation

The flame retardant polybrominated diphenyl ether (PDPE), is know to persist in the environment and accumulates in the bodies of young adults. Animal studies confirmed that

PDPE reduces the level of phosphoenolpyruvate carboxy kinase, a key enzyme in glucose and fat metabolism. These results are consistent with the hypothesis that PDPE may an obesogen, contributing to the epidemic of obesity in the US.
Sensitization measured as IgE antibodies levels and intake of arachadonic acid, an omega-6 fatty acid (AA) were higher among obese vs. non obese; and between women with asthma than no asthma ($p<0.05$). Dietary AA correlated significantly with intake of animal protein ($r = .8; p<0.01$)) and with sensitization and antibody levels ($p<0.01$).

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Climate Change

☑ 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			7%	
102	Soil, Plant, Water, Nutrient Relationships			41%	
112	Watershed Protection and Management			12%	
131	Alternative Uses of Land			33%	
401	Structures, Facilities, and General Purpose Farm Supplies			2%	
403	Waste Disposal, Recycling, and Reuse			3%	
605	Natural Resource and Environmental Economics			2%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	2.9	0.0
Actual Paid	0.0	0.0	3.8	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**
0	0	165030	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	132117	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

Activity for the program includes:

• Measuring C pools and greenhouse gas emissions (CO_2, CH_4, N_2O) in agricultural and suburban landscapes and comparing these data with data previously collected from forest plots in the same area
• Using the combined data set to calibrate a high spectral resolution remote sensing image from NASA's AVIRIS instrument in the Durham, NH area
• Using the field and remote sensing data to parameterize the denitrification decomposition (DNDC) computer simulation model, validate and upscale model predictions
• Generating spatially continuous predictions of C pools, greenhouse gas emissions, and reflection of solar radiation (shortwave albedo) to determine the net radiative forcing values (in W m^{-2}) for the major components of the landscape (mowed versus grazed pasture, corn fields, forest, and suburban lawns)
• Making future projections of C, N and water balances for both agricultural and forested landscape units, using newly available CO_2 and climate change projections through 2100.
• Investigating the effects of different cropping systems, soil insects, and microbial community composition on Soil Organic Matter (SOM) turnover and soil nitrogen cycling.

2. Brief description of the target audience

Target audiences include agricultural producers, natural resource managers,consumers, those involved in the related food products and marketing webs, land managers, scientists, public policy makers, and those who rely on agricultural and forest products currently and will in the future. Ultimately, all citizens in New Hampshire, New England, and the United States have a strong stake in this topic and, therefore, the research outcomes.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	821	2230	441	299

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

Patent Applications Submitted

Year: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	18	18

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2014	16

Output #2

Output Measure

- Number of graduate students directly involved in the project

Year	Actual
2014	5

Output #3

Output Measure

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

Year	Actual

2014	3

Output #4

Output Measure

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

Year	Actual
2014	16

Output #5

Output Measure

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

Year	Actual
2014	16

Output #6

Output Measure

- Number of websites in which project results have been incorporated

Year	Actual
2014	4

Output #7

Output Measure

- Postdocs and other scientists taking who learn climate change research methods.

Year	Actual
2014	5

Output #8

Output Measure

- Produce a detailed database of carbon pools in soils and plant biomass and soil greenhouse gas emissions as well as information about farm management practices was amassed for use in calibrating and validating process-based models of drivers of climate change (Community Land Model).

Year	Actual
2014	1

Output #9

Output Measure

- Documented concentration of total dissolved nitrogen in wet deposition (rain, snow) in the Great Bay watershed over three years.

Year	Actual
2014	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of graduate students trained to become the future generation of scientists.
2	Information relayed to non-scientific stakeholders through integrated research and extension partnerships.
3	Unbiased knowledge about tradeoffs among multiple land management strategies in terms of their net climate effect.
4	Understanding the impact of atmospheric deposition on water quality in order to develop management strategies that stakeholders can used to improve water quality.
5	Address microbial contributions to soil organic matter accumulation, and also to the timing and extent of soil organic matter (SOM) loss and N mineralization in various cropping systems

Outcome #1

1. Outcome Measures

Number of graduate students trained to become the future generation of scientists.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results
This quantitative measure only counts students who have completed a MS or Ph.D. degree

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

Information relayed to non-scientific stakeholders through integrated research and extension partnerships.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	10

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
It is well accepted that ecosystems respond to climate variability, atmospheric deposition, and changing landscapes. Detailed measurements and modeling of the responses provide critical information of local communities to develop more sustainable practices and protect sensitive ecosystems such as New Hampshire's Great Bay Estuary.

What has been done
The amount of nutrients and acids in precipitation has been assessed through continued long-term sampling of rain chemistry in New Hampshire. Baseline quantification of the magnitude of and timing of nitrogen fluxes were determined for the Lamprey River and Oyster River. A budget was determined to net radiative forcing of mixed forested, agricultural and residential landscape while carbon pools and greenhouse emissions were measured over these landscapes.

Results
Wet deposition is the largest source of imported of nitrogen (29 percent) in both the Great Bay watershed and the Lamprey River watershed. These results were communicated to multiple stakeholder and policy groups in public presentations throughout the year and through reports to the Lamprey River Hydrologic Observatory and the Durham/UNH Integrated Permit Project Team/Agency. Results of landscape modeling were presented to the New England Society of American Foresters, the Society for the Protection of New Hampshire Forests and via a report for the National Center for Climate Education.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
131	Alternative Uses of Land
401	Structures, Facilities, and General Purpose Farm Supplies
403	Waste Disposal, Recycling, and Reuse

Outcome #3

1. Outcome Measures

Unbiased knowledge about tradeoffs among multiple land management strategies in terms of their net climate effect.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Climate change and ecosystems processes are influenced by mixed land including agriculture, forest and residential homes. Carbon storage, non-carbon greenhouse gas emissions and surface energy exchange mediated by shortwave albedo, are altered by land management; each can have climate consequences that either offset or exacerbate one another. Thus far, there are few tools available to help scientists or policy makers weigh the relative tradeoffs of various land cover types and land management activities for climate mitigation strategies.

What has been done
Over the course of this project, a database was amassed of carbon pools and greenhouse emissions. Remote sensing images were calibrated for foliar N and albedo. Model simulations with the DeNitrification-DeComposition (DNDC) model were used for estimating carbon storage and greenhouse gas losses in agricultural landscapes. Synergistic efforts with NH EPSCoR have allowed estimates carbon pools and greenhouse gas emissions in the forested portion of the study area using the Photosynthesis (Pn) and EvapoTranspiration (PnET) model.

Results
Findings to date suggest that at both short and long-term time horizons, biophysical factors such as albedo and surface heat fluxes may influence climate forcing more than biological processes such as carbon storage and greenhouse gas emissions. As a result, the current policy focus on carbon sequestration in soils and plant biomass may be too narrow for developing a comprehensive approach for mitigating climate change across a mixed land use landscape.

4. Associated Knowledge Areas

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

112	Watershed Protection and Management
131	Alternative Uses of Land

Outcome #4

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Atmospheric deposition,the transfer of nutrients, metals, and microbes from the atmosphere to the earth's surface, is a fundamental part of environmental health. This information is useful for assessing the impacts of dirty rain on ecosystem health, relative to other human impacts such as forestry and agriculture. This information has been critically important in local discussions and decision-making related to management of New Hampshire's Great Bay Estuary. The primary output of the project is the dissemination of findings that quantify the magnitude of atmospheric deposition of various pollutants in temperate and tropical watersheds.

What has been done
Quantifying the amount of nutrients and acids in precipitation has been assessed through continued long-term sampling of rain chemistry in New Hampshire and Puerto Rico.

Results
One NHAES project documented that the concentration of total dissolved nitrogen in wet deposition (precipitation and snowfall) in southeastern New Hampshire ranged from 0.56-0.66 mg N/L on an average annual basis from 2011 to 2013. Total annual precipitation amounts from 2011-2013 have ranged from 1028 to 1303 mm/yr. Wet deposition is the largest source of imported of nitrogen in both the Great Bay watershed and the Lamprey River watershed. Based on the Great Bay Nitrogen Non-Point Source Study conducted by the NH Department of Environmental Services (2014), it is estimated that approximately 29 percent of the total nitrogen (both point and non-point sources) delivered to Great Bay is from atmospheric deposition. Isotopic signature of nitrate found in several streams throughout the Great Bay watershed does not reflect the isotopic signature of wet deposition and suggests that the nitrogen originating from atmospheric deposition is highly processed prior to reaching Great Bay.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management

Outcome #5

1. Outcome Measures

Address microbial contributions to soil organic matter accumulation, and also to the timing and extent of soil organic matter (SOM) loss 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
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The loss of soil organic matter (SOM) is one of the greatest challenges to agricultural sustainability. It has enhanced soil compaction and trace gas emissions,increased dependence upon external fertilizer inputs, and exacerbated environmental nitrogen losses.

What has been done
If soil organic matter is predominantly microbial biomass, plant inputs that build biomass should also increase Soil Organic Matter (SOM). The MIcrobial-MIneral Carbon Stabilization (MIMICS) model, newly built upon the Community Land Model (CLM) platform, was used with meta-analyzes of with a new microbial-explicit soil biogeochemistry model to explore the relationships between plant litter chemistry, microbial communities, and SOM stabilization in different soil types and with different management practices.

Results
Globally that the highest SOM concentrations are associated with plant inputs containing low C/N ratios. These results are confirmed by individual tracer studies pointing to greater stabilization of low C/N ratio inputs, particularly in clay soils. Reconsideration of the mechanisms stabilizing SOM also will challenge long-held views about how to optimize plant community management to increase SOM.

New carbon inputs are more rapidly incorporated into biomass in organic systems, which is related to 20 percent higher microbial growth rate, 15 percent higher biomass, and 20 per cent

higher growth efficiency. These differences in microbial physiology appear related to greater stabilization of new carbon inputs. Thus,microbial communities in diverse organic cropping systems have microbial physiological characteristics that enhance the efficiency of new carbon input conversion to soil organic matter.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Other (none)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

While research projects in this planned program are at different states of maturity, all are considered successful and productive.

- Publication of peer-reviewed papers in high impact journals. There were 18 publications from resulting from several of the research projects. Many were in high impact journals.
- Presentations in major national and international conferences: all three projects in the planned program have featured presentations at national and international meetings.
- Results of the atmospheric deposition program are being incorporated in local and regional planning efforts to ameliorate eutrophication of New Hampshire's Great Bay Estuary.

Key Items of Evaluation

- Discovery of more efficient C cycling in organic cropping systems. New carbon inputs are more rapidly incorporated into biomass in organic systems, which is related to 20 percent higher microbial growth rate, 15 percent higher biomass, and 20 percent higher growth efficiency. These differences in microbial physiology appear related to greater stabilization of new carbon inputs. Microbial communities in diverse organic cropping systems have microbial physiological characteristics that enhance the efficiency of new carbon input conversion to soil organic matter. (Ninh, H.T., A.S. Grandy, K. Wickings, S.S. Snapp, W. Kirk, and J. Hao. Organic amendment effects on potato productivity and quality are related to soil microbial activity. Plant & Soil, 386:223-236, 2015)
- Findings to date suggest that at both short and long-term time horizons, biophysical factors such as albedo and surface heat fluxes may influence climate forcing more than

biological processes such as carbon storage and greenhouse gas emissions. As a result, the current policy focus on carbon sequestration in soils and plant biomass may be too narrow for developing a comprehensive approach for mitigating climate change across a mixed land use landscape. (Burakowski et al. Spatial scaling of reflectance and surface albedo over a mixed-use, temperate forest landscape during snow-covered periods. Remote Sensing of Environment. 158, 465-477. 2015).

- The concentration of total dissolved nitrogen in wet deposition (precipitation and snowfall) in southeastern NH ranged from 0.56-0.66 mg N/L on an average annual basis from 2011-2013. These data were integrated into Non-Point Source Study conducted by the NH Department of Environmental Services (2014); it is estimated that approximately 29 percent of the total nitrogen (both point and non-point sources) delivered to Great Bay is from atmospheric deposition.

V(A). Planned Program (Summary)

Program # 3

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			4%	
135	Aquatic and Terrestrial Wildlife			21%	
212	Diseases and Nematodes Affecting Plants			8%	
215	Biological Control of Pests Affecting Plants			7%	
311	Animal Diseases			10%	
501	New and Improved Food Processing Technologies			7%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources			25%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins			10%	
723	Hazards to Human Health and Safety			8%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	1.5	0.0
Actual Paid	0.0	0.0	3.4	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	127743	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	203867	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

Several different research projects are conducted under this program, and 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;
- Developing new methods to distinguish between benign and virulent 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

The target audiences for these research activities include both discrete and overlapping audiences.

- For bacterial biofilms, the audience targeted 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 target audience includes the shellfish industry, shellfish regulatory agencies, graduate and undergraduate students, high school students, faculty collaborators, and other scientists.
- For microcystins from cyanobacterial bloom, the target audience includes students (college and pre-college), scientists, lake shore residents, lake association members, local and regional decision makers, source water protection and watershed managers, surface drinking water suppliers, and public health and environmental agencies.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1390	11250	112	25

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

Patent Applications Submitted

Year: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	3	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2014	22

Output #2

Output Measure

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

Year	Actual
2014	7

Output #3

Output Measure

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

Year	Actual

2014	14

Output #4

Output Measure

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

Year	Actual
2014	12

Output #5

Output Measure

- Number of graduate students directly involved in the research.

Year	Actual
2014	6

Output #6

Output Measure

- Number of reviewed, bulletin, popular and other publications

Year	Actual
2014	1

Output #7

Output Measure

- Number of websites in which project results have been incorporated

Year	Actual
2014	5

Output #8

Output Measure

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

Year	Actual
2014	30

Output #9

Output Measure

- Postdoc and other scientists trained in cutting edge research methods

Year	Actual
2014	14

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased knowledge about the incidence and detection of vibrio in oysters.
2	Knowledge of environmental and biological factors associated with reduced concentrations of vibrios in harvested and processed oysters.
3	Number of agencies and stakeholder groups involved in research outreach related to vibrios in shellfish.
4	Increased knowledge about mechanisms of biofilm adaptation and diversification in pathogens and symbionts.
5	Knowledge about the changes in Vibrio genomes, which cause transitions to virulence;
6	Understanding of how microcystin toxins spread from lakes to the terrestrial food chain
7	Implement an evolution-in-action curriculum that allows high school students to observe bacterial evolution associated with biofilms in a week-long study.

Outcome #1

1. Outcome Measures

Increased knowledge about the incidence and detection of vibrio in oysters.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Shellfish harvesting and public health are being threatened by the emerging incidence of Vibirosis in consumers of shellfish from the Northeastern United States. Changes in pathogenic Vibrio populations in the Northeast US are likely consequences of changing environmental conditions and their detection is complicated because not all strains are virulent. A simple method for screening pathogenic Vibrio species is essential for industry and regulators to shape locale-specific harvest management plans.

What has been done
A tiered conceptual approach for detection and enumeration of pathogenic Vibrio species in coastal ecosystems has been further optimized based on new findings. Over the past year we have expanded our routine surveillance at a new site and included plankton as an added ecosystem matrix for tracking Vibrio population dynamics. PhD and undergraduate students have worked with plankton ecologists to develop novel ways of sampling for and separating zooplankton from phytoplankton in estuaries, and have teamed with students and a professor from a local technical college to determine photosynthetic pigments present in the phytoplankton and water samples. Efforts were further modified to include more frequent (biweekly) sampling to determine environmental variability in Vibrio and plankton levels during the warmer summer months

Results
The research to date has continued to result in significant changes in knowledge about the dynamics of Vibrios in shellfish in Northeast estuarine ecosystems. Conditions, as in sea surface temperatures, in regional larger coastal ecosystems like the Gulf of Maine and Long Island Sound also appear to influence Vibrio species populations in estuarine ecosystems. Recent surveillance of Vibrio concentrations in water, shellfish and sediments now suggests that association with plankton is a significant ecosystem factor that affects Vibrio populations, and that remote sensing

may aid the need to track and predict risk conditions. Much needed knowledge about the emergence of pathogenic strains of Vibrio parahaemolyticus in the Northeast as a result of collaborations with state public health and resource agencies.

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 #2

1. Outcome Measures

Knowledge of environmental and biological factors associated with reduced concentrations of vibrios in harvested and processed oysters.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Shellfish harvesting and public health are being threatened by the emerging incidence of vibirosis in consumers of shellfish from the Northeastern U.S. Where more northerly states with colder coastal ecosystems had rare disease occurrence in the past, recent increases in incidence has triggered costly harvest management and monitoring needs for industry and public health agencies alike.

What has been done
The understanding of conditions that allow for reducing pathogenic Vibrio levels in harvested shellfish has been enhanced. In 2014 was the fourth year of monthly oyster relay experiments, where oysters were relayed from a harvest area with elevated levels of Vibrio species to one where Vibrio levels were minimal.

Results
Overall results suggest that relay is a viable strategy for post-harvest treatment to reduce Vibrio concentrations in oysters within 14 days. The underlying mechanisms for why this happens

continue to be the focus of our research. 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 determine which bacteria increase when pathogenic Vibrio species decrease, and thus may be involved in competitive exclusion of pathogenic Vibrio species during the relay process. Taxa identified from this approach and those cultured from oyster and estuarine water samples collected during relay will be used in in vitro competition experiments against local Vibrio parahaemolyticus strains to select the best candidates to test for experimentally excluding pathogenic Vibrio species from harvested shellfish.

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 #3

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 Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	9

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

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

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
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Defining adaptive mutations in bacterial populations growing on surfaces presents a huge challenge for understanding this important process in host adaptation.

What has been done
A method was developed for identifying haplotypes from mutations with shared trajectories in evolving populations and also statistical methods for assigning predicted functions to these mutations.

Results
Major lineages define mutants that are broadly adaptive, which continually give rise to low-frequency specialists, which as a group are highly diverse. Thus the specialists with unique functions for adherence and biofilm assembly are derived from many lineages.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There is a rising threat of seafood-borne illness from Vibiro parahaemolyticus due to complex factors, including changing harvest practices, increased shellfish production, increased summer seasonal demand and climate changes.Even with these complex factors, there is ample evidence that changes in bacterial populations have also contributed to disease, and that in recent years, both endemic pathogens have emerged and non-native strains have invaded the region and are causing illness. It is currently difficult to detect rare pathogenic strains.

What has been done
Several alternative host models have been developed to assay for virulence. Of these Arabidopsis thaliana, C. elegans were studied in more detail

Results
There has been success with the C. elegans model in discriminating between clinical strains of varying virulence, and the assay can distinguish between harmless environmental and clinical strains, although variability continues to be an issue and must be addressed before large scale application. Virulence was quantified for more than 50 clinical and environmental strains using the assay. The traits that influence virulence (animal death and intestinal colonization) in the model including capsule, siderophore, and hemolysin of the bacteria. It has been demonstrated that human body temperature primes this virulence, as only pathogenic strains have enhanced nematode killing at 37C compared to 20C. The stress hormone norepinephrine enhances virulence and even acts as a cue for virulence gene expression in the absence of an important global regulator.

4. Associated Knowledge Areas

KA Code	Knowledge Area

311	Animal Diseases
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #6

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Reported incidences of harmful cyanobacteria blooms in freshwaters (HCBs) have increased worldwide. There are also frequent reports of deaths of domestic animals such as dogs and cattle caused by drinking water contaminated with toxic cyanobacteria. Recent evidence indicates toxins produced by aquatic cyanobacteria are linked to a wide array of human diseases including liver tumors and amyotrophic lateral sclerosis (ALS) or Lou Gehrig's disease. Water bodies with frequent HCBs may have higher incidences of diseases such as ALS, although the means of transmission of the toxins are not known.

What has been done
Experiments evaluated the exposure of leafy crops to lake and pond water containing microcystin-producing cyanobacteria.

Results
The transfers of MCs within lakes that may result in biomagnification at higher levels in the lake food chain, such as in fish, thereby representing a potential source of toxins for humans and animals. Additionally, MCs may be transferred to crops; for example, 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. Soil samples taken at varying distances from the shore of a cyanobacteria-dominated lake tested positive for MCs as well as for living cyanobacteria. Tests to determine whether cyanobacteria and their toxins are transported from lake water as aerosols

show evidence of airborne movement of both the toxins and cells of cyanobacteria. Aerosol testing was carried out on eight lakes in New Hampshire as well as Lake Attitash, MA. Cyanobacteria cells as well as MCs were detected from each of the lakes. Work with aerosols suggests a mechanism to disperse cyanotoxins directly to crops and humans that reside near lakes with HCBs.

4. Associated Knowledge Areas

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

Outcome #7

1. Outcome Measures

Implement an evolution-in-action curriculum that allows high school students to observe bacterial evolution associated with biofilms in a week-long study.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	80

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Teaching evolution is challenging because it is typically not viewed as an empirical science.

What has been done
NHAES researchers (#226672) developed an innovative evolution-in-action curriculum that allows high school students to observe bacterial evolution associated with biofilms in a week. This also teaches biotechnology, ecology, microbiology, and genetics. During 45 minutes each day, students ranging from grades 9-12 organize themselves in working groups, define responsibilities, document their procedures, count and record their observations, and statistically analyze their results. They articulate new hypotheses and predictions and even test some of them.

Results
This curriculum not only demonstrates that evolution is a tangible process that happens in real time, but also provides practical laboratory experience and knowledge of fundamental concepts in microbiology, ecology, genetics, and physiology. Classes committed to this curriculum see the

genomes of their bacterial mutants completely sequenced, putting these 14-year-olds at the cutting edge of biotechnology and introducing them to the 21st century language of genomics. Learning with bacterial evolution curriculum, as judged by common assessments, improved by 50 per cent which was strongly significant, relative to the standard evolution curriculum.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Other (none)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The basic research projects covered in this planned program are most often evaluated by publication in peer-reviewed journals and successfully defended masters or Ph.D. theses and include:

Haney, J.F. and W. Lampert. 2013. Spatial avoidance of Microcystis aeruginosa by Daphnia: fitness consequences and evolutionary implications. Limnol. Oceanogr. 58 (6): 2122-2132.
Cooper V.S. The Origins of Specialization: Insights from Bacteria Held 25 Years in Captivity. 2014. PLoS Biol. 12(2):e1001790. doi: 10.1371/journal.pbio.1001790.
Cooper, V.S., R.K. Staples, C.C. Traverse, and C. N. Ellis. 2014. Parallel evolution of small colony variants in Burkholderia biofilms. Genomics. pii: S0888-7543(14)00184-0. doi: 10.1016/j.ygeno.2014.09.007.

Key Items of Evaluation

- The Cooper project (#226672) extended a decade of investment in building a curriculum that engages young biology students to study evolution-in-action. This curriculum demonstrates that evolution is a tangible process that happens in real time, but also provides practical laboratory experience and knowledge of fundamental concepts in microbiology, ecology, genetics, and physiology. Students ranging from grades 9-12 articulate new hypotheses and predictions and even test some of them. Classes committed to this curriculum will see the genomes of their bacterial mutants completely sequenced, putting these 14-year-olds at the cutting edge of biotechnology and introducing them to the 21st Century language of genomics.
- Research lead by Haney (#227004) demonstrated that microcystins toxins produced

by cyanobacteria in lakes are transferred by irrigation and aerosols to food crops. Microcystins are hepatotoxins, and are also suspected as factors contributing the onset of Amyotrophic Lateral Sclerosis.

V(A). Planned Program (Summary)

Program # 4

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			2%	
133	Pollution Prevention and Mitigation			5%	
135	Aquatic and Terrestrial Wildlife			2%	
201	Plant Genome, Genetics, and Genetic Mechanisms			4%	
202	Plant Genetic Resources			4%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants			5%	
204	Plant Product Quality and Utility (Preharvest)			6%	
205	Plant Management Systems			5%	
206	Basic Plant Biology			2%	
212	Diseases and Nematodes Affecting Plants			11%	
213	Weeds Affecting Plants			5%	
301	Reproductive Performance of Animals			16%	
302	Nutrient Utilization in Animals			2%	
305	Animal Physiological Processes			5%	
307	Animal Management Systems			14%	
308	Improved Animal Products (Before Harvest)			1%	
701	Nutrient Composition of Food			2%	
702	Requirements and Function of Nutrients and Other Food Components			2%	
903	Communication, Education, and Information Delivery			7%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	11.0	0.0
Actual Paid	0.0	0.0	17.4	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	873971	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	1155709	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	2039	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Conduct applied and discovery research in multiple aspects of plant and dairy cattle agriculture, agronomy, pathology, related genetics and genomics, nutrition, and integrated aquaculture, involving shellfish, finfish, invertebrates, and seaweed. Disseminate recommendations to stakeholders in the state and region agricultural community.

2. Brief description of the target audience

Research conducted under this planned program are meaningful to different target audiences. These include consumers of animal and plant-based foods and products, organic and conventional farmers, aquaculture ventures, restaurants and other businesses reliant on local foods, master gardeners, home gardener associations, consumers and legislators, and those engaged in the extensive food systems network. Audiences also includes scientists, veterinarians, agricultural researchers, extension specialists, agricultural teachers, graduate and undergraduate students, and the faculty and staff of the region's land-grant universities.

3. How was eXtension used?

The results of a sweetpotato early harvest study in northern New England were disseminated using eXtension http://extension.unh.edu/resources/files/Resource004491_Rep6396.pdf). The impact of harvest date on yield and sweetness were determined. Marketable yield nearly tripled from an early harvest in August, and to the third harvest in late September. Potatoes must be stored at cool temperatures for at least three weeks so that some starch reverse break down to simple sugars.
Results of a two year brussel sprouts variety trial and management by topping, conducted at the NHAES Woodman Farm, were disseminated using eXtension,
http://extension.unh.edu/resources/files/Resource003914_Rep5563.pdf None of the open pollinated varieties did well under these field conditions. Several hybrid varieties were identified as having high

yields varied between the two years of the trials.

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	21917	9799	176	250

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

Patent Applications Submitted

Year: 2014
Actual: 1

Patents listed
PCT/US14/29910 Rick H. Cote, Karyn B. Cahill, and KEVIN D. SCHUSTER. Methods of Identification and Use of Nematicide Compounds.

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	2	39	41

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2014	74

Output #2

Output Measure

- Number of graduate students directly involved in the research

Year	Actual

2014	40

Output #3

Output Measure

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

Year	Actual
2014	7

Output #4

Output Measure

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

Year	Actual
2014	39

Output #5

Output Measure

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

Year	Actual
2014	16

Output #6

Output Measure

- Number of reviewed, bulletin, popular and other publications

Year	Actual
2014	1

Output #7

Output Measure

- Number of websites in which project results have been incorporated

Year	Actual
2014	12

Output #8

Output Measure

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

Year	Actual
2014	2

Output #9

Output Measure

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

Year	Actual
2014	4

Output #10

Output Measure

- New varieties of mellon, pumpkin and squash developed in cooperative breeding programs between NHAES and several seed companies

Year	Actual
2014	32

Output #11

Output Measure

- Establish a mapping population from a natural hybrid Berberis x ottawensis from Lime CT for mapping wheat stem rust (Puccinia graminis) resistance the alternative host for the fungus.

Year	Actual
2014	200

Output #12

Output Measure

- Collaborative annotation of the genome of the lamprey eel, a primitive jawless fish

Year	Actual
2014	1

Output #13

Output Measure

- Develop gene expression profiles (RNA-seq) for two genotypes of the marine alga Porphyra umbilicalis Kutzing from contrasting habitats: an estuarine tidal rapids, and open coastal population. These habitats have vastly different levels of nitrogen and phosphorus which are limiting for algal growth.

Year	Actual
2014	3

Output #14

Output Measure

- Molecular marker development and validation contributing to the first high-throughput genotyping platform for strawberry breeding: the Affymetrix Axiom IStraw90 SNP array.

Year	Actual
2014	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased knowledge about plant varieties and production practices suited to the state and region.
2	New knowledge about dairy production, nutrition, animal health and dairy products important to regional producers.
3	Advances in squash varieties having enhanced eating properties and nutritional benefits including carotenoid concentrations.
4	Increased knowledge about integrated multitrophic aquaculture systems.
5	New genomic knowledge translated into tools and strategies to facilitate varietal selection through marker assisted breeding.
6	New commercialized varieties of cucurbit vegetables suited to state and region growing conditions.
7	Improved range of weed management options available for sustainable and organic growers.
8	A working technology to produce triploid green sea urchins for use in natural harvest and land based aquaculture.
9	Improvement in finfish aquaculture in recirculating production systems
10	Develop regionally appropriate management systems to suppress soil borne pathogens for both organic and conventional farms.
11	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.
12	Produce new genetic and molecular tools to investigate the mechanisms of fungal rust resistance in barberries, an alternative host of wheat stem rust
13	Improve dairy calf health and growth rates.
14	Increase the utilization efficiency of the germplasm collections through phenotypic and genotypic characterization and evaluation of the germplasm held in the collections for high-priority traits, especially resistances to biotic and abiotic stresses and nutritional traits.
15	Production of new varieties of ornamental gourds and pumpkin.
16	Enhance understanding of how actinorhizal symbiosis between the nitrogen fixing bacteria Frankia and its plant hosts contribute to environmental restoration.
17	Develop new methods to study inter-cellular interactions between somatic cells of the ovary, germ cells and the embryo of ruminants.

18	Design of next-generation nematicides with improved target specificity and reduced environmental side effects.
19	Assess the current and historical distribution of invasive weed species in Northern New England.

Outcome #1

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	350

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
New Hampshire experiences a challenging growing climate and high land and labor costs, making fruit and vegetable production expensive. Sustaining agriculture requires that growers increase profitability, either through increasing production efficiency or by producing unique, high-value products. Variety trials and evaluation of new production systems, including season extending methods, may help producers improve their bottom line.

What has been done
1. Tomato, cucumber, zucchini and summer squash variety trials were conducted in high tunnels over several years.
2. The results of sweet potato variety trials were disseminated to New Hampshire and northern New England growers.
3. Production of several salad greens mixed were studies in low tunnels and minimally heated greenhouses.
4. Brussel sprout variety trials and topping were conducted in the field over two successive years.

Results
1.Vegetable varieties differ with respect to yields, resistance to pests and diseases, and market desirability, variety choice can greatly impact profits. Results from this research have shown that changing varieties can increase grower's marketable yields by 60 percent or more. For example, for tomato, switching varieties could increase market value of yields from a single 10x32m high tunnel by $10,000 or even more.

2.The recently published 2012 Agricultural Census stated that
33 acres of sweetpotatoes are grown by more than 100 growers in New England (compared with just four acres in 2007). Assuming an average price per pound of $1, and an average yield of 10 tons/acre, the annual economic value of this crop would be roughly $660,000.
3a. Some species (e.g. onions, spinach, kale) frequently survived winters in low tunnels, whereas others experienced variable results (e.g. lettuce, chard, broccoli). However, low tunnels present significant logistical difficulties for growers, and as a result, adoption of this low-cost technique is likely to be limited.
3b.Online Extension tools have been developed for growers, including an enterprise budget that allows growers to evaluate the profitability of winter greens production in minimally heated greenhouses. Due to high temperature requirements for basil, it would require considerably more labor resources than initially planned and budgeted.
4.?Results of a two year brussel sprout variety trial and management by topping, conducted at the NHAES Woodman Farm, were disseminated using eXtension, http://extension.unh.edu/resources/files/Resource003914_Rep5563.pdf None of the open pollinated varieties did well under these field conditions. Several hybrid varieties were identified as having high marketable yields. Varieties yields varied between the two years of the trials.

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Purchase feeds including forages and grains constitute most expenses for organic and conventional dairy farms in the Northeast. Research with alternative forage crops (AFC) and

alternative feed sources are needed to reduce feed costs and increase the social and economic sustainability of dairy farming in the region.

What has been done

1. Surveys and focus group studies were conducted with Northeast dairy farmers about challenges surrounding sustainability of providing high quality animal feeds.
2. Feeding trials were conducted with alternative protein sources including field peas supplemented with rumen protected lysine and methionine

Results

1.Results from surveys and focus groups of Northeast dairy farmers confirm that opportunities exist to develop resilient alternative forage crops 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 energy and protein use efficiency and animal health in dairy cows fed supplements such as field peas and flaxseed meal.
2. Preliminary results indicate that alternative forage crops have potential to extend the grazing season and replace traditional forages in dairy farms. Our preliminary results also showed that field peas can replace corn meal and soybean meal in dairy diets without a negative impact on milk production and milk components (i.e., fat, protein, and lactose).

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals
305	Animal Physiological Processes
307	Animal Management Systems
308	Improved Animal Products (Before Harvest)
903	Communication, Education, and Information Delivery

Outcome #3

1. Outcome Measures

Advances in squash varieties having enhanced eating properties and nutritional benefits including carotenoid concentrations.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Hybrid varieties of fresh market winter squash and pumpkin have largely supplanted open-pollinated varieties because of their uniformity and consistency of yield and fruit quality. Open pollinated varieties, on the other hand, are still the dominate type grown by farmers for the pie and baby food processing industry.The potential of interspecific hybrids for the fresh market squash industry is no less than that of the processing industry. However, the hybrids tested to date produce exceptionally early female flowers and tend to set some fruit too close to the crown of the plant, thereby suppressing vegetative growth and resulting in variability in fruit size and flesh quality.

What has been done
Current breeding efforts are focused on developing strains of Cucurbita moschata fresh market types of squash which flower later and have a higher ratio of male to female flowers such as occurs in some of the processing cultigens. It is expected that such strains in hybrid combination with C. maxima will result in a more acceptable pattern of fruit set.

Results
1.Seven fresh market inter-specific hybrids were evaluated during the summer of 2014. Fruit size for several hybrids were good but fruit DW and soluble solids were marginal. One notable trait in fruit of all interspecific hybrids was excellent shelf life and resistance to common storage rot diseases. One hybrid, NH1311, has been selected for further evaluation.
2.The interspecific hybrid NH1310 (NH65 x SC936) produced yields greater than 60 metric tons per hectare in 2012 and 2013, and fruit solids content (8.0 to 9.5 percent) was acceptable for pie processing. However, the texture of the pumpkin puree appeared excessively stringy for use for pie puree stock.
2.One of the new C. moschata and two of the new bush C. maxima lines are uniform enough for making experimental hybrids. In a replicated field trial during the summer of 2014 four experimental, interspecific hybrids were evaluated for growth habit, patterns of fruit set, fruit traits, and uniformity: NH1310, NH1321, [NH65 x Long Island Cheese (LIC)], NH1320 (NH65 x NH176-29), and NH1323 (NH65 x NH204-3916). All hybrids showed high tolerance to powdery mildew and leaf canopies were more resistant to late season senescence than in C. moschata hybrids growing in an adjacent plot. Mesocarp dry weight (DW),in the hybrids were similar, with values of 9.6, 9.1, 9.1, and 9.7 percent and this was unexpected because flesh dry matter in squash generally shows additive genetic variation with hybrid dry weights close to the mean of the two parents.
3. In an effort to improve puree texture both for pie stock and baby food, additional bush C. maxima and vining C. moschata breeding lines are being developed with selection for improved textural properties of the cooked flesh and with carotenoid profiles enhanced for nutritional value.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Increased knowledge about integrated multitrophic aquaculture systems.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The increased interest in Integrated Multi-Trophic Aquaculture (IMTA) provided the focus for studies to investigate integrating the culture of finfish, oysters, sea urchins and seaweeds in various combinations with the goals of: (1) increasing the economic potential of an aquaculture enterprise and (2) to determine the potential environmental advantages of reducing waste production through combining species.

What has been done
A series studies were conducted testing various combinations of species that might be integrated into aquaculture systems in New England.
1.The portion of the project focused on eastern oyster (Crassostrea virginica) farming in combination with seaweeds and sea urchins, with the overall aim being an assessment of the IMTA potential for New Hampshire oyster farmers.
2.Studies were conducted that focused on determining ammonia production rates from American oysters of different sizes and densities (0.006 kg/L and 0.013 kg/L), juvenile black sea bass (Centropristis striata) and hybrid striped bass (Morone saxatilis x M. Chrysops) held at two densities (0.005 kg/L and 0.010 kg/L). The studies with the hybrid striped bass served as a foundation for later aquaponic studies in which these fish were co-cultured with lettuce and other greens, in freshwater systems.
3.The primary focus of the seaweed work has been to develop and optimize techniques for the nursery production of several native species of seaweed.

Results

1. Results for combined eastern oyster, seaweed and urchins studies were highly variable. The major issue that became evident early on was that the type of gear used to deploy the seaweeds was critical to their growth. Typically used approaches such as rope culture did not work on in New Hampshire estuarine sites due to strong tidal currents that caused rapid fouling by drifting material. While experiments demonstrated potential for oyster/seaweed IMTA and identified gear development as the most important area for further research.
2.High density hybrid striped bass treatment group produced 3.7 times more ammonia (224 mg/kg) than the low density treatment (60.5 mg/kg) over a 12-hour period. Black sea bass are extremely sensitive to ammonia production and the experiments were terminated prior to (12 hour) completion. Ammonia production was inversely proportional to size in American Oysters. Aquaponic studies with both fish species were successful over 60-day periods, during which marketable greens were produced.
3. To grow sea vegetables in coastal or shore based aquaculture systems, it is necessary to have a reliable source of "seed stock," that can be grown out at the aquaculture site. The accomplishment of this portion of the project has been to determine optimum culture conditions (temperature, light level, day length, and nutrient concentrations) for the production of spores and growth into sporelings that can be out-planted at aquaculture sites. Methods were developed for freezing sporelings so that they can be stored for later grow-out. This is a key accomplishment as it allows a continuous and reliable supply of sporelings for commercial operations, for IMTA.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
302	Nutrient Utilization in Animals
307	Animal Management Systems
903	Communication, Education, and Information Delivery

Outcome #5

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual

2014 0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The US ranks number one in the world for strawberry production. Because the domesticated strawberry is octaploid, it is very difficult to breed with conventional tools, and strawberries are propagated by vegetative cloning. Newly available genomic resources for diploid strawberry will facilitate the use by breeders of molecular markers as an aid to plant breeding (marker assisted breeding = MAB), to efficiently exploit wild related species as gene sources for improvement of cultivated strawberries, and to aid in the ultimate production of superior varieties that will benefit growers and consumers.
A prerequisite for implementation of MAB is the identification of marker-trait associations.

What has been done
NHAES (@0299267) researchers contributed substantially to the advancement of MAB in strawberry by helping to design and evaluate the first high-throughput genotyping platform for strawberry:the Affymetrix Axiom IStraw90 SNP array

Results
1.The design of high-throughput genotyping platforms requires the prior development of genomic resources such as reference genome assemblies and genetic linkage maps. Using marker data from the IStraw90 array, NHAES researchers have constructed the first genetic linkage map of the ancestral diploid strawberry species, Fragaria iinumae.
2.The Affymetrix Axiom IStraw90 SNP array is now available for commercial purchase from Affymetrix, Inc., and its use is being adopted widely throughout the world.
3.NHAES researchers identified markers associated with novel flower color traits in the context of a breeding program aimed at combining fruit quality and ornamental values in new strawberry cultivars. As a concequence of this effort, ten advanced selections were chosen for potential variety protection, and ten innovation disclosures have been filed with the UNH Office of Sponsored Research.

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)

Outcome #6

1. Outcome Measures

New commercialized varieties of cucurbit vegetables suited to state and region growing conditions.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Development of new varieties has been a key underpinning for production of abundant and nutritious vegetables in North America. 1)An important method for use in reducing the cost of hybrid seed production in melon is to employ female parents in hybrid production that are gynoecious, or largely produce only female flowers.
2)In summer squash, the glabrous trait argely eliminates the large trichomes (spines) on stems and petioles which irritates the skin of workers and results in unsightly abrasions to harvested fruit.

What has been done
1)In melon, the gynoecious (female flowering) trait was developed in New Hampshire melon lines in the early 1970s Numerous backcrosses of female lines to acceptable parentage have been required to eliminate undesirable genes that were transferred from the original plant sources of genes for female flowering, a phenomenon called linkage drag.
2)In yellow summer squash, a glabrous mutant was discovered in 1992 in a relic variety. This trait has been utilized at the University of New Hampshire to develop improved inbred lines for producing hybrids, one of which was released in 2009.

Results
NHAES researchers successfully developed one Galia (green fleshed) inbred and two cantaloupe inbred lines with good eating quality, appearance, and resistance to powdery mildew and fusarium wilt. These lines can either be used directly for making hybrids or can be further improved for specific melon types with minimal additional breeding
input.
2)In 2014,22 experimental hybrids carrying the glabrous trait were tested for resistance to powdery mildew disease. Several of the hybrids looked promising for commercial use and one has been released to a seed company for commercial production.

4. Associated Knowledge Areas

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

Outcome #7

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Organic producers routinely cite weed control as a significant challenge to their operations and request applied research aimed at developing more effective and sustainable weed management strategies. Cover crops grown as monocultures or as mixtures may provide opportunities for ecologically-based weed management.

What has been done
1.Field experiments aimed at determining the effects of cover crops and cover crop mixtures ("cocktails") on weed population dynamics were established at the UNH Kingman and Woodman Research Farms.
2.Two field experiments were established at the UNH Kingman and Woodman Research Farms to examine how mixtures of perennial ryegrass affect stand dynamics, forage productivity, and weed abundance relative to ryegrass monocultures. Ryegrass and weed biomass have been measured twice each growing season.

Results
1.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.In general, ryegrass productivity could be increased by 21 percent relative to the most productive monoculture simply by planting a six-cultivar mixture.

4. Associated Knowledge Areas

KA Code	Knowledge Area
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems

Outcome #8

1. Outcome Measures

A working technology to produce triploid green sea urchins for use in natural harvest and land based aquaculture.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Edible sea urchin fisheries are high-value commercial enterprises on all coasts of the United States. Drastic overfishing of this natural resource has resulted in a near collapse of the fisheries. Alternatives to direct harvest of wild sea urchins are vital to sustain this fishery that provides an exportable product for American fishermen and with potential to help. the US trade deficit.

What has been done
1. Laboratory methods were developed to generate triploid green sea urchin embryos.
2. Various methods were explored to transfer embryos to hatcheries and maintain embryos through sequential stages of metamorphosis.

Results
This study has established that a variety of individuals can produce triploid sea urchins. However the difficult step in the overall aims of study was the succesful transfer of triploid late plutei to a hatchery facility. In each case, our recirculation regimedamaged the larvae. As a result, embryos did not achieve metamorphosis and did not generate adult triploid sea urchins. This aspect of this study requires more attention.
The techniques to accomplish this are in press in the following book, Sea Urchin and Sea Cucumber Aquaculture Hardcover, eds. Nicholas Brown & Steve Eddy to be published June 15, 2015, by Wiley-Blackwell. Methods developed in this study the enhancement of nutritive phagocyte size, taste and availability will be readily available to all involved in sea urchin aquaculture.

4. Associated Knowledge Areas

KA Code	Knowledge Area
307	Animal Management Systems

Outcome #9

1. Outcome Measures

Improvement in finfish aquaculture in recirculating production systems

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The growth of aquaculture is meeting resistance in many areas because of issues related to sustainability. One remedy for all of these concerns is to grow fish in tanks in land-based systems that continuously re-use water (recirculating systems). Because of the expenses involved in recirculating high-value fish, such as summer flounder and black sea bass must be produced. Growth rate remains the dominant factor controlling profitability of land based culture of these species, and the costs associated with juvenile growth to market size must be reduced to gain competitiveness.

What has been done
The use of the phytoestrogen genistein to feminize summer flounder populations was investigated. The effects of population density were determined on sex differentiation in black sea bass.

Results
The major finding of these studies included gene expression profiles during sex differentiation (summer flounder) and sex change (black sea bass). As growth is sexually dimorphic in these species, these findings provide insight into improving profitability of marine aquaculture, and development of monosex populations (all female) will have a dramatic economic impact on production costs for producers.

4. Associated Knowledge Areas

KA Code	Knowledge Area

135	Aquatic and Terrestrial Wildlife
305	Animal Physiological Processes
307	Animal Management Systems
308	Improved Animal Products (Before Harvest)

Outcome #10

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
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The overarching goals of the project are to determine the mechanisms by which alternative control strategies, such as cultivar mixtures, cover crops, and organic amendments, alter the microbial community in the soil including both pathogenic and beneficial organisms. Alternative control strategies will lessen the need for chemical control of fungal pathogens, and protect beneficial organisms need to maximize crop yields.

What has been done
1. Alternative assays were developed for screening for resistance to soilborne root and will pathogens for strawberry.
2. Comparative genomics was used to investigate what factors may control why some strains of V.dahlie infect strawberry while other infect mint.
3. Fungal biomass was evaluated after mixtures of perennial ryegrass were establish at sites in Maine, New Hampshire, Pennsylvania and Vermont.

Results
1.The green fluorscent protein (GFP) labled strain of V. dahliae to measure colonization of susceptible, tolerant (visually healthy but ingress of fungal hyphae present), and resistant (visually healthy no ingress of fungal hyphae). This process was initiated in the past year and protocols for inoculum production, inoculation, and visualization by confocal microscopy have all been standardized. Screening strawberry cultivars with known levels of resistance and susceptibility has been initiated.

2.Preliminary results indicate that the strawberry strains of of V. dahliae belong to genetically distinct lineages. One of the strawberry strains is more closely related to a strain recovered from lettuce than to the other strawberry strain. This may indicate that virulence to strawberry is present in several lineages of V. dahliae.
3. Soil has been collected from four sites in three consecutive years. Significant increase in fungal biomass was measured at all locations one year after the plot were established. However, a decrease in fungal biomass was measured at the end of year two, likely due to the fact that there was a significant winter-kill of the perennial ryegrass, that left many of the plot with 70-90 percent clover. This dramatic shift the plant community had an important effect on the soil microbial community.
4.A survey was completed of fungal pathogens Rhizoctonia associated with wheat, canola, soybean, and dry bean.

4. Associated Knowledge Areas

KA Code	Knowledge Area
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
212	Diseases and Nematodes Affecting Plants

Outcome #11

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
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Controlling reproduction either by improving efficiency or preventing population increases in commercially important and non-indigenous fish species, respectively, is of critical importance to farmers and fish and wildlife biologists. To control reproduction, it is critical to understand the underlying mechanisms of neuroendocrine control; i.e. the hormones and receptors that mediate these processes: gonadotrophin releasing hormone (GnRH) and its receptors in the brain.

What has been done
Major brain and pituitary reproductive hormones and receptors as well as expression of these hormones in black sea bass, hagfish and lampreys. The identified hormones are the major hormones that control reproduction in these fish as well as other vertebrates.

Results
1.Identification and functional studies of the glycoprotein hormone (GpH) in hagfish and lamprey pituitaries.
2.The distribution of the three identified GnRH receptors in the brain and pituitary and other tissues of lampreys were determined at three distinct life stages.
3. Two GnRH receptors were identified different stages of development in the black sea bass brain.

4. Associated Knowledge Areas

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

Outcome #12

1. Outcome Measures

Produce new genetic and molecular tools to investigate the mechanisms of fungal rust resistance in barberries, an alternative host of wheat stem rust

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Wheat is one of three grains that produce 60 percent of the world's caloric intake. Barberries, (Berberis spp.) is the alternative host of Puccini gramis f. sp. tritici, the causal organism of wheat stem rust. Barberries were eradicated in the wheat belt, in the 1900's. However barberries are wide spread as an ornamental in the Northeast United States. Wheat production has returned to the NE USA. Developing genomic resources for barberries will support global barberry

surveillance efforts to detect new strains of wheat rust. These resources also will aid in understanding how some species of barberry are resistant to Puccini.

What has been done
A Berberis spp. germplasm collection is being built at the NHAES, for the purpose of developing taxonomic molecular markers.
A naturally occurring hybrid population B. ×ottawensis was identified in Lime Kiln CT. Controlled crosses were made to develop mapping populations for barberry.

Results
200 offspring of the hybrid B. ×ottawensis were phenotyped, sampled, propagated. Genotyping-by-sequencing was carried out on four barberry accession to provide molecular markers for mapping resistance genes.

4. Associated Knowledge Areas

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

Outcome #13

1. Outcome Measures

Improve dairy calf health and growth rates.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Dairy producers are interested in improving calf health and growth. This will result in decreased veterinary and medical expenses along with optimal growth response resulting in an earlier age at first calving. Calves are born with a naive immune system and must obtain their initial immune functioning system from the first secretion of the udder-colostrum. Approximately 60 percent of the nation's newborn dairy herd fails to adequate immunity (defined as 10g/L immunoglobulin G at 24 hours of age).

What has been done

1.Investigate whether the diet of the prepartum cow impacts immunoglobulin G uptake in their calves.
2. Compare dairy calf development on alternative diets of high protein milk replacer compared to conventional milk replacer.

Results

1. Modifications on the diet that the cow receives prepartum can affect immunoglobulin G uptake by their respective calf. This is important because producers may be able to correctly feed their prepartum dams to maximize immunoglobulin G uptake by their respective calf.
2. Calves fed a high-protein milk replacer (26 percent crude protein) grow at a faster rate, but produce twice as much urine and are only about 50 per cent as efficient in utilizing dietary nitrogen compared to calves fed a conventional milk replacer (22 per cent crude protein).
3. These new management strategies will be disseminated to regional dairy farms via the NH Dairy Report, in the next fiscal year.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
302	Nutrient Utilization in Animals
305	Animal Physiological Processes
307	Animal Management Systems

Outcome #14

1. Outcome Measures

Increase the utilization efficiency of the germplasm collections through phenotypic and genotypic characterization and evaluation of the germplasm held in the collections for high-priority traits, especially resistances to biotic and abiotic stresses and nutritional traits.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Hull-less pumpkin seeds are an important oil seed crop in Eastern Europe, and are used in North America as a snack seed and in trail mixes. However, currently available cultivars of hull-less pumpkin seed pumpkins have low seed yield.

What has been done
Several hull-less seeded breeding lines have been developed at the University of New Hampshire during the past 30 years, as a result of combining germplasm from various sources, including a plant introduction accession from Poland which was instrumental in breeding for larger seed size and improved seed fill. The inbred lines developed at UNH have been used for F1 hybrids, two of which were previously commercialized.

Results
In 2014, eight semi-bush experimental hybrids were evaluated, seven of which had powdery mildew resistance. Seed fill was excellent and seed size good (161 to 222 mg) in all hybrids. Plot yields among the hybrids, extrapolated to an acre basis, ranged from 1,944 to 2,639 pounds of hull- less seed, the highest yields obtained to date in hull-less pumpkins.

4. Associated Knowledge Areas

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

Outcome #15

1. Outcome Measures

Production of new varieties of ornamental gourds and pumpkin.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Traditional breeding projects at the University of New Hampshire have been highly successful in developing new varieties of ornamental pumpkins and gourds that enhance the capacity of

farmers to provide a diversity of these ornamentals at local markets such as roadside stands, farmers markets, and related retail markets. Prior to 1996, the white nest egg gourd was a rare variety, late in maturity and relatively unproductive.

What has been done
1. Several color and pattern traits have been introgressed into egg gourd, along with the bush habit of growth and earlier maturity.
2. The color and pattern genes are being transferred from egg gourd lines into ornamental pumpkin

Results
1.A multiline variety released from this effort is called Goblin nest egg gourd.
2.In 2014, pumpkins in the 500 to 2000 g size class were obtained with multiple color and striping combinations.

4. Associated Knowledge Areas

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

Outcome #16

1. Outcome Measures

Enhance understanding of how actinorhizal symbiosis between the nitrogen fixing bacteria Frankia and its plant hosts contribute to environmental restoration.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The actinorhizal symbiosis represents an important ecological and economic role in agriculture. The plants involved are also of economic significance with respect to land reclamation, reforestation, soil stabilization, landscaping, fuel, and as a food source for ruminant animals. Actinorhizal plants provide an excellent mechanism to restore disrupted environmental sites. Genomic data resulting from this research provide new insights as how Frankia contributes to environmental restoration. One of the most serve environmental factors affecting arable land is

salinity. Other environmental factors impacting arable land are contamination with heavy metals.

What has been done
1.Continue studies to identify and clarify the roles of Frankia natural products play in the actinorhizal symbiosis and for life in the rhizosphere, the Frankia genomes have been data mined and potential novel natural products have been identified.
2. Several Frankia strains that were isolated from Casuriana plants, which are known to be salt tolerant, were evaluated.
3. A comparative analysis of the Frankia genomes has provided several models to explain heavy metal tolerance levels among the Frankia strains.

Results
1.Analysis of the Frankia genomes suggested that some of these strains have the metabolic potential to degradation naphthalene and other toxic hydrocarbons.
2. Key genes involved in Frankia response to harsh saline conditions were identified by comparative gene expression studies.
3. Lead (Pb+2) tolerance concurs via a binding mechanism that uses carbohydrates and phosphate molecules. Copper (Cu+2) tolerance was also shown to driven by another binding mechanism that generated Cu+2 containing nanostructures found on the surface of the cells.
3.

4. Associated Knowledge Areas

KA Code	Knowledge Area
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants

Outcome #17

1. Outcome Measures

Develop new methods to study inter-cellular interactions between somatic cells of the ovary, germ cells and the embryo of ruminants.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The pregnancy rate in lactating cows on the average US dairy farm is currently at an all-time low (between 20-30 percent). Resulting infertility costs that exceed $350 million annually to dairy producers. The research focuses on the ovarian and embryonic mechanisms that underlie the causes of anovulation, fertilization failure, and early embryonic loss in ruminants.

What has been done
A serum-free, bovine granulosa cell (bGC) culture system has been developed which will enable further investigation of signal transduction pathways invoked during immune-mediated apoptosis, and potential mechanisms to evade such attack.

Results
This culture system provides for hormone-induced cell proliferation, cytokine-induced cell death, and the variable expression
of pro-survival, hormone receptor, and steroidogenic genes of bGCs in a manner similar to that described for previously reported culture models. Importantly, however, the current model provides for culture of bGCs from small follicles in a manner that preserves animal variation for experimental purposes.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals

Outcome #18

1. Outcome Measures

Design of next-generation nematicides with improved target specificity and reduced environmental side effects.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Agricultural damage caused by nematodes primarily occurs through the crops root system. Traditional nematicides are typically neurotoxins that are environmentally dangerous, of limited efficacy, and toxic to humans, birds, fish, and bees. There exists a need to develop next-

generation nematicides with greater target discrimination, efficacy, and environmental safety profiles.

What has been done
Bioinformatic analyses of known endoparasitic nematode genomes (and other nematode genomes, including the completed genome of C. elegans) have been conducted to identify and categorize putative nematode phosphodiesterase (PDE) genes into phylogenetically distinct families referenced to the Class I vertebrate PDE superfamily.PDE3 and PDE4 inhibitors show particular promise for disrupting the physiology of nematodes C. elegans and Meloidogyne hapla (root knot nematode)

Results
The nematode PDE3 sequences form a clade that exists as an out-group of other metazoan phyla; similar results are seen for PDE4. Furthermore, within the Anthropoda phylum, PDE3 is absent in the Insecta species examined and was present only in the Arachnida class. The evolutionary divergence of nematode PDEs and the absence of PDE3 in insects makes PDE3-selective inhibitor compounds particularly attractive targets for development of nematicides with reduced adverse effects on animals other than nematodes.
The research conducted in this project has led to a patent application PCT/US14/29910 Methods of Identification and Use of Nematicide Compounds

4. Associated Knowledge Areas

KA Code	Knowledge Area
212	Diseases and Nematodes Affecting Plants
305	Animal Physiological Processes

Outcome #19

1. Outcome Measures

Assess the current and historical distribution of invasive weed species in Northern New England.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Ongoing climate changes will make new habitats suitable for both native and invasive weeds in the Northern New England (NNE: Vermont, New Hampshire, Maine) region, resulting in new problems for weed management and potentially added costs to growers.

What has been done
Extensive seedbank surveys were conducted on 77 organic vegetable farms across the three states in Northern New England. Geographic and climatic data specific to each of the 77 farms that were sampled across the three participating states. Contemporary and historical genetic/genomic patterns of variability were assessed within each of the targeted weed species, three distinct approaches were taken with respect to ten species.

Results
More than 52,000 seedlings were identified and enumerated, providing a broad picture of weed distribution in the three state region. Species differed markedly with respect to morphological diversity, ranging from a lack of evident diversity among samples of hairy galinsoga (Galinsoga ciliata) to remarkable ranges of diversity in pigweed (Amaranthus spp.) and yellow wood sorrel (Oxalis stricta), the latter including variations in flower color and size, the extent of stem and petiole "hairiness," leaf color, and others.

4. Associated Knowledge Areas

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

V(H). Planned Program (External Factors)

External factors which affected outcomes
- Other (None)

Brief Explanation

None

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The primary criteria for productivity for projects covered in this planned program are a robust record of peer-reviewed publication. Projects in this planned program produced 41 peer reviewed papers as well as five graduate theses, and three book chapters.

Key Items of Evaluation

• NHAES researchers contributed to the first high-throughput platform for genotyping for strawberry, the Affymetrix Axiom IStraw90 SNP array. This is being widely adapted for Marker Assisted Breeding (MAB) in strawberry.
• Four hybrid varieties of kabocha (buttercup) squash have been released which are being commercially marketed.
• Field peas, an alternative forage crop, has been shown to replace corn meal and

soybean meal in dairy diets without negative impact on milk production and quality. These will reduce feed costs for dairy farmers in the Northeast.

- Tomato variety trials in Northern New England have demonstrated that switching varieties could increase market value of yields from a single 10x32m high tunnel by $10,000 or even more.
- New Hampshire Producers have greatly expanded production of sweet potatoes following NHAES/UNHCE field trials. The crop value for sweet potatoes has grown from $33,000 to $660,000 over a five year period.

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Supporting Rural Economies

☑ 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			20%	
133	Pollution Prevention and Mitigation			5%	
205	Plant Management Systems			25%	
403	Waste Disposal, Recycling, and Reuse			10%	
601	Economics of Agricultural Production and Farm Management			10%	
608	Community Resource Planning and Development			5%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities			25%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	1.9	0.0
Actual Paid	0.0	0.0	1.4	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	76046	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	111669	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	435	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

• Used focus groups of New Hampshire farmers and conducted a general population survey of residences on produce purchasing habits especially as they relate to locally grown produce.
• Investigate the changing organizational structure, tax policy and fiscal standing of local governments and the impact of tax and/or expenditure limitations on local government fiscal stress and economic growth in rural areas.
• Document the realignment of U.S. nonmetro population growth and decline during the periods before, during, and after the Great Recession of 2006-2009, with associated shifts in rural unemployment and investigate linkages between job loss and population dynamics, and changes in rural housing markets
• Developed root sampling procedures to measure root tolerance of shrubs and trees to extreme cold exposure. These will provide means to test environmental and cultural factors of container nursery stock, to improve overwintering and transplant success of trees and shrubs used in Northern New England Landscaping. This is a multimillion dollar industry in the region.
• Determine the viability of using controlled-release fertilizers for nutrient delivery for greenhouse crops.

2. Brief description of the target audience

• Scientists, undergraduate and graduate students, citizens, land use professionals, homeowners, legislators, contractors, firms and rural residents, demographers, social and natural scientists as well as policy-makers and the media.
• State policy makers, planners and concerned citizens who will facilitate actions to enhance the social and economic development of the state, aid in developing comprehensive plans to guide future landscape development, and protect the state's abundant natural resources.
• Nursery producers and landscape contractors in NH and throughout the northeast.
• Owners and operators of greenhouses who produce floriculture crops, extension professionals, agricultural service providers, and high school agriculture and biology teachers.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1175	0	0	0

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

Patent Applications Submitted

Year: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	2	3	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Year	Actual
2014	13

Output #2

Output Measure

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

Year	Actual
2014	6

Output #3

Output Measure

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

Year	Actual
2014	2

Output #4

Output Measure

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

Year	Actual
2014	3

Output #5

Output Measure

- Number of graduate students directly involved in research project.

Year	Actual
2014	5

Output #6

Output Measure

- Number of websites in which project results have been incorporated

Year	Actual
2014	5

Output #7

Output Measure

- Number of undergraduate students directly involved in the projects

Year	Actual
2014	1

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of presentations to civic and government entities to increase knowledge of demographics and migration in the region and nation.
2	Availability of modified production systems for woody nursery crops in northern nurseries.
3	Availability of new management guidelines for use of controlled-release fertilizers in greenhouse floriculture.
4	Improved methods to facilitate two-way communications between public and decision makers, and survey instruments associated with natural resource and agriculture management
5	To assess emerging opportunities for expanding local agriculture in Northern New England

Outcome #1

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
2014	6

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A critical goal of demographic trends in rural economies is not only to collect data but to disseminate information about trends in the recessionary and post-recession period to critical policy audiences and stakeholders through policy oriented presentation.

What has been done
Data has been collected about population growth and decline, changes in employment and rural housing, and migration and diversity in rural New Hampshire and Northern New England.

Results
Presentations included two briefings to senior staff of the U.S. Forest Service, "Demographic Trends and Implications for U.S. National Forests" and "Demographic Transformation in the Forested Regions of Nonmetropolitan America: Implications for Carbon Sequestration, Forest Harvesting and Ecosystem Services in June 2014; serving on the Science Steering Committee, Towards Scenarios of U.S. Demographic Change Workshop, Interagency Working Group on Scenarios and Interpretive Sciences, U.S, Global Change Research Program, in June, 2014; an invited presentation at the New Hampshire Charitable Foundation Leadership Summit "New Hampshire Demographic Trends in the New Century." in April, 2014; briefing Commissioner Patricia Barry of NH Dept. of Education on "New Hampshire Demographic Trends: Implications for School Age Children." January 2014; an invited presentation to the Tri-State Bankers Trust Forum on "Demographic Trends and Developments in Northern New England." in September, 2013; and an invited presentation to the Riverwoods Community on "Changing Demographic Trends in the New Century: America's Growing Diversity." in October, 2013.

4. Associated Knowledge Areas

KA Code	Knowledge Area

803	Sociological and Technological Change Affecting Individuals, Families, and Communities

Outcome #2

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The overall goals of one NHAES research project are to determine the importance of environmental and cultural factors on root cold tolerance (RCT)of container nursery stock, to improve overwintering and transplant success of trees and shrubs used in Northern New England landscaping. This is a multimillion dollar industry in NH.

What has been done
1)Research was initiated to further knowledge about root tolerance to extreme cold exposure. Much of this first season's work was in refining and repeating root sampling procedures and lab protocols to assure their reliability.
2)The effects of three production methods: below ground fabric container (FC), pot in pot(PiP) and field grown, for river birch trees Half of the trees for each treatment were root pruned before transplant.

Results
1)Four species of nursery-grown shrubs were sampled and run through the programmed freeze treatments during the course of the winter. A significant quadratic relationship between electrolyte leakage and minimum temperature exposure for most species. Multiple tests per species over three years of experimentation to determine a cold tolerance threshold (based on 50% damage) for each plant, that can be used by growers for making crop protection decisions.
2) Evaluation continued on three different nursery production methods and consequence of root pruning at transplant. All trees were able to establish new roots, with a mean north- south spread of 11.7' for PiP, 12.1' for FC and 13.3' for field-grown trees, which corresponded with total stem caliper increases of 2.0, 2.7 and 3.7" respectively. These differences were correlated with initial tree size (field-grown trees were largest and PiP smallest at transplanting). The strong radial

distribution of structural roots observed in field-grown trees is purported to be the best structure for long term tree health. Root pruning to remove defects in PiP trees at transplanting was successful and no additional defects were observed at the termination of this experiment. The FC trees generally had good root structure but some new roots grew inward or tangentially to the original rootball.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems

Outcome #3

1. Outcome Measures

Availability of new management guidelines for use of controlled-release fertilizers in greenhouse floriculture.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Common practice with most greenhouse crops is to fertilize with a water-soluble fertilizer on a constant or near constant basis. Although relatively easy to manage their use can be very wasteful unless runoff is captured and reused. Controlled-release fertilizers (CRF) have been shown to reduce the amount of nutrients being lost to leaching and therefore the reducing fertilizer cost.Recent technology advancements have allowed fertilizer manufactures more precisely deliver nutrients due to altering coatings, and the decrease the individual granule sizes of CRFs. These advancements have made CRFs a more viable option for greenhouse crops.

What has been done
Over the course of this project the growth of bedding plants such as geraniums, poinsettias, cyclamen, gerbera, and begonias have been tested using controlled release fertilizers (CRFs). Nutrient analysis was conducted of effluent from pots to determine if less fertilizer is wasted by leaching when controlled release fertilizers are used. Finally pH and electrical conductivity of the substrate was monitored to evaluate the effects of controlled released fertilizers on these parameters.

Results
All species have shown to respond favorably to being grown using controlled release fertilizers.In all cases the amount of fertilizer lost due to leaching was significantly lower than that of plants grown with the typical constant liquid feed regime used in most commercial greenhouse. Additionally the cost of fertilizing plants with controlled release fertilizers was one-third that of constant liquid feed; $1.00 per 100 pots using controlled release fertilizers verses $3.25 per 100 pots using constant liquid feed The electrical conductivity was observed to be 10 fold lower when controlled release fertilizers are used. This indicates that plants are using released nutrients nearly at the same rate of release from the fertilizer and implies lower amounts of nutrients being loss to leaching.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
133	Pollution Prevention and Mitigation
205	Plant Management Systems

Outcome #4

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 Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
To be effective, local state and federal agencies and non-profit organizations need to be able to identify, characterize, and communicate with all stakeholder groups of a specific program or policy.

What has been done
An intercept survey/interview was conducted for the New Hampshire Seacoast Advisory Committee. This survey, previously conduced in 1996 with pencil and paper, was carried out in

2014 using iPads. The effectiveness of digital data collection was evaluated.

Results
1.The intercept survey/interview found that visitors were generally satisfied with both the quantity of parking available and the price charged for parking. The intercept survey did show that parking was more of a problem in Portsmouth and Jenness Beach sub-areas. Likewise visitors to those same two areas were more likely to negatively evaluate the available and cleanliness of public restroom facilities (another topic identified as extremely important by the Advisory Committee). This research documented that iPads were a cost effective data collection tool. A total of 3031 iPad intercept interviews were completed via an off-line application developed by Qualtrics. The interviews were collected at nine sampling sites, on 3 sampling days and at 3 sampling times. The average interview time was 10 minutes which was essentially the same as the pen and paper surveys. However the iPad offline application eliminated the data entry step of the process since the data was uploaded directly from the iPads to the data base once the iPads were connected to the internet.
Another time and cost saving step of this research design is the technological integration of the iPad Intercept Interview with the Web-based Follow up Survey. However the percentage of those who agreed to follow-up surveys decreased significantly, from 51 percent to 5 percent from the more expensive mail followup survey conducted in 1996 to the email survey in 2014.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development

Outcome #5

1. Outcome Measures

To assess emerging opportunities for expanding local agriculture in Northern New England

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The focus this project is to assess the potential for local agriculture in northern New England. This requires a better understanding of production potential, consumer demand and willingness to pay a premium for local produce.

What has been done
An integrated supply-demand approach was used to both assess the potential for producing more locally demanded products and the premium the region's residents are willing to pay. The approach involved farmers via focus groups and extension outreach, and general population surveys.

Results
Survey respondents spend an average of 21 % of their grocery budget on fresh produce, primarily at the grocery store both for the year and during the growing season. Almost all have purchased local fresh produce in the past year. During the growing season some respondents changed their primary source of fresh produce from the grocery store to farmers markets or directly from producer. There may be more concern for supporting local business and not as much concern about purchasing organic, consistent with other studies. The top reasons respondents purchase local fresh produce are concern for healthy eating, quality of the produce, and to support local farms. Receiving information about where to purchase local fresh produce through word of mouth, lack of information as a reason for not purchasing local fresh produce, and the perceived lack of availability of local fresh produce may explain why more people are not using farmers markets and direct from producer sources.or the three crops studied, premiums per pound estimated indicate different demand curves for local/organic than for conventional produce. Consumers in the study are willing to pay approximately 35 percent more for local green beans and snap peas and 55 percent more for local cucumbers. Organic premiums were lower, approximately 30 percent and 25 percent, respectively, for green beans and cucumbers, indicating that consumers value "local" more than "organic," and gives important price information to producers which they can weigh against their production costs in deciding what and how much to produce.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

The Great Recession (2006-2009) brought the collapse of the stock market, high foreclosure rates, falling housing prices, rising unemployment and unexpected downturns in migration and fertility rates. All of these factors have had distinctive impacts on rural communities, as compared to urban population centers.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The primary evaluation of research and integrated projects in planned program area come from a robust record of publication in peer-reviewed publications, popularity of workshops, response to surveys , and the utilization of results by popular media and government agencies. By all of these criteria, the research covered by this planned program area appears to be successful.

Key Items of Evaluation

- Demographic studies by Ken Johnson of the Carsey Institute are supported by a multi-state project. In the past year he has discussed recent demographic trends and the impact of the recession of these demographic trends in rural America, in the state of New Hampshire and in the U.S. There have been more than 1,000 media mentions of these demographic studies in the last year, including major national outlets such as the New York Times, Wall Street Journal, Washington Post and USA today.
- Applying controlled release fertilizer to production of greenhouse bedding plants reduces fertilizer cost by 70 percent, while decreasing the release of nutrients in runoff by approximately ten fold compared to liquid fertilizer. These new recommendations for improved bedding plant fertilizers have been widely disseminated to growers and greenhouse managers.

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Sustaining Natural Resources

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships			14%	
112	Watershed Protection and Management			39%	
133	Pollution Prevention and Mitigation			4%	
403	Waste Disposal, Recycling, and Reuse			6%	
511	New and Improved Non-Food Products and Processes			4%	
608	Community Resource Planning and Development			13%	
901	Program and Project Design, and Statistics			10%	
903	Communication, Education, and Information Delivery			10%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
Actual Paid	0.0	0.0	1.9	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**
0	0	76286	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	129751	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

• Students conducted interviews of tourists about their experience in the tourist corridor of Rockingham County. Results were used by the Regional Planning Commission, NH State Park and NH Department of transportation
• Stable isotopes of nitrate were used to examine timing of storm exports of different sources in river cachement.
• A method was tested to recycle excess nitrogen from the Great Bay Estuary by using eelgrass wrack as animal bedding.

2. Brief description of the target audience

Target audiences for the research projects covered by this planned program include: resource managers, farmers and land owners as well as the general public in the Great Bay Estuary watershed, UNH graduate and undergraduate students, as well as state and local government officials, town councilors, watershed associations, farmers, school children, families, and citizens interested in watershed health.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	93	5000	0	0

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

Patent Applications Submitted

Year: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	0	7	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Undergraduates who participated in research.

Year	Actual
2014	20

Output #2

Output Measure

- Number of graduate students directly involved in research projects.

Year	Actual
2014	3

Output #3

Output Measure

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

Year	Actual
2014	4

Output #4

Output Measure

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

Year	Actual
2014	5

Output #5

Output Measure

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

Year	Actual
2014	8

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	A spatially distributed river network model for the Great Bay watershed that relative land use sources and sinks for N, P and C.
2	Is it possible to remove nitrogen from the Great Bay Estuary by removing eelgrass wrack to be used as animal bedding, and subsequently for organic enrichment of soils?

Outcome #1

1. Outcome Measures

A spatially distributed river network model for the Great Bay watershed that relative land use sources and sinks for N, P and C.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Seven rivers drain a mixed landscape of agricultural, forested and suburban land into New Hampshire's Great Bay Estuary. Development in the region have resulted in eutrophication of the Estuary and the decline of this ecosystem. The Environmental Protection Agency has mandated that communities improve sewage waste treatment. However, this will go only part way to restoring the health of the estuary. Municipalities and regulatory agencies critically need additional information about nonpoint sources are contributing to eutrophication.

What has been done
1)Sensor networks were installed along portions of the Lamprey designed to quantify the amount and stoichiometry of C, N, and P in the mainstem or trunk of the Lamprey River during base flow and during storms, and compare with headwater storm events to determine changes due to river network biogeochemical processes or unaccounted for sources. 2)Synoptic surveys throughout 2013 and 2014 were conducted to quantify N concentrations in a variety of catchments.

Results
1)Nitrate exports from agricultural lands are more responsive per unit storm runoff than suburban lands. Agricultural lands have higher nitrogen, but lower chloride than suburban lands. Chloride is elevated in areas with impervious surfaces due to road salt applications. 2) Dissolved organic nitrogen exports were higher in suburban (62-93 kgN/km2) than agricultural land (42 kg/km2) and forest (44 kg/km2), so that total nitrogen fluxes from agricultural catchments are lower than from urban catchments.Land cover alone cannot explain much of the variation across a wide range of agricultural and suburban land. Land management practices also are likely significant while the distribution of land use within the catchment, relative to streams, also may be important.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management

Outcome #2

1. Outcome Measures

Is it possible to remove nitrogen from the Great Bay Estuary by removing eelgrass wrack to be used as animal bedding, and subsequently for organic enrichment of soils?

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There is too much nitrogen in Great Bay Estuary. Current approaches to reversing this problem included expensive upgrades to sewage treatment, but there are still high levels of N in the Bay's sediment. Is it possible to remediate N already in the Great Bay by repurposing eelgrass wrack as animal bedding?

What has been done
Eelgrass was collected, dried, and delivered to Tuckaway Farm in Lee, NH.

Results
The dried eelgrass proved successful as bedding for horses. Based on chemical analysis of the dried eelgrass, it will be possible to calculate the potential nitrogen removal from the estuary.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
403	Waste Disposal, Recycling, and Reuse
903	Communication, Education, and Information Delivery

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Other (developing animal care plan acceptable for UNH Institutional Animal Care and Use Committee)

Brief Explanation

The initial funding of the project # 228521 was delayed by almost a year and caused a year's delay in initiation of project activities.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The key measures for evaluation of the research in this planned area include the presentation of results in national conferences and to stakeholder groups as well as publication in peer-reviewed journals. The projects covered in Sustaining Natural Resources met these criteria with strong engagement with stakeholders, a significant number of presentations at national and international conferences, and a robust publication record.

Key Items of Evaluation

NHAES research is making significant contributions to the knowledge base needed to target efforts to on non-point sources of N loading in New Hampshire's Great Bay Watershed.

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
	Number of children and youth who reported eating more of healthy foods.
Climate Change (Outcome 1, Indicator 4)	
	Number of new crop varieties, animal breeds, and genotypes whit climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
	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)	
	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
	Number of viable technologies developed or modified for the detection and
Sustainable Energy (Outcome 3, Indicator 2)	
	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
	Tons of feedstocks delivered.